

# Long Term Care Covid-19 Commission Mtg.

Professor Siegel  
on Monday, February 1, 2021



77 King Street West, Suite 2020  
Toronto, Ontario M5K 1A1

[neesonsreporting.com](http://neesonsreporting.com) | 416.413.7755

1  
2  
3  
4  
5  
6  
7  
8  
9  
10  
11  
12  
13  
14  
15  
16  
17  
18  
19  
20  
21  
22  
23  
24  
25

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.

-----

1 BEFORE:

2

3 The Honourable Frank N. Marrocco, Lead Commissioner

4 Angela Coke, Commissioner

5 Dr. Jack Kitts, Commissioner

6

7 PRESENTER:

8

9 Jeffery Siegel, Ph.D., Professor, Department of

10 Civil and Mineral Engineering, University of

11 Toronto;

12

13 PARTICIPANTS:

14

15 Alison Drummond, Assistant Deputy Minister,

16 Long-Term Care Commission Secretariat;

17 Ida Bianchi, Senior Legal Counsel, Long-Term Care

18 Commission Secretariat;

19 Adriana Diaz Choconta, Senior Policy Analyst,

20 Long-Term Care Commission Secretariat;

21 Angela Walwyn, Senior Policy Analyst, Long-Term

22 Care Commission Secretariat;

23 Lynn Mahoney, Counsel, Gowling WLG;

24 Patricia Brooks, Counsel, Gowling WLG;

25

1 ALSO PRESENT:

2

3 Carissa Stabbler, Stenographer/Transcriptionist

4

5

6

7

8

9

10

11

12

13

14

15

16

17

18

19

20

21

22

23

24

25

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

2  
3 COMMISSIONER JACK KITTS: I'm here with  
4 the second Commissioner, Angela Coke, and we're  
5 here to listen to what you have to say. I  
6 understand Ida is going to work with you on that,  
7 so --

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

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

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

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

1 throughout the presentation.

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

8 DR. JEFFREY SIEGEL: Absolutely.

9 IDA BIANCHI: Thank you.

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

13 IDA BIANCHI: Yeah.

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

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

1 systems in LTC facilities.

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

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

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

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

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

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

12 And in particular --

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

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

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

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



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

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

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

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

25           COMMISSIONER JACK KITTS: Okay,

1 respiratory. Okay. Thank you.

2 DR. JEFFREY SIEGEL: And --

3 COMMISSIONER JACK KITTS:

4 Commissioner Coke?

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

12 DR. JEFFREY SIEGEL: Absolutely.

13 COMMISSIONER ANGELA COKE: Did I  
14 interpret that right?

15 DR. JEFFREY SIEGEL: 100 percent.

16 COMMISSIONER ANGELA COKE: Okay.

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

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

25 DR. JEFFREY SIEGEL: Absolutely right,

1 yes.

2 COMMISSIONER ANGELA COKE: Okay.

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

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

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

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

25 Hopefully the only acronyms I'll use

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

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

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

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

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

1 moisture problem.

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

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

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

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

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

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

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

10 And what we've learned in the next  
11 150 years through a variety of research is that  
12 indoor air quality has a variety of impacts on  
13 chronic and acute health outcomes, and the list is  
14 very, very long here.

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

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

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

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

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

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

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

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

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

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

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

15 COMMISSIONER JACK KITTS: Thank you.

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

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

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



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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

1 very similar systems.

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

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

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

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

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

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

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

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

19 IDA BIANCHI: And not about quality of  
20 the air?

21 DR. JEFFREY SIEGEL: Correct.

22 IDA BIANCHI: Okay.

23 DR. JEFFREY SIEGEL: Yes.

24 IDA BIANCHI: Got it.

25 DR. JEFFREY SIEGEL: And I mean, I

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

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

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

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

25           And I wanted to show you this picture

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

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

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

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

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

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

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

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

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



1 early last year.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

25 DR. JEFFREY SIEGEL: Yes, and the

1 more --

2 IDA BIANCHI: (INAUDIBLE).

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

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

9 DR. JEFFREY SIEGEL: Absolutely, yes.

10 IDA BIANCHI: Okay.

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

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

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

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

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

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

17           IDA BIANCHI: Okay. Thank you.

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

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

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

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

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

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

25 And so if you think about a long-term

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

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

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

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

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

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



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

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

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

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

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

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

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

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

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

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

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

3 And I want to make a -- go ahead.

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

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

12 Go ahead.

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

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

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

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

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

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

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

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

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

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

1 1 to 3 micron particles.

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

6 So that means on a single pass through  
7 the filter, if everything is going the way it  
8 should, 85 percent of the disease-containing  
9 particles will be removed. By the time the second  
10 pass happens through that filter, it's more like  
11 97 percent or so, and by the third pass, it's  
12 99 percent and change have been removed.

13 So MERV 13 -- yeah, go ahead.

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

16 DR. JEFFREY SIEGEL: Yes.

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

21 DR. JEFFREY SIEGEL: Right.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

24 IDA BIANCHI: Thank you, Dr. Siegel.

25 DR. JEFFREY SIEGEL: And the other



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

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

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

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

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

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

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

12                   IDA BIANCHI: Thank you, Dr. Siegel.

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

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

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

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

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

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

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

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

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

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

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

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

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

19 DR. JEFFREY SIEGEL: Sure.

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

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

24 IDA BIANCHI: Okay.

25 DR. JEFFREY SIEGEL: So ASHRAE has

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

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

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

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

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

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

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

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

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

14 DR. JEFFREY SIEGEL: Okay.

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

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

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

5           IDA BIANCHI: Thank you.

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

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

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

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

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

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

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

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



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

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

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

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

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

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

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

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

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

25 If we actually want to make this

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

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

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

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

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

25 One of the questions that I got earlier

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

25           So that is to say when our ventilation

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

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

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

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

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



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

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

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

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

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

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

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

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

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

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

1 value that information.

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

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

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

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

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

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

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

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

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

25                   Anyone?

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

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

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

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

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

23                   COMMISSIONER JACK KITTS: Thank you.

24                   IDA BIANCHI: Thank you.

25                   COMMISSIONER FRANK MARROCCO (CHAIR):

1     Bye, Doctor.

2                     DR. JEFFREY SIEGEL:   Bye.

3                     IDA BIANCHI:    Bye.

4

5     -- Adjourned at 3:13 p.m.

6

7

8

9

10

11

12

13

14

15

16

17

18

19

20

21

22

23

24

25

1 REPORTER'S CERTIFICATE

2  
3 I, CARISSA STABBLER, Registered  
4 Professional Reporter, certify;

5  
6 That the foregoing proceedings were  
7 taken before me at the time and place therein set  
8 forth;

9  
10 That all remarks made at the time were  
11 recorded stenographically by me and were thereafter  
12 transcribed;

13  
14 That the foregoing is a true and  
15 correct transcript of my shorthand notes so taken.

16  
17  
18 Dated this 1st day of February 2021.

