SCOTTISH HOSPITALS INQUIRY

Hearings Commencing
19 August 2025

Thursday, 28 August 2025

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10.02

THE CHAIR: Good morning. Before we begin today's session of the hearing, I would like to say that it was with great sadness that I and the other members of the inquiry team learned of the passing away of Molly Cuddihy. Ms Cuddihy gave evidence to the inquiry in the first of our hearings in 2021. It was evident from that testimony that she was a young woman of great courage, great determination and clear intelligence. Our thoughts are with her family today. Thank you. We will now proceed with today's hearing, which I think is the evidence of Professor Mike Stevens.

MR CONNAL: That's correct, my Lord.

Professor Michael Stevens

Sworn

THE CHAIR: Thank you, professor.

A Thank you very much.

THE CHAIR: Now, you're scheduled for today. I'm not sure how long your evidence will take. We will probably take a coffee break at half-past-11, but if you want to take a break at any other stage, just give me an indication and we can do that.

A Thank you.

THE CHAIR: Now, Mr Connal.

Questioned by Mr Connal

Q I'm obliged, my Lord. Good morning, professor.

A Good morning.

Q You've given evidence before, and I don't intend to go back over who you are and what your CV is. That's already in the documents that the inquiry has, which participants will be familiar with. For the purposes of today, as a guide to moving through the topics, I'm proposing to look at one document as the base, which is what was described as a rebuttal of what we've been calling the HAD report which you and your colleagues were asked to prepare, and we find that at bundle 44 at page 120. Just wait for it to come up on the screen.

THE CHAIR: That's volume 3, isn't it?

MR CONNAL: Yes. No.

THE CHAIR: Yes.

MR CONNAL: The error must be mine. Bear with me a second. I'm just trying to find it in a long list, I'm afraid.

THE CHAIR: Right. We seem to have it on the screen.

MR CONNAL: Ah, good. We've got it. I'm obliged. Now, just for the sake of formalities, I take it that that was a document to which you and your colleagues all contributed?

A Yes, we did indeed.

Q But so far as this morning is concerned, are you content to incorporate it as part of your evidence?

A Absolutely.

Q Thank you. You were asked to produce this by the inquiry, and you duly obliged, and we'll just go through it. The document starts at page 123, logically, by setting out as background the role of the oversight board, the work, and then ultimately the Case Note Review. What you have done in this document, as I understand it, is to take the HAD report, look at certain parts of it, and then comment on it as you go through. Is that correct?

A That's correct.

Q Now, am I right in understanding that you've had the opportunity of looking at some of the further material that's been produced since this was produced, such as further charts and so on?

A Yes, I-- yes, I have.

Q We'll come to that later, and I think you've also had an opportunity or taken the opportunity of listening to the evidence of Dr Agrawal and also the evidence yesterday, is that correct?

A Yes, and Dr Drumright.

Q Yes, and Dr Drumright. So, all of the three HAD authors?

A Yes, yes.

Q It's probably fair to say that some matters, at least, have moved on since this rebuttal has been prepared, is that correct?

A Yes. I mean, there is some substantial sections that have clearly changed in response to further analyses.

Q That may allow us to move a little more quickly than might have been the case over some of these issues. Now, just going to the substance of the document in front of us. At page 124, you make what is in effect the first substantive point of what you might regard as criticism of the HAD report which is that they don't discuss IPC at all, or hardly at all. Did you think that was an important point?

A Absolutely. I think we felt it was an absolutely critical issue in relation to rates of infection, which was their principal focus.

Q Yes. Now, at this point of your report, what you're doing is, in your introduction, picking up things that are in the HAD early stages rather than in the detailed chapters. On page 125, near the foot of that page, you make a point about whether the precise route of transmission of an infection is usually established when there's been an investigation. Now, you say it's almost never established, is that right?

A Yes, I think it's-- I think there are many opportunities for a route of transmission to the patient, and it would be difficult to prove without any doubt which that route is. I mean one can make certain assumptions in the clinical care of

patients, particularly in the care of the patients we're discussing where they-- and I think we-- I think we talk about this both here and possibly later in our document, that most, but not necessarily all, of the patients will have indwelling central venous lines which were manipulated frequently. They often undergo a number of other invasive procedures. So, there are-- there are portals of entry, but there are also routes of transmission from the multiple exposures to other people and to other things in their environment.

Q Yes, and I think you are quite correct that you list some of these perhaps in detail later in your response. Is that right? Now, perhaps the sharpest-- I can suggest one of the sharpest points of departure identified in your early stage discussion of this comes on the next page, where you quote a part of the executive summary of the HAD report, where it says that:

"Attributing the source of a BSI pathogen to the built environment of the hospital can only be shown if: the strains identified are indistinguishable, a source is present, and a route of transmission and a portal of entry are identified."

Now, your response to that is simply to say that's not true.

A Well, it's not consistent with the standard infection prevention control definition, I think, and it really all hinges around the issue of strains becoming-- being identified as indistinguishable and the definition of the-- or the identification of the route of transmission and the portal of entry. So, there's rather more precision in this statement than I think exists in real life.

