Long Term Care Covid-19 Commission Mtg.

Professor Siegel
on Monday, February 1, 2021

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MEETING OF THE LONG-TERM CARE COVID-19 COMMISSION

--- Held via Zoom, with all participants attending remotely, on the 1st day of February, 2021, 2:00 p.m. to 3:13 p.m.

BEFORE:

The Honourable Frank N. Marrocco, Lead Commissioner
Angela Coke, Commissioner
Dr. Jack Kitts, Commissioner

PRESENTER:

Jeffery Siegel, Ph.D., Professor, Department of Civil and Mineral Engineering, University of Toronto;

PARTICIPANTS:

Alison Drummond, Assistant Deputy Minister, Long-Term Care Commission Secretariat;
Ida Bianchi, Senior Legal Counsel, Long-Term Care Commission Secretariat;
Adriana Diaz Choconta, Senior Policy Analyst, Long-Term Care Commission Secretariat;
Angela Walwyn, Senior Policy Analyst, Long-Term Care Commission Secretariat;
Lynn Mahoney, Counsel, Gowling WLG;
Patricia Brooks, Counsel, Gowling WLG;

ALSO PRESENT:

Carissa Stabbler, Stenographer/Transcriptionist

-- Upon commencing at 2:00 p.m.

COMMISSIONER JACK KITTS: I'm here with the second Commissioner, Angela Coke, and we're here to listen to what you have to say. I understand Ida is going to work with you on that, so --

IDA BIANCHI: Sure. And also, Patti Brooks, who was very helpful on getting Dr. Siegel here.

Patti, you can put yourself on the screen, please.

Good afternoon, Commissioners. You've had a chance to exchange some pleasantries with Dr. Siegel. I will tell you that he's a professor in the Department of Civil & Mineral Engineering at U of T, and he also has appointments at The Dalla Lana School of Public Health and the Department of Physical & Environmental Sciences.

He's here to talk to you today about the role of heating, ventilation, and air conditioning in the management and/spread of infectious disease. Obviously heating, ventilation, and air conditioning is typically known as HVAC, so we'll be using that acronym

throughout the presentation.

And, Dr. Siegel, I'm going to turn it over to you now to start. And I'll just let you know that I or Patti or one of the Commissioners may ask you questions as you proceed if we think something needs to be clarified. So please proceed.

DR. JEFFREY SIEGEL: Absolutely.

IDA BIANCHI: Thank you.

DR. JEFFREY SIEGEL: First and most important question is can people see the slide? Okay, the title slide.

IDA BIANCHI: Yeah.

DR. JEFFREY SIEGEL: Excellent. Good. Okay. So first of all, I want to say thanks for inviting me here. I think throughout this pandemic, HVAC systems have been completely neglected, and they're potentially important in some buildings at some times.

And I'm really grateful for the opportunity to talk about them and also hope that the Commission's kind of engagement with this topic continues. And you should think about inviting others, for example, those that actually manage these systems, the men and women who manage these

systems in LTC facilities.

So if I think about the starting point -- and I've structured this presentation to address the questions that I got beforehand, and hopefully there be will be more questions as we go through this, but I think the very starting point here is, you know, we don't really know how much of a role HVAC systems have played in individual outbreaks or generally in the problem of disease spread.

My speculation is that HVAC systems are sometimes important, but they're very rarely, if at all, the most important factor. So they're one of the many kind of things that add to the mix.

But even if they're not the most important factor, I want to point out that the opposite is probably relevant too: That we have a lot of opportunity with our existing as well as with potential enhancements to HVAC systems to stop the spread of or limit the spread of this respiratory disease as well as other respiratory infectious diseases that we worry about in LTC facilities.

The other comment I have to make is that, you know, I've looked quite hard, and I have

not seen data about the state of what the HVAC systems are, how they work, how well they're working in LTC facilities. And my guess based on what I see in other buildings is that there are probably some pretty large failures.

And I would think that one of the things I hope to leave you with in this presentation is point out just kind of how bad the overall state of HVAC is in many of our buildings and how that might translate to opportunities for improving that in long-term care homes.

And in particular --

IDA BIANCHI: Dr. Siegel, it looks like Dr. Kitts has a question for you.

COMMISSIONER JACK KITTS: Just a question that was a bit of a mind-bender for me, that they're rarely the most important factor in spread, but they're very important factor in reducing spread.

Is that -- can you just tell me why they're not such an important factor in allowing spread or creating --

DR. JEFFREY SIEGEL: So I think that it's more the case that there are other factors that are more important.

So as an example, an HVAC system can't do anything about close-contact transmission of the disease; right? And so I think that what we know about this disease is that a lot of the transmission is happening because of close contact, and so limiting close contact or controlling the potential for an infected person to have close contact is probably quite important in a lot of the outbreaks that we're looking at. But, of course, that has nothing to do with the HVAC.

But the flip side of that is that I'm not saying it is the case that they could be helpful in control, but there is a lot of potential that is unrealized in using HVAC systems to limit control. And so that's where that comes from.

COMMISSIONER JACK KITTS: Unrealized and (INAUDIBLE). Is that the problem? It's unproven?

THE WITNESS: It depends on what your standard for proof is. If your standard for proof is SARS-CoV-2, infectious SARS-CoV-2, yes, definitely unproven. If your standard is other respiratory diseases, there's a lot more proof out there.

COMMISSIONER JACK KITTS: Okay,

respiratory. Okay. Thank you.

DR. JEFFREY SIEGEL: And --

COMMISSIONER JACK KITTS: Commissioner Coke?

COMMISSIONER ANGELA COKE: I was just trying to clarify something you said before. If I'm understanding this right, you're -- not necessarily know the state of HVAC in long-term care homes, but are you saying that generally speaking, a lot of HVAC systems in a lot of buildings are not what they should be?

DR. JEFFREY SIEGEL: Absolutely.

COMMISSIONER ANGELA COKE: Did I interpret that right?

DR. JEFFREY SIEGEL: 100 percent.

COMMISSIONER ANGELA COKE: Okay.

DR. JEFFREY SIEGEL: Yeah, you interpreted that very right. And I think most people would be surprised at how bad HVAC systems are in our buildings.

