SCOTTISH HOSPITALS INQUIRY

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Day 39
Thursday, 31 October 2024
Mr Allan Bennett (Part 1 of 2)

CONTENTS

Pages

BENNETT, Mr Allan (Affirmed)

Questioned by Mr Connal KC 2-156

10:03

THE CHAIR: Good morning. Mr Connal?

MR CONNAL: Mr Allan Bennett, my Lord.

THE CHAIR: Mr Bennett. Good morning. Good morning, Mr Bennett. Now, as you appreciate, you're about to be asked questions by Mr Connel, who's sitting opposite you, but first I understand you're prepared to affirm.

THE WITNESS: Yes.

Mr ALLAN BENNETT
Affirmed

THE CHAIR: Thank you very much, Mr Bennett. Now, we have you scheduled for two days, although I'm bearing in mind that we will be aiming to finish before three tomorrow. We'll take coffee breaks at about half past eleven, but, as I say to all witnesses, if you want to take a break at any time, just give me an indication and we'll take a break.

The other thing I'd like to say is you've got quite a large space to fill. There's the assistance of the microphones, but can I encourage you to speak maybe a little more slowly than you might otherwise speak and a little bit louder than you would? I mean, it's not always easy, but----

THE WITNESS: Okay.

THE CHAIR: -- I'm very conscious of this because my hearing is not what it was. Now, Mr Connal.

Questioned by Mr CONNAL KC

MR CONNAL: Thank you, my Lord. Mr Bennett, you have produced two reports that we're going to ask you about in the course of this session of your evidence, one on ventilation deficiencies, which I'll come to in a moment, and another on Cryptococcus.

A Yes.

Q In each case, you were also asked a series of what one might describe as supplementary questions, and you've produced written replies to these questions, is that correct?

A That is correct.

Q Thank you. We'll deal with these in due course, but if we can go to the first of them for identification. Can we go to bundle 21, volume 1, page 611? Now, presumably, you recognise that as the report that you produced on that topic?

A I do.

Q You do. Thank you very much. There isn't, in fact, a statement from you. You simply produced these reports and supplementary material, is

that correct?

A That's correct.

Q Now, if we go to page 613-- I'm going to come to your CV just in a moment, but I just want to check exactly what you were asked to do. You were asked to address questions from a microbiological perspective, in particular whether the ventilation systems were in an unsafe condition in the sense that it prevented an additional risk of avoidable infection, and then whether that had changed.

Now, just while I'm on that page, I think you probably understand that one view expressed in this Inquiry is that you can't just look at ventilation because there are other things that are done to keep people safe in their rooms, as they now are in the new hospital. I think you touch on that later in your report when you mention bundles.

A Yes.

Q That's something you're familiar with?

A Yes. Often in hospital infection control, a series of infection control practices are referred to as a bundle, which may be hand washing, it may be isolation rooms, it may be wearing of protective equipment, etc., etc.

Q Your expertise lies in the ventilation element?

A In this case, yes. I am aware of certain aspects of other infection control practices, but I was not asked to address them in the report.

Q Thank you. Perhaps we can just have a look at your experience and qualifications, maybe just to pause a little bit on that for a moment. So if we go to page 614, in paragraph 2.1, you narrate your early career, including time at the now defunct National Engineering Laboratory in East Kilbride, before you went down to Porton Down.

A Yes.

Q Essentially, what you tell us there is that from 1988 until 2023, under various labels, you worked at Porton Down, is that right?

A That is correct.

Q In terms of what you were actually doing there, you say in paragraph 2.2 that:

> "[Your] research interests [of 35 years] have been around airborne transmission of infection and its prevention."

So, that's what you've been focusing on, is that right?

A That has been a major focus of my working career at Porton Down.

Q Yes, and you narrate that you've led a research group of 10 to 20 scientists, and you mention various projects. In 2.3, you mention testing

equipment used in various places, including healthcare, including, I see, filters and air samplers, which we've heard a bit about in this Inquiry. Is that the kind of thing you were looking at?

A Yes. I have some experience of testing laboratories to ensure that they have the correct air change rates, pressure differentials and to make sure that the filters are operating correctly.

Q Then, in paragraph 2.4, you say you have "experience of leading investigations of microbial contamination of air" in a variety of locations, a little excursion into anthrax due to drumming.

A Yes.

Q An investigation about animal skins, if I recollect correctly.

A Yes. It was a fatal case of anthrax in the Scottish Borders, and also into another fatal case in London. In both cases, it was associated with the playing and possible manufacture of djembe drums.

Q You do seem to then be involved in advising in various pandemics – you say the 2009-2010 influenza pandemic and the COVID pandemic – further on in 2.4, going on to the top of page 615 in your report. So, again, were you looking at airborne transmission? Is that what you were focusing on?

A There's two aspects of this: (1) I led teams who air sampled in hospitals around patients with influenza and with SARS-CoV-2 to measure the potential emission of aerosol particles from those patients. I also, during the COVID pandemic, especially during the early stages, was part of a subgroup of Sage looking at environmental factors in the transmission of COVID, looking at the things like ventilation, disinfection, etc., and to give advice to the main Sage group.

Q Thank you, and you actually say at the end of paragraph 2.4 that the results of your studies, you say, "impacted on infection control guidance," is that right?

A Well, yes. I mean, I think the results of those studies-- there wasn't just air studies. The study of how long the organism survives on surfaces did impact on infection control guidance for the wider public.

Q In paragraph 2.6, you mention a slightly different issue, which is high containment facilities, but presumably also concern with transmission in the air. Is that what you're focusing on there?

A I think what I'm trying to get across-- I sort of understand a certain amount about the design and building of complex facilities that involve specialist ventilation systems.

Q In 2.7, you tell us that you're a member of the International Editorial

Board of the Journal of Hospital Infection since 2017----

A Yes.

Q -- where you're looking at publications on the environment and infection control in healthcare, is that right?

A That's correct. So the journal sends me papers in my specialist area, which I review to assess whether they're suitable for publication and also to maybe suggest changes that need to be made.

Q Then, also in that paragraph, you tell us you were involved in investigating the Northern Ireland neonatal Pseudomonas outbreak, is that right?

A That's correct, yes.

Q Also a global outbreak of another bacteria we've been hearing about during the Inquiry, Mycobacterium chelonae.

A Yes.

Q Although, in your case, it was associated with cardiac surgery, is that right?

A That's correct, yes.

Q The next one, is that a third investigation, "sink-associated anti-microbial resistant [gram-negatives]"?

A Yes.

Q That was a different one?

A Yes, they're all different group-- I mean, the group I led in a UK HSA, we tended to be called in to give specialist-- to carry out specialist research in environmental transmission of various microorganisms, often associated with the use of equipment and often associated with potential airborne transmission.

Q Thank you. If we go on to 616, you say that you're an expert in the transmission of airborne microorganisms and the prevention of their spread, but you acknowledge, I think – and this is a point that some are interested in – you have no clinical expertise; you haven't been a doctor.

A No, no, I've never had any clinical practice.

Q Yes, and you haven't worked directly in a hospital environment other than when you've been carrying out your research, is that right?

A Yes, I've never had a day-to-day job in a hospital, but I have visited a reasonable number of hospitals in the UK.

Q Yes, thank you. The Inquiry has already heard a lot of evidence about ventilation generally, so I may not need to take you to the whole of your material on the introductory section, but that starts on page 616 where you say, well, you need to understand what was in place and also how air is involved in the transmission of organisms, is that right?

A Yes.

Q Were you given an understanding of what was in place, what was actually built at the Queen Elizabeth Hospital?

A I was given access to a wide range of documents about the hospital and about its construction, a very wide range of documents which I've referred to, but I have to state I only visited the hospital once, in October 2023, so I don't necessarily have a great, in-depth knowledge of walking around the hospital, if you know what I mean. I was there for a short period of time.

Q You were proceeding on the documents that you were given. Do you know anything about what oral discussions did or did not take place about ventilation decisions at the Queen Elizabeth Hospital, or were you just working on documents?

A Well, I mean, I wasn't there, so yes, I-- If oral discussions were not written down, I would not know of any evidence of oral discussions.

Q I might just ask you at that point, if somebody is going to make a significant decision about how the ventilation system is to be structured or any proposed alterations to the changes or anything of that kind, would you normally expect to see something in writing?

A I think anything that has an impact on infection control or, in fact, anything that has an impact on the design and the cost, etc. of the building, I would expect to see some form of written evidence and a rationale for decisions.

Q In paragraph 4.2, you say that the primary function of ventilation is to provide a comfortable environment, and you say it's also intended to protect patients from exposure to microorganisms in the air. We'll come back to one or two questions about that a little later, but you describe hospitals as "unusual public spaces." Why do you call them unusual public spaces?

Q I dealt often with spaces in which people move through on a transient basis. So, for example, we will come into this room at ten o'clock and we'll leave at four o'clock, and we'll be here for maybe four hours during that period of time, and that's our exposure. But in a hospital, the patients are there 24 hours a day, so they need to be protected 24 hours a day.

Q Are there other people who need to be protected other than simply the patients?

A Well, the staff, yes. And, well, you have a duty of care for anybody in your building, so staff, visitors, you know.

Q Thank you. Then you make a point in paragraph 4.3 that ventilation has

perhaps gone up the list of things people are interested in since the COVID pandemic. Is that a fair comment?

A I think that's a very fair comment.

Q Do you think things have changed post-COVID in terms of attitudes to ventilation?

A I think they have. I think there's a lot more lobbying, a lot more pressure groups looking at improving ventilation, and also some international organisations seem to be pushing ventilation as a priority.

Q You go on in paragraph 4.4 to record, as we know, that the Queen Elizabeth Hospital is fully sealed, mechanically ventilated, no natural ventilation, and then you say:

> "This decision was taken at least partially due to concerns about odours from the neighbouring … facility."

Is that something that you were told in documents or-- Why do you say that?

A I think I've read that in, yes, a number of documents that were written around before the building was finally designed and constructed, I think, from design teams, and I think-- Well, I mean, I can't say for definite, but yes.

Q I think you say it was partly due to that. Have you had to look at any range of documents about why the building is where it is, or has that not been within your remit?

A I've been asked to write a report assessing the impact of the proximity to the sewage treatment works.

Q Yes, which is a separate document----

A A separate document, yes.

Q -- that no doubt we'll all look at on another day, but subject to that, for the purpose of this report, why the building is sited where it was, that wasn't within your remit, was it?

A No, I don't think it's part of the remit of this report or the Cryptococcus report either.

Q Thank you. You simply record, which I think we know, that carbon filtration had been proposed and then wasn't in the end result used, so we can move on to 618. You start with the topic "Dilution of Air." Probably material that the Inquiry has heard from various witnesses, but you're saying there:

> "The provision of the supply is to provide a comfortable environment and to remove contaminants…"

Is that right?

A Yes, and maybe to remove heat as well.

Q Sorry?

A To remove heat.

Q To remove heat as well. Okay. Now, we've had a lot of discussions about air changes and litres per second

and other measures of the movement of air in a patient space. In paragraph 4.6, you talk about it in the context of air changes per hour.

A Yes.

Q Is that what you're used to doing?

A I think generally amongst infection control people and among people in my field, we've always used air changes per hour as a measure of ventilation. However, I am aware that the more wider architects and engineers are starting to use litres per person per second, which is something I never really have used in my career.

Q Then you record in that paragraph something we've heard a lot about, an air change rate of six for wards and single rooms, and 10 for specialist facilities. You reference HTM and SHTM references for that. Are you making a point at the end of that paragraph about why air change rates measured in this way are good, because they can be measured and monitored easily?

A I mean, I'm sure the litres per person per second-- Well, I mean, you can't really monitor how many people there are in a room, but that could be monitored with a nominal number of people.

THE CHAIR: Whereas air change can be monitored? Air change rate.

A I think it's easier to monitor because you know the volume of the room and you know the air flow, so you can monitor like that. When it's 8 litres per person per second, if you had to monitor, you would have to decide on the nominal number of people within the area that you're ventilating.

MR CONNAL: Now, this is just a point of detail: in 4.7, you touch on the litres per second provision and you reference the Scottish building standards, and then you say:

> "… fresh air provision rate is not currently used as a specification in relevant healthcare guidance."

Now, I'm not sure we need to dig it out, but NSS tells me that there is a provision in SHTM 03-01, Part A (2022) at paragraph 4.22 that says:

> "In the absence of other guidance, 10 L/s/person per second should be taken as the minimum ventilation requirement."

A But that's in the absence of other guidance when there is already guidance for 6 air changes and 10 air changes per hour.

THE CHAIR: Could I just have that again? This is what NSS have brought to your attention, Mr Connal?

MR CONNAL: Yes, my Lord. We have, obviously, all the documents available if need be, but the quotation is

to SHTM 03-01, Part A (2022) at paragraph 4.22.

THE CHAIR: What's the point they're trying to make?

MR CONNAL: That, in general areas and wards, this guidance says:

> "In the absence of other guidance, 10 L/s/person should be taken as a minimum ventilation requirement."

THE CHAIR: Right, thank you.

A So I think they may be addressing public areas, not wards and not patient rooms.

THE CHAIR: I don't seem to follow because there's other guidance which does address these areas, yes.

MR CONNAL: One of the points that a number of witnesses have been keen to stress to us, Mr Bennett, and it appears you would agree with them, is that it's not just a question of talking about air change rates and pressures, but what can be important is the direction that the air moves. Is that of significance in a health care setting?

A Yes. Obviously, if you have a patient with tuberculosis, for example, in a room, you want to be sure that none of that air from that room gets outside the room and potentially infects other people. Therefore, you want the air from outside to go into that room to make sure that any aerosol generated is extracted and doesn't go into an occupied area.

On the other hand, if you have a patient who is severely immunocompromised and is at danger of being exposed to maybe common microorganisms, you then will want them to be in a room in which the directional airflow-- well, filtered air supply is in the room and the air from that room goes out into the ward or the adjacent area to protect that person from other patients, staff and environmental sources of infection.

Q What you've done in this section of your report, as you indicate at the end of paragraph 4.8, is just touch on the basic principles of how this operates.

A That is correct.

Q In 4.9, you're dealing with the infectious person, such as the one with tuberculosis. Just a point of detail: you say in the middle of 4.9:

> "… normal practice … house them in a negative pressure space where all air from the room will be extracted…"

Is it all air that is extracted? Is it as absolute as that?

A Yes, yes.

Q Does some of the air not mix and dilute?

A All the air will, at some time, be removed from the room, so you'll have an extract system which pulls a certain

volume of air per second from that room and, if the room's got 10 air changes, that means 10 times the volume of the room will be extracted from the room-- sorry, the volume will be extracted from the room.

Q Thank you, and then 4.10, we come to the example you gave about immunocompromised patients. I just wanted to pause on that just for a second because you point out, no doubt correctly, that these patients are highly vulnerable to infections by opportunistic pathogens, and then you say in the middle of that paragraph:

> "These agents may be common environment agents or be human derived from other patients, staff or visitors."

A Yes.

Q So, in your experience, that's a possible source of challenge to the vulnerable patient, is that correct?

A Yes, yes. I mean, all this is obviously a clinical decision of whether the vulnerability of the patient will depend on a clinical assessment of, for example, a white blood count, etc.

Q Yes, yes. Well, can we go on to page 620? I just wanted to make sure I'm understanding the point you're making in paragraph 4.11. If I'm understanding
it correctly, what you're saying there about-- you're saying, well, the level of pressure is decided by national guidance and the magnitude required to avoid fluctuations from positive to negative.

Now, is that something about if you want negative, it can't be just negative, or positive, just positive; there has to be a sufficient amount of positivity or negativity in the pressure? Is that the point you're making?

A Yes. I mean, if you have, for example, a room at 10 pascals positive pressure and it fluctuates by-- because things do fluctuate-- it fluctuates by 2 pascals, then you will get something between 8 and 12 pascals positive.

However, if you set the room at 1 pascal positive and it has a 2-pascal swing, then that'd be from minus 1 pascal to 3 pascals, so if the pressure differential is set too low, there is a possibility that it may swing in the other direction.

Q Yes, and presumably, that then has consequences for the intended treatment of the patient, whether you're removing infective items with a positive pressure or you're trying to keep them out.

A Yes, it does, yes.

Q Now, in the next section – and you're dealing, I think, largely still with introductory material – you're talking about filtration and you talk about HEPA filters, which we've heard quite a lot

about, and where they may be installed, and the point that I think we've had from other witnesses that you need to monitor them to see whether they're blocking up and becoming less efficient as a matter of routine.

A I mean, there's different reasons for monitoring the HEPA filters. You can monitor the pressure drop across a filter because, if the filter gets blocked, it may affect the flow, the volume of air going into an area, but there is also-- with HEPA filters, there is a requirement in specialist facilities to test them on, I think, an annual basis in order to show that they're performing correctly.

THE CHAIR: Can you help me with a term which, no doubt, I should understand but don't: "room junction," which we see, for example, in 413?

A That just means-- In some instances – and I don't think in the QEUH hospital – you can put filters basically like there, on the actual ceiling, but that is not done at the Queen Elizabeth Hospital, so it's a bit irrelevant.

THE CHAIR: Because the HEPA filters are, as it were, further back----

A Yes.

THE CHAIR: -- in the system, but if I wanted to know what "room junction" means, it's the interface between the ventilation system and the actual space----

A Yes.

MR CONNAL: -- the room space.

A Yes.

THE CHAIR: Thank you.

MR CONNAL: Then, finally on HEPA filters, you mention at the bottom of that page the portable filters, which we've heard a little bit about and which you'll touch on later, and you make a point about what they do and don't do there, portable HEPA filters.

A Yes. So, if you've got a room-- If there's a HEPA filter in the supply to a room, then you cut no environmental-- well, it really cuts down any chances of environmental organisms entering a room. If you've got a recirculating HEPA filter in the room, those agents can get into the room, but then they will be filtered out by the recirculating HEPA filter, but they will be in the room. They will get into the room.