Q So, I understand from your earlier answer that routes of transmission and possible points of entry are often-- a number of these are identified in an individual patient case, would that be correct?

A Yes, I think-- I think that's the case.

Q Rather than be able to say, "Well, it's X, which"----

A Yes.

Q -- "has gone in via Y," you may have A, B, C, D, E, F, G. Is that the kind of picture you're trying to paint?

A Yes, I mean, I think it would be very difficult to say, unless testing is undertaken, to prove the situation, for example, that an infection was acquired from a shower trap, that a portal of entry was when a central venous line was accessed on a particular occasion on a particular day. But nevertheless, all these are risks within the environment of the patient, and the whole point about Infection Prevention Control is an awareness of those risks and attempts

therefore to mitigate them.

Q Then your conclusion is that you can attribute quite reasonably the origin of an infection to a source if the data is consistent with that being the case?

A Well, I think you can impute that by demonstrating the classical association of time, place and person, which, you know, is the principle behind which we undertook our work.

THE CHAIR: Does something perhaps turn on how you understand the word "attributing"? I'm thinking particularly under reference to strains being indistinguishable.

A Yes, I mean, I suppose you're right, my Lord, that it's the strength of the use of the word "attributing", and I don't know whether perhaps "attributing" also imposes or includes an element of designation rather than certainty. I'm just not sure.

THE CHAIR: Mm-hmm. I mean, it occurs to me that there might be a difference between imposing the criterion of 100 per cent scientific certainty as opposed to clinical judgment. When I use the word "clinical judgment", I mean, the sort of level of association which a clinician would regard as sufficient to proceed with his treatments or his attribution of causation. That's maybe not very well said, but what I'm, I think, maybe interested in exploring is, I suppose, whether clinicians always proceed only if they have scientific certainty as to-- here we're talking about cause and effect.

A I think it would be almost fair, my Lord, to say that clinicians proceed very often without evidence or scientific certainty, in that one has to make judgments based on the information available to you at the time. And I suppose if I bring that back to the context of this matter, I would say that's exactly why hospitals hold multidisciplinary meetings like PAGs and IMTs, to consider the weight of the evidence that would direct you to a supposition that a particular source was a likely cause of infection in this setting.

THE CHAIR: Thank you.

MR CONNAL: Well, can I come now to another point where you've picked up on something early in the HAD report and then sought to deal with it, which we find starting near the foot of the same page, page 126, where you pick up a statement that, "If the built environment poses an increased risk of infection, then this would manifest in an increased rate of infection." You say, well, sounds "intuitively correct", but-- You have a "but" there. Is that right?

A Yes. I mean, I suppose I would summarise our position as this,

that the expression of an increased risk of an infection to an individual is not equivalent to the identification of an increased rate of infection in the population from which they come. Now, that may sound a little semantic, but in essence that a patient could be exposed to an increased risk of infection without that necessarily reflecting an increased number in the-- an increased overall rate of infection because one has to consider the individual circumstances of the patient. And I think this is a little bit of a theme in our rebuttal that we undertook a process which was more, I suppose, holistic in terms of patient circumstance, whereas the HAD team undertook a review of changes in the rate of infection, and I think that's a difference in approach. And I suppose I would say that in a sense they're complementary, but merely because you don't see an increase in rate of infection doesn't exclude the possibility that there wasn't a risk of infection to an individual.

Q I think this is a point that has emerged, as you have gathered, on several occasions so far in discussions with others, that the exercise that the CNR did, which involved examining individual patient material, is not something that either this Inquiry or indeed the HAD team were able to do because of the issue of-- Well, they weren't given that material to do that. On page 127 at the top, you sort of pick up the suggestion that, well, the CNR doesn't help, but do you think the fact that you were able to do individual patient examination in terms of data was something that was important to your work?

A I think I-- I think it was unquestionably important, that simply-- and perhaps I can distil it this way: simply looking at the date at which a patient got an infection doesn't tell you very much about the potential for the risk of that happening. Perhaps I maybe-- perhaps I'm not-- well, I know I'm not being clear, but perhaps I could give an example. So it may be that a patient had been an inpatient for seven weeks, and, you know, with is a scenario we would have encountered in the Case Note Review. A patient would've been continuously an inpatient for, say, seven weeks and then developed an infection, and our-- you know, our hypothesis was that it's much more likely that that infection arose from the experience of being in the inpatient environment than that the patient brought that infection in with them and it suddenly popped up seven weeks later.

Now, on other occasions, a child would present to the emergency department of the daycare unit with evidence of an infection but had not been

in contact with the hospital environment for perhaps a couple of weeks, and so there's a different weighting, or there was a different weighting in our minds, as to the nature of the potential for an environmental origin for that infection. I hope that's helpful.

Q Thank you very much, Professor. So we find on page 127 the point that you've just made a moment ago about the increased risk of infection to an individual not being the same as an increased rate of infection in the population. I don't really want to get into a great debate about clustering, but can I just ask you about what you say in the next paragraph because you've put it in reasonably straightforward language, I would suggest? Can you just take us through what point you're trying to make in that paragraph there?