19  
20 

21 \_\_\_\_\_  
22 NEESONS, A VERITEXT COMPANY

23 PER: CARISSA STABBLER, RPR  
24  
25

**WORD INDEX**

< \$ >

\$10 59:12

< 1 >

1 35:24 36:1  
59:11

10 41:20 59:11

100 9:15 39:3

13 34:14, 17, 22  
35:18, 23, 24

36:13, 14, 19

37:13, 16 40:6,  
22 44:13, 14, 15

56:15

15 25:10 41:20

150 13:7, 11

16 35:24

180 22:14

1-inch 39:20

1st 1:12 62:18

< 2 >

2 22:8

2:00 1:13 4:1

20 19:10

200 31:12

2021 1:12 62:18

2-year-old 33:10

< 3 >

3 36:1

3:13 1:13 61:5

30 33:12 34:9

< 4 >

4 16:5

40 25:13

< 5 >

50 16:6

52.2 35:2

< 6 >

60 19:10 33:12  
34:9

62.1 16:2

6-inch 39:14

< 8 >

80 15:11

85 35:25 36:8

< 9 >

97 36:11

99 36:12

< A >

ability 26:2

42:19 56:13

abolitionist

12:25

Absolutely 5:8

9:12, 25 15:7

20:14 28:9

35:7 45:8

48:16 52:22

55:25 56:18

abstract 25:17

academic 60:19

acceptable

15:10, 12

access 22:6

accrue 14:5

18:20

achieve 44:14,  
15

acknowledges

13:7

acronym 4:25

acronyms 10:25

Act 45:16

actionable 46:2

48:1

active 35:12

48:12

activity 12:15

actual 15:6, 14

16:3 19:18

acute 13:13

add 6:14 13:15

49:23 51:14

adding 51:15

address 6:4

13:23 23:11

addressed 24:20

addresses

32:17 46:11

addressing

10:22

Adjourned 61:5

Adriana 2:19

advocate 48:16

after 25:19

33:13 34:9

afternoon 4:13

11:18 51:1

age 40:3

ago 11:22

12:14 13:7

25:10

ahead 10:21

34:3, 4, 12

36:13 43:23

air 4:21, 24

10:24 11:1, 21

12:12, 15, 17

13:4, 8, 12, 18,

19, 24 14:1, 4,

13, 15, 19, 21, 25

15:5, 6, 10, 12,

14 16:13, 19

17:4, 6, 7, 11, 12,

16, 21, 25 18:5

19:16, 22 20:20

21:4, 16 23:3

24:18, 22, 23

25:4 28:24

30:3, 10, 13

32:20 37:14

38:1 40:17

44:16 45:5, 23

49:7, 9 51:5

54:3 57:3 58:3,

6, 7 59:6, 11

airborne 14:23

28:16, 21 29:1

36:4

air-cleaning

57:22

Air-Conditioning

35:9

airflow 17:10

24:4, 25 30:2,

21 31:14 46:18

49:2

airflows 30:7

31:2, 4

airplanes 14:16,

18

Alison 2:15

allowing 7:21

American 35:8

amount 10:8

16:19 21:12

50:10

Amoy 31:9

Analyst 2:19, 21

and/spread 4:22

Angela 2:4, 21

4:4 9:5, 13, 16,

21 10:2 60:1

animals 26:17

anyway 26:22

apart 27:7

apartment 31:9,

13

apologies 37:3

application 54:2

applying 47:12

appointments

4:17

approaches

51:15

appropriate

34:19 44:4

appropriately

44:4 49:14

approval 26:16

approximately

36:5

area 12:15

19:21 30:5, 24

50:14 53:23

54:4, 18

areas 30:22

53:21

article 25:10

32:8

articles 23:23

24:9 25:13, 20

32:8

ASHRAE 16:2

34:18 35:1, 2, 6,

8, 15, 19 37:9

38:24 39:1

43:9, 25 44:7

50:4

asked 11:19

aspect 22:17

aspects 35:16

assessed 36:18

Assistant 2:15

associated

25:25 27:5

32:1 35:11 52:2

association

25:15

associative

31:25

assume 19:14

assuming 27:14

attending 1:11

attention 29:14

attracted 40:14

Austin 33:8

availability

52:16

available 55:7

58:15

avoid 51:25

avoided 59:7, 13

< B >

back 26:22

31:15 54:5

57:11 59:7, 11,

12

background

10:24

bad 7:8 9:19

balancing 46:18

base 48:25

50:18

based 7:3

16:18 37:3 42:9

baseline 11:5

basic 22:17

42:14 45:7

46:16

basically 24:3

50:7

basis 11:6

bath 49:6

bathroom 49:4

beautiful 39:13

beautifully 40:22

Beecher 12:24

beginnings 56:9

behaviour

58:18, 19

believe 45:12

55:25

benefit 56:23

59:13

benefits 59:9

best 25:8 37:25

bet 34:16

60:14, 15

better 26:6

48:8, 15, 20

50:1 51:24 57:3

Bianchi 2:17

4:8 5:9, 13

7:13 16:12

20:6, 19, 22, 24

26:9 27:3, 23

28:2, 5, 10

29:17 34:4, 13,

21 35:4 36:14,

17, 22 38:24



<p>39:24 41:12 42:22 43:3, 16, 20, 24 45:12, 15 46:5 59:22 60:24 61:3 <b>Bible</b> 11:23 <b>big</b> 21:7, 22 27:12 28:8 33:22 37:10 58:2, 19 <b>bigger</b> 27:23 51:9 <b>biggest</b> 13:17 58:5 <b>big-picture</b> 10:20 23:7 46:22 <b>biological</b> 42:3 52:2 <b>bit</b> 7:16 17:1, 6 29:21 37:3 39:11 42:9 43:23 49:22 53:5 <b>blessing</b> 12:6 <b>bluntly</b> 19:20 <b>board</b> 26:16 <b>bogus</b> 57:21 <b>book</b> 13:3 <b>bothered</b> 48:24 <b>bottom</b> 10:5 <b>box</b> 21:23 <b>breathe</b> 13:18 58:6, 7 <b>breathing</b> 30:5 <b>brief</b> 11:21 <b>Brooks</b> 2:24 4:9 15:16 <b>brought</b> 54:4 <b>build</b> 15:19 <b>builder</b> 18:18 <b>building</b> 10:9 12:4, 8 15:18 17:22 19:8, 12, 24 20:10, 11 21:4 22:22 24:7, 21 29:2, 23, 24 30:6, 17 31:7, 8, 9, 13, 18 43:11 44:3 46:3, 24 48:25 49:4, 15, 17 50:15 54:19 57:1 59:7</p>	<p><b>building-level</b> 10:19 <b>buildings</b> 5:19 7:4, 9 9:11, 20, 23 13:9 18:25 19:19 27:18 30:19 37:18 40:21 41:3, 4, 9 42:10 44:4 47:8, 16 49:2 58:6 60:13 <b>built</b> 18:18 <b>bullet</b> 10:5 <b>bunch</b> 42:2 44:2 <b>business</b> 14:25 <b>buy</b> 38:20, 21 <b>Bye</b> 61:1, 2, 3 <b>bypass</b> 37:11, 15 45:4</p> <p>&lt; C &gt; <b>call</b> 25:19 58:5 <b>called</b> 15:9 40:8 43:10 44:1, 7 46:17 54:2 <b>calls</b> 53:1 <b>Canada</b> 13:16, 23 53:2 <b>capacities</b> 38:19 <b>capacity</b> 27:16 29:14 50:24 56:4, 13 <b>capital</b> 19:10 <b>carbon</b> 47:16 <b>CARE</b> 1:4 2:16, 17, 20, 22 7:11 9:9, 22 10:7, 16 11:12 14:9 16:9 21:22 22:21, 23 23:10 28:18, 19 31:1 34:15 39:3, 11, 12, 19 40:7 42:6, 7 43:12 45:10, 16 47:12 48:23 51:2 52:22 53:19 55:10, 23, 25 56:7 59:8, 13 <b>carefully</b> 19:14 <b>Carissa</b> 3:3 62:3, 23 <b>carry</b> 25:1</p>	<p><b>case</b> 7:24 8:12 14:12 25:6 31:8, 17 33:1 34:17 <b>cases</b> 31:19 <b>cat</b> 38:7 <b>categories</b> 46:8 <b>causal</b> 24:10 <b>causality</b> 23:15 <b>causation</b> 10:12 <b>caused</b> 24:4, 25 25:4 30:7 <b>ceiling</b> 54:4 <b>certain</b> 20:16 25:13 27:9 <b>certainly</b> 13:22 19:7 26:14 31:18 41:9 43:14 59:1 <b>CERTIFICATE</b> 62:1 <b>certification</b> 15:21 16:10 <b>certify</b> 62:4 <b>CHAIR</b> 60:7, 25 <b>challenge</b> 23:8 51:3 52:7 53:16 59:14 <b>challenges</b> 18:21 <b>challenging</b> 58:25 <b>chamber</b> 32:12, 15, 25 <b>chance</b> 4:14 <b>change</b> 26:24, 25 36:12, 23 37:24 38:5, 16, 17 39:16 41:7 48:2 55:1 56:18 <b>changed</b> 22:10 46:20 <b>changes</b> 55:1 58:19 <b>changing</b> 60:16 <b>chapters</b> 13:3 <b>characterization</b> 10:8 <b>charge</b> 40:12 <b>charged</b> 40:16 <b>chasing</b> 48:13 <b>cheaper</b> 38:22 <b>cheapest</b> 20:2 <b>China</b> 24:3</p>	<p><b>Choconta</b> 2:19 <b>chronic</b> 13:13 <b>circle</b> 33:22 <b>circumstance</b> 50:23 <b>cite</b> 23:24 <b>cited</b> 24:15 <b>Civil</b> 2:10 4:16 <b>clarified</b> 5:6 <b>clarify</b> 9:6 <b>classic</b> 16:24 <b>classify</b> 32:11 <b>clean</b> 21:16 <b>cleaners</b> 32:20 44:16 <b>cleaning</b> 28:24 <b>clearly</b> 42:20 <b>climate</b> 56:18 <b>close</b> 8:5, 6, 7 43:8 53:25 <b>close-contact</b> 8:2 <b>closest</b> 23:2 <b>Code</b> 15:18 16:1 20:10 24:20 <b>codes</b> 15:25 16:8 20:17 <b>coils</b> 21:8 <b>coincidence</b> 21:17 <b>Coke</b> 2:4 4:4 9:4, 5, 13, 16, 21 10:2 60:1 <b>cold</b> 29:9 47:2 51:4 <b>colleagues</b> 25:11 <b>collected</b> 10:6, 19 37:20 49:21 <b>come</b> 57:7 <b>comes</b> 8:15 13:17 32:25 43:8 <b>comfort</b> 19:15 <b>coming</b> 16:19 18:6 <b>commencing</b> 4:1 <b>comment</b> 6:24 14:1 18:15 24:14 31:24 34:7 40:1 41:23 44:21, 23 45:17 48:3</p>	<p>52:21 53:7 54:16 57:10 <b>commented</b> 50:5 <b>comments</b> 52:14 <b>commercial</b> 19:8 21:20 22:22 29:23 <b>COMMISSION</b> 1:4 2:16, 18, 20, 22 <b>Commissioner</b> 2:3, 4, 5 4:3, 4 7:15 8:16, 25 9:3, 4, 5, 13, 16, 21 10:2 14:14 15:3, 15 60:1, 3, 7, 23, 25 <b>Commissioners</b> 4:13 5:4 35:5 59:23 <b>commissioning</b> 44:25 <b>Commission's</b> 5:22 <b>commit</b> 47:23 <b>communication</b> 58:17 <b>COMPANY</b> 62:22 <b>competent</b> 54:18 <b>complain</b> 29:8, 9 47:3 <b>complaints</b> 46:23 <b>complete</b> 56:17 <b>completely</b> 5:17 13:21 18:24 19:17 43:6 45:20 <b>complex</b> 30:19 <b>compliance</b> 54:23 <b>compliant</b> 50:8 <b>complicated</b> 14:25 31:14 <b>comply</b> 20:17 <b>component</b> 14:23 <b>components</b> 17:9 42:17 <b>concentrations</b> 47:17, 19</p>
--	---	---	---	--