Also, the thing about portable HEPA filters is they are not generally tested, so people do not test them on a regular basis to see whether they're still operating correctly. And obviously, since some of them are on the floor, they may be subject to being used as door stops or they may be accidentally kicked or, in some instances, they're accidentally switched off, so they don't have the same assurance and performance of a supply HEPA filter.

THE CHAIR: Would I be right in thinking that, if your HEPA filter is, at some point, in the source of the incoming air, it will trap either 99.98----

A Yes.

THE CHAIR: -- or 99.9 of incoming pathogens, depending on size? But with the portable HEPA filter – I'm imagining something that is sitting somewhere in the room – to an extent, it's a random event as to whether any particle which has come into the room encounters the filter? Or is there a mathematical inevitability that it will encounter the filter?

A I think, with these filters, a lot depends on flow rate through the filter. Are they just putting a tiny part of the air in that room through a filter, or are they correctly sized? And also, where are they positioned? So, if you had a small recirculating HEPA filter in that corner there, the person over there will almost definitely not get any benefit from it.

So, it depends how many additional air changes they supply for a room-- you know, clean air changes. So, I didn't see anything-- So, having a small one in a big room won't do anything, but having a big one in a small room will be better.

But the problem you get with such-- sometimes you get concerns about noise and sometimes you get concerns that people are accidentally switching them off because they don't know what they are, or are people unplugging them and putting something else in the plug socket?

THE CHAIR: Let me just repeat the question: if we have a HEPA filter in the corner and we're concerned with the impact of that HEPA filter on the air quality in a larger space, I think – I mean, this is my ignorant suggestion – it would seem to me that whether, if there is somewhere in the space, something you want to filter out, would I be right in thinking that it is random as to whether or not that thing that you want to filter out ever encounters your HEPA filter?

A I mean, I think it's one of these things that, if you want to pay somebody to do computer modelling of something like that, you can get figures for this. It's going to depend on where the aerosol source is, where the portable HEPA filter is, and the amount of air that goes through the portable HEPA filter.

THE CHAIR: Right, thank you. Sorry, Mr Connal.

MR CONNAL: No. Now, I'm content to move from portable HEPA filters now, Mr Bennett. You deal in the next section with what you describe as "practicalities." You mention something we've heard of from other witnesses, that usually systems are designed with some extra capacity, what you describe, I think, as "oversized" because fan performance

reduces over time, and also, you say, to allow for the potential of increased airflow in the future. Is that something that's normally built into a system, in your experience?

A I'm not an expert on the construction of hospitals in the UK, but in my experience of other facilities, there is margins built in so that you're not using everything 100 per cent so that there is a potential to increase the flow through a system.

Q I think other witnesses have suggested, perhaps, that it's easier to spend some extra money building in the flexibility at the start, because it can be difficult to change things later. Would you agree?

A Oh, yes. I mean, I think that is the trick of designing buildings which require a good ventilation system is that, you know, if you don't get it right first time, then you're going to have to strip everything out and put something else in, and that causes disruption and increased cost.

Q Thank you. Now, again, bearing in mind the report was prepared a little while back before we heard a lot of the evidence that we've now heard, you then go on to deal with various types of isolation rooms and you give general descriptions of these.

You talk on page 622 of negative pressure rooms and you set out when they're used. You talk about positive pressure rooms on the next page, but the next item you deal with are these PPVL rooms. Now, we've heard quite a lot of evidence about PPVL rooms. You, I think, when you're talking about them, assume they can be used for two types of patients, is that right?

A They have been used for-- in some cases, for both immunosuppressed patients, patients with an aerosol transmissible disease, but also for patients who are immunosuppressed and have a transmissible disease.

Q There's a debate as to whether they're set up properly and whether they have other issues, but why are they, at least in principle, capable of dealing with both of these?

A Because of the air direction, because there is no way for aerosol to be moved from the room through the positive pressure lobby and out of the-- as long as the air change rate is high enough in the lobby-- and move out into the general ward. And it also provides a supply of HEPA-filtered air for the immunosuppressed patient.

Now, you know, a lot of this-- sometimes you've got to look in the detail of some of these things and sometimes, you know, there may be-- The rooms have got to be used properly. There's no

point having any isolation room and somebody jams the door open, for example, or is in and out of the room on a sort of regular basis.

Q When you comment on PPVL rooms, you refer to a study. It sounds a bit like a Dutch study to me. Anyway, it doesn't matter. At the top of page 623 – I won't try to pronounce the name – but the 2020 study----

A He's actually an Irish----

Q Oh, it's an Irish one?

THE CHAIR: That's a bit counterintuitive.

MR CONNAL: Now, it's been suggested that the study in question didn't involve a very extensive exercise – it was only two isolation rooms over eight weeks – and the authors suggest perhaps a bigger study would be a good idea. Would you agree?

A I would agree, yes. I mean, I was just using it as-- as mentioning that people have used PPVLs to house infectious patients.

Q Thank you. Then, as I said earlier, you go on to positive pressure isolation rooms, and I'm not going to ask you about that. You touch on chilled beams, and I am going to ask you about that a little later because you just deal with it by way of introduction at this point.

So, having had that introduction, you then go on in section 5 to head this section as "Air Microbiology." So, this is where you're trying to look at what the potential link is between ventilation and infection, is that right?

A Yes, I'm trying to look at what the potential sources of microorganisms in the air that could be a potential hazard for patients.

Q You make the point in 5.2 that there are lots of organisms floating around in the air to which we're all exposed, but some people may suffer if they are exposed to them.

A Yes.

Q In section 5.4, you're indicating there that there's been some revisiting of the question of how things like SARS are transmitted, is that right?

A The potential for aerosol transmission of diseases like influenza and SARS has long been a point of disagreement between different scientists about to what degree they are capable of being transferred longer distances, and this became quite political and quite a major argument during SARS-CoV-2 about how much transmission was long distance, i.e. longer than 1 or 2 metres.

Q So this is why we had discussions about, "Keep 2 metres away from each other" and so on.

A Exactly, exactly. But, like anything, it's a spectrum, in my viewpoint. I was a co-author of a paper in which we

did manage to find a few papers that seemed to be showing longer than 2-metre transmission of SARS-CoV-2 from the scientific literature of reasonably high-status papers.

Q Yes. These are the two papers that are referenced in the latter part of paragraph 5.4 in the details – I mean the footnotes – and I'm not going to ask you to look these up. You say, well, it depends on the amount of aerosol, particle size, how infectious it is and so on.

A Yes.

Q Yes. Then you make a point that's particularly aimed at people in hospital, I think-- that you say duration of exposure increases the risk.

A Yes.

Q Is this your 24 hours point?

A Yes.

Q So unlike, you know, me going down to my local restaurant and going in and moving around there, the inpatient essentially stays in one location?

A Yes, yes, so, the patient will be-- For example, if there's one patient with disease X and a patient who isn't exposed to that in the same ward, the fact that they're there for 24 hours means that exposure-- You know, they may not be exposed to high concentrations, but they're exposed for a long time.

Q Then you go on in your general discussion here, having dealt in that section with airborne transmission, to another topic that you obviously studied during COVID, I think, in particular the contamination of surfaces, is that right?

A Yes.

Q How you can pick things up. I see here:

"Particles contaminating bedding may be re-aerosolised…"

Is that right?

A Yes, that's been demonstrated.

Q So you describe that as a risk which is lower than direct transmission but might be significant?

A Yes, for some diseases.

Q Then the next section is direct exposure to an environment, is that right?

A Yes, yes.

Q You list there things like Aspergillus and Cryptococcus, "commonly found in outside air."

A Yes, yes.

Q Also Aspergillus----

A Yes, yes.

Q -- arising from water damage, is that right?

A It can-- Aspergillus can arise from building works, it can arise from various things, but I think there was evidence of Aspergillus growing in water-damaged surfaces in the Queen Elizabeth Hospital.

Q Yes. You make the point about building works in that answer, and I think you say:

"Aerosolization of fungal opportunistic pathogens has been linked to [building and demolition works]."

Is that right?

A Yes, so it has, yes.

Q Look at the top of page 626, and steps need to be taken to protect against that?

A Yes.

Q Then other agents frequently found in showers and so on, is that right?

A They can be found, yes. They can be found in water and showers.

Q Then you deal with indirect transmission, and then, in 5.10 on page 626, you deal with the issue of particle size. Just tell us what you're trying to explain in that section.

A Yes, okay. Basically, when we-- For example, when we maybe sneeze or cough or whatever, and we're infected with an agent, we create a-- we generate particles from our respiratory tract. If these particles are of a large size, they will-- Say it's me; I'm doing this respiratory process. The larger particles will deposit out reasonably quickly, so they will hit the desk, they'll hit the computer screen in front of me.

However, if I generate small particles, say around 1 and 2 micron, they will be capable of remaining in the air for significant amounts of time and they may even reach you across this large circular table and you would have the potential of breathing them in.

So, generally, ventilation doesn't impact on the larger particles because they're not around for long enough for ventilation to be a big deal. However, for the small particles with a-- which will remain in the air for a reasonable amount of time, that's the sort of particles that ventilation is capable of stripping out.

So, having a large air change rate won't-- If I have a person next to me and I sneeze on them, whether it's 2 air changes or 22 air changes, they're still hit. But if I produce a small particle, then that air change difference will have an impact on your risk of breathing in that particle.

THE CHAIR: That is because of the dilution effect----

A Yes.

THE CHAIR: -- which higher rather than lower air change rates will achieve.

A Will remove the particle quicker by dilution.

THE CHAIR: Right.

MR CONNAL: Yes, we'll come back to some calculations on that in a minute, because you go on to say-- you explain larger particles have more

infectious agents than smaller particles and so on. Can I just ask you: at paragraph 5.13, you say:

> "Filtration of liquid is often defined by particle size cut offs. This is not the case for particulate filtration."

Now, just help us understand what point you're making there, please.

A I think sometimes people-- Well, basically, when you have a HEPA filter-- Many studies have been carried out, and the particle size most likely to penetrate through a HEPA filter is between 0.1 and 0.3 microns. Now, below that and above that, the efficiency of a filter will be higher. So, when it says the filter is 99.95 efficient, it is tested with particles between 0.1 and 0.3 microns, and, in reality, it's probably more efficient for particle sizes of higher than that.

The other point I'm making is that, often, viruses can be of a size like 0.1 micron. But, in reality, when we generate an aerosol from our bodies, it's not just a virus that's coming out; it's mucus, it's bits of cells, it's bits of other stuff. So, the virus is not naked; it tends to be covered in something, so it tends to be of a bigger particle size than you would expect by the size of the virus.

THE CHAIR: Right, just so that I'm following that, the point that I'm taking from that – and there may be other points to take – is that although the pathogen, what you're trying to prevent coming in contact with a vulnerable person, may be of the order of 0.1 micron – in other words, very, very small – a HEPA filter, which is effectively filtering out particles in excess of 0.3 microns, will actually trap at least a significantly large number of the pathogens, because the pathogens will typically be part of a "larger package," or whatever metaphor one uses.

A Yes.

THE CHAIR: I mean, have I got the point you were making?

A Yes. I mean, the point is that the filters are-- The 99.95 is the minimal value; they probably are more effective against larger particles.

THE CHAIR: Wow, okay. Fine.

MR CONNAL: What they're tested with are particles of a particular size, is that right?

A Yes.

Q Is that where the 99.5 comes in?

A Basically, your engineers will spray aerosols or something called dispersed oil particles of that size, and it will measure the concentration before and after the filter. And from that data, they will calculate our percentage efficiency, and if that percentage efficiency is within spec, they will pass

the filter for use.

Q Thank you.

A So, if you've got a filter that was tested in 2023 and shown to be 99.95 per cent and tested in 2024 and shown to be 99.95 per cent, you pretty well know that-- sorry, and it's the same efficiency, you pretty well know that that's been performing like that all through the year.

Q Thank you. The next general topic you deal with is inhalation of infectious aerosols, and you explain where they lodge in the human body. I just wanted to come back to the calculation that you do here in 5.15. You say:

> "People at complete rest inhale approximately 6 litres of air per minute, and this can be used as a rule of thumb…"

Then you do a calculation on page 628. Can you just take us through that?

A I think what I'm just trying to show is how big a volume that somebody breathes per day, so they breathe almost nine cubic meters of air per day. So I'm just trying to show that the actual volume that somebody breathes over the course of a day is-- I mean, that's a very, very small room. The volume-- all the air in the very, very-- well, probably a cupboard. Three meters. Yes, I mean, that's a tiny room. Sorry----

Q You're trying to point out the amount that somebody breathes in?

A Yes, during the 24-hour period of time.

Q That's a patient at complete rest?

A Yes, yes.

Q So does a patient who might move about a bit breathe in more or less?

A Yes, they will. They'll breathe in a lot more.

Q A lot more?

A Yes.

Q Thank you. In the next section, you're dealing with generation of infectious aerosols and, to some extent, we've probably touched on this already in the discussion about the debate during COVID, so I won't ask you to go back there. When you're coming on in 629 to deal with the environment, we encounter fungal spores. So they apparently can travel considerable distances, is that right?

A Well, some fungal spores have got mechanisms which facilitate their spread in the air.

Q Small particle sizes quite often?

A Yes.

Q Then you make a point I think some other witnesses have talked about, that if you're going to get aerosols from

liquids, you need to insert an amount of energy in order to aerosolise into the smaller particles, is that right?

A Correct, yes.

Q Now, air sampling. We've had quite a lot of discussion about the pros and cons of air sampling. There are two types that you discuss, two types of sampling, one at 520, which is a sampling mechanism which pulls air over an agar plate, is that right?

A Yes.

Q Then you see what then develops from that, and we'll come back in just a second, but the other idea is you just do a particle count.

A Yes.

Q That tells you numbers but not what they are, is that right?

A So, if you want to have a general idea, a rapid idea, of the cleanliness of a room, using a particle counter will measure the number of particles within a size range, and that is a rapid-- that will give you a rapid readout.

If you're doing microbiological air sampling, you're going to have to wait a period of time to get the result, but that result can tell you what the microorganism is and what concentration of microorganism it is. However, as somebody who has done a lot of air sampling in his time, it's all about where you put the sampler and when you switch it on, and that's always an important thing.

Q Is that the point you're making in 521: okay, you need the right sampler, you need the right media, but it depends where you're sampling and when?

A It can be very difficult to assess the meaning of a negative sample because you could have sampled at the wrong time, in the wrong place. You could be using the wrong equipment, you could be using the wrong agar plate. So it's not an easy thing to do.

Q Does that affect its utility when you're trying to investigate something that's happened at an earlier point in time when you haven't been sampling?

A Yes. I think the problem, I think, you have is just because it's not here today doesn't mean it wasn't there two weeks ago.

Q Thank you. Now, you go on in the next section – and I'll probably not delay you much on this – to touch on patient placements and the standard patient placement arrangements. You actually have lifted a number of the sections of this report straight from the SOP that you were provided with, is that right?

A That is correct, yes.

Q I just wanted to ask the one point, just so we don't completely miss it, on page 633. Remember I asked you

about PPVL rooms---

A Yes.

Q -- and how they're set up?

A Yes.

Q You've made the point near the foot of 633 that, in all instances in the new hospital, "there's an additional extract in variable locations in the ceiling of the patient room." Do you have any particular comment on how that affects things?

A To be honest, I'd need to see a diagram and I'd need to see a visualisation before I can make any comment.

Q Thank you, and then your only comment appears on 635, where you say there are various standard operating procedures available, you haven't seen them before 2022, and you're just making the point there's no air change rates or pressure differentials defined for the BMT rooms.

A Yes, just an observation.

Q The concept of single rooms, you touch on briefly on page 635, and you're saying that they tend to be a slight negative pressure just by having the en suite, is that right?

A I mean, that tends to be because you have an extract from the toilet area, so it tends to get-- and I think they're defined in the SHTMs as being zero or slightly negative.

But what I'm trying to sort of state there is there is the potential for air to move both directions in these rooms. They're not-- they're normally negative pressure, but that pressure can fluctuate because there's no monitoring. And, for example, if somebody decides they want their room at 28 degrees and somebody wants the-- next door wants their room at 17 degrees, there will be flow of air from one to another.

Q And you made a point about leaving doors open. So, can we move on to another section, section 7, the use of ventilation and guidance. So, you start by telling us that ventilation, as a strategy to reduce infection, is not a new topic. It's been around for a long time.

A I think since Florence Nightingale and probably before.

Q But there's more attention on it at the moment. Now, there's quite a lot of discussion about the evidence behind guidance. Guidance it is, but nevertheless-- you're dealing with that in 7.2. What point are you trying to make in this paragraph? What are you trying to explain to us?

A I mean, I have probably a few points. I mean, I think one of the things-- in medical science and in biological science, things move very quickly, and you know, things change and all the evidence you're looking at is often from

the last two, three, four, five years.

However, in this area, most of the big studies were carried out in the 50s, 60s and 70s, and haven't really been sort of repeated, partly because they were regarded as being of a high enough quality for people to act upon them.

Also, I think it's very difficult to come up with an experiment in which you house 10 vulnerable patients without positive pressure rooms, and 10 vulnerable patients with a positive pressure room. A lot of this stuff is very difficult to do nowadays.

Q Notwithstanding the age of the material which gives rise to this guidance, has the guidance remained the same, essentially?

A Yes, I think, because of-- I mean, I think a limited amount of studies carried out in those days, and then people work at learning from those studies and design hospitals to match those sort of findings.

Q In fact, you instance the one that various people have referred to, the Lidwell study, as one of the bases for this material, is that right?

A Yes.

Q You explain, on 636 going on to 637, what was actually done to calculate things in the Lidwell study.