A Okay, perhaps I could just quickly revise it. Yes, I mean, I think this paragraph actually reflects some of the exemplars we gave in the Case Note Review and where we're arguing essentially that to see sequential or several examples of the same infection, perhaps several examples of another infection occurring within a relatively short – I mean, when I say "short", I'm talking about a number of weeks or possibly a few months – in the same environment seem to us to be a-- what's the word I'm looking for, a coincidence, than to actually imply that there was some reason for the apparent clustering of these events in time and place.

Q You're dealing with that in the context of the proposition that the bloodstream infection might have been endogenously acquired. The way I read it was you were saying, "Well, what's the chance of all of these patients round about the same"----

A Yes, popping up with a gut translocated or an infection from their skin or upper respiratory tract, yes, I mean, I think you've put that rather more clearly than I did. Thank you very much.

Q Thank you. Now, in the next section of your report, which started on page 128, you pick up on part of the HAD report which talks about listings of microorganisms and so on, and I'm not proposing to take you to that. On page 129, you have a heading, "What is meant by an outbreak?" Now, this is perhaps where the apparent requirement of HAD for genetically indistinct microorganisms changes the game completely because if you very rarely get that, you wouldn't get an outbreak on their definition at all. Is that fair?

A No, although I-- you know, I sense from both reading the report and hearing the responses of the authors that they recognise that to be the case, that

there is a real world and there is the world of aspiration. And, you know, I believe that in time methodology and scientific technology will move on so that you may have almost real time-- the real time ability to confirm a genetic identity, but that's not the situation we find ourselves in today. But there's no doubt that that methodology, I suspect, will come and, you know, the world will look differently then.

Q The definition of an outbreak that you used was the one from the National Infection Prevention Control Manual. Is that right?

A Yes, I think our approach was consistent with that definition, and I think that's the standard to which Infection Prevention Control teams work.

Q And the point you make, I think, on the next page is the one you've made earlier, that it's not always possible to identify the source – this is about the third paragraph on that page – either until later or sometimes at all. You may never know.

A Well, I think the point we're making here, and I think it's a point that we-- that, you know, we had made more than once, is that if you're looking to link a patient sample to an environmental sample, you have to take the environmental samples in sufficient number and range to have the opportunity of identifying the link.

Q Right. I'll return to the needle in a haystack proposition that you mention later just a little further on. I think later you make the point that root cause analysis, which is a particular approach to investigation, wasn't introduced in the Queen Elizabeth Hospital until relatively late on in the period----

A Well, the end of 2019.

Q 2019?

A Yeah.

Q Thank you. Now, if we could move on from there, if we go to page 133, we then find you're picking up on chapters commenting on how your Case Note Review dealt with certain bacterial species, and I think the way in which this rebuttal runs is you look quite carefully at Klebsiella and then in less detail at some of the other organisms. Is that correct?

A Yes. I mean, we decided that we would take a greater focus on Klebsiella, I think not merely because we thought it was a specific exemplar, but because Professor Hawkey and colleagues made the point, you know, and I think it-- you know, it's justifiable. It's a difference in quantum, which is possibly a word we'll come back to, but they made the point that the majority of Klebsiella infections arise endogenously and that they're not necessarily that

frequently found in water supply. And I think what we wanted to do is to rehearse the fact, and referring to some of their own statements as well as other literature, that actually Klebsiella can be found in-- in water and surfaces that have been in contact with water in the ward and we're just really making the point that this is perhaps a little more complex than the-- or a little more uncertain, perhaps, is what we were really trying to express, than the statement that might otherwise have been believed.

Q And in fairness to you, as you perhaps just illustrated, as you go through your rebuttal document you do pick up on areas where there is agreement between the HAD authors and the CNR authors and you----

A Yes, I think they're asked-- you know, they're-- I mean, you know, it comes back to what we said-- perhaps what we-- what we've tried to say that there is perhaps not such a great distance between us and that we're just-- we've come at this from different perspectives.

Q I just say that because as an example we find on page 133 a statement lifted from the HAD report that:

> "It's important to maintain a balanced view. Just because bacteria of the same species can be found in sites that are not necessarily the source of the infection."

And you say, "Good, we agree with that; that's the way we approached it."

A Well, it certainly wasn't our starting point, you know, that we-- I hope we were able to an open mind by looking at the sort of broader circumstances of the patient's situation.

Q Having produced another quotation from HAD, you then at the foot of that page say, "Well, this appears to agree that the hospital environment could be a source of that particular Gram-negative bacteria."

A Absolutely. I mean, we're-- I mean, I think what we were seeking to do was to slightly redress the balance from this being presented as an organism that largely was not found in the hospital environment as a cause of infection because it was endogenously acquired, to suggesting that-- that there was perhaps a slightly greater risk of this organism being found in the hospital environment and that it wasn't necessarily all endogenously acquired.