<p><b>concern</b> 10:19 <b>concerns</b> 14:13 <b>conditioned</b> 17:11, 21 <b>conditioning</b> 4:22, 24 19:22 <b>conditions</b> 35:21 <b>conduct</b> 26:16 <b>confusion</b> 28:12 <b>consistent</b> 28:20 <b>constructed</b> 19:24 <b>construction</b> 15:23 19:11 <b>contact</b> 8:5, 6, 8 53:25 <b>contain</b> 31:4 <b>contemporaneous</b> 54:24 <b>continues</b> 5:23 <b>control</b> 8:13, 15 14:22 17:8, 10 18:4, 6 20:5 25:14 29:15 32:9 56:20 <b>controlled</b> 27:2 35:20 <b>controlling</b> 8:6 34:19 <b>controls</b> 17:23, 25 18:1 <b>cool</b> 45:22 <b>cooling</b> 17:16 21:8 22:2 56:15, 16, 17 <b>cools</b> 17:7 <b>core</b> 43:10 44:7, 10, 18 50:4 <b>correct</b> 15:8 20:21 62:15 <b>correlation</b> 10:13 <b>correspondence</b> 44:19 <b>corresponds</b> 33:19 <b>corridor</b> 30:23 <b>cost</b> 28:3 56:22 <b>costs</b> 19:11 27:13 57:5, 6 59:8, 13 <b>Counsel</b> 2:17, 23, 24</p>	<p><b>couple</b> 12:13 25:16, 20 43:17 52:14 <b>course</b> 8:9 16:23 27:15 40:16 <b>covered</b> 38:7 <b>COVID</b> 33:11 <b>COVID-19</b> 1:4 11:9 23:13 28:16 44:5 56:6 <b>COVID-positive</b> 41:17 <b>creating</b> 7:22 <b>criminal</b> 48:21 <b>criteria</b> 25:14 <b>current</b> 16:11, 13 54:24 55:15 <b>currently</b> 46:10  &lt; D &gt; <b>Dalla</b> 4:17 <b>damaged</b> 12:5 <b>dampers</b> 45:5 <b>data</b> 7:1 10:6, 19 26:10 35:19 37:19 40:19 42:14, 21 46:8 48:1 49:19 53:13 55:7, 14 <b>Dated</b> 62:18 <b>daughter</b> 33:10 <b>day</b> 1:12 62:18 <b>days</b> 33:12 34:9 <b>deal</b> 46:15 52:6 54:11 <b>dealing</b> 25:3 29:2, 13 <b>dealt</b> 25:20 <b>debate</b> 28:16 <b>decades</b> 14:3 59:16 <b>decline</b> 40:2, 4 <b>declines</b> 40:18 <b>deduce</b> 9:23 <b>define</b> 18:23 <b>definitely</b> 8:22 52:9 <b>definition</b> 15:11 17:17 <b>degrees</b> 22:14 <b>delivered</b> 17:25 54:5</p>	<p><b>demonstrates</b> 16:20 <b>Department</b> 2:9 4:16, 18 <b>depend</b> 31:6 <b>depending</b> 19:9 30:2 50:11 <b>depends</b> 8:19 37:25 38:1 39:7, 8 <b>Deputy</b> 2:15 <b>described</b> 22:2 <b>design</b> 26:12, 15 56:25 <b>designed</b> 19:15, 19, 23 20:7 21:11 22:18 39:17 53:18 58:17 <b>designer</b> 20:11 <b>designing</b> 27:9 <b>details</b> 31:7 50:7 <b>determine</b> 26:12 32:19 <b>devastating</b> 10:18 <b>devoted</b> 13:3, 5 <b>Diaz</b> 2:19 <b>differ</b> 50:11 <b>difference</b> 25:9 <b>Differences</b> 18:19 47:19 <b>different</b> 16:4 17:21 18:11, 25 19:25 25:13 32:9, 19 35:22 37:8 38:12, 18 41:10, 24 44:2, 3 50:13 <b>dining</b> 50:14 53:23 <b>dioxide</b> 47:16 <b>direct</b> 32:5, 6, 13 33:2, 4, 6 48:9 <b>directly</b> 30:22 37:7 <b>dirty</b> 38:1, 11 <b>disease</b> 4:23 6:9, 21 8:3, 4 11:8 14:12 23:16, 17 24:6, 13 25:2, 25 26:3, 25 27:6</p>	<p>28:20 31:6, 22 32:24 34:20 36:3 50:19 51:8 53:12 55:3 56:5, 23 57:20 <b>disease-</b> <b>containing</b> 32:2 36:8 <b>diseases</b> 6:22 8:23 25:16 <b>disgusting</b> 38:6 <b>disproportionately</b> 14:5 <b>distances</b> 51:11 <b>distill</b> 19:3 <b>distributed</b> 22:3 <b>distributes</b> 17:10 <b>distribution</b> 17:20 <b>divide</b> 46:8 50:1 <b>Doctor</b> 60:8 61:1 <b>dog</b> 38:7 <b>doing</b> 10:23 47:10, 24 57:23 <b>dollar</b> 48:7, 9 59:5, 12 <b>domestic</b> 13:1, 2 <b>door</b> 22:6, 9 <b>doors</b> 49:15 <b>doubt</b> 43:13 <b>downstream</b> 25:2 <b>downwind</b> 24:6 <b>dozen</b> 23:23 24:9 <b>drafty</b> 47:1 <b>dream</b> 39:12 <b>drier</b> 51:5 <b>droplet</b> 32:3 <b>droplets</b> 51:9 <b>Drummond</b> 2:15 <b>dry</b> 51:4, 6 <b>dust</b> 33:16 38:10, 19 <b>dynamic</b> 18:8, 14  &lt; E &gt; <b>earlier</b> 11:17 31:16 50:25</p>	<p>54:22 <b>earliest</b> 12:12 <b>early</b> 24:1 28:15 <b>easy</b> 52:3 <b>eating</b> 54:1 <b>economics</b> 55:24 <b>effect</b> 23:19 54:20 56:19 <b>effective</b> 31:22 32:5 33:4 36:24 53:11, 21 58:16 <b>effectively</b> 53:14 <b>effectiveness</b> 54:10 <b>effects</b> 14:4 15:14 <b>efficiency</b> 32:3 35:21, 25 40:13 <b>electric</b> 40:12 <b>electrical</b> 19:12 <b>electrostatic</b> 40:17 <b>elements</b> 45:3, 8 <b>else's</b> 30:24 <b>enable</b> 16:14 <b>encourage</b> 31:1, 7 60:10 <b>endorse</b> 43:6 <b>energy</b> 27:13 <b>engagement</b> 5:22 <b>Engineering</b> 2:10 4:16 54:9 <b>Engineers</b> 35:10 <b>enhancements</b> 6:19 <b>enormous</b> 51:20 56:6, 23 57:24 <b>enormously</b> 59:7 <b>enter</b> 30:4 <b>entirely</b> 55:18 <b>environment</b> 34:11 52:8 <b>Environmental</b> 4:19 13:17 58:5 <b>environments</b> 29:16 32:16 39:1 <b>envision</b> 26:19 <b>Epidemic</b> 44:1</p>
--	--	---	--	---