COMMISSIONER ANGELA COKE: Okay. And given that the long-term care homes, a lot of them are very old buildings, one might deduce from that that they're probably a problem?

DR. JEFFREY SIEGEL: Absolutely right,

yes.

COMMISSIONER ANGELA COKE: Okay.

DR. JEFFREY SIEGEL: Yeah. And towards the end of the presentation, I'll talk about what I think are some opportunities, but the bottom bullet point here is I have seen no data collected on any outbreak anywhere, including in long-term care homes, that does any amount of characterization of the building or of the HVAC system in that facility.

And so right now, we're not only at the place where we can't evaluate causation. We can't even evaluate correlation. That is to say we don't even know what factors were there.

And that's a problem in all facilities, but I think in long-term care facilities where we've seen, you know, obviously some very devastating outbreaks, the fact that we haven't collected building-level data is a real concern.

So these are the kind of big-picture questions that I was presented with ahead of time that I'll be addressing. I want to spend just what I hope will be two or three minutes kind of doing the very background about indoor air quality.

Hopefully the only acronyms I'll use

are indoor air quality and HVAC. And I just want to give a very high-level view of those systems so that we're all kind of on the same page when we talk about them.

Then I'll take that baseline and talk about what we know about from the evidence basis of the role of ventilation facilitation in both general respiratory infectious disease but also for COVID-19 specifically.

I already told you that very little is known about the state of ventilation and filtration in long-term care homes, but I'll say a few more things specifically about it. And then where I hope I'll be spending most of my time is what I think are specific recommendations about improving the situation.

And some more questions came in earlier this afternoon, and I'll either integrate those in, or hopefully they'll be asked as I go through.

So if I want to start with the kind of very brief history of indoor air quality, to my knowledge, it starts a few thousand years ago. There is a section of Leviticus in the Bible, and in fact, in most religious texts, there's something similar about what to do when your home has a

moisture problem.

And to save you reading through all this, if your home has a moisture problem, you first get rid of the building materials that are moisture damaged. And if that doesn't work, you get the priest in to say a blessing. And if that doesn't work to get rid of the moisture problem, you get rid of the building.

And that's pretty much what we do now. We don't use priests; we use mould remediators. But to my knowledge, this is kind of some of the earliest written material on indoor air quality.

If we fast-forward to maybe a couple hundred years ago or so, there started to be some activity in the area of indoor air quality. So Dr. Pettenkofer was kind of the great grandfather of the modern study of indoor air quality.

And he has a lot of hippie statements, like the quote here saying, you know, if you've got the odour of manure in the space, get rid of the source of the problem. Don't try and ventilate your way out of the problem. And that's still true today.

And then Harriet Beecher Stowe, who was a prominent abolitionist but also who wrote

extensively about the domestic realm, and she has wonderful writings about the domestic realm. Her most famous book has two chapters devoted to indoor air quality, one solely to ventilation and one devoted to health.

And, you know, the quote here acknowledges that we knew, you know, 150 years ago that, you know, good indoor air quality is essential to our buildings.

And what we've learned in the next 150 years through a variety of research is that indoor air quality has a variety of impacts on chronic and acute health outcomes, and the list is very, very long here.

And I will also add that for almost everywhere on the globe, including in Canada, our biggest environmental health risk comes from the things we breathe and indoor air.

And one other point about indoor air quality -- or maybe two other points: First is that it's completely unregulated. You will not find almost anywhere in the world, but certainly in Canada, almost any regulations at all that address indoor air quality, and there's a variety of political reasons for that.

But the comment about indoor air quality, and I think this is maybe something we've learned a lot more about in the past few decades, is that poor indoor air quality, the health effects accrue disproportionately to vulnerable parts of the populations.

And I mention that explicitly because part of what is going on, in my opinion, in long-term care homes is that we are seeing a vulnerable population that is -- you know, already has existing health issues that are exacerbated by, in this case, infectious disease spread, but more generally by indoor air quality concerns.

COMMISSIONER JACK KITTS: Is there any regulations for indoor air quality in hospitals or parts of hospitals or in airplanes?

DR. JEFFREY SIEGEL: Short answer to those things is -- well, airplanes, no. Hospitals, there's not per se indoor air quality regulations. There often are ventilation regulations, which are a proxy for indoor air, and occasionally there are infection control regulations that include an airborne component.

But there is not -- it turns out it's a very complicated business to regulate indoor air,

and it's not done, like I said, almost anywhere in the world.

COMMISSIONER JACK KITTS: So what they're looking at is the process by which you're supposed to keep the air fresh as opposed to what the actual freshness of the air is?

DR. JEFFREY SIEGEL: That is absolutely correct, yes. And not only that. The regulations that exist are typically for something called acceptable indoor air quality, which roughly has a definition of 80 percent of the people will perceive the air quality to be acceptable.

It doesn't have anything to do with the actual health effects of that indoor air.

COMMISSIONER JACK KITTS: Thank you.

PATTI BROOKS: And, Jeff, just another question: Is that -- for hospitals, is that like a Building Code issue, or is that ongoing? Because at the time of build or --

DR. JEFFREY SIEGEL: So the hospital certification process usually includes an ongoing process where it is maintained, but the original regulations are at the time of construction.

And that's a problem for all ventilation codes, is that if you look at the

history of -- pick your favourite ventilation code. Mine is ASHRAE Standard 62.1. If you look at the standard, the actual ventilation rates that are required in different spaces have varied by roughly a factor of 4 from the highest to the lowest point over the past 50 years or so.

And so there are variations over time, and most codes do not grandfather that in. Sometimes for health care facilities there are certification requirements that require you to maintain the current standard.

IDA BIANCHI: And how would you maintain a current standard of indoor air quality? Like, what are the mechanisms that enable you to do that?

DR. JEFFREY SIEGEL: Yeah, so almost always it's filtration -- excuse me, ventilation based, and so that means that you have to verify that the amount of outdoor air that is coming in to each space demonstrates that it meets whatever the minimum is in the standard. That's the usual.

We've already used the term HVAC systems, and so, of course, I have to show a picture. And this is kind of the classic picture of an HVAC system. It doesn't turn out to be that

useful of a picture, but it does have a little bit of utility for a second here.