THE CHAIR: Would I be right in saying-- I tried to explore this with Professor Hawkey yesterday. The way I put it to him was to ask him what he saw as the purpose of chapter 3 of the HAD report. I'm not too sure how successful I was, but would I be right in saying that if

one goes to chapter 3 and, looking at your responses, if the question is, “Is it possible that the source of the various microorganisms which are listed in chapter 3--” if the question is, “Is it possible that they might thrive in a water environment and therefore make the water environment a possible source of infection?” There is no occasion in chapter 3 when the authors of the HAD report say, “This organism [which the CNR have assumed was a potential environmental source] cannot ever be found in the water environment.” That’s a rather clumsily put question. Is there any instance where on one side the authors of the HAD report say, “This organism cannot come from the environment” and on the other side the authors of the CNR report say, “It can”?

A No, I don’t believe-- I don’t believe there is a clear divide in-- at all. There are nuances, and there’s a-- there is a particular comment, I think, about Acinetobacter, which is-- and here I’m not a microbiologist, but I think there’s a comment that this is an organism that quite likes surfaces that have dried after water exposure and I think what some of the detail in this chapter does for us is it identifies that, you know, these are individual organisms, they exist within a general group labelled environmental and enteric, but they do have some nuance in terms of their behaviour, but I don’t think it rules out any of them from-- I don’t think there’s a fundamental disagreement.

THE CHAIR: Well, that’s possibly a rather better way of putting it because I couldn’t actually identify an absolute disagreement, bearing in mind, as you say, there’s nuances one way and the other.

A Yeah. I mean, I-- perhaps if I may be allowed just to extend my comment to say-- and maybe Mr Connal will take me there in a moment. It’s just the Mycobacterium chelonae in their consideration of what’s environmental-- it’s a striking absence and it remains, to me, unexplained as to why they chose not to do that, but there has been a lot of discussion, I know, about how you-- how you derive your list.

MR CONNAL: Well, I think all I need to do in light of the discussion you’ve just had, Professor, is just record. So again, we can follow through the way this rebuttal has been prepared, that what you then do – having picked up on the fact that it’s possible that there may be an environmental source or an environmental method of transmission – in the succeeding pages is you pick up on a number of publications which you were able to find which say things like these are potential reservoirs of infection and

similar material. Is that the way that next section follows.

A Yes, I think we were keen, really, to reinforce our position that-- I mean, for example, looking at page 134, we just wanted to reinforce our position that Enterobacter in this context is found in the environment. I don't think anyone would disagree with that, but it has been clearly identified as a source of infections in patients and that you have to look quite hard to identify the source.

Q Yes, and you follow through a number of-- I won't get to read through all of the extracts of material that you've put together because they all say variations on the same theme. Is that correct?

A I think that's correct.

Q And you pick up in particular, I think, on 135 and running onto 136 some comments from a working party, which Professor Hawkey also participated about how, in particular, Gram-negative organisms may transmit and what the routes of transmission may be and the possibility, at least, of water sources being involved.

A Yes, I think the quotes are on the next page, 136.

Q So 136.

A Thank you.

Q At the top, so we see there:

"Environmental screening should be considered when there's unexplained transmission of Gram-negative organisms or a possible common source. Transmission from patient to patient is believed to be mainly via hands of staff [etc]…"

Common environmental sources have been described, water supply mentioned as a possibility and so on. So you're picking up on more material in the literature, in this case partly authored by Professor Hawkey, which at least raises the possibility of water sources being involved. Is that correct?

A Yes, and I think underlying this is the theme that infection prevention control measures are important in addressing these risks.

Q Yes. You then pick up a comment near the foot of page 136 about sink traps and the presence of biofilm. The HAD authors say that the-- I think this is a quotation. Is this a quotation from the Hawkey study or is this a quotation from the HAD report? The one about sink traps.

A The second to last paragraph on page 136 is, I think, a quotation of the text in the HAD report.

Q Yes, that's the way I read it. Thank you. So the HAD author is saying that sink traps are sometimes seen as the most important source of Gram-negative infections in wards with vulnerable patients. Would you agree with that?

A Yes, I mean, I believe that to be the case, yeah. I mean, they are important, but so are a number of other things, clearly.

Q There seemed to be some misapprehension which perhaps lurked behind some of the discussions over the past few days that you were saying that everything comes from the environment, but that wasn't the conclusion you were reaching, was it?

A Well, it wasn't intended. When I reread some of the documents, I mean, I-- it's important to have insights in retrospect, I suppose, and I recognise that in describing in the Case Note Review that the majority of the cases were possibly related to the environment what we were trying to articulate was, well, they are possibly related to the environment but we're not saying that they are, and one or two people-- I think not necessarily in the HAD report, but one or two people have picked up this this percentage of-- you know, they say that-- you know, 70 per cent are possibly related to the environment, so we're kind of implying that they are related the environment but we haven't been to prove it. It's not-- that's not the truth, that's not the situation, that's not the message we intended to portray.

Q Well, just so we're clear. Since we have you here, what was the message you were intending to portray?

A Well, the message we were intending to portray was that we estimated at about 30 per cent, thereabouts, of the infections that we investigated we felt how-- there was good reason to believe that they-- that on the balance of probabilities, they derived from the environment in which the patient had been treated.

Q And that was primarily from-- let me just call it from a water-related source, rather than the water sink traps, drains, whatever. Is that right?