<p><b>equipment</b> 20:18 <b>especially</b> 25:24 52:8 56:18 <b>essential</b> 13:9 45:8 <b>essentially</b> 41:5 <b>establish</b> 23:15 <b>evaluate</b> 10:12, 13 <b>evaporates</b> 51:10 <b>events</b> 56:19 <b>evidence</b> 11:6 25:8 27:4 31:21, 25 32:5, 6, 23 33:3, 5, 6 <b>exacerbated</b> 14:11 <b>example</b> 5:24 8:1 22:20 24:15 27:18 31:8 32:11 33:6 34:23 38:3 39:4 44:11 50:12 51:18 53:24 <b>Excellent</b> 5:14 28:23, 24 <b>exchange</b> 4:14 <b>excuse</b> 16:17 <b>exhaust</b> 17:13 49:4 <b>exist</b> 15:9 47:8 <b>existing</b> 6:18 14:11 20:9 <b>exists</b> 31:14 <b>expect</b> 28:21 <b>expensive</b> 19:7, 13 27:24 38:20 53:17 54:7 56:21 <b>explanation</b> 24:11 <b>explicitly</b> 14:7 <b>extensively</b> 13:1 <b>extent</b> 46:11 <b>extra</b> 50:24 <b>extrapolate</b> 29:5 <b>extreme</b> 56:19  &lt; F &gt; <b>face</b> 53:4 59:14 <b>facilitation</b> 11:7</p>	<p><b>facilities</b> 6:1, 23 7:3 10:15, 16 16:9 28:18 48:24 55:4 56:2, 8 <b>facility</b> 10:10 39:3 54:14 55:10, 15 56:14 <b>facing</b> 53:6 <b>fact</b> 10:18 11:24 26:20 28:11 35:13 43:22 51:8 <b>factor</b> 6:13, 16 7:17, 18, 21 16:5 <b>factors</b> 7:24 10:14 31:18 39:8 <b>factory</b> 40:12 <b>failure</b> 22:16 23:7 53:2 58:13, 14 <b>failures</b> 7:5 20:5 23:11 46:22 <b>fair</b> 39:15 42:23 <b>falls</b> 49:7 <b>familiar</b> 17:24 <b>family</b> 55:9 <b>famous</b> 13:3 31:8 <b>fan</b> 49:6, 7, 8 <b>fans</b> 21:8 <b>fantastic</b> 37:2 <b>fast-forward</b> 12:13 <b>favourite</b> 16:1 <b>feasible</b> 26:18 <b>February</b> 1:12 62:18 <b>feeling</b> 60:20 <b>filter</b> 17:5 21:3, 5 22:7, 9, 22, 24 23:1, 4, 5 32:4 33:25 34:1 35:18, 20, 23, 25 36:7, 10, 17, 18, 19, 23 37:12, 13, 14, 16, 21, 24 38:6, 20, 22 39:2, 8, 13 40:6, 14, 21, 22 41:1, 6 45:3 49:12 52:10 <b>filtering</b> 38:2</p>	<p><b>filters</b> 21:6 32:4 34:14 37:8 38:10, 18 39:14, 16, 17, 20 40:2, 4 41:7, 10, 16, 20, 21, 22, 25 42:4, 15 46:20, 21 52:16, 18, 20, 23, 24 53:4 56:15 60:16 <b>filtration</b> 11:11 16:17 31:21, 22 32:10, 14, 24 34:18 35:19 37:9 40:8 44:13, 14, 15 49:13 52:10, 12, 15 53:3 55:16 56:12 <b>final</b> 41:20 <b>find</b> 13:22 34:23 40:6 42:3 <b>finding</b> 28:25 <b>findings</b> 25:23 <b>finish</b> 34:5 <b>flip</b> 8:11 <b>floor</b> 19:21 49:8 <b>flu</b> 32:18, 21 56:6, 9 <b>flushing</b> 30:20 <b>follow</b> 50:3 <b>followed</b> 43:12 <b>food</b> 55:12 <b>Force</b> 44:1 <b>forced-air</b> 18:10 38:4 <b>foregoing</b> 62:6, 14 <b>forth</b> 62:8 <b>found</b> 33:17, 19 41:21 <b>frame</b> 22:9 <b>Frank</b> 2:3 60:7, 25 <b>frankly</b> 31:21 <b>frequently</b> 38:16 <b>fresh</b> 15:5 <b>freshness</b> 15:6 <b>front</b> 23:2 <b>function</b> 19:9 21:9, 10, 11 45:6 <b>functioning</b> 45:11 <b>functions</b> 22:1</p>	<p><b>fundamental</b> 17:15 21:14 27:15 <b>fundamentally</b> 17:3, 15 <b>fur</b> 38:8 <b>future</b> 52:24  &lt; G &gt; <b>gap</b> 57:16 <b>Gardens</b> 31:9 <b>gasketed</b> 52:11 56:14 <b>gather</b> 48:24 <b>general</b> 11:8 38:10 57:17 58:14 <b>generally</b> 6:9 9:9 14:13 53:12 <b>generators</b> 51:20, 21 <b>give</b> 11:2 21:19 37:25 55:22 60:19 <b>given</b> 9:22 26:19 40:11, 12 <b>gives</b> 47:3, 25 <b>glad</b> 58:23 <b>globe</b> 13:16 <b>goal</b> 43:15 <b>Good</b> 4:13 5:14 13:8 19:16 27:5 32:11 41:18 44:19 47:4 51:18 52:17 53:13 54:10 56:14 58:16 59:2 <b>government</b> 57:7, 24 <b>Gowling</b> 2:23, 24 <b>grandfather</b> 12:16 16:8 <b>graphic</b> 29:19, 25 <b>grateful</b> 5:20 <b>great</b> 12:16 27:1 48:11 54:2 <b>grille</b> 49:6 <b>gross</b> 22:16 23:11 <b>group</b> 37:20</p>	<p>41:14 <b>groups</b> 40:20 <b>growth</b> 52:2 <b>Guangzhou</b> 24:3 <b>guess</b> 7:3 31:1 <b>guidelines</b> 38:25 44:12, 20 47:10  &lt; H &gt; <b>half</b> 49:21 <b>happened</b> 22:13 <b>happening</b> 8:5 36:4 43:14 <b>happens</b> 21:22 36:10 40:15 <b>hard</b> 6:25 18:23 42:11 44:8 52:17, 20 <b>harm</b> 58:11 <b>harmful</b> 51:21 <b>Harriet</b> 12:24 <b>Health</b> 4:18 13:5, 13, 17 14:4, 11 15:14 16:9 28:18, 19 51:22 58:5 59:7, 13 <b>healthy</b> 21:16 <b>Heard</b> 60:4 <b>heart</b> 55:6 <b>heat</b> 56:19 <b>heating</b> 4:21, 23 17:16 19:22 22:2 35:9 <b>heats</b> 17:7 <b>Held</b> 1:11 <b>help</b> 38:25 <b>helpful</b> 4:9 8:13 <b>helps</b> 40:13 <b>high</b> 34:2 35:23 <b>high-efficiency</b> 40:3 41:21 <b>higher</b> 27:19 <b>higher-risk</b> 57:2 <b>highest</b> 16:5 <b>high-level</b> 11:2 <b>highlight</b> 43:17 <b>highly</b> 22:21 <b>high-quality</b> 57:25 <b>high-risk</b> 53:20 54:11 <b>hippie</b> 12:18</p>
---	--	---	---	--