A Well, I mean, most of Lidwell's stuff was mathematical, and he was relying on some other studies. I think possibly the value is-- we're going back to Lidwell. Well, I mean, basically, he was basically showing, I think, what we call a protection factor. So, if we imagine, for example, he says the directional airflow could greatly reduce the transfer of aerosol particles from isolation to an adjacent room by about 10 to the 3. That means that, if you have an isolation room and you've got 1,000 particles, only one of those particles will go into the next room if you've got that directional flow.

However, if you don't have that flow, all of them will go, so you're giving a protection of 1000 against exposure to airborne particles by the use of that directional airflow. He showed that by having a positive pressure ventilated lobby. This seemed to increase the factor up to 10 to the 6 and 10 to the 7.

So, therefore, this is giving you a very, very high level of protection. Obviously, this requires the room to be operated correctly and to be shown to be operating correctly, but he demonstrates that by mathematics but also by having his mathematics confirmed by studies using different particulate tracers.

Q I think the point you make about correct functioning was picked up by a later researcher, who said, "Well, we looked at these rooms, but actually, they weren't being operated correctly, which

diminished the effect of the research."

A I mean, I don't know if I remember this correctly, but at one stage in time in the United States, they had rooms with switches that they could switch from positive to negative, and sometimes people made a mistake or weren't trained enough and they actually put, for example, TB patients in positive pressure rooms, which meant that the air was going from the infected case into the general ward, and that caused outbreaks. So I think one thing that's very important is for people to understand the operation of such rooms and to be au fait with how they should be operating.

Q If we go on to page 638, it appears that your group did a study on this, on one of these topics, anyway. 638 going on to 639.

A Yes, we did. This was done in microbiology laboratories but also in a clean room facility, and what we did was generated aerosols. I think we did. Yes, we generated them inside the room and then measured them outside the room with a directional air flow, and then we adjusted that directional air flow and measured the protection factor, and that was with somebody going through the door. So even with somebody going through the door of the room, we still obtained quite a good protection factor.

Q You then say that another researcher did work on negative pressure rooms and produced information about how they functioned.

A Yes. I mean, the pressure differential is, to me, a monitor of how well the directional airflow is operating, but it's the directional airflow itself that is providing the protection.

THE CHAIR: Let me just tease that out, Mr Bennett. First of all, I'm going to write down what you've just said. The pressure differential is the measure, did you say?

A Yes.

THE CHAIR: Of the effectiveness of-- Did you say the directional----

A Directional airflow.

THE CHAIR: -- airflow. As I was saying, can I invite you to sort of tease that out?

A Okay. You'll have a room with a door and, for a negative pressure room, air will go from the outside into the room, maybe through a grille, maybe through the sides of the door, whatever mechanism, and that will cause a pressure differential across that door which will be measured by a piece of equipment called a manometer, which you----

THE CHAIR: Right. So, if I'm following this, supply, all things being equal, will increase the pressure of the space into which the supply is going?

A Generally, in the same room, if you increase the air flow going into the room, you will increase the pressure. But different rooms may have different setups, so you could have a room that is very, very well sealed with a low inflow, but that would give you a very high negative pressure but with a lower inflow. So the relationship between pressure differential and volumetric inflow will be dependent on the room's setup.

THE CHAIR: Right. I interrupted you, but I was sort of inviting you to tease out what you were saying to Mr Connal, or have you maybe said what----

A I think I've just said it. I think-- Yes.

THE CHAIR: Okay, yes.

MR CONNAL: Am I right in understanding that what you're trying to say is that the key is to have enough pressure to make sure the flow keeps going the way you want it, if I can put it in layman's terms?

A I don't necessarily think it's too important in this context, but what I'm saying is what is protecting you is the directional air flow, and the pressure differential is a way to monitor that it's happening and it's an easy way to monitor that.

Q So, in paragraph 7.11, you say:

> "… the pressure differential across the door needs to be maintained at a high enough level to protect against flow reversals."

Was that your example from earlier about fluctuations one way or the other?

A Yes, and that needs to be monitored just in case there's a problem.

Q Then you say people have tried setting up model rooms, but it's difficult to duplicate an actual hospital environment.

A I think, well, every hospital is going to be different, and I think it's difficult. One of the problems I find with so-called CFD modelling is that often there is no check that it is actually by experiment that the results obtained are correct, but----

Q You then go on, in the next section of your report, to pick up some evidence about outbreaks which you suggest may have been caused by ventilation deficiencies. There's some TB outbreaks mentioned, I think, in paragraph 7.14. Now, CDC, which you mention at various points in your report, is that the Centre for Disease Control in the US?

A That's correct, yes.

Q Is that a respected source for information on things like ventilation?

A It's a respected source for information about infectious diseases and their prevention.

Q Right.

A So I think what happened in the 80s and 90s was tuberculosis became a real issue for HIV patients, and back in those days, many HIV patients were housed in hospitals because of the seriousness of their illnesses, and because they were in hospitals that also had patients with tuberculosis, that facilitated the spread among that community, with disastrous consequences.

Q You instance various studies on page 640 and 641 in various locations which you say are linked to low air change rates, among other things. The top of 641.

A Well, that's the-- Basically, those papers blamed lack of negative pressure rooms and low air change rates for their outbreaks and the size of the outbreaks, and then-- The problem, again, is we come down to bundles, as the CD guidance for TB isolation was not necessarily 100 per cent about ventilation. It's also about other things. But once that was adopted, the problem seems to have gone away or reduced.

Q In fact, you make that point about what we've already identified as bundles in paragraph 716 of your report, that protective isolation is a range of measures, and you say it can be difficult to separate the impact, is that right?

A Yes, yes. So, you know, I think it's very difficult to get significance that one thing works, but often it's easier if you're looking at a range of practices.

Q You deal with it on page 642 for some-- you make some further comment about what the literature shows you, although you pick up Aspergillus, I see, at the end of 7.17 in your report, where HEPA filters seem to be the answer, is that right?

A Yes. Yes, sorry. I think those reports suggested that the use of HEPA filters had controlled outbreaks.

Q I want to move on to the guidance, which we've heard a lot about already, so I'll be able to take some of it fairly short, but if I can just take the start of this. You deal with it initially on page 642, then you go on to 643. You say you accept, at the top of the page, that the guidance papers are "the work of groups of experts," "rely on a limited evidence base and more on a practical assessment of best practice over the years."

What you then say is it may be difficult for existing hospitals to comply, but it's expected that the new hospital would be built to meet existing guidance, and if it wasn't, there would be a written explanation for the logic. Can I just ask you about that? If you were going to not comply, would you expect any such derogation to be done if it impacted on

patient safety?

A I mean, I would think that anybody reading HTM 03-01 or SHTM 03-01 would regard it as being the guidance that should be used to construct a new hospital. And, you know, it's not an extreme document; it's a document that is developed by a very wide authors list who are pushing and pulling in different directions, so I would think anybody who is building a hospital ventilation system would be using this as the basis of what they do, and if they weren't doing it, they would be giving an explanation for differences in approach.

Q So would you accept it, at least in principle, is possible for a derogation to be made from that guidance, provided it's suitably explained?

A I think there's certain principles expressed in the guidance – for example, the air change rates – that is quite specific. It doesn't say, "Six air changes for a ward and do what you like for a single room." It says, "Six air changes for a single room." So I think an explanation would need to be afforded of why that wasn't regarded as being important in this brand-new hospital.

Q Now, I think we know from a later section, but I'll just deal with it now, that you don't think you've seen any such explanation in relation to this hospital, anything written down at the time, which explains why guidance was not to be followed.

A I mean, I have seen-- The rationale appears to be to do with energy efficiency, BREEAM ratings, but there doesn't appear to have been any assessment of the impact of the reduced air change rates in terms of infection control and safety. So I've not seen a document that looked at that decision from that sort of area.

Q One point that I've been asked to put was whether you'd seen an email from an individual called Alan Seabourne, which was written in 2016, so around about seven years after these things were decided. I think you had seen that in the course of your work on this report, is that right?

A I think I saw it yesterday.

Q Had you seen it before?

A No. Well, I can't say for definite I haven't seen it before, but I don't remember seeing it before.

Q Can we just look at that? It's bundle 12, page 813. (After a pause) Now, this obviously is written, as I said, in June 2016, and it says about halfway down:

> "… no reason for the decision to be made without the input and approval of those responsible for infection control…"

Then, there's an example and so

on. Is that the kind of document that you were talking about expecting to see, which explains the reasoning and justification?

A Well, they seem to have had a lot of discussion, which-- I have not seen any notes or any-- I don't know, but I mean, infection control people aren't necessarily experts on HTM 03-01 or SHTM 03-01, but they tend to respect documents like that and expect documents like that to be in the basis of a design. I would expect that-- Yes, well, he's basically saying there was a free and frank exchange of views. They're talking about design, dialogue, discussion. I mean, I would expect there to be written records of this process.

THE CHAIR: Well, apart from anything else, would you not expect the record to be contemporaneous, contemporaneous with the decision?

A Oh, yes, yes.

THE CHAIR: First of all, it's an email.

A Yes.

THE CHAIR: It's an email which reflects the author's recollection of events, what, seven years before?

A Yes, yes, yes. I mean, I don't know whether you've asked Annette Rankin whether she's aware of any documentation, but----

MR CONNAL: Well, I think you can take it, Mr Seaborne, having checked with both the authors of the questions I'm putting to you – and the position was raised with a senior Board representative – no such documents have been located, as we sit here today, which are contemporaneous to that decision.

Can I just ask also, there's some discussion as to whether the derogation covered all rooms or whether it was meant to be only general wards. Has it been part of your remit to try and interpret that contractual document at all?

A No, no. I mean, I'm not an expert in contractual law and----

Q We'll maybe come back to that later, but that's not what you were-- If you were going on a search for something, that's not what you would be looking for?

A No, no, no.

Q Let's leave that email. Thank you. Can I just bring you back, just before we break, perhaps, to this whole question of the guidance? Can we go back to the witness statement at 643, and you reference there someone called Malcolm Thomas. Now, you say he was the lead author of many of the editions, so is this somebody who'd been around the hospital ventilation circuit for a long time?

A Yes.

Q You obviously think what he

says there is significant because you quoted in his report, and he says that:

> "HTM 03-01 is based on 'good solid work many years ago' … Where we have encountered problems, it's generally been clear that guidance wasn't followed."

Then you quote in the next paragraph:

> "… ventilation rates … are not opinion, they've been proven to work in practice and over an extended period of hospital design and operation. History appears to show that this is the correct way of doing things."

Now, just in terms of your reading of the material, do you agree or disagree with what Mr Thomas is quoted as saying there?

A Well, it's his own opinion and you have to take that at face value. You know, I think he believes that the HTM 03-01 is a document based on good science and that it's shown to work in practice.

THE CHAIR: I think the question was – if you're in a position to answer it, Mr Bennett – would you agree with that?

A I would agree that he's the person who would have the best insight into that, and I would agree on that basis. I mean, I don't have--

THE CHAIR: Ah, right. Are you deferring to someone who has a particular reputation, or are you coming to a conclusion on the basis of your own experience? Maybe----

A A mixture. I mean, I think you have to-- I think, in my experience----

THE CHAIR: I think the point is, Mr Bennett, I'm particularly interested in your view because you're here, as opposed to Mr Thomas, who's not here.

A I mean, in my experience, having a document that gives advice on how to design and build a hospital and has been in that format pretty well for 20 years and is an accepted way of doing things, I think you go with it. You have to accept that as being your Bible. You have to accept it as being the best way of doing things, so-- and as far as I'm aware, there's not been problems with-- major problems with ventilation when people have adopted the practices within HTM 03-01.

THE CHAIR: (After a pause) Thank you.

A I think what he says in 721, I think, is important-- is one thing-- When people are maybe moving into new sectors, like, for example, if there are-- And I don't know about the background of some of the companies involved with this, but if you're moving into a new area and you're not 100 per cent familiar with the background, documents like this become very, very important to you, and you can't

just swat them away, in my point of view.

MR CONNAL: This might be an appropriate point, my Lord, to break.

THE CHAIR: Mr Bennett, as I said we usually take a coffee break at about half past eleven. Could I ask you to be back for five to twelve?

A That's very generous.

THE CHAIR: Right, and I hope you get a cup of coffee.

A Thank you.

(Short break)

THE CHAIR: Ladies and gentlemen, I brought one folder but left the other folder and the notebook in my room. (Same handed, after a pause) Thank you very much indeed. Thank you. Excellent. Mr Connal.

MR CONNAL: Thank you, my Lord. Mr Bennett, can I just ask you one question to see whether you were able to help us or not that relates to some evidence we touched on earlier about PPVL rooms?

A Yes.

Q Do you remember, at one point, you were assisting his Lordship to understand what the phrase "room junction" meant, and that was in relation to where filters might be placed?

A Yes.

Q Now, are you able to help us at all to what impact on the operation of a so-called PPVL room there might be if the HEPA filter was in the ceiling of the room?

THE CHAIR: Right. When you say "the ceiling of the room," that's the bedroom, which is protected?

MR CONNAL: The bedroom.

THE CHAIR: Yes, okay.

A So the supply filter is in the ceiling and not in the-- I mean, I-- In my viewpoint, as long as it's-- as long as the ducts are all right and as long as it's serviced and maintained all right, I can't see much of a problem. I would defer to, possibly, Andrew Poplett's viewpoint in that, as somebody with more expertise in what actually happens practically in hospitals.

MR CONNAL: Thank you. As it happened, we got to page 645 of your report and, oddly enough, the next topic you touch on is HEPA filters. You narrate there that one of the issues with HEPA filters is sometimes said to be cost.

Going to 646, you note a reference in SHTM 03-01 to a risk assessment on the use of filters, and you note it seems to be talking about cost, not infection control. You're perhaps a little surprised, it appears, that there's not more emphasis on precisely where and when HEPA should be used in the guidance, is that right?

A As somebody who doesn't know the HTMs off by heart, I was surprised by how almost negative the focus was on-- for HEPA filters, and I was just surprised. I was surprised. I was wondering whether it was because they felt it was mentioned in other documents. That's the only thing I could think of.

Q You deal with this on page 647, near the foot of the page, where you say:

"… the advice on the use of high-grade filters in UK and Scottish guidance is patchy and not helpful…"

But there is guidance available from America?

A I mean, I think that's an interesting aspect-- is that-- you know, especially with the Beatson, to what extent they actually looked towards international experts to build a facility. Of course, that was back in the 1990s.

Q So that's the-- you're thinking of the Bone Marrow Transplant Unit for adults in the Beatson hospital before the time when it was moved over to the Queen Elizabeth?

A Yes.

Q I think we know from other evidence that they took some advice from an American expert at that time?

A That's correct, yes.

Q Now, you then walk us through some of these other issues. You deal on page 648 with air change rates, where you point out where these are covered. You say the air change rates "have been in place and remained stable since 2007," and then pressure regimes didn't appear prior to 2005, is that right?

A I couldn't find any reference in the HTMs.

Q Yes, and you think that might have been American influence again from CDC?

A I would think so. You know, I think, to some extent, a lot of countries take their lead from what is done by CDC.

Q Yes. You say, in terms of the detail and how that's worked out, on page 649, that the pressure differential advice has remained consistent, essentially, since 2005, is that right?

A Yes.

Q Then you make a point about the need for proper monitoring systems, which we've probably taken from other witnesses and I needn't trouble you to go into in any great detail.

Now, can I just take you to another topic that I promised to return to, which was chilled beams. Can I just say in introduction to this that if I talk about chilled beams, I'm not going to get into a debate as to whether the precise piece of kit installed in the new hospital was technically a chilled beam or something similar to a chilled beam, because we're

just going to try and deal with this generally. You touch on that at page 652, and you say that the first time it appears is in 2007, in the guidance.

A Yes.

Q Then you go on to quote a number of the provisions from different iterations of both HTM and SHTM 03-01, is that right?

A Yes.

Q Then you go on to point out that while things like maintenance requirements had cropped up – access and cleaning cropped up in 2009 – by 2021 and 2022, obviously after this hospital has been built, things have changed in the guidance.

A Yes, yes. There seems to have been a realisation that these can cause problems and they should be removed from patient areas.

Q Yes, and what you actually quote there on page 654 is, I think, a wording we've probably seen with others. They talk about regular cleaning, and it says:

> "… in clinical areas and patient bedrooms, routine access will be a major problem in an operational hospital. [And then] Chilled beams should not be installed in clinical areas without the agreement and writing of the VSG."

Now, that's a reference to----

A Ventilation Safety Group.

Q Ventilation Safety Group, which also emerges later in the guidance, is that right?

A That's correct, yes.

Q You pick up the fact that there's always been reference to dew point controls, but, clearly, the approach to chilled beams has shifted.

A Yes.

Q Now, is that a shift between their first appearance in the guidance in 2007 and where we are in the latter guidance at 2021/2022?

A I mean, I think it must have been because of reports of negative aspects of their use, you know, and I think also an understanding that the maintenance schedule may be more than a once-every-six-months visit. So that seems to be the advice given by the manufacturers and in the early (inaudible). But then it seems to become a thing that they need more regular maintenance, and then that makes access to patient rooms become more problematic.

Q Yes. The next topic you touch on, again, is something we've heard of from some other witnesses, which is the need, if you're having pressurised rooms, to have appropriate seals or sealed rooms, is that right?

A Yes.

Q I don't know whether you agree with-- I think another witness may have said something along the lines of, "There isn't much point installing a pressurized system if the room isn't sealed." Would you agree with that?

A Well, you can't protect against leaks from the room if the room is-- has a false ceiling and is not sealed, so yes.

Q So a false ceiling, in the sense of a lowered ceiling, would be all right, but it would have to be a sealed ceiling?