A Well, I think-- I think when you talk-- and I think Professor Hawkey had possibly made this point at some point in his report, but when you think about the patient environment, you do have to think about everything. You have to think about equipment and of course, you know, water affects equipment as well, because of course, most equipment is washed with water, not all. You have to think about equipment, you have to think about pharmacy preparations. I mean, there's a clear example that has been discussed on many occasions about a Cupriavidus infection in a patient in 2016, which wasn't part of the Case Note Review but nevertheless was a seminal case because it could be shown to be linked to the preparation of a pharmaceutical product. And so there

are many things you have to think about in terms of the environment, but clearly, water and water-related phenomena it comes very high on that-- on that list of possibilities.

Q You then go on in your rebuttal to pick up on some of the literature that was considered. I think you refer to a thing called Kizny-Gordon.

A Yes.

Q Am I right in thinking that that, rather than a study, it was a literature review of studies?

A Well, it was a systematic review and I think in the hierarchy of searching literature systematic reviews are considered to be pretty high and that's because there is a structured approach that one needs to undertake to do a systematic review. I mean, it's not just a casual label; it defines a methodology and it means that, if done properly, the authors have screened a number of publications to make sure that they only include ones that are of adequate standard to answer the question in-- in hand. And so, you know, we-- we recognise that that was, by nature of its methodology, a-- and because it refers to-- it's not just a single study. There's always a danger of taking conclusions from a single study because it may prove to be an exception, but a systematic review generally offers better quality evidence.

Q Just so I'm clear, because a layperson might not understand from my casual reference to a literature review the point that you're just making, that this is a particularly rigorous scientific review process that you've just described.

A Yes, I mean, clearly, if done properly, and I-- you know, I believe-- I believe this was a rigorous-- looking at the paper, I believe it was a rigorously undertaken process.

Q Yes. What you've then gone on to do is pick up on a number of quotations from that review, largely around the possibilities of reservoirs of infection in a variety of sources. Is that right?

A Yes, and I think at the end of this section we possibly-- I think there's a comment that we make that-- that we've slightly gone to town on this section in Klebsiella because we were trying to establish the point, and what you see-- the sections that follow this are much briefer because we didn't rehearse the same principles.

Q Right. What you've done is you've-- yes, as you say, you've gone to town a bit on Klebsiella to show the point you're trying to make, and then you don't then repeat that at length in every other discussion.

A No, but the general principles,

I think, are applicable.

Q How could you-- Would you like to summarise the general principles that you're picking up here, just so we know what they are?

A Well, I think, just to go back to what we were discussing a moment ago, it's essentially to say that, you know, we recognise that infections do arise endogenously within-- within patients who are already colonised with an infection within their gut, but there is also-- there are also many possibilities for these infections to manifest through transmission from the environment.

And perhaps one of the points that we haven't articulated particularly well, or we haven't been explicit about it, and it reflects something that Professor Hawkey talks about, which is he talks about a colonised patient then colonising another patient. And, to my mind, the transmission of an infection from a colonised patient to another patient actually represents a challenge for infection prevention and control, and if a patient acquires an infection in the environment from another patient, then I see that as an environmental infection. If a patient brings a-- bring an infection with them, an organism in their gut with them into hospital-- But the difficulty is we very rarely know that.

Although, very interestingly, I noticed in, I think, Ms Harvey-Wood's witness statement a reference to the previous practice of screening stools in patients at Yorkhill, to see if you could identify what the-- what the sort of current flora of the gut was and how predictive it was, and-- I think it was her reference – excuse me if I've got that wrong –but I just don't know the literature to say that if you try to screen people's gut or to take throat swabs or skin swabs-- I just don't know how predictive that is of subsequently developing an invasive infection. There must be a literature somewhere, but it's rather removed from my expertise, I'm afraid.

Q Yes. So your point is that, if there's been patient to patient transmission, or patient to surface and surface to patient or something----

A Yes.

Q -- of that kind, that still involves patient number two or three or whatever picking up that infection from the environment.

A Yes, because-- because, I mean, whilst nothing is perfect, it represents a failure of the precautions that we try to take, which is hand washing and cleaning and unnecessary patient contact, perhaps, you know.

Q As you pointed out, you deal with other organisms rather more shortly for the reasons you've just explained.

Can I just ask you about Enterobacter because you've got a little more narrative on that than on some of the others, which appears at page 139. This may be the point you're trying to make about how much difference there is between the CNR authors and the HAD authors, because you say early on there HAD seemed to "play down" the risk of hospital-acquired infections due to Enterobacter, although you say, "Well, there are studies that show that it's possible."

A Yes, I mean, rightly or wrongly, you know, our impression was that there was a sense in which it was-- there was an assumption that Enterobacter is an endogenously-acquired infection, and I think, you know, the first point we're making here is that, "But, actually, there are studies that show it's clearly in the environment and that it can infect patients and that the link with the environment has been established," and-- So that was the first point.

I mean, there is a much more complicated area about Enterobacter which I-- I feel slightly cautious about engaging with, but perhaps-- perhaps you might give me the opportunity to do that because it relates-- or unless you want to talk about it under whole genome sequencing, because it-- a lot of play has been made in evidence given that if you have an isolate of a bacterium called Enterobacter cloacae and you submit it to whole genome sequencing, you may decide it's not Enterobacter cloacae – maybe another subset of Enterobacter.