<p><b>historically</b> 31:19 <b>history</b> 11:21 16:1 57:11 <b>hits</b> 22:11 <b>hold</b> 38:19 <b>home</b> 11:25 12:3 22:23 31:1 33:8, 9, 25 34:23 38:9 39:13, 20 43:12 57:8 58:7, 10 <b>homes</b> 7:11 9:9, 22 10:8 11:12 14:9 21:22 22:21 23:10 39:11 40:7 42:6, 7 45:10, 16 47:12, 24 51:2, 19 52:22 53:19 55:23, 25 56:16 60:13 <b>Hong</b> 31:10 <b>Honourable</b> 2:3 <b>hope</b> 5:21 7:7 10:23 11:14 43:11 46:3 <b>hopefully</b> 6:5 10:25 11:19 <b>horribly</b> 40:25 <b>hospital</b> 15:20 27:18 29:6 41:16, 17, 18 60:4 <b>hospitals</b> 14:15, 16, 18 15:17 28:7, 23 29:7 41:19 <b>host</b> 18:5 <b>hot</b> 17:25 47:1 <b>hour</b> 49:21 <b>hours</b> 52:5 <b>house</b> 18:9 38:4, 12 <b>huge</b> 51:2 57:16 <b>human</b> 58:18, 19 <b>humidifier</b> 51:24 52:3 <b>humidifiers</b> 51:16, 19 <b>humidity</b> 17:8 18:4 47:15</p>	<p>51:1, 3, 14, 15 52:6 56:20 <b>hundred</b> 12:14 <b>HVAC</b> 4:25 5:17 6:8, 11, 19 7:1, 9 8:1, 10, 14 9:8, 10, 19 10:9 11:1 16:22, 25 17:3, 7, 12, 18 18:2, 8, 16, 22 19:4, 19 21:6, 20 23:7, 15 24:4, 12, 23, 25 25:5 27:8, 9 29:8 30:7, 9 31:17 33:25 35:11, 16 41:18 42:17, 24 45:9, 13 46:12, 19 47:4, 10 48:15 49:16 51:15, 24 55:7, 14, 22 56:1 57:18 58:25 59:2, 15 60:4</p> <p><b>&lt; I &gt;</b> <b>Ida</b> 2:17 4:6, 8 5:9, 13 7:13 16:12 20:6, 19, 22, 24 26:9 27:3, 23 28:2, 5, 10 29:17 34:4, 13, 21 35:4 36:14, 17, 22 38:24 39:24 41:12 42:22 43:3, 16, 20, 24 45:12, 15 46:5 59:22 60:24 61:3 <b>idea</b> 17:24 21:14 25:4 27:1 44:25 45:1 56:24 <b>identify</b> 58:11 <b>ilk</b> 23:24 <b>illuminated</b> 54:5 <b>illustration</b> 21:19 <b>imagine</b> 53:23 55:13 <b>immeasurably</b> 49:24</p>	<p><b>immediately</b> 54:20 <b>impact</b> 32:19 <b>impacts</b> 13:12 <b>implicated</b> 25:5 30:10 <b>important</b> 5:11, 18 6:12, 13, 16 7:17, 18, 21, 25 8:8 17:19 18:16 19:2 23:18 24:18 25:22 28:6 29:5 30:14 31:5, 17, 18 37:5, 6 43:18, 21 53:8 55:14 57:19 60:5 <b>improve</b> 23:9 56:12 <b>improving</b> 7:11 11:15 48:6 52:9 60:22 <b>inactivated</b> 53:15 <b>inactivity</b> 59:16 <b>INAUDIBLE</b> 8:17 28:2 <b>include</b> 14:22 <b>included</b> 25:21 <b>includes</b> 15:21 <b>including</b> 10:7 13:16 17:4 <b>incorrectly</b> 22:19 <b>increase</b> 27:17 50:20, 24 <b>increasing</b> 44:12 56:9 <b>indeterminable</b> 26:13 <b>index</b> 31:11 <b>individual</b> 6:8 24:5 57:8 <b>individuals</b> 30:1, 4, 5 31:3 33:14 60:17 <b>indoor</b> 10:24 11:1, 21 12:12, 15, 17 13:3, 8, 12, 18, 19, 24 14:1, 4, 13, 15, 19, 21, 25 15:10, 14 16:13 19:16 24:13 34:10</p>	<p>38:14 57:3 58:3 59:6, 10 <b>indoors</b> 26:1 51:11 <b>industry</b> 39:23 53:3 <b>infected</b> 8:7 24:5 25:1 30:1, 4 31:3 <b>infection</b> 14:22 28:7 29:14 48:10 51:12 <b>infectious</b> 4:23 6:22 8:21 11:8 14:12 25:16, 25 26:3 31:22 32:2, 24 50:19 51:7 53:12 55:2 56:5 <b>infective</b> 34:8 <b>infectivity</b> 34:8 41:24 <b>infer</b> 32:4 <b>information</b> 44:2 48:25 57:16, 25 58:1, 14, 21 <b>informative</b> 60:6 <b>input</b> 58:17 <b>inside</b> 22:7, 25 24:6 51:5, 6 <b>insight</b> 47:4 <b>inspecting</b> 45:3, 4 <b>inspection</b> 45:3 46:9, 10 47:7, 11 55:7 <b>installed</b> 20:1 22:14, 15, 18, 19 40:7 53:18 56:14 <b>installer</b> 19:20 20:10 <b>insufficient</b> 26:10 45:21 <b>integrate</b> 11:18 <b>interconnected</b> 31:2 <b>interject</b> 35:4 <b>interpret</b> 9:14 <b>interpreted</b> 9:18 <b>invest</b> 28:8 59:6, 12 <b>investigations</b> 23:14</p>	<p><b>investment</b> 56:1 57:12 <b>investments</b> 59:10, 19 <b>inviting</b> 5:16, 23 <b>involved</b> 19:11 33:7 <b>issue</b> 15:18 37:10, 22, 23 41:8, 9, 10, 11 51:2 53:6 58:3, 20, 21 <b>issues</b> 14:11 46:12 54:8, 9, 15</p> <p><b>&lt; J &gt;</b> <b>Jack</b> 2:5 4:3 7:15 8:16, 25 9:3 14:14 15:3, 15 60:3, 23 <b>Jeff</b> 15:16 <b>Jeffery</b> 2:9 <b>JEFFREY</b> 5:8, 10, 14 7:23 9:2, 12, 15, 17, 25 10:3 14:17 15:7, 20 16:16 20:13, 21, 23, 25 26:14 27:11, 25 28:3, 9, 11 29:18 34:6, 16, 25 35:7 36:16, 21 37:1 39:5, 25 41:13 43:1, 5, 19, 22, 25 45:14, 19 46:6 60:9 61:2</p> <p><b>&lt; K &gt;</b> <b>kind</b> 5:22 6:14 7:8 10:20, 23 11:3, 20 12:11, 16 16:24 17:14 18:19 19:5 20:11 22:2 23:6, 12 24:17 25:4 26:2 27:7 30:18 31:13, 25 32:7, 11 38:18 40:6 44:25 46:7, 21 47:21 48:13 50:1, 16 52:1 53:2 54:9 56:25 57:14, 21 58:23 59:8</p>
---	--	--	--	---

**kinds** 32:6  
33:16 49:20  
**Kitts** 2:5 4:3  
7:14, 15 8:16,  
25 9:3 14:14  
15:3, 15 60:3, 23  
**knew** 13:7  
**knowledge**  
11:22 12:11  
23:14, 25 24:20  
**known** 4:25  
11:11  
**Kong** 31:10

< L >

**laboratory** 35:21  
**lack** 59:2, 3  
**Lana** 4:18  
**language** 18:23  
**large** 7:5 28:23  
**laudable** 43:15  
**laughable** 45:21  
**laundry** 50:14  
**layer** 38:7  
**layered** 18:7  
**Lead** 2:3  
**learn** 46:24  
**learned** 13:10  
14:3 60:3, 5  
**leave** 7:7  
**led** 24:12  
**left** 32:8 33:1,  
23  
**Legal** 2:17  
**level** 26:8  
34:18 49:13  
**levels** 26:2  
**Leviticus** 11:23  
**Li** 25:10  
**life** 19:5 37:8,  
22 40:15 41:2  
**light** 53:9, 15,  
16 54:5  
**likes** 30:20  
**limit** 6:20 8:14  
**limitations**  
27:12, 15  
**limiting** 8:6  
**limits** 42:19  
**listed** 25:16  
**listen** 4:5  
**literature** 23:23  
24:9 25:7 30:9  
40:20 42:2  
**live** 38:3, 9

**lives** 38:12  
48:20  
**living** 30:22, 24  
31:12  
**local** 53:3  
**long** 13:14  
22:8 39:15  
**longer** 36:4  
47:25 51:10  
52:24  
**Longer-term**  
54:21  
**LONG-TERM**  
1:4 2:16, 17, 20,  
21 7:11 9:8, 22  
10:7, 16 11:12  
14:9 21:22  
22:21, 23 23:10  
30:25 34:14  
39:3, 11, 12, 19  
40:7 42:6, 7  
43:12 45:10, 16  
47:12 48:23  
50:2 51:2  
52:22 53:19  
55:10, 23, 24  
56:7 57:14  
**long-winded**  
37:4  
**looked** 6:25  
25:12, 14 41:15  
**looking** 8:9  
15:4 42:10  
46:18 49:12  
55:9  
**looks** 7:13  
22:25 32:9, 18  
38:6  
**lot** 6:18 8:4, 8,  
13, 23 9:10, 22  
12:18 14:3  
18:6 31:6, 24  
33:2 37:14  
38:10 39:22  
40:16 44:8  
46:24 47:3  
50:23 51:25  
57:6, 21 58:22  
60:3, 4, 5  
**lots** 40:19  
**loved** 55:9  
**low** 25:24  
**low-efficiency**  
34:1 41:6

**lower** 23:2  
33:23  
**lowest** 16:5  
**LTC** 6:1, 22 7:3  
**Lynn** 2:23  
  
< M >  
**made** 40:8  
55:7 62:10  
**Mahoney** 2:23  
**main** 35:10, 19  
**maintain** 16:11,  
13 22:17 45:23  
60:12  
**maintained**  
15:22 18:19  
**maintaining**  
57:18  
**maintenance**  
20:4 45:1, 7  
46:17 51:25  
56:22 60:14  
**maintenance-**  
**poor** 52:8  
**making** 44:4  
45:1, 5 48:19  
52:11  
**manage** 5:24, 25  
**management**  
4:22  
**manufacturer**  
38:17  
**manure** 12:20  
**Marrocco** 2:3  
60:7, 25  
**masked** 53:25  
**masks** 40:10, 11  
**material** 12:12  
**materials** 12:4  
**matter** 37:13  
**maximize** 27:10  
**maximum** 27:7  
**meaning** 59:11  
**means** 16:18  
33:17 36:2, 6  
46:4 56:13  
**measured** 35:22  
49:2  
**measurement**  
49:11  
**measures** 18:3  
**measuring** 34:8  
**mechanical**  
19:11 20:17  
22:24 24:20

**mechanisms**  
16:14  
**media** 24:16  
40:9 52:20  
**meet** 20:16  
50:17  
**MEETING** 1:4  
50:18  
**meets** 16:20  
36:19  
**meltblown** 40:9  
52:20  
**membranes**  
51:6  
**men** 5:25  
**mention** 14:7  
28:13 53:7  
57:15  
**mentioning** 21:2  
**MERV** 34:14, 17,  
22 35:1, 18, 23,  
24 36:13, 14, 19  
37:13, 16 40:6,  
22 41:20 44:13,  
14, 15 56:15  
**met** 25:13  
**metal** 22:9  
**metres** 22:8  
**micron** 36:1  
**mind** 39:10  
**mind-bender**  
7:16  
**minds** 47:22  
**Mine** 16:2  
**Mineral** 2:10  
4:16  
**minimize** 28:7  
**minimum** 16:21  
26:11 50:18  
**Minister** 2:15  
**Ministry** 43:13  
44:19  
**Ministry's** 42:24  
**minute** 18:11, 12  
**minutes** 10:23  
**mirror** 44:10  
**missing** 60:11  
**misting** 51:19  
**mix** 6:14  
**modelling** 32:19  
33:1  
**modern** 12:17  
**modification**  
21:13