So fundamentally, what an HVAC system does is it takes air including air from outside, and usually there will be a filter or something to do a little bit of treatment of that air. And then the HVAC system heats and cools that air.

Sometimes there's humidity control components to it. Often there's pressure and airflow control, and it's -- distributes that conditioned air to the space.

Many HVAC systems also take air from the space and either exhaust it to the outside or recirculate it in the space. And so that's kind of the fundamental schematic. I mean, fundamentally, it's heating, cooling, and treating the air.

The problem with that definition is that very few HVAC systems look nice and neat like this schematic. Some of the important things are -- is that there's often a distribution system to get that conditioned air to different parts of the building.

There is many controls. So we're all probably familiar with the idea of a thermostat that controls how much hot air is delivered to the

space, but there are many, many controls in a typical HVAC system.

There are various safety measures. There might be humidity control. There can be a whole host of other things, how much outdoor air is coming in. So there's a lot of control systems that are layered on top of this.

And HVAC systems are very dynamic. Like, even in my house, which has the simplest possible forced-air system, how it performs at any one minute might be very different from how it performs the next minute. And there's a variety of reasons for that, but the operation is very temporally dynamic.

And then the last comment is perhaps the most important one here: No two HVAC systems look the same, perform the same, even if they were built by the same builder at the same time and have been similarly maintained. Differences kind of occur right at the start and accrue over time.

And so one of the challenges with trying to do anything with HVAC systems is that the language becomes very hard to define things specifically because it might look completely different in any two buildings, even theoretically

very similar systems.

And I want to make two very important points that I'm going to distill down to one point. I think if we think about HVAC systems, if you don't kind of spend your life thinking about them, you know, you might think that these are -- you know, they're certainly very expensive.

A typical commercial building, depending on its function, is spending anywhere between about 20 and 60 percent of the capital costs of construction is involved in the mechanical and the electrical systems in the building. So they're very expensive.

You would assume they're carefully designed, they are there to provide comfort and good indoor air quality, and they're operated well. And that's just completely wrong.

The actual scenario in almost all of our buildings is the HVAC system is designed often by the installer using what are, bluntly, rules of thumb: How much floor area, okay, that's what size of heating and air conditioning system I put in.

You know, they were designed obviously at the time that the building was constructed, which is very different often than now. They were

installed by the person who could do it the cheapest, and they have been probably systematically neglected in terms of their maintenance. And so the usual is to have substantial control and operation failures.

IDA BIANCHI: So, Dr. Siegel, when you say they were designed using rules of thumb, are you saying that there isn't something in -- there wouldn't have been something in the existing Building Code that tells the installer or the designer of the building what kind of system needs to go in there?

DR. JEFFREY SIEGEL: In short, yes, that's -- what you said is absolutely true. In reality, there's often things like you have to be able to meet certain temperatures. You have to obviously comply with mechanical codes, which are mostly about safety of the equipment and --

IDA BIANCHI: And not about quality of the air?

DR. JEFFREY SIEGEL: Correct.

IDA BIANCHI: Okay.

DR. JEFFREY SIEGEL: Yes.

IDA BIANCHI: Got it.

DR. JEFFREY SIEGEL: And I mean, I

don't want to spend a ton of time here, but I think it's worth mentioning, you know, most people think that a filter is in a system to protect the quality of the air and the people in the building. A filter has nothing to do with that.

The reason we use filters in our HVAC systems is to stop big things from getting into our fans and our cooling coils. They serve a system protection function, not a people protection function. They can serve a people protection function, but that's not what they were designed to do, and that's not often with some amount of modification.

And so even this fundamental idea of, oh, this is the system that's supposed to provide me with clean, healthy air, I think that that's more or less a coincidence most of the time if it does do that.

So just to give a little illustration of that, this is a commercial rooftop HVAC system. I'm sure that there are many of these in some types of long-term care homes. This happens to be a big box retail store, but you see these same sorts of things.

And I wanted to show you this picture

because this unit has all of the functions that I just described: Heating, cooling, ventilation kind of all in one unit, and it's distributed to a part of the store. And you might already see where I'm going with this.

This is with the access door to the unit open, and what's inside that unit is a filter that's about 2 metres long and has a rigid, thick metal frame. And so the filter in this door can never be changed because it can't be removed because as you slide it out, it hits the roof parapet.

And this happened because this particular unit was installed 180 degrees from how it was supposed to be installed. And this is what I mean by gross failure, that, you know, you can't even maintain the most basic aspect of this system because it was designed and installed -- or it was installed incorrectly.

Another example that's also probably highly relevant to long-term care homes: This is a filter rack, again, in a commercial building. And if you're in a long-term care home that has a mechanical room, there's probably a filter rack that looks something like this inside of it.

And you can see in that filter that's closest to the front on the lower side, it's pulling out of the rack. And so obviously the air is going around that filter, not through that filter.

And so this is the type of kind of big-picture failure that we see in all HVAC systems. And so our challenge here if we want to use these systems to improve the situation in long-term care homes is that at least some of what we need to do is address these gross failures.

So if we move on kind of more specifically to COVID-19, I want to start by saying there, to my knowledge, are no investigations that establish causality between an HVAC system and either the spread of the disease or a reduction in rate of transmission of the disease.

And I think that's important, but there aren't studies that prove that there's no effect either. There just hasn't been the studies that have been done.

What there are at this point is about a dozen, maybe more, articles in the literature that are of the ilk of what I cite here. This is the first one, to my knowledge, that was published

early last year.

And this was in a restaurant in Guangzhou in China. And basically, because of the HVAC system, more the airflow caused by the HVAC system in this place, an infected individual spread the disease to those downwind of them inside of the building.

And like I said, there are about a dozen articles like this in the literature at this point where, you know, it's not causal, but there is a plausible physical explanation where the operation of an HVAC system led to the transmission of the disease in an indoor space.

The other comment I'll make about this particular example -- it's been cited so widely in the media that I'm sure many of you have seen it before, but that this points out just kind of how important air movement is in the space.

And that's not something that's addressed by any mechanical code, to my knowledge, anywhere in any type of building; right?