And the difficulty I have is that, you know, as a clinician rather than a microbiologist or a molecular geneticist, as a clinician, if the Microbiology department tells me that a patient has got an infection with Enterobacter cloacae, I understand that concept and, with the assistance of the microbiologists, I know what I need to do in terms of how to treat that patient. For us then now to be asked to consider that Enterobacter cloacae isn't necessarily Enterobacter cloacae, but it could be one of a number of different subsets, is something that actually doesn't really terribly well inform clinical practice because, over the years, we've called Enterobacter cloacae, "Enterobacter cloacae", and-- and merely using the data from whole genome sequencing to say, "Well, there's a whole load of different subtypes there," doesn't affect the fact that we treat them all the same.

And I don't know, and, you know, I mean, I can't even surmise-- I don't know whether there is adequate information to say that one subtype of Enterobacter cloacae is more pathogenic than another subtype, and I suspect that that data

doesn't exist in a clinically relevant setting. I also suspect that in 10 years' time the microbiologists may well have subdivided Enterobacter cloacae into clinically relevant separate-- separate species that-- that, as clinicians faced with infections, you might take a slightly different approach to.

But, currently, I feel that the-- that the fragmentation of the Enterobacter family is-- whilst one has to take note of the evidence for it, doesn't actually help the clinical scenario.

Q Because you still treat what you have been advised by its presence.

A I don't know whether there's any grounds for doing any different than that, and it would-- you know, it would be interesting to talk to Professor Hawkey about it, but----

Q So to that extent, the debate – if it's a debate – about whether it is or is not the precise name when it's further analysed doesn't at the moment impinge on clinical practice. Is that really the point you're trying to make?

A It doesn't impinge on clinical practice. The question then is whether it should impinge on the identification of a-- or the proof of a-- of a relation to a source, which I think is probably the point that Professor Hawkey would want to make more forcefully.

Q So, if you're doing the idea of trying to find a genetically indistinguishable piece of material, both in sample and in test, you might have to look at a different label other than, "Enterobacter cloacae"?

A Well, I mean, again, I think, you know, I would revert to Professor Wilcox. We've discussed this on a number of occasions and did so during the preparation of our rebuttal. The-- Our belief is that bacteria exist in the environment in a number of subspecies, and the merely, "You identify one and not another," doesn't necessarily exclude the presence of the other, as it were.

Q Yes.

A But perhaps I'm sliding a little further away from the point you were trying to make.

Q Not at all. That's very helpful, professor. I was proposing to move on from Enterobacter at this point, unless my Lord wishes to----?

THE CHAIR: No.

MR CONNAL: No? Thank you. If we go then on to-- I'm just trying now to illustrate the way you've prepared the document. If we go on to page 140, we pick up on Pseudomonas, and largely what you say there is there doesn't seem to be much disagreement because HAD say:

"It is the most important bacterium when considering colonisation of hospital

water systems which can then lead to infection in susceptible patients."

And you agree with that?

A Yes, I mean, it's a-- it's a clear focus of concern and a lot of remediation.

Q Yes. Now, the next one is – I always get this pronunciation wrong – a Acinetobacter.

A Acinetobacter.

Q Now, did I understand that the point that you were making there was that the behaviour – that may be the wrong word, but I think you know what I mean – of that particular organism may be associated with resistance to drying in a way that others don't----

A Yes, so it can persist on a dry surface, whereas others-- I mean, so, for example, sink traps are always wet. There's always residual water in a sink trap, but Acinetobacter, I understand, can exist on a surface that's been cleaned and dried. When you look at the surface, there's no water there, but-- And I was using it, and I hadn't realised we'd quoted it, actually, but I was using it as an example of the subtleties, the nuances of difference in the behaviour of these bacteria, and this is a particular characteristic, and I'm sure microbiologists could tell you far more than I-- than I could possibly say about these different groups of-- types of drugs-- of bugs.

Q So, if we go on just in this section briefly to go to 142, when we have Stenotrophomonas. Now, what I was picking up from paragraph 3.5 of your rebuttal was perhaps a difference in emphasis in the words used by HAD and the words used by you. Am I right in doing that?

A Yes, I think you're absolutely right. The emphasis-- I think we were just bristling slightly at the terminology, "relatively rarely causes infections", and I-- I think what we saw in the Case Note Review is that it was one of the more prominent causes of the infections. And, you know, we were just making the point, which I-- you know, I'm quite sure Professor Hawkey would agree with, that actually Stenotrophomonas maltophilia is increasingly recognised as an important pathogen, particularly in immunocompromised patients and, you know, we did this very simple literature search just to say there's a whole range of literature out there. I mean it's possible we didn't need to say that, but it exists.

Q At that point you stopped bristling and moved on to another point?

A Yeah, we did.

Q Your next heading is just what you might describe as others. Now, I wanted then to go on, on page 143, to ask you a couple of things. First of all, I

think from watching the other evidence in this case, in particular the evidence of Dr Drumright, you had picked up perhaps a question from Mr Mackintosh which you felt didn't quite correctly explain what was and what was not in the CNR Case Note Review, which was something to do with the Cupriavidus from 2016 and one Mycobacterium chelonae, is that right?