**moisture** 12:1,  
3, 5, 7 52:1  
**money** 27:13,  
22 47:17 48:5  
55:22 57:5, 6, 7  
**monitor** 47:14  
**monitoring**  
47:13, 22, 23  
48:3, 7, 11, 12,  
17, 18  
**month** 38:6  
39:16, 21  
**months** 38:21,  
23 39:2, 17  
40:24 41:3  
**morning** 42:24  
**mother** 33:9  
**mould** 12:10  
**move** 23:12  
31:20  
**movement**  
24:18 25:4  
30:11, 14  
**mucous** 51:6  
**multifamily**  
30:16  
  
< N >  
**N95** 40:10  
**neat** 17:18  
**necessarily** 9:8  
**needs** 5:6  
20:11 42:21  
46:13, 19  
**NEESONS** 62:22  
**negative** 45:24  
**neglect** 59:17  
**neglected** 5:18  
20:3  
**network** 31:2, 14  
**new** 26:4 40:23  
60:22  
**newer** 38:12  
**nice** 17:18  
39:13 47:14  
55:19  
**nonhospital**  
29:16  
**normal** 37:15  
**notes** 62:15  
**notice** 38:5  
**Number** 25:23  
26:1, 6, 7 37:7,  
22, 23 41:16

<p>47:24 53:1</p> <p>&lt; O &gt;</p> <p><b>observational</b> 26:23</p> <p><b>obvious</b> 54:8</p> <p><b>occasionally</b> 14:21</p> <p><b>occur</b> 18:20</p> <p><b>occurs</b> 46:19</p> <p><b>odour</b> 12:20</p> <p><b>office</b> 29:23</p> <p><b>offices</b> 29:9</p> <p><b>oil</b> 57:22</p> <p><b>old</b> 9:23</p> <p><b>older</b> 38:9</p> <p><b>ones</b> 27:12 32:25</p> <p><b>ongoing</b> 15:18, 21 28:3 56:21</p> <p><b>on-site</b> 29:12 46:15 49:16 60:14</p> <p><b>Ontario</b> 42:13 56:16</p> <p><b>open</b> 22:7 27:8 30:21</p> <p><b>operated</b> 19:16</p> <p><b>operating</b> 27:18 28:6 49:15 57:1</p> <p><b>operation</b> 18:13 20:5 24:12 39:18 49:17</p> <p><b>operators</b> 57:8</p> <p><b>opinion</b> 14:8 36:25</p> <p><b>opportunities</b> 7:10 10:5 60:22</p> <p><b>opportunity</b> 5:21 6:18 42:25</p> <p><b>opposed</b> 15:5</p> <p><b>opposite</b> 6:17</p> <p><b>options</b> 32:10</p> <p><b>Oregon</b> 41:14</p> <p><b>organization</b> 43:9</p> <p><b>original</b> 15:22</p> <p><b>outbreak</b> 10:7 56:9, 11</p> <p><b>outbreaks</b> 6:9 8:9 10:18 48:12, 23 49:23</p> <p><b>outcomes</b> 13:13</p> <p><b>outdoor</b> 16:19</p>	<p>18:5 45:5</p> <p><b>outlined</b> 43:13</p> <p><b>output</b> 35:1, 19</p> <p><b>outside</b> 17:4, 13 51:4</p> <p><b>overall</b> 7:9</p> <p><b>oversize</b> 27:15</p> <p>&lt; P &gt;</p> <p><b>p.m</b> 1:13 4:1 61:5</p> <p><b>paid</b> 29:14</p> <p><b>pandemic</b> 5:17 55:3</p> <p><b>paper</b> 26:21, 23 32:17 33:7 41:13 49:5</p> <p><b>parapet</b> 22:12</p> <p><b>part</b> 14:8 22:3 25:3 46:9 58:19 59:18</p> <p><b>participants</b> 1:11 2:13</p> <p><b>particle</b> 32:1, 3 47:18</p> <p><b>particles</b> 32:15 35:22 36:1, 5, 9 40:14, 16 51:20, 21</p> <p><b>particular</b> 7:12 22:14 24:15 50:23</p> <p><b>particularly</b> 32:18 54:16</p> <p><b>parts</b> 14:5, 16 17:21</p> <p><b>pass</b> 30:4 36:6, 10, 11</p> <p><b>passes</b> 24:25</p> <p><b>path</b> 30:2</p> <p><b>paths</b> 30:21</p> <p><b>patient</b> 31:12 50:12</p> <p><b>patients</b> 41:17</p> <p><b>Patricia</b> 2:24</p> <p><b>pattern</b> 49:1</p> <p><b>patterns</b> 49:19</p> <p><b>Patti</b> 4:9, 11 5:4 15:16</p> <p><b>pay</b> 59:11</p> <p><b>pays</b> 59:7</p> <p><b>people</b> 5:11 9:19 15:11 21:2, 4, 9, 10 28:18 29:7</p>	<p>30:18 31:12 37:20 38:17, 25 46:25 47:3 49:14 54:1 55:11 57:17, 18, 19, 25 58:9, 11, 13, 18 60:12</p> <p><b>people's</b> 51:6</p> <p><b>perceive</b> 15:12</p> <p><b>percent</b> 9:15 15:11 19:10 35:25 36:8, 11, 12</p> <p><b>perfectly</b> 37:17</p> <p><b>perform</b> 18:17 37:8</p> <p><b>performance</b> 40:2, 4</p> <p><b>performing</b> 40:21, 23, 24 41:5 47:5</p> <p><b>performs</b> 18:10, 12 37:17, 18, 21</p> <p><b>period</b> 47:25 52:23</p> <p><b>periodically</b> 46:19</p> <p><b>person</b> 8:7 20:1 25:1</p> <p><b>personnel</b> 46:15 49:16</p> <p><b>perspective</b> 48:4 60:20, 21</p> <p><b>pets</b> 38:4</p> <p><b>Pettenkofer</b> 12:16</p> <p><b>Ph.D</b> 2:9</p> <p><b>Physical</b> 4:19 24:11</p> <p><b>pick</b> 16:1</p> <p><b>picture</b> 16:24 17:1 21:25 33:22 37:11</p> <p><b>piece</b> 49:5 60:11</p> <p><b>pieces</b> 30:15</p> <p><b>place</b> 10:12 24:5 46:14 52:11 62:7</p> <p><b>plan</b> 42:24 43:4, 5, 8, 18 44:9, 22, 24 50:5</p> <p><b>plausible</b> 24:11</p> <p><b>played</b> 6:8</p>	<p><b>pleasantries</b> 4:14</p> <p><b>point</b> 6:3, 6, 16 7:8 10:6 13:19 16:5 19:3 23:22 24:10 28:12 29:5, 20, 25 34:9 36:22 41:25 44:25 47:22 59:5</p> <p><b>pointer</b> 33:24</p> <p><b>pointing</b> 33:24</p> <p><b>points</b> 13:20 19:3 24:17 37:6</p> <p><b>Policy</b> 2:19, 21</p> <p><b>political</b> 13:25</p> <p><b>poor</b> 14:4</p> <p><b>population</b> 14:10</p> <p><b>populations</b> 14:6</p> <p><b>portable</b> 32:20 44:16 51:16 52:12</p> <p><b>positive</b> 33:11</p> <p><b>possible</b> 18:10 27:21 44:14 50:20</p> <p><b>potential</b> 6:19 8:7, 13 25:1</p> <p><b>potentially</b> 5:18 30:3 51:11 53:25</p> <p><b>PPE</b> 40:10 52:18 53:5</p> <p><b>practical</b> 27:12 29:22 60:20</p> <p><b>practically</b> 36:2</p> <p><b>prefilters</b> 41:20</p> <p><b>presence</b> 41:15</p> <p><b>PRESENT</b> 3:1 41:22</p> <p><b>presentation</b> 5:1 6:3 7:8 10:4</p> <p><b>presented</b> 10:21</p> <p><b>PRESENTER</b> 2:7</p> <p><b>pressure</b> 17:9 47:19</p> <p><b>pressurization</b> 45:24, 25</p> <p><b>pretty</b> 7:5 12:9 59:15, 19</p> <p><b>priest</b> 12:6</p> <p><b>priests</b> 12:10</p>	<p><b>problem</b> 6:9 8:17 9:24 10:15 12:1, 3, 7, 21, 22 15:24 17:17 28:22 30:10 39:22 48:14 51:16 52:1, 2 56:7 58:2, 20, 25 59:1, 18</p> <p><b>problems</b> 29:13 51:17 52:1</p> <p><b>proceed</b> 5:5, 7</p> <p><b>proceedings</b> 62:6</p> <p><b>process</b> 15:4, 21, 22 46:10, 11 47:7</p> <p><b>procure</b> 52:17, 23, 25</p> <p><b>produce</b> 53:4</p> <p><b>professional</b> 35:10 43:9 62:4</p> <p><b>Professor</b> 2:9 4:15</p> <p><b>project</b> 26:12</p> <p><b>prominent</b> 12:25</p> <p><b>promoted</b> 57:23</p> <p><b>promulgation</b> 35:12</p> <p><b>proof</b> 8:20, 23</p> <p><b>properly</b> 45:6</p> <p><b>proposal</b> 29:20</p> <p><b>proposition</b> 27:4</p> <p><b>protect</b> 21:3 45:9 55:17</p> <p><b>protection</b> 21:9, 10</p> <p><b>prove</b> 23:19</p> <p><b>provide</b> 19:15 21:15 60:21</p> <p><b>providing</b> 57:25</p> <p><b>proxy</b> 14:21</p> <p><b>Public</b> 4:18 57:17</p> <p><b>publicly</b> 55:7</p> <p><b>published</b> 23:25 42:14 44:2</p> <p><b>pulling</b> 23:3</p> <p><b>put</b> 4:11 19:22 38:24 49:6 55:9</p> <p><b>puzzle</b> 30:15</p> <p>&lt; Q &gt;</p>
---	---	--	--	--