So you can have air travel from, let's say, a supply register supplying air from the HVAC system through a room to a return register, and if that airflow caused by the HVAC system passes by an

infected person, it has the potential to carry that disease to those downstream.

And so part of what we're dealing with here is this idea of kind of air movement caused by the HVAC system that, again, has been implicated in some of these case studies that are in the literature.

The best evidence we have that ventilation can make a difference is this review article from about 15 years ago by Yuguo Li and his colleagues.

And what they did is they looked at about 40 different articles that met certain quality control criteria that looked at what the association was between ventilation and a variety of infectious diseases that are listed in a couple of sentences I took from the abstract here.

This was obviously before SARS-CoV-2, but it was after what we now call SARS-1, and at least a couple of the articles dealt with SARS-1 included in this review.

And there were two really important findings from this review. Number one is that ventilation, especially low ventilation is associated with the spread of infectious disease

indoors; and number two, that we don't yet have the ability to set kind of safe ventilation levels for any infectious disease, let alone something relatively new like SARS-CoV-2.

And so all we know right now is that the more ventilation the better, number one, and number two, that we don't -- we can't set a safe level of ventilation.

IDA BIANCHI: Dr. Siegel, so you say there's insufficient data to specify and quantify the minimum ventilation requirements. Could you design a study or a project to determine that, or is that just indeterminable?

DR. JEFFREY SIEGEL: I could certainly design a study to do that. I'm not sure I would get review board approval to conduct that study. And there have been studies done with animals.

But, yes, it's very feasible to envision that study, given the resources. Most of our studies of ventilation, in fact almost everything in this review paper -- I'm trying to think back, but anyway, much of what's in this review paper are observational.

You know, we change the ventilation rate, and we saw a change in the disease

transmission rate. But it would be a great idea to do much more systematic, controlled research.

IDA BIANCHI: So if you couldn't do that, and you have evidence for the proposition that good ventilation is associated with a reduction in the spread of disease, is there some kind of maximum ventilation that you -- like, apart from open windows, but through the HVAC system, is there a certain way of designing your HVAC to maximize ventilation?

DR. JEFFREY SIEGEL: Yeah, so you run into some practical limitations. The two big ones are money and energy costs.

But assuming that those aren't fundamental limitations, of course you can oversize a ventilation system so that you have the capacity to increase ventilation. And that's done in some buildings. So, for example, a hospital operating room has a much higher ventilation rate than a school.

And so it's possible to do it. It's just a question of money.

IDA BIANCHI: So the bigger the ventilation the more expensive it is?

DR. JEFFREY SIEGEL: Yes, and the

more --

IDA BIANCHI: (INAUDIBLE).

DR. JEFFREY SIEGEL: -- ongoing cost as well, yeah.

IDA BIANCHI: Sorry. But in a space such as an operating room where it's very important to minimize the spread of infection, hospitals do invest in big ventilation in those spaces?

DR. JEFFREY SIEGEL: Absolutely, yes.

IDA BIANCHI: Okay.

DR. JEFFREY SIEGEL: And in fact, that's been another point of confusion that maybe I'll just mention now because -- in response to your question.

Early on when there was much more of a debate about whether COVID-19 could be airborne or not, one of the things I think we were seeing is people were saying, well, in health care facilities we're not seeing health care workers get this disease at a rate that's consistent with what we would expect if it were airborne.

And I think the problem with that is that hospitals do by and large have excellent ventilation and excellent air cleaning. And so you can't then take that finding and say, well, you

know, it's not airborne because in a typical building, we're dealing with much, much worse ventilation.

And I think that that's really an important point, is that you can't extrapolate from -- you know, a hospital is the one -- I mean, you talk to people who work in hospitals, and they'll complain about the HVAC system just like we all complain about how cold it is in our offices or whatever.

They'll do the same thing, but the reality is it's just, you know, there's an on-site staff who's dealing with problems. There's a ton of capacity. There is attention paid to infection control. And none of those things are true in nonhospital environments.

IDA BIANCHI: Okay. Thank you.

DR. JEFFREY SIEGEL: So this is a graphic that one of my students came up with for a proposal, and it makes a point that I want to make that I think is going to show up a little bit later in terms of practical recommendations.

This is a commercial office building. I'll show you a residential building, a similar graphic, in a second. But the point that this

makes is if you have infected individuals, who are shown here in yellow, depending on the airflow path in the space, you know, the air can potentially pass by those infected individuals and enter into the breathing area of uninfected individuals.

And in a typical building, many of those airflows are caused by the HVAC system. And so one of the ways, and this is the way that shows up most in the literature, that HVAC systems are implicated in spread is this problem of air movement.

So I've taken to not just referring to ventilation but referring to ventilation and air movement together because they're both important pieces of the puzzle.

If you think about a multifamily residential building where, you know, there starts to be so many things going on, I think people kind of undervalue how complex many of our buildings are. So you have things likes toilets flushing, you have open windows, you've got airflow paths that might go directly between living areas, they might go into a corridor and then into someone else's living area.

And so if you think about a long-term

care home, I guess I would encourage you to think about it as an interconnected network of airflows. And if there are infected individuals, those airflows can contain the SARS-CoV-2 virus.

And you know, how important it is to disease spread is going to depend a lot on the details of the building. But I would encourage you to, for example, look at a famous case, Building E in Amoy Gardens, which was an apartment building in Hong Kong.

And during SARS-1, a single index patient spread SARS-1 to 200 other people living in the apartment building because of this kind of complicated airflow network that exists.

And so this gets back to something I said much earlier. You know, it's not always the case that the HVAC system is important or that the building factors are important, but they certainly can be historically when we look at cases.

So if we move from ventilation to filtration, there's frankly much less evidence that filtration can be effective for infectious disease reduction.

But I will comment that there's a lot of kind of associative evidence, where that is to

say we know the particle size that's associated with a respiratory infectious disease-containing droplet or particle, and we know the efficiency of the filter, so we can infer that filters are effective. But there is less direct evidence.

The kinds of direct evidence that are out there are kind of summarized in the two articles I have here. The article on the left looks at tuberculosis, control of different ventilation and filtration options, and it is a good example of kind of what I would classify as chamber tests.