A Yes, but constructed in such a way that it's sealed. The problem is you could probably seal this ceiling by using a lot of silicone sealant, but two weeks later, it wouldn't be sealed because of deterioration.

Q You're pointing out that, because this is a grid system of ceiling tiles of some kind----

A Yes.

Q Yes, and what you essentially do in the next couple of pages is pick up references to the need for a sealed environment, and then you come to a conclusion on that, I think, at 657, in paragraph 7.61: the reference to control of pressure "will be problematic."

A Yes. I mean, if you're going to leak test a room and you've got a false ceiling, then it's not going to pass your leak test, your leakage rate test.

Q Yes. We're just about to come to that, and I just wanted to ask you about that because at least one other witness we've heard had something to say about what this idea of leak testing means. Does it mean it doesn't leak, or does it mean that it leaks within certain parameters?

A Perhaps certain-- Well, I'm not familiar with the details of the leak testing that-- in this document, but normally, you carry out a leak test and you expect a leak rate, you know, because nothing is totally sealed. I mean, if it's totally sealed, the whole room will collapse in a leak test, but you expect some sort of leakage but that leakage needs to be defined as being appropriate.

Here, they say one litre a second of air per cubic metre of the envelope volume, so that is a-- so, therefore, they've set a parameter to be met. So, if it meets that parameter, that's great. If it doesn't, then they may want to do some investigation to where the air is leaking.

Q Essentially, what you do in the next couple of pages of your witness statement is you pick up what the different guidance documents say at different points about the question of-- well, I think it was called air permeability.

A Yes, yes.

Q Okay, so going to 660, this just gives rise to a general question, I

suspect, about when would you need backup air handling, or why would you need backup air handling? Is that a question you can answer or not?

A I probably can't answer. I'm not really familiar with the uses of backup air handling units in hospitals. Basically, you would need a backup air handling unit if you need to switch one off but keep the facility operational. So you may want to switch one off because you want to maintain it, you may want to switch it off because you want to do some test work on it, or it may be a belt-and-braces approach: "Oh, my God, what happens if one fails? We've got another one going." But I must admit, it's not an area I'm familiar with the practice in hospital environments, so.

Q Thank you. Again, in the next section, much of what you're doing is narrating for us what the guidance says when we're dealing with the question of commissioning, which is part of the process of ensuring that the ventilation system does what it says on the tin, essentially.

A Yes.

Q In the pages that run from 661 onwards, you're setting out a series of requirements and guidance, including reference, I think, to the COSHH regulations as part of that picture, is that right?

THE CHAIR: Can I just check a small matter of detail? In relation to the part of your report which deals with commissioning, I'm assuming you're adopting – because of your references to the SHTM 03-01 – the definition of "commissioning" that we see in either the 2014 or the 2022 versions. In other words, commissioning is something that's done during the course of construction----

A Yes.

THE CHAIR: -- by the contractor or specialist subcontractor in relation to specific items of plant.

A Yes, you make sure they----

THE CHAIR: Thank you.

A -- are absolutely the same.

THE CHAIR: Thank you. Sorry, Mr Connal.

MR CONNAL: I don't think I'll ask you to read through that part of your report because, essentially, you're quoting from various guidance documents, is that correct?

A Yes, and I think for the-- again, I think for the intricacies of commissioning and validation, I think Andrew is far more experienced and knowledgeable than I am.

Q Yes. Well, in fact, in the narrative sequence of your report, validation then crops up at 667, where you quote the COSHH regulations. You quote part of SHTM 03-01, which, in turn,

refers to the regulations, and then you quote over the page a version of validation that we've heard about, that the system will be acceptable if it is considered fit for purpose and will only require routine maintenance. But you defer to Andrew Poplett on the details of validation, is that right?

A I think that wouldin be better.

Q Yes, so you set out the information that's provided in the documents about that, and then also about annual verification, is that right?

A Yes.

Q So if we go to 673, and you've just picked up that piece of information that you happen to have individual knowledge of, is that right, in relation to tuberculosis?

A Yes, yes. I mean, I think it's an interesting aspect as not necessarily everything works dovetailed or joins together in this sort of area.

Q What do you mean by that?

A Well, I think in the NICE guidance, they're talking about 10 pascals negative pressure well in the SHTM. I think they talk about minus 5 pascals for an isolation room. So I think-- yes.

Q Yes. Just to make sure we have the reference that you're looking at there, on 674, you talk about the NICE tuberculosis guidance and then you set out a table, but the reference to 10 pascals, I think, appears at the top of 675, where you say-- and there's a definition of a negative pressure room and then a reference to 10 pascals.

A Yes.

Q So that's what they're talking about for TB?

A That appears to be, yes.

Q Then we pick up the international or United States influence in a section on that-- it starts on that page. You make the point that it's an international profession, medicine.

A Yes, and practices will come into being maybe before there is actually guidance, and guidance may-- sorry, UK guidance may lag behind international guidance in some areas. So, when the Beatson was constructed, there wasn't, as far as I'm aware-- I haven't gone back that far, but there wasn't necessarily documents telling them how to do it in the UK, so they approached experts in the US.

Q You suggest at the foot of that page that the Centre for Disease Control is especially influential, and also the World Health Organisation. Does WHO get involved in this kind of issue?

A It can, but I don't think it does in this-- The WHO has got a-- the problem that WHO has-- well, not problem, but WHO has to cater for the

global-- on a global basis. So, therefore, they are going to be interested in more sustainable and achievable standards that can be met worldwide. Well, the CDC guidance is aimed, firstly, at the US but also maybe at more developed countries.

THE CHAIR: I mean, just maybe at risk of repetition, you're using the example of WHO. Their constituency is worldwide and, therefore, does that mean that when they are a source of recommendations, their audience is countries with very limited health resources, as well as countries with greater health resources, such as Western Europe or North America?

A Exactly, so their recommendations are global recommendations and-- for example, recommending that every country in the world, say, for example – I'm just pulling this one out of the hat – has HEPA filters on TB wards and they need to be tested every 12 months. If you're in a country that doesn't have a company who can do that service, it's totally unrealistic, so they would possibly strip out something like that.

THE CHAIR: Thank you.

MR CONNAL: Well, if we just go to the next page, 676, we'll see a short discussion. I'm not going to take you through all the quotations, but you've identified CDC guidance as a "gold standard." Why do you say that?

A I think, at that time, the CDC were-- this is the first document that was making those suggestions, and that, obviously-- and it was quite high level. You can see that they're talking about 12 air changes, and we ended up with 10 air changes.

I think what's happening is something gradually-- with medicine and other areas, somebody has a new idea, and that idea maybe spreads and then has currency, and then it becomes adapted as best practice and then guidance documents. I think this is what happened with the CDC guidance. The UK has not followed it completely, but they've incorporated ideas from it.

Q Yes. I think you're making the point that there was guidance from the US which had been through a series of additions, which you might expect a new hospital to take account of.

A Yes, you'd expect-- I mean, somebody who is at the cutting edge of, say, bone marrow transplantation will be aware of the scientific literature, will attend meetings, and this sort of stuff will be discussed and they will be aware of it. They won't be engineers and they won't be Estates staff, and they won't be able to maybe understand the details, but they'll be aware of the information.

Q What you've then done, I think, is extract a number of comments from, I think, the CDC guidance, is that right?

A That's correct, yes.

Q On different topics.

A Yes.

Q I just want to take you through one of them in particular. Near the foot of page 676, we'll see what kind of protective environment it is in a moment. You say:

> "[It's] a specialized patient-care area, usually in a hospital, with a positive airflow…"

So that sounds like someone with an immunocompromised position. It says:

> "The combination of HEPA filtration, high numbers of air changes per hour (> 12 ACH), and minimal leakage of air into the room creates an environment that can safely accommodate patients who have undergone allogeneic hematopoietic stem cell transplant."

So that's the kind of guidance that was coming out from the States in the 1990s, is that right?

A That's correct, yes.

Q So HEPA filtration, high number of air changes and then minimum leakage. No doubt there are ways of achieving that.

A Yes.

Q Then you instance various other sections. If we just move on briefly, then, to 678, we see the tailpiece to this useful collection of information. You say:

> "… these documents were prepared by expert groups set up by CDC, regularly reviewed and the guidance was freely available…"

So is this, again, a gathering of practice rather than research?

A Yes. I mean, this is documents that are freely available from CDC and published in scientific journals that are read by people who are specialists in this field.

Q In fact, then we pick up the reference just in that paragraph to the individual who helped with the Beatson, which is Andrew Streifel.

A Yes.

Q Thank you. Now, I think earlier you said that not everything slots neatly into everything else in this field when we were talking about the NICE figures.

A Yes.

Q The next topic you pick up is the Joint Accreditation Committee of JACIE, which we've heard arises-- we've heard referred to as an accreditation that bone marrow transplant units seek.

A Yes.

Q The sixth edition that you've quoted here from the JACIE accreditation

material, do you know when that is dated? If you don't, it doesn't matter. We'll check it.

A Yes. I mean, I think that's from their website. I find it quite difficult to-- I couldn't track back on the editions.

Q It may not matter, Mr Bennett.

A I mean, I think the one thing about-- This is an international organisation a bit like WHO, so they're not saying you should have 10 air changes plus 10 and a HEPA-filtered room because they're dealing with countries at-- You know, I'm not totally familiar with the organisation. I don't know their scope, but I understand they're at least Europe-wide. So they're dealing with countries who maybe don't have the infrastructure, so they can't just not accredit. They're not going into the specifics.

THE CHAIR: It's a similar point to the one that you made in relation to WHO: if a body is seeking to lay down minimum standards for countries all over the world, or even a large number of countries, you've got to bear in mind, well, not every country can be expected to have the same resources.

A Yes.

THE CHAIR: I suppose the qualification in relation to the Joint Accreditation Committee is that it appears to – or the recommendations that you've drawn attention to – relate to facilities for haematopoietic cellular therapy, so that's setting the bar for the sophistication of the treatment reasonably high.

A Yes. I mean, I think part of this actually goes back to a previous comment I made about room selection. What they seem to be suggesting here is you need a process to prioritise the patients who get the best rooms, and that will be done on the basis of a clinical assessment of the patient, I would imagine. We also say the auditing of airborne microbial infections in non-HEPA rooms should be performed as part of a quality management programme.

MR CONNAL: You're referring to a section of your report at 797 (sic), where you've extracted something from the JACIE guidance----

A Yes, yes.

Q -- where they at least posit the possibility that you may not have enough HEPA-filtered rooms for your needs and then say what you have to do about it.

A Yes, and what you do about it is come up with a process of allocating the rooms to the patients most in need.

Q Yes, but the heading you've selected immediately above that – perhaps a more general statement – refers to a unit of "adequate space and design that minimizes airborne microbial contamination." So, if that's the objective,

then you look at the detail.

A Yes. I mean, there's two ways of writing legislation. There's the prescriptive, "You will have this and that," then there's the-- oh, God, what's the other one? Then there's this sort of thing, which gives you sort of a performative idea but doesn't actually prescribe how you do it.

Q Yes, so you accept that the JACIE material isn't prescriptive in its detail as to what you've to do to minimise airborne microbial contamination, is that right?

A Well, I mean, then it says:

> "… HEPA filtration with positive pressure is recommended for high-risk patients."

I suppose it's a matter of language. Because I have to say I'm not a clinician, so the clinicians are the ones who should be able to separate patients out into high risk to lower risk, and that's one thing I've been a wee-- This seems to be suggesting that that you should do that and that should be written as an SOP, and that should indicate where patients should be housed during their treatment.

Q (After a pause) Essentially, your tailpiece to this review of material is simply to note that the Beatson Centre BMT unit pre-move had this ventilation system designed in a particular way with assistance from Andrew Streifel and, indeed, Peter Hoffman with an air change rate of 10, and 10 positive pascals.

A Yes. I mean, it was a group-- All the patients were housed in the ward, but that ward was under those conditions, yes.

Q Yes, and you note that there's an airlock, but that's an airlock to get into the ward as opposed to into individual rooms.

A Yes, yes.

Q Thank you. Now, the next section of your report picks up what you say are deficiencies in the Queen Elizabeth Hospital compared to guidance, and you look only at a limited number of wards, as you say, in paragraph 8.2. Now, what you say in that is that these were all used to house patients with immunosuppression at some time between 2015 and now.

Now, would I be right in thinking that you know that 6A was used on a-- let's call it a temporary basis? People were moved in, they were there for a while and then, at a later stage, they were eventually moved out.

A That's my understanding, yes.

Q You also touch on 5C and D, which is infectious diseases. So, what you're then setting out, as I understand it, Mr Bennett, is a kind of narrative going through the different wards and picking up on what the differences are when you

look at the guidance.

A Yes, and also some of the wards were modified during the period, so I've looked at how those modifications changed the state of----

Q You start off on page 682 by picking up general wards, so not one of the list, where you point out that the guidance requires six; that that wasn't achieved; that the chilled beams are there, which is contrary to the latest versions but not the versions of the guidance at the time the hospital was built.

A Yes.

Q Then you go on to Ward 2A. Now, the Inquiry has actually produced a separate paper on specialist ventilation areas, but you cite the guidance from the UK and from Scotland about 10 air changes, positive pressure, and also you mention what Yorkhill had, which is where, essentially, the 2A patients were beforehand.

A Yes.

Q Then you cite something that we've heard about from other witnesses, that when patients started to move into the hospital, issues started to be picked up on what the quality of the environment was for those patients in 2015, is that right?

A Yes.

Q That, I take it, is material that you simply gathered from the documents that were provided to you by the Inquiry?

A Yes, yes, yes.

Q Then you instance, on 684, that they were moved out of the ward into 4B and 6A after three years of being housed in a substandard facility. Then some discussion about dew points and chilled beams, and then you pick up the fact that, ultimately, there was a lot of work done, but it's oversimplified.

Chilled beams, thermal wheels, suspended ceilings to be removed, all rooms sealed, airlock, backup air handling unit, pressure monitoring, all in the specification which you instance in paragraph 813 of your report. Then you pick up on a validation report from '22. So your conclusion, I think, is in 815. Is that a positive conclusion about the state of Ward 2A?

A Yes, yes. I mean, when I visited, it looked very swish and very impressive.

Q I take it you're assuming that it performs in accordance with the validation details that you set out above?

A Well, yes. I mean, I haven't seen the validation reports from 2023 or 2024, but I've got no indication that they were not suitable.

Q Thank you. We then come to Ward 4B, which is the adult bone marrow transplant unit. Are you aware that the

decision to move that into the Queen Elizabeth was taken during the construction process?

A I think I was. Yes, I mean, there's so many documents. Yes, I think I was aware of that, yes.

Q Are you in a position to comment one way or the other on whether the date at which that decision was taken impacted on the options available to cater for this cohort of patients?

A Well, the hospital-- As far as I'm aware, there wasn't any part of the hospital designed to meet the standards that would be expected for those patients, because the hospital was generally designed on the sort of general ward principle.

Q Yes, so it was designed on the general ward-- I'm not sure whether you can help us with this or not, Mr Bennett, but let me just ask you anyway: so if somebody comes along and says, "We want to move the Beatson BMT unit into the new hospital; this is the kind of requirements that we have," can you help us or not as to whether that was difficult to do, easy to do, or anything of that kind?

A It's very difficult. I mean, retrofitting ventilation systems into buildings will involve quite a lot of work and maybe a bit of building redesign. Since the ward was designed to have 2.5 air changes, to increase that to 10 air changes would mean increasing the capacity of the plant by fourfold, which I would imagine would require the whole HVAC system to be stripped out and replaced. So it would be an expensive and time-consuming process.

Q Again, you may or may not know this, so please just tell me if you don't: have you been made aware of any exchanges between the contractors and the Board about what could or could not be done within the existing building envelope on air changes?

A I think I've seen documents. I forget, sorry. I mean, there's so many documents, but I think I've seen documents about what could and could not be achieved for various wards to improve the ventilation system. There was discussions about duct sizes because you can only get so much air through a size of duct, so you need to increase the size of the duct. So there-- I think I've seen such reports.

Q I'll ask you more specifically, then: are you aware of any discussion as to whether 10 air changes could be achieved with the existing air handling units?

A I think-- Yes, I've seen such documents and it couldn't be achieved.

Q It couldn't be achieved?

A Yes.

Q So that would mean either accepting a lower air change unit or stripping out the existing ones, presumably?

A Yes, as I remember, yes.

Q The point you make in your report is that the Beatson had been designed with input from international and national experts and was regarded as an exemplary facility. Then you explain what it had and then, as we know, ultimately, it moved over and then moved out again.

A I mean, as I remember, the decision seemed to be made to allow patients rapid access to intensive care. Now, again, I'm not a clinician. You know, I don't know whether somebody thought that they could drop the-- this was of greater benefit to the patients than having the Beatson facility or having a worse facility. I don't know whether those-- I've not seen any evidence that those things were weighed together, but I know that was the rationale given for the move.

Q I think that would be the move, if I'm right in thinking. We know that the Beatson patients moved into the new hospital and then, after not very long, moved back to the Beatson.

A Yes.

Q So you'd be talking about the move back into the new hospital once there had been some discussion about what could or could not be done.

A Yes, I mean, I'd say-- Sorry, I'm not sure of the timescales of some of this sort of stuff, but yes.

Q Well, perhaps we can pick that up at page 687 where, having listed a number of the deficiencies that were identified, you note at 8.20 that:

> "A decision was taken to return patients to the Beatson Unit in July 2015."

Then, in 8.21:

> "… a series of … works were carried out and patients [seemed to have] returned … in July 2018."

Then, you set out some details of a number of the works that were done and what they did or didn't show. So can we turn to your tailpiece on this topic, which is on 688? Just take us through what your point is in paragraph 8.22.