**qualified** 54:16  
57:9  
**quality** 10:24  
11:1, 21 12:12,  
15, 17 13:4, 8,  
12, 20, 24 14:2,  
4, 13, 15, 19  
15:10, 12 16:13  
19:16 20:19  
21:3 25:14  
57:3 58:3 59:6,  
11  
**quantify** 26:10  
**question** 5:11  
7:14, 16 15:17  
27:22 28:14  
37:7 40:2  
42:11, 23 50:8,  
17 55:21  
**questioning**  
54:22  
**questions** 5:5  
6:4, 5 10:21  
11:17 37:2  
49:18 50:25  
52:15 53:9  
58:23 59:24  
**quickly** 43:2  
**quite** 6:25 8:8  
35:23 38:11  
48:13  
**quote** 12:19  
13:6  
  
< R >  
**rack** 22:22, 24  
23:3 45:4 49:14  
**range** 36:5  
**rarely** 6:12 7:17  
**rate** 23:17  
26:25 27:1, 19  
28:20 48:2  
**rated** 41:1  
**rates** 16:3  
47:18  
**read** 44:8  
**reading** 12:2  
**real** 10:19 37:8,  
18, 22 40:15  
41:11 52:7, 19  
53:2 59:14  
**reality** 20:15  
29:12 52:7  
**really** 5:20 6:7  
25:22 29:4

33:2 37:6  
39:14 40:1  
42:19 43:7, 18  
46:1 47:1  
49:18, 24 54:22  
55:19, 23 57:19  
58:18 60:10  
**realm** 13:1, 2  
**reason** 21:6  
33:21 41:7  
**reasons** 13:25  
18:13  
**recirculate**  
17:14  
**recommendation**  
34:18 53:19  
57:15  
**recommendation**  
s 11:15 29:22  
43:10 44:7, 10,  
18 46:7 50:4  
**record** 47:7  
**recorded** 62:11  
**red** 33:17  
**reduce** 48:9  
56:10 57:3, 22  
**reducing** 7:19  
53:11  
**reduction** 23:16  
27:6 31:23  
**referring** 30:12,  
13  
**Refrigerating**  
35:9  
**refrigeration**  
35:17  
**register** 24:23,  
24  
**Registered** 62:3  
**regular** 46:9  
**regulate** 14:25  
**regulations**  
13:23 14:15, 19,  
20, 22 15:8, 23  
45:13, 16, 18, 20  
**reinforce** 60:21  
**relatively** 26:4  
**relevant** 6:17  
22:21 32:14  
35:14 40:1  
**religious** 11:24  
**remarks** 62:10  
**remediators**  
12:10

**remember** 56:5  
**remotely** 1:12  
**removal** 40:13,  
18  
**remove** 41:25  
**removed** 22:10  
36:9, 12  
**replace** 39:2  
**replaced** 39:21  
**Reporter** 62:4  
**REPORTER'S**  
62:1  
**require** 16:10  
**required** 16:4  
52:23 55:4  
**requirements**  
16:10 26:11  
**requires** 51:25  
**requiring** 54:23  
**research** 13:11  
27:2 32:13, 14  
37:3 48:18  
**resident** 46:23  
47:15 50:12  
**residential**  
29:24 30:17  
32:21  
**residents** 33:9  
39:3 45:9  
48:20 53:24  
55:17  
**resistant** 44:5  
**resolution** 33:13  
**resolvable** 59:1  
**resource** 54:15  
**resources**  
26:19 53:22  
59:4  
**respiratory** 6:21  
8:23 9:1 11:8  
32:2 51:9 53:12  
**respond** 56:4  
**response** 28:13  
**responsible**  
60:15  
**responsive**  
48:16  
**restaurant** 24:2  
**retail** 21:23  
**return** 24:24  
**review** 25:9, 21,  
23 26:16, 21, 23  
33:8 41:14  
**rich** 60:18

**rid** 12:4, 7, 8, 20  
**rigid** 22:8  
**rip** 49:5  
**risk** 13:17 48:9  
57:4, 23 58:5  
**risk-reflective**  
56:25  
**RNA** 33:18, 19  
34:2, 10 41:15,  
22  
**robust** 47:6  
**role** 4:21 6:8  
11:7 32:24  
52:12 57:24  
**roof** 22:11  
**rooftop** 21:20  
**room** 22:24  
24:24 27:19  
28:6 46:25  
50:12, 14 57:2  
**rooms** 47:15  
55:11  
**roughly** 15:10  
16:4  
**route** 36:4  
**RPR** 62:23  
**rules** 19:20  
20:7  
**run** 27:11  
  
< S >  
**sad** 59:16  
**safe** 26:2, 7  
**safety** 18:3  
20:18 54:8  
**sample** 33:18,  
20  
**samples** 33:12  
**sampling** 33:16  
**SARS-1** 25:19,  
20 31:11, 12  
**SARS-CoV-2**  
8:21 25:18  
26:4 31:4  
33:18 41:15  
53:14  
**save** 12:2  
**scale** 35:24  
36:15, 18  
**scaled** 32:15  
**scary** 51:20  
**scenario** 19:18  
37:15  
**schematic**  
17:15, 19

**School** 4:18  
27:20  
**Sciences** 4:19  
**scope** 53:6  
**screen** 4:12  
**se** 14:19  
**sealed** 37:12,  
17 49:13  
**secondary** 59:9  
**Secretariat** 2:16,  
18, 20, 22  
**section** 11:23  
**Senior** 2:17, 19,  
21  
**sentences** 25:17  
**serious** 42:21  
48:5, 13, 22 56:7  
**serve** 21:8, 10  
**session** 60:6  
**set** 26:2, 7 62:7  
**settings** 32:21  
**severity** 56:10  
**Short** 14:17  
20:13 39:7  
**shortage** 52:19  
**shorthand** 62:15  
**short-term** 50:2,  
3  
**show** 16:23  
21:25 29:21, 24  
33:21 40:21  
**showed** 37:10  
**shown** 30:2  
54:10  
**shows** 30:8  
**side** 8:11 23:2  
**Siegel** 2:9 4:10,  
15 5:2, 8, 10, 14  
7:13, 23 9:2, 12,  
15, 17, 25 10:3  
14:17 15:7, 20  
16:16 20:6, 13,  
21, 23, 25 26:9,  
14 27:11, 25  
28:3, 9, 11  
29:18 34:6, 16,  
25 35:7 36:16,  
21 37:1 39:5,  
24, 25 41:12, 13  
42:22 43:1, 5,  
19, 22, 25 45:14,  
19 46:6 59:23  
60:9 61:2  
**signals** 34:2  
**signature** 42:3

**similar** 11:25  
19:1 29:24 50:5  
**similarly** 18:19  
**simplest** 18:9  
**single** 31:11  
36:6  
**situation** 11:16  
23:9 42:7, 20  
48:4, 6, 22 50:1  
**size** 19:21 32:1  
33:18 36:5  
**sized** 35:22  
**skip** 43:23  
**slide** 5:11, 12  
22:11  
**small** 37:19  
41:16  
**smaller** 47:24  
53:20  
**snake** 57:21  
**Society** 35:8, 10  
46:13 57:13  
**solely** 13:4  
58:20  
**solution** 52:3  
59:18  
**solve** 51:17  
**sophisticated**  
49:11  
**Sorry** 28:5 34:4  
**sorts** 21:23  
**source** 12:21  
**sources** 38:14  
**space** 12:20  
16:20 17:11, 13,  
14 18:1 24:13,  
18 28:5 30:3  
50:11, 14 54:3,  
6 57:1  
**space-by-space**  
50:16  
**spaces** 16:4  
28:8 47:16, 20  
54:11 57:2, 4  
**speak** 57:12  
**speaking** 9:10  
**specific** 11:15  
38:25 42:5  
44:11 46:7  
50:21  
**specifically**  
11:9, 13 18:24  
23:13 35:2  
42:1 53:13

**specify** 26:10  
**speculation** 6:11  
**spend** 10:22  
19:5 21:1  
47:17 48:7  
50:6 52:5  
**spending** 11:14  
19:9  
**spent** 48:6  
**spread** 6:10, 20  
7:18, 19, 22  
14:12 23:16  
24:5 25:25  
27:6 28:7  
30:10 31:6, 12  
32:20 34:19  
51:11  
**spreads** 34:10  
**square** 33:22  
**Stabber** 3:3  
62:3, 23  
**staff** 29:13  
55:12 60:14, 15  
**standard** 8:20,  
22 16:2, 3, 11,  
13, 21 35:2, 20  
37:9  
**standardization**  
39:23  
**standards**  
35:13, 14, 15  
46:2 47:9 50:9,  
17, 18 54:24  
55:1, 2  
**stands** 35:6  
**start** 5:3 11:20  
18:20 23:13  
**started** 12:14  
**starting** 6:2, 6  
**starts** 11:22  
30:17  
**state** 7:1, 9 9:8  
11:11 59:16  
**statements**  
12:18  
**static** 40:12  
**steam** 51:23  
**Stenographer/Tra**  
**nscriptionist** 3:3  
**stenographically**  
62:11  
**sticks** 49:7  
**stop** 6:19 21:7  
36:24