A I mean, what has become clearly established in all that I've read about this inquiry is that Greater Glasgow and Clyde acknowledged that there are two infections that have irrevocably been linked to the environment through molecular typing, genetic typing, one of which is a Cupriavidus and the other is a Mycobacterium chelonae. We mentioned them both in the Case Note Review for different reasons. The Cupriavidus patient, and it caused us some confusion, I think, when we were doing our work, was back in 2016. This patient was not in the Case Note Review because it wasn't a haematology-oncology patient. I believe it was a renal patient, and we did do a certain amount of searching around to try and ascertain that.

Now, I have seen, even in, I think, is it Harvey-Wood, the statement that the patient was attributed to being a haematology-oncology, but that patient does not belong to the Case Note Review. It doesn't negate the importance of recognising that Cupriavidus has been found in the environment, and the frequency in which it's found in water has been discussed, I know, and that an infection in a patient has been linked to the water supply. So, I mean, essentially, we make that point just to try and get rid of it, because it doesn't, in a sense, belong to us.

The second is a case of Mycobacterium chelonae. There were three patients with Mycobacterium chelonae included in in the Case Note Review with four infections between them, because one of the patients had what was counted as a second infection, but because of the nature of this organism, I mean, I personally, I suspect it was because it was never eradicated. It was a very difficult infection to eradicate. We were told by NHS Glasgow and Clyde that they had whole genome sequencing evidence that this case linked to an environmental sample. But we could never identify that information from the information they gave us. So, that, the point we made in our report was that we would have clearly labeled this case as definitely related to the environment, but we didn't because we hadn't seen, at first hand, the evidence for that linkage. But it seems to me that everyone accepts that that

linkage is there.

Q Yes. So, this was you adopting what one might describe as a rigorous approach. You were only labeling things that came from the material that you were able to analyse and discuss.

A Yes, I think it would have been-- actually, I would-- you know, I would use a word as strongly as irresponsible for us to say there is a definite relationship to the environment in an individual patient when we ourselves had not seen the data. You know, and, personally, I don't dispute the statement, but I hadn't seen the data, and I wasn't prepared to write it down.

Q Thank you. Now, earlier in your evidence today, you mentioned Mycobacterium chelonae in the context, I think, of the fact that it's not listed by the HAD authors?

A Yes.

Q Now, you found that surprising. Why did you find that surprising?

A Well, I find it surprising for two reasons. One is because some atypical Mycobacterium are considered to be potentially within an environmentally acquired group of infections. Secondly, because there were three patients and four infections identified in the Case Note Review, and I just wondered why they chose not to comment even. I mean, there's no mention of it anywhere.

Q I think we've had other evidence, I think it may be the point you made a minute or two ago, that this particular organism is challenging to treat, if I----

A Yes.

Q -- just use that as a----

A Yes.

Q -- euphemism.

A Yes.

Q Is that correct?

A Yes, it requires-- I mean, I have to say, I've never treated a case of this Mycobacterium. I mean, it happens, but in my experience, it's unusual-- to have three cases in a series of patients would be most unusual in my experience. It requires very prolonged exposure to antibiotics.

Q Yes.

A Months. Months of----

Q Months?

A Months of antibiotic exposure.

Q Right. Thank you, professor. Now, I think that takes us conveniently to a different chapter of your rebuttal, and the next chapter starts on page 144. What you're doing there is you're looking at the HAD report challenges to the methodology that the CNR had used, and you summarise some of the points that you want to pick up on that page. I think we can perhaps most easily take them as

they come rather than getting you to read through all of that now. So, if we go to the first of these, which appears in detail on page 145, this seems to be focused around a discussion of the significance of the fact that some patients are at home, some patients at home during treatment, and what importance that had to the conclusions that you're able to reach as the source of infections. I think, as I understand it, the point you make in the rebuttal is that not all the references that HAD quoted were published at the time you did your work but you thought that the selection was, well, as you put it, selective but you accept that source outwith the hospital is a possibility.

A Yeah, indeed it is. It has to be and, in fact-- and I hope we strengthened our position by pointing out that there is one patient in the Case Note Review where we unequivocally said that the infection we believe to be related to the home environment. Indeed, that was the conclusion of the clinical team, we found out subsequently, who had been caring for that patient.

Q Now, I was interested in two points in the next paragraph on that page, the paragraph which starts, "We wish to point out". Can I just ask you the first one? You've probably picked up that there have been discussions over the relevance of paediatric haemato-oncology experience as compared to experience in adult haemato-oncology, and whether the two-- as I say, we're just treating everybody the same, or whether there are significant differences, and you kind of mention that in passing at the start of the paragraph that none of the HAD authors have experience. Is this important in your view?

A I do think it's important. I suppose at one level, one-- and I think this is-- Dr Agrawal said this in his evidence. He said, "Well, you know, I know about infections in immunocompromised patients, and essentially, we're looking at the rates of infections in populations of immunocompromised patients, and I don't need to know anything more than the number of those infections and the type of infections." I suppose I would argue-- well, I would argue, not I suppose. I would argue that that has to be contextualised, because the children that predominantly made up the Case Note Review were children with cancer or leukaemias.