So this wasn't direct research on filtration, but it was research on relevant particles in a chamber that then could be scaled up to other environments.

The paper on the right addresses the flu virus particularly, and it looks at -- uses modelling to determine what the impact of different portable air cleaners would be on the spread of the flu virus in residential settings.

And I would say that most of our evidence, maybe even all of our evidence on the role of filtration in infectious disease either comes from chamber tests, like the ones on the

left, or from modelling, like the case on the right, and we really don't have a lot of direct evidence. Even though I think it's very likely that they are effective, we don't have direct evidence.

An example of more direct evidence -- this is a paper I was involved with. It's in review right now. This is a home in Austin, Texas, and there are two residents of this home: A mother and her 2-year-old daughter.

They both tested positive for COVID, and the samples that we took were 30 to 60 days after symptom resolution in both of those individuals.

And what you see here are we did various kinds of dust and swab sampling. And if you see a red symbol, it means we found the SARS-CoV-2 RNA, and the size of that sample corresponds with how much of the RNA we found in that sample.

And the whole reason I show you this picture is because of the big circle and square that are in the lower left -- I'm not sure if I have a pointer, but if I do, I'm pointing at it -- and that is on the HVAC filter in this home. It

was a very low-efficiency filter, but we got very high signals of the RNA there.

And I want to make a -- go ahead.

IDA BIANCHI: No, sorry, go ahead. You finish.

DR. JEFFREY SIEGEL: I was just going to say, I want to make a comment: We weren't measuring infectivity, and nothing was infective, I think, after 30 to 60 days. But the point is the RNA spreads everywhere in a typical indoor environment.

Go ahead.

IDA BIANCHI: And can I ask you, is it the MERV 13 filters that are used in long-term care?

DR. JEFFREY SIEGEL: I bet that that's not the case universally. MERV 13 is the recommendation from ASHRAE of the filtration level that is appropriate for controlling the spread of the disease.

IDA BIANCHI: And can you tell me why the MERV 13 would be more superior than something you would find in this -- for example, this home in Texas?

DR. JEFFREY SIEGEL: Okay. Yeah, so --

okay, so the MERV is the output of an ASHRAE standard, specifically ASHRAE Standard 52.2 where --

IDA BIANCHI: Oh, can I interject here and just ask you to tell the Commissioners what ASHRAE stands for?

DR. JEFFREY SIEGEL: Absolutely, yes. Thank you. ASHRAE is the American Society of Heating, Refrigerating and Air-Conditioning Engineers. They are the main professional society associated with HVAC systems.

They are active in the promulgation of standards. In fact, when I talk about ventilation standards, most of the standards that are relevant are ASHRAE standards as well as other standards having to do with other aspects of HVAC and refrigeration as well.

And so a MERV 13 filter, MERV is the main data output from this ASHRAE filtration test standard where a filter is tested under controlled conditions in a laboratory, and its efficiency is measured for different sized particles.

A MERV 13 filter, which is quite high on the MERV scale that goes from 1 to 16, a MERV 13 filter has an efficiency of at least 85 percent for

1 to 3 micron particles.

And so what that means practically is we think most of this disease transmission, at least in the longer airborne route, is happening between particles of that size range approximately.

So that means on a single pass through the filter, if everything is going the way it should, 85 percent of the disease-containing particles will be removed. By the time the second pass happens through that filter, it's more like 97 percent or so, and by the third pass, it's 99 percent and change have been removed.

So MERV 13 -- yeah, go ahead.

IDA BIANCHI: So MERV 13 -- MERV is the scale and --

DR. JEFFREY SIEGEL: Yes.

IDA BIANCHI: -- any filter -- like, the filter gets assessed against the scale, and so what you need is a filter that meets the MERV 13 to do what you just said it could.

DR. JEFFREY SIEGEL: Right.

IDA BIANCHI: And at what point do you need to change the filter? Is there -- like, is there a -- when does it stop being effective, in your opinion?

DR. JEFFREY SIEGEL: Okay. So you ask fantastic questions, and this is all what my research is based on, so apologies for a little bit of a long-winded answer, but I think it's important.

So two really important points before I directly answer your question: Number one is that filters perform very different in real life than they do in an ASHRAE filtration standard test. And a big issue is something I already showed you a picture of is bypass.

So if the filter is not sealed well, it doesn't matter that you have a MERV 13 filter if a lot of the air is not going through the filter. And bypass is the normal scenario.

And so a MERV 13 filter, that's how it performs when it's perfectly sealed. How it actually performs in real buildings, there isn't a ton of data out there. But what I and a small group of other people have collected suggest that almost always the filter performs much worse in real life, so that's issue number one.

Issue number two is, you know, how often do you change the filter. And, you know, the best answer I can give you is that depends, and

what it depends on is how dirty the air is that you're filtering.

And so if you, for example, live in a house with pets, and you have a forced-air system, you probably notice that even if you change your filter every month, it looks disgusting. It's covered with a thick layer of, you know, dog or cat fur or whatever.

If you live in an older home like I do, there's a lot of dust in general, so my filters get quite dirty. And so -- but that would be very different from someone who lives in a newer house that is well ventilated and doesn't have some of those indoor sources.

So there's no one answer about how frequently to change it. What I usually tell people is change it to what the manufacturer says. And different filters have different kind of capacities for how much dust they can hold, and so, you know, you might buy a very expensive filter that can last for six months. You might buy a much cheaper filter that can only last for one or two months.

IDA BIANCHI: And does ASHRAE put out any guidelines or help for people for specific

types of environments? Like, so does ASHRAE say, you should replace the filter every two months in a long-term care facility with 100 residents, for example?

DR. JEFFREY SIEGEL: They do not. And they've talked about it several times, and the short answer is it just depends on too many factors, and it depends on the filter itself too; right?

Keep in mind that, you know, some long-term care homes -- this is maybe a little bit of a dream, but let's say we go to a long-term care home. They have a beautiful filter with nice, thick, 6-inch thick filters that can really last a very long time. And, you know, it's not fair to tell them to change their filters every month because those filters are designed for six months of operation.