**store** 21:23  
22:4  
**Stowe** 12:24  
**strategies** 44:3  
**structural** 53:2  
**structured** 6:3  
**students** 29:19  
**studies** 23:19,  
20 25:6 26:17,  
20  
**study** 12:17  
26:12, 15, 16, 19  
**stuff** 40:9  
42:14 52:18  
**stuffy** 47:1  
**substantial** 20:5  
59:19  
**sucking** 49:7, 9  
**sufficiency**  
45:17, 20  
**sufficient** 46:4  
**suggest** 37:20  
49:20  
**suggesting**  
53:13  
**summarize**  
58:24  
**summarized**  
32:7  
**superior** 34:22  
40:8  
**supplement**  
44:16  
**supply** 24:23  
**supplying** 24:23  
**supposed** 15:5  
21:15 22:15  
39:21  
**surprised** 9:19  
**susceptible** 51:7  
**swab** 33:16  
**symbol** 33:17  
**symptom** 33:13  
**system** 8:1  
10:9 16:25  
17:3, 7, 20 18:2,  
10 19:19, 22  
20:11 21:3, 8,  
15, 20 22:17  
23:15 24:4, 5,  
12, 24, 25 25:5  
27:8, 16 29:8  
30:7 31:17  
38:4 41:19, 22

45:2, 9 47:4  
51:15, 24 54:3  
**systematic** 27:2  
**systematically**  
20:3  
**systems** 5:17,  
25 6:1, 8, 11, 19  
7:2 8:14 9:10,  
19 11:2 16:23  
17:12, 18 18:6,  
8, 16, 22 19:1, 4,  
12 21:7 23:8, 9  
30:9 35:11  
42:16, 17 45:10  
46:14, 16, 20  
48:15 53:10, 17,  
20 55:5, 22  
56:1 57:18  
58:25 59:2, 15,  
17 60:12  
**< T >**  
**takes** 17:4  
**talk** 4:20 5:21  
10:4 11:4, 5  
29:7 35:13  
46:7 57:17, 18  
58:9  
**talked** 39:6  
58:22  
**talking** 46:25  
49:11 52:6  
60:17  
**targeting** 53:20  
**Task** 44:1  
**technical** 58:20  
**technologies**  
57:22  
**technology** 59:3  
**tells** 20:10  
**temperature**  
47:15  
**temperatures**  
20:16 45:23  
**temporally**  
18:14  
**ten-point** 42:24  
44:9, 21, 24 50:5  
**term** 16:22  
**terms** 20:3  
29:22 47:13  
**test** 35:19 37:9  
**tested** 33:11  
35:20

**testing** 46:17  
**tests** 32:12, 25  
**Texas** 33:8  
34:24  
**text** 44:8  
**texts** 11:24  
**thanks** 5:15  
59:22  
**theoretically**  
18:25  
**thermostat**  
17:24  
**thick** 22:8 38:7  
39:14, 20  
**thing** 29:11  
47:8 55:19  
**things** 6:14 7:7  
11:13 13:18  
14:18 17:19  
18:5, 23 20:15  
21:7, 24 28:17  
29:15 30:18, 20  
40:17 43:17, 20  
44:10 46:4  
47:14, 18 48:1,  
9 49:10, 20  
50:1 54:14, 15,  
17, 19 55:10  
56:4, 15 58:10,  
12 60:16  
**thinking** 19:5  
**third** 36:11  
**thorough** 60:2  
**thousand** 11:22  
**thumb** 19:21  
20:7  
**time** 10:21  
11:14 15:19, 23  
16:7 18:18, 20  
19:24 21:1, 17  
36:9 39:15  
40:18 41:2  
47:25 48:2, 11  
50:6 52:23  
62:7, 10  
**times** 5:19 39:6  
**title** 5:12  
**today** 4:20  
12:23 51:4  
**toilet** 49:5  
**toilets** 30:20  
**told** 11:10  
**ton** 21:1 29:13  
37:19



<p><b>top</b> 18:7 <b>topic</b> 5:22 <b>Toronto</b> 2:11 <b>training</b> 49:22 <b>transcribed</b> 62:12 <b>transcript</b> 62:15 <b>translate</b> 7:10 <b>transmission</b> 8:2, 5 23:17 24:12 27:1 36:3 50:19 51:8 53:11 55:3 56:23 57:4, 20 <b>travel</b> 24:22 51:10 <b>treated</b> 55:11 <b>treating</b> 17:16 <b>treatment</b> 17:6 <b>true</b> 12:22 20:14 29:15 62:14 <b>trying</b> 9:6 18:22 26:21 <b>tuberculosis</b> 32:9 <b>turn</b> 5:2 16:25 <b>turns</b> 14:24 <b>type</b> 23:6 24:21 45:7 46:16, 21 47:7, 10 59:6 <b>types</b> 21:21 39:1 40:20 41:10 42:15 44:3 46:13, 21 47:8 49:18 <b>typical</b> 18:2 19:8 29:1 30:6 34:10 40:5 41:19 54:13 56:7 59:10 <b>typically</b> 4:24 15:9</p> <p><b>&lt; U &gt;</b> <b>ultrasonic</b> 51:19 <b>ultraviolet</b> 53:9, 10, 15, 16 <b>understand</b> 4:6 49:19 55:24 58:18 <b>understanding</b> 9:7 48:19 49:23</p>	<p><b>undervalue</b> 30:19 <b>unfortunate</b> 59:20 <b>unfortunately</b> 52:4 <b>uninfected</b> 30:5 <b>unit</b> 22:1, 3, 7, 14 <b>universally</b> 34:17 <b>University</b> 2:10 <b>unproven</b> 8:18, 22 <b>unrealized</b> 8:14, 16 <b>unregulated</b> 13:21 <b>upgrade</b> 55:4, 22 <b>upgraded</b> 55:16 <b>upper-room</b> 54:3 <b>useful</b> 17:1 <b>uses</b> 32:18 <b>usual</b> 16:21 20:4 <b>utility</b> 17:2 <b>UV</b> 53:20 54:3, 5, 8</p> <p><b>&lt; V &gt;</b> <b>value</b> 48:18 58:1 <b>valued</b> 55:19 <b>variations</b> 16:7 <b>varied</b> 16:4 <b>variety</b> 13:11, 12, 24 18:12 25:15 51:14 59:8 <b>various</b> 18:3 33:16 47:9 <b>ventilate</b> 12:21 51:3 <b>ventilated</b> 38:13 <b>ventilation</b> 4:21, 24 11:7, 11 13:4 14:20 15:25 16:1, 3, 17 22:2 25:9, 15, 24 26:2, 6, 8, 11, 20, 24 27:5, 7, 10, 16, 17, 19, 24 28:8, 24</p>	<p>29:3 30:13 31:20 32:10 35:13 42:16 44:12 47:18 48:2 50:8, 10, 13, 17, 24 54:24, 25 55:2, 5, 16, 17 56:3, 8, 10 <b>verify</b> 16:18 <b>VERITEXT</b> 62:22 <b>view</b> 11:2 60:18 <b>virus</b> 31:4 32:18, 21 42:1, 3, 4 53:14 <b>vulnerable</b> 14:5, 10</p> <p><b>&lt; W &gt;</b> <b>Walwyn</b> 2:21 <b>wanted</b> 21:25 40:1 <b>warm</b> 55:6 <b>water</b> 51:9 <b>ways</b> 30:8 <b>week</b> 54:14 <b>weeks</b> 40:23 <b>widely</b> 24:15 <b>window-opening</b> 49:1 <b>windows</b> 27:8 30:21 <b>WITNESS</b> 8:19 <b>WLG</b> 2:23, 24 <b>women</b> 5:25 <b>wonder</b> 43:6 <b>wonderful</b> 13:2 43:6 <b>word</b> 48:22 <b>work</b> 4:6 7:2 12:5, 7 29:7 <b>workers</b> 28:19 <b>working</b> 7:3 45:2 <b>works</b> 49:5 <b>world</b> 13:22 15:2 41:24 42:12 52:19 <b>worry</b> 6:22 <b>worse</b> 29:2 37:21 <b>worth</b> 21:2 <b>writings</b> 13:2 <b>written</b> 12:12 <b>wrong</b> 19:17</p>	<p>48:21 <b>wrote</b> 12:25</p> <p><b>&lt; Y &gt;</b> <b>Yeah</b> 5:13 9:17 10:3 16:16 27:11 28:4 34:25 36:13 43:22 45:19 <b>year</b> 24:1 41:2 56:7 <b>years</b> 11:22 12:14 13:7, 11 16:6 25:10 <b>yellow</b> 30:2 <b>Yuguo</b> 25:10</p> <p><b>&lt; Z &gt;</b> <b>Zoom</b> 1:11</p>
---	--	---	--