A I just think, you know, it's the fact that they built a facility in the Beatson that met-- seems to meet the requirements of SHTM 03-01 and was a well-designed, good facility, and the patients have been moved into a facility that is of a lower standard. I mean, I think what people are used to is things becoming of a better standard and I think it's a little bit disappointing.

Q I've been asked to put this to you: do you think, given the difficulties

that were encountered, as it were, retrofitting and improving, which led to the position that you've illustrated, do you think, given that, these patients would be better with a new unit?

THE CHAIR: Sorry, could I have the question again, Mr Connal?

MR CONNAL: Yes. Given the recognised difficulties in retrofitting, some of which you've illustrated in your report – and if this is not for you, just say – do you agree that the Board should be looking at delivering a new unit to higher standards for that cohort of patients?

A Well, I would imagine that's a decision of the Board. I mean, I think, to be fair, the air change rate they've managed to step up a bit better. I don't like the fact they've got neutral pressure rooms. I think you can argue a bit about how many pascals positive gives you a safety margin, but, the fact that some of the rooms were in neutral pressure, I think there's-- A lot of these decisions are clinical and financial and operational, and I think those are a matter for a board to consider.

Q Thank you.

A I mean, to be fair to them, they've improved the facility, but it's-- I don't know. I'm from Glasgow and I remember stories about this hospital being the greatest hospital in the world or, you know, going to be a shining star in Glasgow. And in that context, it is a little bit disappointing, I think. Maybe that's too personal a thing to say, but----

Q The next section of your evidence, you move on. We've dealt with 4B, which is where the BMT unit is, to 4C, where there are haemato-oncology patients, and you say that there are deficiencies on that ward for that cohort of patients, is that right?

A Yes.

Q Can I pick up a technical matter that hasn't appeared yet in your report – and I'm not sure elsewhere – which appears at 8.28 on page 690, which is something called a "recirculating Camfil HEPA filter." Now, what's that?

A From my memory, they have ceiling-mounted a device made by a company called Camfil in which air is recirculated through a HEPA filter and comes back into the room, so it's like a portable HEPA filter, but it's located in the ceiling, and I would imagine, because Camfil are a big company, it's probably a higher standard and it probably-- they could probably test the HEPA filter. I don't know if they did, but they probably could.

Q Why would you have what you describe as "an unusual feature" of one of these filters? Why would it be there? Do you know?

A It seems to be-- They had

some-- they seemed to have had some Aspergillus growth in some of the en suites and they were-- I think they found Aspergillus, and there were high particle counts in the en suites, so they put in these units to reduce the contamination levels, but I felt that-- I mean, the patient isn't going to spend that much time in the en suite. The air should be going from the bedroom into the en suite, the air direction, so I wasn't quite sure to what extent it would be protecting the patient.

THE CHAIR: I wonder if I can try and follow this. The en suite is negative to the bedroom----

A Yes, slightly. Yes, yes.

THE CHAIR: -- and the intended flow will be from the bedroom into the en suite?

A Yes.

THE CHAIR: I think I would have assumed "and then to be extracted."

A It will be extracted as well.

THE CHAIR: This filter unit is dealing with the air that's come from the bedroom, but it sort of does a circuit with it? I mean, am I following this properly, that the airflow does a circuit of the filter----

A Yes, yes. So basically, it cleans up----

THE CHAIR: -- and is then extracted?

A Yes, yes, so it will-- it will provide an-- I mean, it's not strictly an air change, but it will clean a certain amount of the air in the en suite, which will take out particulate in the en suite, but then will be extracted.

I must admit, when I visited, I think some of the current members of staff were almost as confused about it as I was, so I'd have to say it seems-- Because the door would normally be closed as well, so it just seemed a wee bit-- I don't know, I don't know, but maybe there's a great idea behind this that I've missed, so.

MR CONNAL: The idea that you've suggested might be behind it is to reduce particle counts in the en suites?

A It might be. I mean, it might be they set a target for a-- for a level of particles that they couldn't meet without the use of such a unit. I don't know. That's a possibility.

Q Then, another feature that you noticed, apart from these recirculating filters, was portable HEPA filters in that ward, is that right?

A Yes, yes.

Q That gives rise to the issues that we've discussed already about portable filters: it depends precisely where they are, how effective they are.

A Yes, yes, and what-- Yes, I mean, I think-- I don't know whether there was a rationale for placement or a

rationale for anything like that, or rationale for the numbers used.

Q They were all at floor level? You've made a point, I think, at the end of----

A I didn't have access to patient rooms, so the ones in the corridor were on floor level. I'm not sure. I can't make any comment on what went on in the rooms.

Q So these were HEPA filters in the corridor of 4C?

A As I remember, yes, but I don't know whether-- As I say, I don't know whether there were ones in the rooms; I didn't have access to the rooms. I don't----

Q Yes. I think the only other point I want to take about 4C, if I may, is one that crops up in paragraph 8.30, just before the bit about HEPA filters, where you've been given a risk assessment from 2021. Perhaps you can just explain to us what a risk rating of 9 means.

A Well, it's a-- With risk ratings, they have-- I think this one had a probability-- You have a five-by-five matrix of probability against severity, and each of them is marked on a scale of 1 to 5, and then you choose how likely something is to happen, in your opinion, and the severity of it happening, and you multiply those ratings together to give yourself a risk rating.

So, in this risk assessment, the people who were agreeing the risk assessment came to a conclusion that "there may occur occasionally severe illness from airborne pathogen exposure on this ward," in the risk assessment.

Q Right, so the way the matrix worked out, it ended up with----

A So, 3 is "occasionally----"

Q -- "occasionally severe" and so on.

A Yes. Yes, yes.

Q "Occasionally severe illness from airborne pathogen exposure." That's what the assessment says.

A Yes.

THE CHAIR: Do we know who carried out that risk assessment? The footnote is 140, but----

MR CONNAL: It will be, I believe, my Lord, in bundle 20 somewhere, and I've no doubt we could find that if that was thought helpful.

THE CHAIR: Right. If I've understood the explanation you've given in relation to the matrix, the highest risk would be 10, is that right?

A No, 5-by-5. It would be 25.

THE CHAIR: It would be 25?

MR CONNAL: Yes.

THE CHAIR: Right, thank you. So it's 9 on a scale of 0 to 25?

A Yes, so 3 to the 3. It's a multiplication, yes.

MR CONNAL: I think, my Lord, I'm about to turn on to a new topic, so this might be an appropriate time to break.

THE CHAIR: Yes. Mr Bennett, we'll take our lunch now, so could I ask you to be back for two o'clock?

A Of course.

(Adjourned for a short time)

THE CHAIR: Good afternoon, Mr Bennett.

A Good afternoon.

THE CHAIR: Now, Mr Connal.

MR CONNAL: Thanks, my Lord. My Lord, we have identified the risk assessment that was mentioned by the witness. He identified it quite properly by an 'A' document number. I can now tell your Lordship that it's in bundle 20. It's document 61 and it's at page 1420. I think it might just be useful to have a very quick look at it just to check that we're looking at the right document. I see my request for it to be brought up has been anticipated.

So, it's a GGC document. It contains a lot of information, which I'm not-- For my purposes, I'm going to go to the matrix, which is what my Lord was asking about, so if we scroll past 1420, I think we'll find it in somewhere like 1423, perhaps. No? Keep going. Here we are. Is this the matrix that you indicated----

A That's the one, yes.

Q -- where you have a likelihood table – "may occur occasionally," for instance, is the one you've highlighted – and a severity table as well. This matrix seemed to have been scored at 3 times 3 equals 9, which is the medium risk, is that right?

A Yes.

Q So we can see the reference to "occasional," and then if we want to find out who was responsible for that, we need to scroll on. We then see that the assessment has been done in 2021 by-- or at least a series of people – Mr Leach, Mr Hart, Professor Leanord, Myra Campbell, Alan Gallacher, Tom Steele, Kirsty Strannigan – all seem to have participated in this process. That's the document you were referring to?

A Yes, it is.

Q Thank you very much.

THE CHAIR: Thank you.

MR CONNAL: Well, we'll move away from that, please, and back to the report, where we'd reached page 691, where we're going to go to Ward 6A. Now, this is the ward about which I made a point, I think, in your introductory section. I take it you recognise that 6A was never designed to be a permanent home for immunocompromised patients but was, in essence, a temporary home?

A Yes.

Q You're aware of that?

A Yes, I am. Yes.

Q In fact, if we go on to page 692, we see that point mentioned at the top: "… originally designed as a general ward," with the air change rates, chilled beams, no HEPA, etc. Then you specify the period during which it was occupied. Now, you say "the ward specification was not increased". Why do you say that?

A Well, it appeared that patients were being moved from Ward 2A because it was of general ward standard, and then they were being moved to another general ward. So, basically, they were moved out of the accommodation, not to be moved into a better accommodation but to be moved into that accommodation to allow the Ward 2A to be upgraded.

Q I take it you would accept that the decision to move from 2A somewhere was a decision that was taken by a range of individuals, including clinicians and infection control specialists?

A I suppose they had no option.

Q I think I'm right in saying that the most vulnerable people were placed in 4B. Were you aware of that?

A I don't remember seeing that document. I mean, that's-- I don't remember seeing any document state that.

Q So you've identified in paragraph 8.32 what you saw as the deficiencies of that ward as a home for immunocompromised patients?

A Yes.

Q Your note of the improvements, I think, appears at 8.34, is that right? On page 693?

A Yes.

Q So that's portable HEPA filter units – I think we discussed where they were earlier – in three rooms, these Camfil scrubbers in the ceilings – which we've discussed and I won't go back to – and HEPA units on the-- well, it says there "rooms and corridors." **(No livestream available between 14:10.43 and 14:11.06)** But clearly some steps were taken by the Board to do something to this unit.

A Yes.

Q Thank you. We'll just move on to 5C and D. This is a slightly more tricky tale to tell, I think, because the arrangements that were made to replicate the Brownlee Infectious Diseases Units are not, perhaps, as clear as some others are, but in any event, the decision was made to move this unit to the new hospital and put it in 5C and D.

As we understand it, the Infectious Diseases Unit, as its name suggests, is intended to deal with people with infectious diseases, but it was being put in a ward which had a general design,

which is your point here, isn't it?

A I must admit, around this issue, I-- I didn't really have that much information about the Brownlee ward that patients were coming from. It's quite difficult: infectious diseases is a very wide range of conditions, some of which are more likely to be infectious through the airborne route than others.

Q Clearly, the rooms on that ward would not be designed specifically for dealing with anyone with a particularly infectious disease because they didn't have the negative pressure. Is that right?

A A decision would be taken by clinicians on whether a patient would be regarded as being infectious and at risk to other people on the ward. In the incidence, if it was a patient with tuberculosis or suspected tuberculosis, it would be expected to be placing them in a negative pressure isolation room.

Q So, what you note is that the anticipation was that anyone who needed to be isolated would have to go to somewhere on another ward where there was a suitable room, is that right? I think you say that in the middle of 8.36.

A 8.36? Okay.

Q You say:

"It was expected that any patient who needed to be isolated would be housed in other wards with isolation rooms…"

A Yes, I see that. Yes.

Q Is that the information you were given?

A Yes.

Q Did you know how many of these rooms there were or what types they were?

A No.

Q What you then do is you record a letter of concern from infectious diseases physicians stating that they weren't clear if the high-dependency unit rooms had:

"… enough air exchanges to keep staff safe, and we do have multiple-drug-resistant tuberculosis presenting commonly, which is of particular concern."

Just pausing at that point, is multiple-drug-resistant tuberculosis a disease of particular concern in terms of how you look after the patient?

A Yes, because it's harder to treat, so if you have a multi-drug-resistant strain of tuberculosis, it will impact on your treatment and maybe your prognosis.

Q Is it infectious?

A Yes. Airborne infection.

Q Yes. Then we see a note on page 694 from Dr Inkster saying that there were no negative pressure rooms. A negative pressure room would be a suitable room for placing an infectious

patient in, I take it?

A That'd be a normal way of doing it, yes.

Q Yes, and then the question is, are the PPVL rooms a normal room?

A Yes.

Q Yes, okay. So, one of the concerns that you seem to have picked up-- mentioned at paragraph 8.38 where you say:

> "… tests had indicated neutral to positive pressure in rooms where TB patients were cared for, thus 'spreading pathogens into the corridor and potentially other rooms'."

Now, if a room with a TB patient in did have neutral to positive pressure, is that concern correct or not?

A That is correct, yes. If the room is positive pressure, then, theoretically, the air from that room will be spread into other rooms.

Q Then there's a similar point made in the same paragraph about immunocompromised patients being cared for with "neutral to slightly negative pressure," thus potentially sucking pathogens into their room from the corridor. Is that a fair concern?

A Yes. I mean-- yes. I mean, you do not want to have immunocompromised-- I mean, this is one of the things-- When you have an infectious disease ward, there's different infections, and you don't want to have somebody with infectious tuberculosis anywhere near somebody immunocompromised.

Q Now, you record in 8.39 that adjustments had been made to ventilation, and there was a report that all rooms "had achieved a notionally negative pressure." Can we come back-- I think you may have touched on this earlier: is "notionally negative" a valuable thing to have achieved?

A I'd rather it-- I'd prefer saying they had a negative pressure of X pascals, I think would be more useful. I mean, notionally negative pressure, I don't know what that means, really.

Q Well, you pick up in paragraph 8.40 on page 695-- you say:

> "Currently, the ID Unit … is achieving air change rates between 2.7 ACH and 3.2 ACH and is achieving a notionally negative pressure regime … ranging from 0 to -3.5Pa."

Now, is that good enough, in your view?

A No. I mean, I think the fact that it's not monitored, the fact there's no alarm system and some rooms are running at neutral pressure-- I mean,

saying that, you know, if they don't have any TB patients, then-- but, I mean, I wouldn't house a TB patient in that sort of facility.

Q Yes, and your point about the alarm is you don't know if the pressure changes?

A Yes, so if there's no monitoring of the negative pressure, then you don't necessarily know that it's performing as required.

Q Then you point out that now there is access to three negative pressure isolation rooms in the Critical Care Unit.

A Yes.

Q That's something that wasn't available initially?

A No, I don't think so, and I remember seeing some negative pressure rooms when I visited. They seemed to be good.

Q Thank you. Now, when we go onto the next section, we're going to come back to the word "bundle" that we picked up very early in your evidence. We find that in paragraph 8.41, where you say:

> "The prevention of nosocomial infection involves a range of preventative measures often called bundles."

What you're doing is looking at

ventilation----

A Indeed, yes.

Q -- because you're not in a position to look at the other ones, is that right?

A That's correct, yes.

Q Now, the first thing that crops up in your consideration of this, which starts at page 696, is an exchange of materials that I think you saw when you were preparing this report that is sometimes described as the M&E log, where there are proposals to reduce the air exchange rates. That's what we perhaps touched on a little bit earlier on when we were looking at Mr Seabourne's email.

A Yes.

Q You note on page 697 that you think the rationale seems to have been energy efficiency and a BREEAM rating.

A Yes.

Q Now, are you able to tell, as a matter of contract reading, which rooms the reduced rate was intended to apply to, or is that not your expertise?

A It seemed to be throughout the hospital. I mean-- but----

Q I think you recognise that, so far as chilled beams are concerned, the advice has changed since the hospital was built.

A Yes, it has, yes.

Q When you refer to chilled

beams, you talk about them being prohibited now, but is a correct wording something like “without the approval of the ventilation group”?

A I’d have to look back on it, but the implication is not to be used in patient care areas, which includes bedrooms.

Q So what we’re then about to do, I think, Mr Bennett, is to look at different areas and you then form a view as to whether there’s an increased risk due to a lower air change rate, is that right?

A Yes.

Q In fact, you pose that question in 8.47. Leave aside CBUs, you say:

> “Does reducing the air change rate to 2.5 ACH from 6 ACH and using CBUs create an increased infection risk if [for the sake of argument] CBUs don’t add [one?]”

So just looking at the air change rate. So you start by acknowledging that patients in single rooms are less exposed to hazards, presumably than a ward, is that right?

A Yes. I mean, by reasons of distance and reasons of possibly the door being closed.

Q Then you go on to say:

> “The patients will still be exposed to visitors, nursing staff and support staff, and doors will not always be closed.”

A Yes.

Q So there will still be exposure? That’s your view?

A Yes.

Q So if we go on to 698, what you’re setting out here is how you work out what the impact is of air change rates on dilution, is that correct?

A That’s correct, yes.

Q You say it will take longer to remove any contaminant.

A Yes.

Q Can you just take us through this calculation so his Lordship understands what you’re doing here?

A Well, basically, this is actually taken from a table from Chinn and Sehulster, but there is a----

Q From where? Can we just----

A From the reference, but there is a standard equation, which I forget, which you can use to calculate this. So, if you assume that the room is perfectly mixed and you’ve got 2.5 air changes, it would take you 56 minutes to remove 90 per cent of the particulate in the room.

However, at 6 air changes, because there’s more air changes, it would only take 23 minutes to remove 90 per cent of the contaminant. So, by increasing the air change rate, you dilute quicker.

Q Yes.

A But, of course, it only matters if

there is a hazard there in the first place.

Q Yes, and just so we have the reference, this is to the paper from Chinn and Sehulster----

A Yes.

Q -- which is referenced in the footnote and is in-- I think we'll find in bundle-- We needn't bring it up on the screen, thank you. We'll just go back to the report. So, if there is a contaminant in the room for any reason – from a patient or a visitor or anyone else, or a member of staff – that's the difference it makes to dilution?

A Yes.

Q So, you then go on to deal in paragraph 8.50 with this question of slight negative pressure because there's an extract, I think, in the en suite.

A Yes.

Q What difference does that make to the discussion you're having here?

A I think at 8.50 what I'm trying to say is there is potential-- there can be potential for spread of air from one room to another room. So it's possible for a room to be-- go positive pressure due to a variety of things, such as temperature differences, it could be air movements caused by other doors opening or lifts, etc., etc., but there's always scope for fluctuations of pressure at those low levels.