You could go to another long-term care home, and they have 1-inch thick filters that are supposed to be replaced every month. And you know, and so that's the problem is that there's not a lot of standardization in the industry --

IDA BIANCHI: Thank you, Dr. Siegel.

DR. JEFFREY SIEGEL: And the other

comment I wanted to make, which is really relevant to your question, is filters decline in performance as they age. And often, the high-efficiency filters decline even more in performance.

So what I mean by that is a typical MERV 13 filter of the kind that we would find installed in most long-term care homes that are using superior filtration are made of what's called meltblown media. It's the same stuff that's used in N95 masks and other PPE.

And it's given -- just like in masks, it's given a static electric charge in the factory that helps its removal efficiency. It helps particles be attracted to the filter.

What happens in real life is, of course, there's lot of charged particles and other things in the air, and so that electrostatic removal declines over time.

And there's lots of data in the literature from many groups and many types of buildings that show that a filter that's performing beautifully, let's say your MERV 13 filter when it's new; a few weeks later is performing much, much less; a few months later is performing, you know, horribly.

And even if it's a filter that's rated for a year of life or something else, by the time you're at nine months out in some buildings, not in all buildings, but in some buildings, it's essentially performing like a very, very low-efficiency filter.

And so another reason to change filters is because of that issue. And it's more of an issue in some buildings. It's certainly more of an issue with different types of filters, but it is a real issue.

IDA BIANCHI: Thank you, Dr. Siegel.

DR. JEFFREY SIEGEL: The other paper that's still in review from a group in Oregon looked at the presence of the SARS-CoV-2 RNA on filters in a hospital that had a small number of COVID-positive patients in the hospital.

And this hospital had a very good HVAC system, as is typical in hospitals. They had MERV 10 prefilters and MERV 15 final filters, so very high-efficiency filters. And they found the RNA present on many of the filters in the system.

Again, there's no comment about infectivity here. That's a whole different world. But the point is we do know that filters can remove

the virus because for this virus specifically as well as for a bunch of others in the literature, we find the virus or the biological signature of the virus on the filters.

So let's make this specific to long-term care homes. You know, what's the situation in long-term care homes? I don't know, and I think we don't know. And so I think that, you know, again, this is based a little bit on what I know about other buildings as well as looking very hard for the answer to this question.

I have seen nowhere in the world, let alone here in Ontario, where there has been any data published, even the most basic stuff: What types of filters are being used? You know, what are the ventilation systems? What are the components of the HVAC systems?

We don't know any. And I think that that really limits our ability to be able to do anything about the situation. So clearly we have some serious data needs.

IDA BIANCHI: And, Dr. Siegel, this may not be a fair question because we just sent you the Ministry's ten-point HVAC plan this morning, but have you had the opportunity to look at it?

DR. JEFFREY SIEGEL: I did look at it quickly, but I did look at it, yes.

IDA BIANCHI: Okay. And what can you tell us about that plan?

DR. JEFFREY SIEGEL: I think that plan is wonderful. I endorse it completely. I wonder if it's really being done, but it's going to get -- that plan gets very close to what comes from ASHRAE, again, this professional organization, what's called their core recommendations.

And I would hope that every building, let alone every long-term care home, followed the -- what's outlined at the Ministry. I doubt whether it's happening, but it's certainly a very laudable goal.

IDA BIANCHI: Okay. And can you highlight a couple -- one or two things that you really think are very important out of the plan --

DR. JEFFREY SIEGEL: Sure.

IDA BIANCHI: -- if there are things that are more important than others?

DR. JEFFREY SIEGEL: Yeah. In fact, I'm going to skip ahead a little bit.

IDA BIANCHI: Okay.

DR. JEFFREY SIEGEL: So ASHRAE has

something called the Epidemic Task Force, and they have a bunch of information published on different building types and different strategies about making buildings appropriate or appropriately resistant to COVID-19.

And what's on the right here are what are called the core recommendations from ASHRAE. And I know it's a lot of text and hard to read, but here's what I like in that ten-point plan is the things that mirror these core recommendations.

So, for example, there are specific guidelines on increasing ventilation as much as you can using MERV 13 filtration. It's not always possible. So achieve MERV 13 filtration, and if you can't achieve MERV 13 filtration, you know, use portable air cleaners to supplement that.

And so -- but if you look at this list of core recommendations, you'll see that there is very good correspondence to the Ministry guidelines.

The other comment -- or that ten-point plan.

The other comment I would make on the ten-point plan is that there is, I think, at least one point on kind of the kind of commissioning idea

or the maintenance idea of going out and making sure that the system is actually working. And there is inspection elements, inspecting the filter rack to make sure there's no bypass, inspecting the dampers for outdoor air, making sure that they function properly.

Those type of basic maintenance elements are absolutely essential because we cannot use the HVAC system to protect the residents of long-term care homes unless the systems are actually functioning.

IDA BIANCHI: And I believe we sent you the regulations such as they are around HVAC --

DR. JEFFREY SIEGEL: Okay.

IDA BIANCHI: -- that are in the regulations under the Long-Term Care Homes Act. Can you comment on the sufficiency of those regulations?

DR. JEFFREY SIEGEL: Yeah. So the sufficiency of those regulations is completely insufficient. I mean, they're laughable. This is, like, you know -- so you have to be able to cool air temperatures. How much? You have to maintain negative pressurization. How much negative pressurization?

There is really nothing here that is actionable or anything. These are not standards. This is -- I would hope that any building could do these things, but this is by no means sufficient.

IDA BIANCHI: Thank you.

DR. JEFFREY SIEGEL: Okay. So let's talk about some specific recommendations. I kind of divide data into three categories.

One is as part of a regular inspection process, and I know there's currently an inspection process. I don't know to what extent it addresses HVAC issues, but I think we need to know -- "we" being society needs to know, you know, what types of systems are in place.

Is there on-site personnel who deal with those systems? What type of basic maintenance? There's something called testing and balancing, which is looking at how the airflow occurs that needs to be periodically done on HVAC systems. How often are the filters changed? What type of filters are there? What types of kind of big-picture failures are there?

As well as resident complaints. I think, you know, you learn a lot about the building by talking to people: Oh, this room is always

really drafty or really stuffy. I'm always hot. I'm always cold. And some of that is, you know, some people complain a lot, but a lot of that gives you very good insight to how the HVAC system is performing.

So I think we need a much more robust inspection process. And for the record, this type of thing does exist for other types of buildings, and there is, you know, various standards and guidelines out for doing this type of HVAC inspection. I do not know of anyone who is applying it to long-term care homes.

In terms of monitoring, there are things that would be nice to monitor. Things like temperature and humidity in resident rooms or other spaces in the buildings, maybe carbon dioxide concentrations. If you want to spend more money, things like ventilation rates, particle concentrations, pressure differences between spaces.

And all of that is -- I'm kind of two minds about monitoring. The first point is if we're going to do that monitoring, we should commit to doing it in a smaller number of homes over a longer period of time. That gives us much more

actionable data because then we see things like, oh, how does the ventilation rate change over time.

The second comment about monitoring is right now, my perspective is that the situation is so serious that I would much rather have money spent improving the situation right now than on monitoring. Every dollar we spend on monitoring right now I can think of a better use for that dollar on direct things that will reduce the risk of infection.

Monitoring is great, but the time for monitoring is when you don't have active outbreaks and when you're not kind of chasing quite a serious problem.

If we had better HVAC systems that were more responsive, then absolutely I would advocate for monitoring. But right now, I have to say that monitoring is more -- of more value for research and for understanding than it is for making residents' lives better.

I think it is -- criminal is the wrong word, but it's a very serious situation that right now we have outbreaks going on in long-term care facilities, and we haven't even bothered to gather the base information about the building. You know,

what's the window-opening pattern in those buildings? Has anyone measured the airflow?

What I always do when I'm in any building and I want to know if the bathroom exhaust works is I rip off a piece of toilet paper, and I put it up to the grille on the bath fan. And if it sticks, that fan is sucking air. If it falls to the floor, which it very often does, that fan is not sucking air.

And so just little things like that. We're not talking sophisticated measurement here. You know, looking at the filter, what is its filtration level? You know, is it sealed appropriately in the rack? How are people operating doors in the building? You know, what does the on-site personnel know about the HVAC and its operation in the building?

Those types of questions we really need to understand if there are patterns for the data here. And the kinds of things that I suggest on this list could be collected in half an hour by someone with a little bit of training, and I think it would just add to our understanding of outbreaks immeasurably. And we really need to do...

If we actually want to make this

situation better, I kind of divide things into short-term and into long-term.

Short-term, we want to follow the ASHRAE core recommendations, which I already commented are very similar to the ten-point plan. And I don't want to spend too much time going through the details here, but basically, you know, the first question is is the ventilation compliant with standards?

And the amount of ventilation is going to differ depending on the use of the space. So, for example, a patient room or a resident room is going to have a different need for ventilation than a laundry room or a dining area or some other space in the building.

So it's kind of a space-by-space question, does the ventilation meet standards? And meeting standards is the base minimum. It doesn't do anything for infectious disease transmission. We want to increase it as much as possible.

And I would like to be more specific than that, but I can't because we don't know the particular circumstance. There might not be a lot of extra capacity there to increase ventilation.

One of the questions that I got earlier

this afternoon was around humidity. Humidity is a huge issue in long-term care homes. And here's the challenge with humidity. The more we ventilate when it's cold and dry outside, like today, the drier the air gets inside. The drier the air gets inside, the more people's mucous membranes dry out and the more they become susceptible to infectious disease transmission, as well as the fact that some of the bigger respiratory droplets, the water evaporates in them, and they travel much longer distances indoors, and potentially we spread infection further.

So you might say, well, why don't we just add humidity? There are a variety of approaches for adding humidity in a HVAC system or even portable humidifiers. The problem is those often cause more problems than they solve.

So a good example is many of us use ultrasonic or misting humidifiers in our homes. They are enormous generators of particles, scary generators of particles, which are very harmful to our health.

And so, well, why don't we do a steam humidifier in the HVAC system? That's better, but it requires a lot of maintenance to avoid other

problems, either a moisture problem or some kind of biological growth problem associated with the humidifier. And so there's no easy solution here unfortunately.

And I could spend hours with you talking about humidity and how we deal with it, but the reality of it is it's a real challenge, especially in a maintenance-poor environment.

We should definitely be improving filtration, and that's not just the filter itself but as well as making sure it's gasketed in place. I think there's a role for portable filtration as well.

I got a couple of comments about -- or questions about filtration. One is the availability of filters. Yes, filters have become very hard to procure, and that is because the good filters use the same stuff that's in PPE, and so there's obviously a real shortage in this world of meltblown media, which makes filters hard to get.

The only comment I can say on that is, one, absolutely long-term care homes should be required to procure filters for a period of time in the future so that they're not using filters longer than they should because they can't procure them.

And number two is that I think it calls for a real kind of structural failure in Canada that we do not have a local filtration industry that can produce these filters, like we face with PPE. And that's probably a little bit beyond the scope here but is an issue that we're facing.

The only other comment I'll mention from this list that I think is important is -- I got some questions as well about ultraviolet light.

Ultraviolet systems can be very effective for reducing the transmission of respiratory infectious disease generally, and specifically there is very good data suggesting that the SARS-CoV-2 virus can be effectively inactivated with ultraviolet light.

The challenge with ultraviolet light is that these systems are expensive and that they need to be designed and installed well. So my recommendation for long-term care homes is that, you know, smaller UV systems targeting high-risk areas are probably a more effective use of resources.

So imagine that you have a dining area, for example, where the residents obviously can't be masked and where there is potentially close contact

because it's people eating together. That's a great application for something called an upper-room UV system where air from the space is brought up to the ceiling area where it's illuminated with UV light and then delivered back to the space.

It's expensive. It has to be done well. There are obvious safety issues with UV and some other kind of engineering issues, but it's shown very good effectiveness where it's been done. And so that's how we deal with high-risk spaces.

And I think that everything that you see on this list could be done in a typical facility in a week. So these are all things -- you know, there's some resource issues and other things that I'm not particularly qualified to comment on, but these are all things that, you know, I or anyone else who's competent in the area could go into any building and do these things, you know, that would take effect immediately.