Q So you're talking there about the possibility, for the sake of argument, of a contaminant in Room A getting into Room B?

A Yes. I mean, for example, hotel rooms are almost always at zero to negative pressure because they've got extracts in the toilet, but if somebody smokes in a hotel room and you're walking past the corridor, it's not-- you very possibly will smell it because of the fluctuations.

Q Thank you.

THE CHAIR: If I can just take you back to 8.49, these calculations are in relation to – tell me if I'm wrong about this – a sort of specific event.

A Yes.

THE CHAIR: You have X hypothesis-- a source of infection within the room, such as an infected patient, and one supposes an event – in other words, a sneeze, for example – and then these figures tell you what is happening to the air in the room after that sneeze. But, of course, if there's a subsequent sneeze, again, there's an aerosol----

A But there will always be that difference. Even if it's a continuous source-- It'd be a different equation I'd have to use, but there'd always be that similar difference.

THE CHAIR: Thank you. I'm making sure that I'm keeping up.

A That's fine.

THE CHAIR: Sorry, Mr Connal.

MR CONNAL: No, I think what you then set out in paragraph 8.51 is a point that we've actually already covered, which is you would have expected some kind of written assessment for the change from 6 to 2.5 or 3, and you haven't seen any such thing.

A No. I mean, you haven't managed to provide it to me, but----

Q So, you then go on in paragraph 8.52, page 699, to say that:

> "The reduced air change rate may have the greatest impact in times where there are cases of highly transmissible respiratory viruses…"

So is this you, in effect, using your COVID knowledge to think about highly transmissible respiratory viruses?

A I think this would possibly be foreseeable before COVID, for influenza and RSV. So, yes, I mean those diseases seem to be spread, at least in part, by small-particle-size aerosols. So, due to the lack of-- due to the lower air change rate, it seems feasible that there could be increased transmission of such agents between patients and staff, and staff and patients.

Q When you wrote this paragraph, you said in the middle of the paragraph:

> "The lower air changes will increase the chances of airborne transmission between patients, between staff and between patients and between patients and staff."

A (Inaudible).

Q Yes, and no doubt visitors come in somewhere in there if they're not restricted for any reason.

A Yes.

Q When you say that, that the low air changes will increase the risk, is that a personal view, or are you taking that from some other source?

A I think it's probably a personal view.

Q So, in the next paragraph, when you say, "It seems likely that reduced air change could lead to an increased rate of transmission of respiratory viruses between patients, staff and visitors," that's essentially the same point? This is your view (inaudible – overspeaking)?

A Yes. I mean, I would say-- Let's take a spectrum here. There are people who believe that influenza and COVID are transmitted, basically, by close contact, and they're there. Then there's the people who believe they're entirely transmitted by small-particle aerosols, and they're there. I'm in the middle, so I would say I'm moderate in

that field, and it is an area of a lot of controversy.

THE CHAIR: I'm assuming, when you indicate that spectrum, the whole spectrum is respectable views?

A Yes, yes.

MR CONNAL: Somebody in the middle of that spectrum, as you say you are, might think that lower air change rates would increase the risk.

A Yes.

Q I see you then reference, in 854, a concern that had been picked up by someone else about Mycobacterium abscessus and whether that might be influenced by the air change rates. So, on page 700, in paragraph 8.55, you say that's another type of example where air change rates might make a difference.

A Yes. I mean, it's not just in this hospital, but in other hospitals there are concerns about transmission of opportunistic pathogens between cystic fibrosis patients and, in particular, Mycobacterium abscessus. Now, I don't know how relevant-- I don't know how cystic fibrosis patients are managed in the hospital, so I can't really go too far with that one.

Q But nevertheless, your view is, if I'm picking it up correctly – and I want you to correct me if I'm wrong – that that is an example, from what you've read, of another situation where a reduced air change rate would increase risk?

A Yes. I mean, it could also be a condition in which, because they know they've got a low air change rate, they actually leave a longer time between seeing patients, as a mitigation to make up for that.

Q So there are ways of dealing with the issue, in effect, or maybe----

A Yes.

Q -- but there's still a risk from the lower air change rate?

A Yes, or, you know, having to deal with that may mean that the hospital's less efficient.

Q Then you make the point in 8.56, which we've already discussed, that getting it right at the beginning is easier because later on it's very difficult to fix, and we've heard about that from other witnesses as well. Then you summarise that in 8.57, and we're dealing here with general wards:

> "[A] lower change rate … than recommended by guidance would potentially increase the risk of transmission of respiratory infection between patients, staff and visitors, especially in winter…"

Then you say:

> "… without further analysis, the magnitude of increased risk cannot be quantified."

So you say there's an increased

risk, but you can't put a number on it.

A No, I can't put a number on it, no.

Q I think the point that might be put to challenge you on this is if you can't quantify it, how do you know it exists at all?

A There's a lot of things you know exist that you can't quantify. The risk will depend on the virulence of the virus, the transmissibility of the virus that you're dealing with and a number of other issues. You can do it as analysis. You'd need to make a certain number of assumptions, but I think you know which way it's going.

There is an increased risk. I can say there's an increased risk, but the significance of that increased risk is very hard to put a finger on, and it's not within my-- I think if you wanted to play a bit with the mathematics of this, you could do it and you could probably come up with at least something that makes sense, but it's not my speciality.

Q No. Whatever the issue is over quantification, are you still convinced it's an increased risk?

A Yes.

Q Right. Let's move on. Chilled beam units. Every time I say those words, people in various parts of the room groan – silently, of course – because we've touched on chilled beam

units many a time. You deal with this. You say, well:

"They're an energy-efficient and cost-effective option for controlling the environment."

You pick up on the concerns, leaving aside concerns raised informally in terms of papers. I think I'm right in saying the first paper on this was Dr Inkster's paper, that you know of?

A Yes. I mean, one thing I want to make quite plain is I have never-- I don't have a really good knowledge of CBUs. I don't regard myself as any sort of expert in their operation and I've never fiddled with one.

Q We've already picked up from your earlier evidence that you accept that the original advice didn't prohibit them, and now-- Well, there's a question about the precise wording, but they're clearly not in favour anymore for patient rooms.

A No.

Q So, when you narrate on page 701 the kind of things that seem to have happened with the chilled beam units, you're picking that up from the materials that the Inquiry has provided about the concerns that were raised and the investigations that were done, is that right?

A Yes, yes.

Q Then, since I know this is a point that his Lordship is interested in, in

paragraph 8.59, you're distinguishing between chilled beam units and Swegon Parasol heating/cooling comfort modules. What's the distinction?

A I think I probably have taken that from the Inkster paper because-- Yes, as I say, I wanted to see one of these units, but I never got an opportunity to actually see one of those units, so I----

Q It may be that the answer is in the name: the chilled beam unit chills, and a heating-cum-cooling unit can also heat.

A Well, I mean-- yes. I mean, if the CBUs used in the QEUH are not strictly CBUs, they're still called CBUs in every single piece of documentation I think I've read, so I think the----

Q Yes, and in the end of paragraph 8.59----

THE CHAIR: Well, just at risk of giving this unnecessary focus, you do use the expression "not strictly chilled beam units." Now, from what I understand – and tell me if I'm wrong about this – it's a mechanism whereby a flow of air, either simply by induction or by supply, passes over a coil.

A Yes, yes.

THE CHAIR: Within the coil is water. The water may be either above the ambient temperature or below the ambient temperature, and the purpose of the device is to encourage an induction effect of the air within the space. Now, am I right about that or am I wrong?

A I think you've explained it better than I would explain it.

THE CHAIR: The other thing is that they will tend to be either attached to the ceiling or, as I understand the position to be in the hospital, within the roof space.

A I never had an opportunity to see one of these in operation, and I feel a little bit hobbled by that, and I'm wondering whether, again, Andrew might be better to ask in-depth questions. I wanted to see-- I hoped, in my visit, to be able to go to the workshop and see one of these and be explained how it uses-- That's the way I best understand things, and I feel, as I say, hobbled a little bit because I didn't really get the opportunity.

THE CHAIR: Thank you. Mr Connal.

MR CONNAL: You make a point at the end of 8.59 that you think they're quite an ingenious system, perhaps designed for offices and meeting rooms. Then you're picking up a point, no doubt from your experience on various projects. You say at 8.60:

> "… what evidence was sought by the … design team for assurance that these units were safe to use in hospitals[?]"

You say that a large number of units were purchased. So would you have

expected some kind of research to be done on this? Is that what you're getting at here, before they were introduced?

A As I say, I'm not an expert in CBUs, but in my working career, I have a great deal of experience of HVAC units in rooms leaking and causing problems, and I think probably many people have had that experience in the past. I would expect that, since they're being installed in patient rooms, people would be asking questions about reliability and performance, especially since they're buying so many of these units and relying on so many units. I would expect to have quite a high level of assurance that they will do the job without causing problems.

Now, it's very possible that the manufacturers told them they've been used in American hospitals for the last 20 years without problem. That may have happened, but I just-- I mean, that would be my feeling. You're introducing a new water source into the room, often above the patient's bed. How reliable are the connectors? What's the likelihood of leakage? You know, those sort of questions. Maybe they were asked, but I haven't seen any of the documentation.

Q One of the points you pick up on is perhaps a point you mentioned about American hospitals. You say one of the things that you would expect to have been sought was evidence about previous use in healthcare environments.

A Yes.

Q You haven't seen anything about it?

A I haven't seen anything. I mean, maybe it was done, but I haven't seen anything.

Q The only thing you have seen is a reference to an offer to come and look at a mock-up in the manufacturer's laboratories.

A Yes.

Q So what you were referencing there, am I right in understanding, was other types of air conditioning – if I can use that phrase – units having had problems of leaks and so on?

A Yes, I think. I mean, it's not beyond the realms of possibility of a reasonable person having those concerns, I don't think.

Q So, going on to page 702, as you say, there's an extra water supply. Not, as we've heard from other evidence, a sterile water supply, a water supply that was never intended to come out of the closed loop that it was in. There seems to have been some issue over connections.

A Yes.

Q You think that was a-- I think what you say here is that was "a foreseeable risk," the connections.

A Well, I mean, I'm not a

plumber, but I would imagine that different fittings have got their different risks and different failure rates. And, obviously, compression fittings are quite high spec, but, you know, I would imagine, and I don't know--

To some extent, this is where we cross over a little bit with the water experts, but I would imagine that, if you are going to stick a water connector in the roof above a patient, you're going to want to go for a pretty good fitting to make sure there isn't any potential leakage. It's an area that you don't really want to have water leaking.

Q Then the next point you pick up is on dew point controls, which seem to have been originally intended but subsequently not fitted.

A Yes, and I think that was specified in the HTM for CBUs, even the first time they were mentioned.

Q Again, the possibility of this dew point issue, do you think that was foreseeable?

A Well, I mean, you're told to do dew point control. I mean, that is the recommendation, and they said they were going to do dew point control, so you would imagine that there was a reason to do it and if you don't do it, something bad will happen.

Q You then go on in paragraph 8.63, essentially, to try and pull some of these threads together. You say, "Well, what's the potential impact?" and you say:

> "Having a reservoir of opportunistic pathogens in the ceiling of a patient room is … not a perfect situation..."

Where is this reservoir that you're referring to?

A Well, I mean, Teresa Inkster was taking swabs of these units and was finding potential opportunistic pathogens in them on quite a regular basis.

Q Again, there's a risk here, you say, but not one that you can put a number on?

A Well, the opportunistic pathogens need to get into the person's body in order to have an impact, so the likelihood of the route from the drip or from the condensation event to the patient is very difficult to map.

I mean, the obvious thing is through some sort of wound or skin abrasion, and I think the likelihood of that is (inaudible). I think it's interesting that, in the latest HTM, they say in patient care areas, so I think they're worried about potential people having catheters, people having-- Oh, man, what do you call them again?

Q Hickman lines?

A Hickman lines and things like that, so they're worried about those sort of things, I would imagine. You know, it's

very-- I mean, there's no-- There's very little you can put numbers to here, but there is-- but there are potential routes that you can foresee.

Q Then you make a point about the cleaning burden, which seems to have perhaps been higher than anticipated, six months having been mentioned initially as an appropriate----

A I mean, it's an interesting thing. If they were quoted by the manufacturer six months and then it ends up being six weeks or whenever, I wonder whether they reported that back to the manufacturer.

Q Thank you. Well, as you point out, cleaning one of these in the ceiling of a room with an ill patient in presumably causes all kinds of challenges for the cleaning teams.

A Well, I mean, as I think I read, it's a two-man job involving a ladder – a man on top of the ladder and a man holding the ladder – so it's not going to be done with a patient in the room.

Q So, you discuss this and then you come to a conclusion at paragraph 8.67 where you say, well, the issue might not have been apparent at the start, but it is apparent now:

> "[It's] not acceptable, especially for vulnerable patients… Risks are not insignificant…"

You actually suggest these should be discontinued, presumably in patient areas, is that right, about halfway through this paragraph?

A I mean, I'm just going with the SHTM 03-01.

Q Right. Well, let's move on to another----

A I said-- I also say "when practical" because, you know, I think it's----

Q Sorry, just so I'm getting your answer there. Yes, you're following what is said in the latest version of SHTM 03-01, which is that they cause problems in patient rooms and generally shouldn't be used except with permission of the ventilation group.

A Yes.

Q You read that as saying, basically, "Don't use them in patient rooms."

A I said:

> "… when practical, discontinued, with priority given to wards with the most vulnerable patients."

I mean, it may not be practical. You know, you don't want to have somebody in a room that is 10 degrees centigrade or 40 degrees centigrade, and if they're the only way that you can control the temperature at present, then that's as--

I mean, this is the problem. I mean, I think one of the issues is when you've got a blank sheet, you can do different

things. However, when you've got a pre-existing hospital and you need to adjust things, life becomes harder.

Q Thank you. We're now moving on to another topic, "Deficiencies in QEUH wards – infectious patients." You've already explained to us the kind of protection that they may need: essentially, a negative pressure room to prevent pathogens affecting staff or, presumably, other visitors in the ward or anything else, is that right?

A Yes. I mean, the effect of the lower air change rate is to people who are in the room with a patient.

Q Now, again, on page 706 on this occasion, you say:

> "… having a lower air change rate will increase the risk of transmission of airborne … disease."

So, just pausing there, is that the same point you're making from earlier about how the change rate works?

A Yes, but this is probably heightened because we know that the person in the room, if it's tuberculosis, is generating aerosols of an infectious agent.

Q I need to ask you, when you say this, "having a lower air change rate will increase the risk of transmission," is that your personal view again?

A Well, yes. Yes. I mean, I think it would be a lot of people's view with

tuberculosis.

Q Because you say it again a little further down that paragraph:

> "Within the single room, having an air change rate of 2.5 ACH instead of [say] 10…"

Well, that would be even bigger calculation than the one you gave us for 2.5 as opposed to 6.

A Yes, yes.

Q You say:

> "It will increase the exposure of those entering the patient room."

A Yes.

Q Then you take a point that I think has already been made, that there may be other things that can be done to protect someone coming into the room----

A Yes. Oh, yes.

Q -- such as PPE and so on, but you say it still increases the exposure?

A Yes. I mean, you may already have the-- you may already be wearing RPE anyway, so, therefore, it is a mitigation, but maybe you're using it anyway, so you've still got that increased risk.

Q Let's make sure we're getting the acronym correct: RPE?

A Respiratory protective equipment.

Q Respiratory protective equipment.

A Yes, sir.

Q You say in paragraph 8.70:

"No RPE is 100 per cent effective."

A Yes.

Q What's that based on?

A Based on a very, very large range of studies. I mean, you'll never get a 100 per cent effective filter, but your RPE is even less effective.

THE CHAIR: Again, just----

MR CONNAL: You dropped the end of your-- That sentence dropped away a little bit. Can we just go back and pick that up again?

THE CHAIR: Sorry. It's entirely my fault, and can I apologise for speaking over you, Mr Connal? It was just picking up on, as you say, the acronym. Now, it's "respiratory personal equipment." Am I to imagine a face mask?

A Yes, probably an N95.

THE CHAIR: Probably a----

A Probably an N95 face mask.

THE CHAIR: Right, anything else?

A I don't know what they use in that hospital, but yes, I mean, that'd probably be the normality. Because, with something like that, the filter material is of a certain standard, but the problem is it's all about the seal around your face, so they normally perform less well because you'll get a little bit of leakage across the seal.

MR CONNAL: That conclusion, as to it not being 100 per cent effective, you said was evidenced by any number of studies, is that right?

A Yes.

Q So you're quite confident in your conclusion?

A I'm very confident.

Q Then you actually go on to indicate that low air changes had been postulated----

A Yes.

Q -- as a cause of an outbreak in the UK, is that right?

A That's correct.

Q You tell us which one that was and you give us a reference to the paper. In fact, you then mention it again in paragraph 8.71, is that right?

A Yes.

Q You say:

"This has most often been reported in HIV patients. It would be expected to be a possibility with other airborne infections such as COVID-19, measles, etc."

Is that right?

A Yes, yes.

Q Now, in the next paragraph, you're dealing with a slightly more nuanced point, which is, if you have negative pressure creating a directional airflow-- I want you to stop me if I'm getting this wrong. If you have negative pressure with a directional airflow but the

precise number of pascals of negative pressure is not as good as aimed for as a lower figure – not nominal, not 0.1 or any of these figures but nevertheless lower – you're less concerned about that, is that right?

A As long as it's monitored and as long as it doesn't go positive.

Q So you're still getting the airflow, which is the key? The fact that it's 4 pascals instead of 6----

A You're getting the directional, yes.

Q -- or 6 instead of 7.

A As long as the air is going in the right direction, yes.

Q Right, and then you touch on PPVL rooms briefly in the next paragraph and say, "Well, if these work correctly, then that's fine," and you're not normally needing HEPA-filtered exhausting. Then you touch on chilled beam units again on page 708.

So, we now move to the next category, which is neutropenic or immunosuppressed patients and they are mentioned on page 708 in paragraph 8.77. So we've come from the patient in the infectious state, which we've just discussed. Now we have a patient to whom – I think some of the clinicians would suggest – infection is the real enemy because they can't fight it.

A Yes.

Q That's the point you make, I think, in 8.77 at the start. So, what you're saying here is that the reduced clearance of anything from their room will increase their exposure.

A Theoretically, yes.

Q Well, "theoretically"-- Why the qualification? If there is a contaminant or a pathogen in the room?

A Yes, if-- that's what I mean, yes. So, I mean, for example, if you've got a room that is HEPA-filtered and the patient has minimal contact with staff or visitors, then I suppose the air change rate won't really do much. It won't really do much because there's nothing coming in. So that's why I think, you know, I made that proviso.

Q But in the paragraph in question, you reference the SHTM and, indeed, HTM provision for positive pressure: 10 air changes and HEPA filter.

A Yes, that's the recommendation. Yes.

Q First of all, can I ask you, based on anything you've seen, is there any basis for departing from that recommendation for that type of patient, that you're aware of?

A No.

Q You say:

"These ventilation values by themselves and together provide a highly protective environment…"

A Yes.

Q So, if you then take your hypothetical patient who never sees anybody, who's in the room untouched, you then, I suppose, have the next possibility, which-- they're immunocompromised, they're in the room, but a member of staff or members of staff or other hospital team members or visitors or whatever enter the room. Presumably, is there then a risk of some opportunistic pathogen emerging at some point?

A There could be.

Q There could be?

THE CHAIR: "Could be a risk." Is there a redundancy in that expression?

A I mean, the person entering the room will be wearing some form of clothing that will reduce the chances of transmission of any disease. They will probably be wearing-- they'll be wearing something covering their mouth to stop them generating stuff, so there are other mitigations taking place. So, in this case, I'm not so worried about the air change rate, but on the other hand, they should be having 10 air changes. That's what's recommended.

THE CHAIR: I think my point was maybe just a linguistic point. I mean, to me, if I'd come across the word "risk," that suggests something that could happen but wouldn't necessarily happen. I wondered if there was some nuance you were introducing with "could be a risk."

A I mean, part of this is a language problem. Everything-- there is always a risk. There is always a risk of anything. You know, there's a risk a meteorite is going to strike me now, but----

MR CONNAL: I haven't arranged that.

THE CHAIR: Right.

A You know, sometimes, I think that is a real issue you actually do get with the use of terms like "risk." You know, it is something that is quantifiable, but the real-- So a risk can mean a one in a hundred thousand million or one in two, and I think that's sometimes-- and the problem is, you cannot always put your finger on that.

And also, the questions you're asking-- I don't know the other precautions taken in this hospital that aren't involved with ventilation to any great degree. So if they actually send somebody in a negative-pressure space suit with all the air coming out of it being HEPA-filtered, which is totally sterile, then there isn't really a risk. I don't think they're possibly doing that. But, you know, you see where I'm trying to----

MR CONNAL: Well, if I can try and tie this together. The group of patients we're considering here are ones that are

peculiarly vulnerable.

A Yes.

Q So there is a special issue for them about any opportunistic pathogen, if we're just using that phrase for the moment. That's correct, isn't it?

A I think, I mean, what I'm possibly getting-- not communicating very well is I'm a lot more concerned about the HEPA filter and the lack of positive pressure than I am about the air changes.

Q Yes. Well, I understand that, but if we just stick to the air changes for the moment. What you have then is a patient who is particularly vulnerable----

A Yes.

Q -- and the possibility that, due to something that happens in the room or due to someone who's in the room, an opportunistic pathogen emerges. That's what we're talking about, isn't it, that possibility?

A Yes.

Q If it does, then, air change, in effect-- you say it plays a part in keeping them safe?

A Yes.

Q Is that why you've said, "Well, combined together with the other protections"?

A Yes.

Q Because the HEPA filtration that you mentioned is primarily focused on the air source coming into the room from the general air supply?

A Yes.

Q As opposed to what happens in the room?

A Yes. So-- yes.

Q The positive pressure that you've mentioned does prevent anything going on in the corridor, for instance, entering the room, is that right?

A Yes, yes.

Q So if you then move from-- I'll be doing what you were doing a minute ago, waving my arms around. If you go from, let's say, one extreme, the air coming from the air handling system into the room that's HEPAed.

A Yes.

Q At the doors end, you're stopping anything getting in by the positive pressure. Am I right in then understanding the part played by the air change is in the middle, because it affects what happens when anyone else is inside that room?

A Yes. I mean, if the air is sterile, then, and there's no microorganisms, the air change rate doesn't really matter at all, but if there is something in the room that is producing potentially infectious particulate aerosol of an opportunistic pathogen, then the higher the air changes, the less the person is exposed.

Q Thank you. Now, can we just

move then to the next page, 8.78? I think that, at the start of that paragraph, you say:

> "The [hospital] was originally designed to have an air change rate of 2.5 ACH on all wards, which is much lower than the recommended 10 ACH required for specialist ventilation areas."

Why do you say "all wards"? That's one of the questions I've been asked to put to you. Where do you get the idea that it's for all wards? Is that just by reading the documents that we've seen?

A Well, that seemed to be the implication of the documents I was given about the original design process. There wasn't any statement there that there was any alternative areas with higher or lower air change rates.

Q Thank you. You, I think, didn't see anything to show any significant discussion with infection control people in the material you were given?

A I saw none.

Q In fact, what you then do, having narrated, essentially, the matters we've just been discussing at the end of paragraph 8.78, you say that wards designed with a low air change rate "must have caused concern" in staff coming from the Beatson.

A Well, I would imagine that the Beatson were told that their facilities were designed to provide the best environment for their patients, so to be moved to a facility in which the specifications were dropped, I think, would cause concern of any professional person.

Q In the next paragraph, you deal with this nominal pressure point, which we've now touched on on more than one occasion, but if we could go over the page to 710, what you're talking about there is positive pressure rooms and pressure differentials. Then you say, about halfway through the paragraph:

> "The increased risk ... cannot be easily measured."

Is this another one where it's difficult to put numbers on anything?

A Sorry, which----?

Q Sorry, page 710.

A Yes. I see, yes.

Q Just after the reference to JACIE:

> "The increased risk this posed to the patients cannot easily be measured as the protective impact ... has not been quantified."

A Well, I mean, the point is there's not been any-- What I'm trying to say here is that there's not really been any studies showing positive pressure rooms are any better than non-positive pressure rooms, so there's no actual

evidence of how effective positive pressure is.

Q But that's been provided in successive HTMs and SHTMs since the early 2000s, is that right?

A Yes. I mean, I think we all-- Well, you know, we all know that-- What we know is a positive pressure room will stop the ingress of agents into the room----

Q Presumably that's because the matter-- Sorry.

A What we don't know is, in practice, how effective that is in improving patient outcomes.

Q Yes.

A That's because those studies have not been done.

Q I was going to ask you: the practical effect of it keeping stuff out is presumably just a matter of physics?

A Yes.

Q The air will not flow from a lower pressure to a higher pressure?

A Yes.

Q Then you say that you think it would be the expectation of family and so on that vulnerable patients would be housed in rooms of the specified standard?

A Well, yes, especially if people have been transferred or have knowledge of the facilities pre-existing – the Queen Elizabeth Hospital and the Beatson and other places – and if you read things in the----

Q The JACIE standard, which, as we discussed earlier-- it starts with a general statement and then looks at some details but not as many as some other requirements. You quoted it here, I think, again, saying that the unit should be of a "design that minimizes airborne microbial contamination."

A Yes.

Q You give your view that that's not met if you don't have the things we've just been talking about.

A I can't see how it is met, no.

Q So, again, just for completeness, what you then do in the next section is pick up the same point about directional airflow and precise numbers of pascals, that if you've got a lower number of pascals, but not down to the boundary, then, provided the airflow is maintained, the risk is not significant. Is that essentially what you're saying?

A Yes. I mean, I don't think the risk is significantly increased.

Q (After a pause) Then we're going to pick up exactly the same point again in relation to HEPA filtration because you point out in paragraph 8.81 on page 711 that there is actually no studies that show the precise effect of HEPA-filtered units on patient outcome.

A There's one study that seems

to show a slight positive impact, but it's not statistically significant.

Q In terms of-- well, first of all, it's been in the recommendations for some time. If you have the knowledge that the external air that everybody is otherwise breathing contains opportunistic pathogens-- or may do, which seems to be what you've told us, is that right?

A Yes.

Q You want to prevent an immunocompromised person encountering any of these, if you possibly can.

A Yes.

Q How would you do it without a HEPA filter? Or is that a (inaudible) question?

A I mean, I think that's the thing-- But, as Professor Gibson says, it's inconceivable, isn't it?

Q You then deal with chilled beams, which you won't need to touch on again. On the next page, sealed rooms and validation and commissioning because, as you quite rightly point out, no doubt, if you haven't validated to check that it's doing what it's meant to do, you don't know what it's doing.

A Yes.

Q Yes. So we're on page 713 now. We've got the Camfil units mentioned again and you've already explained what you know or don't about

that. Portable HEPA filters, again. You've given us a little more information, perhaps, on what's known about portable HEPA filters when we go to page 714. You say they've been tested in laboratory conditions and in a COVID ward, is that right?

A Yes.

Q Notwithstanding, you say there's no published evidence of their effectiveness in reducing nosocomial infections, is that right?

A Yes. People have tried, but it's not happened.

Q Yes. One of the issues that you then pick up is-- well, we know that, in effect, they scrub the air, so if there's a pathogen wandering about, it can get drawn in and removed, but you say we don't know what they do to air change numbers in whatever location they are.

A Yes. Well, I mean, that can be calculated, but nobody seems to-- I haven't seen any information that people have said, "Okay, we're going to put in portable air cleaners that will increase the theoretical air change rate from 2.5 to 6," for example.

Q Yes. Thank you.

THE CHAIR: Right. Again, just to make sure that I'm following that, what you're saying has not been studied is the-- I'm not even quite sure if I know.

A Okay. Air change rate

measures the amount of fresh air that comes in per volume of the room per hour. Now, what you can do with portable air cleaners, you can see-- what they do is they produce additional clean air----

THE CHAIR: Right.

A -- by filtering out, so if you've got----

THE CHAIR: It's an additional supply?

A Yes, so if you've got an additional 100 litres a second going through a portable HEPA filter, you then can add that to your air changes, your air change rate calculation, to give you a theoretical higher air change rate.

THE CHAIR: Can I just check something with you, because I don't think-- this is something I don't think I'd picked up. I think I've been thinking of portable HEPA filters as simply-- Presumably they must have some mechanical mechanism for moving air through them, but I've been assuming that the source of the air is within the room----

A Yes.

THE CHAIR: -- and the output of the air is still within the room.

A Yes, yes.

THE CHAIR: So, I can see how that changes-- or adding a portable HEPA filter may have some impact on movement within the room, but does it have any impact on air change rate within the total space? Am I being a bit slow on this?

A It's a theoretical thing. It's clean air. It adds to the cleanliness of the air.

THE CHAIR: (Inaudible).

A It's clean air, yes. So, some people use the flow through a HEPA portable to increase their theoretical air change rate----

THE CHAIR: Right, okay, but it is theoretical? In other words----

A Yes.

THE CHAIR: -- it's introducing one mechanism to compensate for a different mechanism?

A Yes, but it indicates a better quality of air within the area it's used.

THE CHAIR: Right. It's not diluting the air, which is what the air change rate does----

A Yes.

THE CHAIR: -- but it is removing particles?

A Yes.

THE CHAIR: Right, okay.

A I know it's quite a funny sort of concept----

THE CHAIR: No doubt I'm a bit slow on this, but it's important that I keep up.

A Yes.

THE CHAIR: Right. Mr Connal.

MR CONNAL: Right, my Lord. (To the witness) I'm moving now towards the conclusions of your report, and I'm going to skate past one or two areas for reasons that I'll explain as we go.

In section 9, "Other issues," you touch on prophylaxis and you pick up on some references in documents you've been provided of patients being given prophylaxis because of some of the issues with the building. I won't delay too much on this because I'm going to come back to it in a moment. On page 717, you say:

> "[You] do not have the expertise to judge whether these prophylactic drugs would have any adverse effects on patients, but it would be my opinion that they should not be routinely used to protect patients from deficiencies in hospital ventilation systems."

I'm going to come to a point at which you give a further answer on that point just in a few minutes.

Then you touch on a topic which, regrettably, we're going to have to hear a bit more about at a later stage of your evidence, which is pigeons. You say, halfway through 9.8 – or two-thirds of the way through 9.8 – that there were reports of "dead birds and excreta in service floors … common in the Queen Elizabeth Hospital." The question is, well, where do you get that information from, that there were reports of birds and excreta?

A Well, there are numerous sources. Unfortunately, it doesn't seem to be referred. I missed that. Nobody picked up there wasn't a reference.

Q Well, you have a separate paper on Cryptococcus.

A There are photographs I've seen and the maps I've seen.

Q Thank you, and then you touch briefly on thermal wheels, but we know they were removed from 2A. They were-- already got there. You touch, again, on air sampling, and you've told us about air sampling. I'm not going to ask you about the sewage works because that's a different topic, which is going to be covered elsewhere.

I just wanted to ask you about the point you make on page 720, which is flexibility. I think we may have picked this up very briefly earlier on, but you say there:

> "A new-build hospital will be expected to have a long operational life [and so on]."

Why do you mention flexibility in the context of ventilation?

A I think, when you're building a large building which you hope will be operating for many years in the future,

you have to realise that things will change and there will be differences in the way we treat patients, there will be differences in the equipment we use, etc., etc.

Therefore, allowing some flexibility in a design – whether it be allow for space for additional air handling units or larger ducts – may be wise. We can't predict the future, you know. It may be that, with the new government being so keen on prevention, we won't have hospitals in five years' time, but it may be that we have more immunocompromised people, and maybe we have more need for specialist ventilation systems.

There's a lot of concerns about antimicrobial resistance. If people's fears are true, then we're going to have to be a lot more careful in our hospitals to prevent transmission of those infections. So, it's just the idea that if you have a major program that's supposed to be running for 50 or 100 years, you've got to maybe think a little about flexibility.

Q In paragraph 9.16, you express your view that the guidance should be used, and then you say, "Well, if there's going to be a derogation"-- I just want to make sure why you use the precise phrase you use here. You say:

> "… there should be a written rationale agreed by all interested parties, including infection control, that clearly explains the rationale on why this will not impact in patient comfort and outcome."

Is that last part important? We've heard about, well, you should write something down explaining why, but you've mentioned patient comfort and outcome.

A Oh, dear. (After a pause) Well, outcome is probably, as risk of infection is-- I'm not sure why I put patient comfort in it, but you would----

Q So is outcome more important than comfort, then?

A I would imagine, in that context, yes, but I think the general principle is that if you're building it to a lower spec than is recommended by guidance, then, if you give a rationale for it, you might be right. There may be a good reason for it, but you need to give that reason and work it through.

And I think also, to some extent-- I haven't written it here, but for staff-- If you're moving staff from a hospital that's built in a certain way to another hospital that's of a lower standard, I don't know what that does for staff morale and the way staff look at things.

Q Thank you. Well, can we come now to your conclusions of this report? I'll come to the questions you asked about in a moment. These appear first on page 722, and I'm not going to go

through all the conclusions that simply repeat the points that we've just picked up.

A Yes.

Q You make a point in 10.4 that there appeared to be a disconnect between the design team and experienced infection control professionals located in the Glasgow area in Yorkhill and Brownlee, who don't seem to have been consulted, and you say that:

> "This assumption [is] likely given the limited information suggesting there was little, if any, collaboration between the design team and the ... professionals…"

I think the question to you might be, well, how do you know any of that? How do you know what liaison there was or was not with infection control professionals?

A Well, I think, during a lot of the documentation, there are members of staff expressing surprise and alarm at some of the facilities when they are shown them. I mean, I must say I'm not an expert in the building process, and I know, in my field, sometimes you get a problem, it's that-- If you have a PFI build or something like that – and I don't know any of this – people don't see it until it's complete. They don't-- they're not part of the process. They only see it when it's complete.

So I don't know whether that was one of the problems. But it just seems really odd to me that you've got some well-recognised facilities built to a certain standard, and if you want to replicate those facilities – and maybe it's not (inaudible) – but why aren't these people being involved in the design of the new study (sic)?

I know that, when we build new specialist laboratories in my old organisation, you get the people who ran the old laboratories and say, "Okay, does this look good to you?" I really don't quite understand it.

THE CHAIR: Sorry, I missed that last sentence. You were giving the example of building a new laboratory.

A Yes.

THE CHAIR: If you're building a new laboratory, you would----?

A You would include the people who work in the old laboratory in the design process to make sure it meets their requirements and make sure that they're happy with the design. You wouldn't necessarily accept all their comments, but you would pass it by them because they're going to be using it.

MR CONNAL: So, at the moment, am I right that you simply haven't seen any of that anywhere in the material you

were given?

A No, I haven't seen any of that. But, I mean, as I say, maybe it did exist, but it just seems a little bit odd.

Q Did I also understand you to take something from the fact that, when the hospital was opened, people started expressing surprise at what was provided?

A Yes, yes.

Q So whoever was expressing surprise didn't know about it?

A Yes, and that's not just the infection control people, that's some of the-- is it Professor Gibson? I don't think she was infection control, but people like that are expressing, "Wait a minute. This is not what we expect."