Longer-term, this came up in questioning earlier, I think we really want to think about compliance with -- requiring compliance with current contemporaneous ventilation standards.

So that is to say when our ventilation

standards change -- and I think we will see changes in ventilation standards because of infectious disease transmission from the pandemic -- facilities should be required to upgrade their ventilation systems.

It would warm my heart to see that the HVAC inspection data be made available publicly. And, you know, I think that -- you know, I think any family looking to put a loved one in a long-term care facility would look at things like what do the rooms look like, how are people treated by staff, what is the food like.

And imagine if we could have, you know, the HVAC data as something that's important there too: Oh, this facility is current on all of their ventilation. They have upgraded filtration and ventilation to protect their residents.

I'm not entirely sure that that's valued, but that would be a really nice thing to see there.

There was a question about, you know, should we give money to upgrade HVAC systems in long-term care homes. Again, that's not really -- like, I don't understand the economics of long-term care homes very well, but I absolutely believe that

there should be an investment in HVAC systems in these facilities.

I think we want more ventilation capacity so we can respond to things like infectious disease. And remember, it's not just COVID-19. You know, the flu is an enormous, serious problem in a typical year in long-term care facilities. If we had ventilation, and we had the beginnings of a flu outbreak, increasing ventilation would reduce the severity of that outbreak.

I think we want to improve filtration capacity, which means the ability for every facility to have good well installed, well gasketed MERV 13 filters. I think things like cooling -- I know some homes in Ontario do not have cooling or not complete cooling. I think we need that absolutely, especially with climate change and the effect of extreme heat events.

Humidity control. You know, it's expensive to do well, and it does have an ongoing maintenance cost, but that would be another enormous benefit for disease transmission.

And I think that there's this idea of kind of risk-reflective design. You don't need to

make every space in the building like an operating room, but you should make the higher-risk spaces with a much better indoor air quality to reduce the risk of transmission in those spaces.

That all costs money, and that all costs a lot of money, but I can't -- you know, and should that money come from the government or from the individual home operators?

You know, again, I'm not qualified to comment on that. But I will say that I think history will look back, and if we don't make this investment, it does not speak well of us as a society.

And the last kind of long-term recommendation I want to mention here is that, you know, there is a huge information gap out there. You talk to people in the general public. You even talk to people who are maintaining HVAC systems. People don't really know what is important for disease transmission.

You see a lot of kind of bogus or snake oil air-cleaning technologies that don't reduce risk but are being promoted as doing so. And there is an enormous role for government here in providing high-quality information so that people

value that information.

And I think that the big problem we have always had in any indoor air quality issue is that, you know, right now for all of us on this call, our biggest environmental health risk is the air we breathe in buildings, and most of that is the air that we breathe in our home.

And I think most of us don't know that. I mean, I talk to people about, you know, what the things in their home that are most likely to cause them harm, and most people cannot identify those things. And that's -- you know, there's been a failure of people like me, but there's also been a failure in general to make that information available.

And I think good, effective communication that is designed with the input of people who really understand human behaviour and what changes human behaviour is a big part of the problem. So this is not solely a technical issue. There is an information issue here too.

So I know I've talked a lot here. I'd be glad to take further questions, but just to kind of summarize up here, you know, I think we've got a challenging problem with HVAC systems, but it's a

resolvable problem. You know, we can certainly make good HVAC systems. We don't lack for the technology. We lack for the will and maybe the resources.

But I would point out that every dollar we invest in indoor air quality in any type of building pays back enormously in avoided health care costs as well as a variety of kind of secondary benefits.

And so typical investments in indoor air quality pay back about 10 to 1, meaning for every dollar you invest, you get $10 back in benefit, usually in avoided health care costs.

And so the real challenge that we face is that, you know, our HVAC systems are in a pretty sad state because we've had decades of inactivity or of neglect of those systems. So now to use them to be part of the solution to this problem, we need to make some pretty substantial investments. It's unfortunate that that's where we are, but that's where we are.

IDA BIANCHI: Thanks so much, Dr. Siegel. I'll just ask if the Commissioners have any questions for you.

Anyone?

COMMISSIONER ANGELA COKE: That was very thorough. Thank you.

COMMISSIONER JACK KITTS: Learned a lot about HVAC. Heard a lot about it at the hospital, but learned a lot, and it's important, so thank you for the very informative session.

COMMISSIONER FRANK MARROCCO (CHAIR): Thank you very much, Doctor.

DR. JEFFREY SIEGEL: You're welcome. And again, I would really encourage you to -- another piece that's been missing is that -- is the people who actually maintain these systems in the buildings. I don't know how many homes have on-site maintenance staff, but I bet some do, and I bet some have staff who are responsible for many things like changing filters.

I think talking to those individuals, you will get a very rich view of what's going on that -- you know, I can give you the academic perspective, but I have a feeling the practical perspective will reinforce that and also provide new opportunities for improving.

COMMISSIONER JACK KITTS: Thank you.

IDA BIANCHI: Thank you.

COMMISSIONER FRANK MARROCCO (CHAIR):

Bye, Doctor.

DR. JEFFREY SIEGEL: Bye.

IDA BIANCHI: Bye.

-- Adjourned at 3:13 p.m.

REPORTER'S CERTIFICATE

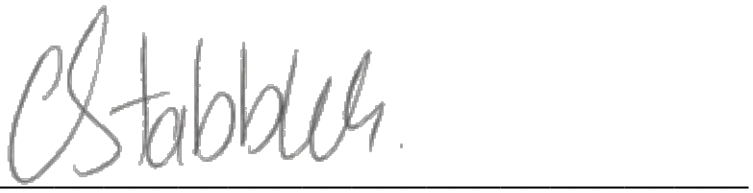
I, CARISSA STABBLER, Registered Professional Reporter, certify;

That the foregoing proceedings were taken before me at the time and place therein set forth;

That all remarks made at the time were recorded stenographically by me and were thereafter transcribed;

That the foregoing is a true and correct transcript of my shorthand notes so taken.

Dated this 1st day of February 2021.



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WORD INDEX