THE CHAIR: Just so that I understand something you said a moment or two ago, Mr Bennett, you gave the example of a PFI. Now, I think I know what you meant, but let me run it back to make sure that I understand the point. Your general point is that you would expect the ultimate users to be consulted in design, just as with your lab.

A Yes.

THE CHAIR: Now, why I think you mentioned PFI – and tell me if I'm wrong about that – is that in such a contract, and this may not apply to the Queen Elizabeth, the ultimate users are acquiring a service or building that's provided by the project company.

A Yes.

THE CHAIR: Therefore, it may be, in a PFI contract, the ultimate users first of all encounter the building at handover. Was that the point that you had in mind?

A Yes.

THE CHAIR: Right. I mean, I think it was quite clear the way you put it, but I just wanted to make sure I'd followed that. Mr Connal.

MR CONNAL: Can we just go to another page of your conclusions, because I'm not going to go through all of them? It's the heading "Compliance with Guidance" on page 724, and you've already made the point about the consistency of guidance on pressures and so on and so forth as we've gone through your evidence.

I just want to make sure there's no misunderstanding about what you say about chilled beams in 10.13. You say that there's a "change of attitude" between 2007 and 2021. Now, am I right in remembering that 2007 is the first time chilled beams made an appearance in the documentation that you've seen?

A I think it was, yes.

Q Then, by 2021, they're not viewed so favourably, if I could put it like that?

A Yes.

Q But it wasn't until that latter

period that that change was made to the guidance, is that right?

A That's correct, yes.

Q So I have to come back to the question of risk again, I'm afraid, because your report says if you don't have air change rates that are as specified, if you don't have positive pressure pascals, if you don't have HEPA filters, you don't have that package of protection for the particular patients-- I think the point that's being suggested is, well, if you can't calculate any of this – because you can't say, "Well, it's a 13 per cent increased risk or 22 per cent increased risk" – how do you know there's any risk at all, other than just your professional view based on your experience?

A I mean, there's obviously some theoretical risk and you can see theoretical routes of transmission, but if I'm a senior manager or if I'm in charge of a hospital like this and it's built to a certain standard – it's built to the standard that is written down – then I can say I've controlled the risk. But if anything goes wrong, you're looking at where you've been below standard.

Now, that may not be the cause of a problem, but, in reality, that is the way people will look at it. You know, in a car, you've got so many safety mechanisms in it, and some of them, I'm sure, there's absolutely no evidence for their use, but a car manufacturer's not going to take that out to save a bit of money.

Q Well, let me just put it back to you this way: you've identified the difficulty in measuring the amount of risk that there is, but you've maintained in your report that there is a risk in all of these situations. There is an increased risk if you don't have air change rates and so on.

A I mean, this is such a general question. I think, if you don't have a HEPA filter in a BMT room, there is a theoretical risk of the person in that room being exposed to an environmental pathogen that could greatly affect their condition. If you have a HEPA filter in the ward, there is no way that, if it's correctly operated, correctly installed, they will have any exposure to an environmental microorganism through the air.

Now, it may be that we've got lovely air in Glasgow and the HEPA filter is totally not required because there wasn't anything nasty in the air, but then again, it might not be. But, you know, putting a figure to these things is terribly difficult.

Q Is the same true of the issue with positive pressure that you explained to us earlier, that positive pressure in immunocompromised individuals – or negative pressure with the other way around, but let's stick to positive for the moment – is used to try and prevent

anything in the corridor entering the room of the immunocompromised patient?

A Yes.

Q You know it works in the sense that the physics works – it keeps it out – so if you follow the logic you've just explained, it is possible that somewhere in that corridor there is an opportunistic pathogen that, if you didn't have pressure, could get in?

A Yes.

Q It might or it might not, but that's what you're avoiding. Is that what you're telling us?

A Yes. I mean, in microbiology and infection, a lot of things are-- It's the old Swiss cheese sort of thing of lining up all the holes, you know. So we're talking belt and braces, we're talking a lot of layers of protection, and some of them may have limited impact, but we really don't know.

But we know, theoretically, that if I'm coming into work and I don't realise I've got COVID and I'm walking past a ward with an immunocompromised person and the room is operating correctly, there is absolutely no way that I'm going to infect that person in the room. But if there isn't any-- if the room is at neutral pressure and there's no HEPA, then there is a possibility that, just by walking past, the aerosol that is generated may go into the room.

Q If I just then follow that sequence, if you then enter the room of the immunocompromised patient which has the other protections and your mask doesn't happen to be precisely fitting or whatever, is there then a possibility that some element of aerosol leaks and affects the patient?

A Yes, yes. I mean, you could also say that you should also have a system in which people don't come to work if they've got a temperature, and you're testing. There's all these different layers of protection, of which the ventilation is one of them.

Q Well, I just want to ask you one more question about that because we had evidence from Mr Hoffman earlier in the Inquiry, who we dragged out of retirement, and he expressed a view that, in relation to immunocompromised patients, the first key was HEPA, the second key was positive pressure, but actually, air changes didn't matter because there was nothing to dilute.

A I don't often agree with Peter, but yes, I'd generally say that's a fair comment. Air changes is the lowest. If I had to rank them, having 10 air changes an hour would be lower than having a positive pressure HEPA-filtered room.

Q The logic behind his position, as I understood it, was that that assumed that nothing came into that room that

needed dilution, and in that event, you're fine.

A Yes, so you assume that the person coming into that room is not going to turn up to work with a respiratory virus, is going to be wearing a complete change of clothes, sterile clothes, and will not pose a risk to the person in the room. So, yes, I would say, if I had to make a choice, I'd accept the 2.5 air changes, but I'd keep the HEPA and I'd keep the positive pressure.

THE CHAIR: As I understood it, you've addressed this point before. If you assume sterile air in the room-- Because of 100 per cent-effective HEPA filtration, air changes have nothing to contribute in addition. But first of all, you have to make that assumption that what we're talking about is an effectively HEPA-filtered local environment and, as Mr Connal has explored with you, no potential source of contamination being introduced into the room, such as a visitor.

A Yes. I mean, there is one slight complication to this, of course-- is the fact that you've got a CBU in the room to keep it comfortable, so 2.5 air changes without a CBU might make it difficult to control the heat in the room.

THE CHAIR: I think, probably, Mr Hoffman accepted that air change rate contributed to patient comfort.

A Yes.

MR CONNAL: And also to protection of patients and others where there was an infectious person in the room, which is the other end of the discussion.

A Yes, yes.

Q Now, Mr Bennett, I'm going to move from your report, and I just want to touch briefly on the Direction 5 process that followed, where you were asked questions and asked to give written answers, because I suspect we can move reasonably quickly through these.

We find the questions and your responses in bundle 21, volume 6, at page 97. We find there that the front sheet and the actual questions start on page 98, and I'm just going to run through these to make sure we've got your answers clearly. Question 1:

> "How should PPVL rooms be used for high-consequence infectious diseases?"

You say they shouldn't because they're not recommended for that, is that right?

A That's correct, yes. I mean, high-consequence infectious diseases are quite high level, high-level organisms.

Q How do you deal with them?

A You have special facilities. I mean, I think there's a network of hospitals who provide wards for people

who are suffering high-consequence infectious diseases. (After a pause) I'm not sure where that is in Scotland, if there is one in Scotland.

Q Yes, it may not matter for present purposes. Then you were asked quite a technical question in question 2 about the PPVL room in the Hambraeus study that you'd instanced and the PPVL design in the SHTM, and you set out a lot of the technical responses to that. I don't think we need to trouble you with that. Then you're asked a question about-- question 6:

> "To what extent would a failure to identify the mainly fungal species that are not covered by posaconazole prophylaxis impact on the risks?"

You say, "Not my area. I'm not a clinician." Then you're asked:

> "To what extent, if any, do the identified risks of chilled beam units apply to all patients in general ward rooms?"

Basically, you say, "It depends," is that right?

A Yes, yes. I think it depends.

Q Patients spending longer times (inaudible) or having particular exercises carried out----

A Yes.

Q -- may have different impacts?

A Yes.

Q We'll leave question 8. I don't think you can add much on that, but we probably come to similar questions to ones I asked you a little while ago where the question is:

> "In relation to paragraph 7.2 of your report, how did the limited evidence base impact your conclusions?"

Just take us through your response to that because it may be important to understand exactly what you're saying.

A Well, I think, you know, basically, the laws of physics don't change, and we know that a correctly operating isolation room can prevent either the flow of particulate into the room or out of the room. That's-- the laws of physics still hold. You know, that is-- It may vary for different designs of the room, but there-- I mean, the evidence base is very much lacking, but then again, to get the evidence base, you almost need to have guinea pigs.

Q Yes. In a sense, question 10 is a similar one: "Why, given all of that, are you still confident?" You just say you think these rooms do help. In question 11, you're asked:

> "Did you give consideration as to whether the environment as a whole presented an additional risk to patients beyond what would be expected in a comparable hospital environment?"

You answered, "No," you would just

look at ventilation.

A Yes.

Q Then you're asked probably a more general question in 12:

> "What additional analysis requires to be done to address the question of whether reduced air change rates lead to an increased risk of infection?"

Just give us your answer to that so we are understanding what that means.

A I think ventilation has become of great interest because of the COVID pandemic, and many people have tried to use mathematical modelling to demonstrate the impact of different air changes on the transmission of COVID under different sort of surfaces, such as in offices and the like. I, you know-- and so you can use such an approach.

The problem is, I think, deciding what your assumptions are and a real issue that-- I mean, one of my areas of interest has always been the air sampling, but it's astonishingly difficult to get an idea of the generation of microbial aerosol from an infected person, even though----

THE CHAIR: Sorry. I missed this, Mr Bennett. My fault. You've always been interested in air sampling, and I didn't hear what you went on to say.

A Okay. So, basically, if you want to do a mathematical model of the impact of air change rates, you need to

have a source term, and that source term will be-- Let's say, we want to see what-- Say you've got COVID and you're generating, at a certain rate. What's your likelihood of you transmitting to there, there and there under different air change rates?

To do that, you really have to have a feel for exactly what you're generating when you've got COVID. The problem about that is everybody's different. People go through different stages of infection, people get infected in different ways, people produce aerosols during different routes, so it's very difficult to get a correct source term that is realistic to model what an infected person does (inaudible).

THE CHAIR: Now, I rather suspect that "source term" is a technical expression----

A Yes.

THE CHAIR: -- and it's not one that I'm-- I mean, you're giving me an example of my being a source term, but for my note, how would you define source term?

A Okay. Basically, source term, you basically create a mathematical function in which, for example, you're generating 1000 infectious units per minute from yourself. You then input that into a mathematical model that models the flows of the air around the room and

model it at 2.5 air changes and model it at 10 air changes, and then see what the concentrations are there, there and there. And then see whether the likelihood is that the air change rate would make a significant change to the potential of infecting somebody.

THE CHAIR: Now, in that example, the source term is 1000 infective units per minute?

A Yes.

THE CHAIR: Right, and the difficulty that you previously identified was deciding on the utility of that assumed source term.

A Yes.

THE CHAIR: Right.

A And it gets a bit more complicated because, obviously, it depends on particle size.

THE CHAIR: Right.

A So, if you're producing 20 micron particles, I think we're all-- we're probably all safe, but if you're producing two micron particles, we might have to worry a little bit. But it's very difficult to get this information to make a good model for a lot of technical reasons and operational reasons.

THE CHAIR: I'll maybe just take the opportunity of intervening, with Mr Connal's permission. As you may be aware, we've had previous hearings concentrating on the Edinburgh hospital.

A Yes.

THE CHAIR: Following these hearings, in which I heard evidence about ventilation and its possible relationship with infection risk, I was invited to consider the possibility of making a recommendation that there should be more research in relation to the relationship between ventilation and risk.

Now, that's a very easy recommendation to make. I recommend that other people go away and work in a way that-- I'm not suggesting how they work, just they should go away and do some work.

Now, my question to you would be, would such a recommendation actually be redundant because that work is already being done? So, what I'm looking to you for is, from your perspective, is there work under way, as one might expect, having regard to our experience of the pandemic?

A I can't say I'm up to date with work that is being carried out at present. A lot of work I've seen has not been carried out in the hospital environment. I worry sometimes-- The problem you sometimes get is things get so stylised that they don't mean anything, because you've got to decide assumptions and variables and all this sort of stuff, and-- (After a pause) I don't like to say anything.

THE CHAIR: Okay.

A I also know the sort of people who would get money from doing this work, and I think I could be accused of having a conflict of interest by saying, "Oh, yeah, give lots of money to my mates" or something.

THE CHAIR: Yes. I think what I was wanting to avoid was making a rather superficial recommendation in circumstances where people are probably hard at work already.

A I think there's an interesting issue about where-- I always think the interesting issue in everything is where you get your bang for the buck. You know, what is actually-- You know, because we're all going on about ventilation, but it may be that the fantastic care and the procedures carried out by the staff at the hospital are doing far more to protect patients than spending lots of money on ventilation.

And you have to remember that the people who drop the air change rate at least were doing it partially for care for the environment. So, there is always a bit of a balance, I think, between a lot of things, and I think looking for more sustainable hospitals is a great thing, but also being aware of the potential impacts of that. I think that's an interesting area, so I don't know. Why am I rambling?

THE CHAIR: I did ask you a very general question.

A But it's something that really interests me. You know, that's why I think it's-- You know, if people had done a bit of work looking at the drop of air change rate and shown that, actually-- argued the fact that, actually, in most instances, this won't make a difference because of this, this and this and this, then that's a valuable contribution, so I think-- It's just so difficult, this area.

THE CHAIR: Right, thank you. Sorry, Mr Connal.

MR CONNAL: I think the only follow-on question I have to that is that one of the points you've made is that the existing recommendations – which apply throughout the UK and seem to have come from-- well, there are a lot of similarities, at least, to some of the American recommendations – they seem to have been in place for quite a long time, as these things go, and have remained fixed at that level.

The question is, is there anyone out there that you're aware of that's digging around trying to find whether these should change or should be different, or whether the focus should move from A to B instead of C to D or whatever? Are you aware of anything that would help his Lordship on that point?

A I'm not sure. I mean, I must say, I really know nothing about what's

done in Europe. I wonder how they deal with those sort of issues. I know the one people who are still interested in this sort of stuff are the Scandinavians. There's still groups in-- One thing is, a lot of this research-- I think people believed that everything had been solved by 1980, and so there's not many people doing-- especially-- and there's not many people totally linked into hospitals doing this sort of work.

THE CHAIR: Sorry, "there's not many people"?

A You know, with linkages to hospitals, doing this sort of work. And a lot of the people, the experts you see, are even older than I am. So, the problem is just some of the knowledge behind this, I think, starts to get a little bit lost, and it may be that some of this stuff does need to be revisited, but it's so difficult to do experiments in this sort of area.

MR CONNAL: Well, I think I just have – I'll explain why in a moment – just one more question. I just wanted to pick up one more of the answers in your Direction 5 questions. You remember a moment or two ago, I took you to a section of your report where you touched on prophylaxis and you made a comment about it.

In question 13 in your Direction 5 questions, the questioner says, well, "What's the basis of your opinion as a non-clinician?" So there's obviously a criticism levied there that prophylaxis should not be used. I'd just like you to take us through your answer because it's quite an interesting one, I suggest. Just explain what the point you're making there is.

A Okay. I mean, if you take a prophylaxis-- if you give a patient some prophylaxis to prevent them being infected by a pathogen, and that prophylaxis has no side effects, then it's an absolute no-brainer. If you need to give a patient a prophylaxis that will make the patient feel pretty rubbish, make them feel ill, then you have to think about the sort of-- almost like the cost-benefit analysis: is it worth putting this patient through this feeling bad in order to protect them?

What I'm saying here is that, in general, I think it's better to use a protective environment to protect a patient than give them heavy-duty prophylaxis that will really not be good for them. However, that's a clinical opinion. You know, I-- And also, for some people, it may be that--

It's funny, I saw a comment – I forget-- from one of the-- a report by a doctor, I think, for the hospital – in which he was saying that he was really impressed by the use of prophylaxis at the QEUH, because they don't do it at his

hospital. But they weren't using it at his hospital because they probably had a better sort of ventilation system.

But these are all clinical decisions, and it may be that, at the end of the day, if they don't have a HEPA filter, it may be that, you know, they aren't obliged to use the prophylaxis. And again, if it's going to cost-- I mean, there's always different drivers. There's always different things. There's money, there's sustainability, there's patients, there's-- that whole sort of thing.

So, it could be argued that it's worth using prophylaxis to save 10 million quid because you're not using HEPA filters. And the prophylaxis, I mean, I don't-- as I say, I don't know about the prophylaxis, how bad the side effects are and how awful they are. I really have no feel for that.

Q Thank you, Mr Bennett. My Lord, these are all the questions I had intended to ask Mr Bennett, at least, as I say, as at present advised on his general ventilation paper. I'm conscious he had a paper on Cryptococcus and some Direction 5 questions on Cryptococcus.

I'm also conscious that normally we would have a break to see whether anything arising had given rise to questions, but I was perhaps going to tentatively suggest that the sensible thing to do would be to rise now, since it's four o'clock, in any event. If there are questions that people wish to raise, they can intimate them in the earlier part of tomorrow morning, and then we can pick up on any general matters tomorrow before we move on to Cryptococcus.

THE CHAIR: You might even take the opportunity of this afternoon to raise questions.

MR CONNAL: Well, it's always possible, my Lord, yes.

THE CHAIR: Yes. Mr Bennett, I think we will follow Mr Connal's suggestion. In other words, we will rise for today.

A Right.

THE CHAIR: I look forward to see you at ten o'clock tomorrow.

A Okay. Thank you very much, sir.

(<u>The witness withdrew</u>)

THE CHAIR: As I look forward to see everyone else at ten o'clock tomorrow.

(<u>Session ends</u>)

16:06