There were, as I think we made clear, children with other forms of blood disease included within it but nevertheless-- and this is a very young population, the Case Note Review points out that the median age for the diagnosis of the children

included in the cohort was three and a half, and the median age at which the first infections occurred in that group of patients was still at around about the age of five or something. So, these are very-- this is a very young population. It's a characteristic of children's cancer work that a great number of the patients you work with are very young. Some of these patients are diagnosed at or soon after birth.

Now the ability to assess and clearly to manage very young patients is the essence of what paediatric care is about and, you know, we have skills and experience that are relevant to understanding how, in this very specific setting, infection presents itself, is managed, and some of the consequences of the way in which you do manage them in terms of drug dosing and choice of drugs and so on. I would argue that at the other end of life, people who are experienced in looking after elderly and fragile people have to have a similar set, a similar but different set of skills, that would allow them to do their job. So, I think it is insufficient to say it doesn't matter that you don't have any insights. I mean, apart from the fact, you know, that the range of diseases that we treat in childhood cancer and blood diseases is not the same as in adults. It is a different world, no doubt about that.

Q Yes, I think, and no doubt someone will correct me I'm misremembering it, Professor Hawkey said, "Well, the treatments are different. They're not simply small adults." If that's what he said, would you agree with that?

A Yes, it's a very-- it's a very well-known-- it's a very well-worn phrase, "Children are not small adults," and paediatricians used to say it a lot. You know, it's absolutely true. You know, you can have-- you can have-- you can have the same disease in children as in adults, in relation to cancer or leukaemia, but even when you do, it isn't necessarily treated with the same intensity. It's treated more intensively in young children, and the ability to push children in terms of intensity of treatment is probably greater than it is in the average adult population, or not necessarily with younger adults, but----

THE CHAIR: Sorry, my fault. Could you just repeat that last point, professor? I lost----

A Well, the point-- the point I'm making is that you-- and I think I said it in relation to the quote about the Aitken study which is about the Meropenem, that, yes, we do see acute myeloid leukaemia, which was the nature of the population. We see acute myeloid leukaemia in children. We don't see it that much. We see another kind of

leukaemia, acute lymphoblastic leukaemia more commonly. Although the approach to treatment is broadly similar, the intensity with which you can push young people with your chemotherapy is by and large greater. There's a resilience that we harness in young people to allow us to treat them relatively more intensely under some circumstances and with good effect. So, for example, survival rates for the commonest kind of childhood leukaemia are much, much greater than for the same disease when seen in an adult population and, you know, there may be many factors, but one of the factors is that you can by and large deliver and sustain delivery of more intense treatment in young children than you could in someone even in their 30s or 40s.

THE CHAIR: Thank you.

MR CONNAL: Now, I just wanted to pick up a point which piqued my interest slightly, which you mentioned at the very end of your narrative on page 145, following a discussion about, you know, home-acquired infections and so on and so forth. You say that:

> "… the desire to maximise time for the patient to be at home is not merely for reasons of social benefit or family cohesion … but also because of the recognised risk of hospital acquired infection."

Now, that may sound slightly counter-intuitive if you're thinking of people acquiring an infection, the idea of, "Well, let's take them into a nice, sterile hospital environment," but you're making the point that some of it is the other way around.

A I think it's well recognised that the worst place for patients to be is in a hospital if they don't need to be there, and I think that drives all manner of healthcare initiatives. If you look across the piece, patients spend much shorter times in hospital now for many conditions than they did in the past, and one element of that of course is all about using facilities more efficiently, but underpinning it it's also a recognition that being in hospital isn't necessarily the most healthy place to be. You are potentially exposed to more intrusive interventions. You are potentially exposed to more infections, and moreover you're removed from the necessity to perhaps be as active as you should be when you're recovering from potentially serious illnesses and so on. So hospitals are important, but being out of hospital-- I mean, home is generally a safer environment than a hospital.

Q Thank you. You then go on, on 146, to explain some of the information that you had access to in order to carry out the task that you were

doing, this Tableau software, and I don't think anything particularly turns on that for present purposes. You go on to confirm that you considered the possibility of a source outwith the hospital, as well as hospital source, so I don't think I need delay you on these because I think you've made your point very clearly. I'm not sure I'll need to delay you much on the next point either because we come on page 148 to what you're heading as "The Meropenem theory". Now, this is one of the matters that might be regarded as having moved on a bit since this document was drafted, but you indicate at the start of that section that you accept the general proposition that broad spectrum antibiotic use can create issues which lead to infections. That's not in itself in dispute, is it?

A Not at all.

Q Then you pick up the reference to Stenotrophomonas, which you've already made here this morning. The point, as I understood it, that you were making at this stage was that the Aitken study, which you mentioned earlier today, which is mentioned and referenced in the course of page 148, and we see the bundle reference there – I don't think we need to look it up – you felt that as a document on which to form a conclusion had weaknesses in it. Is that right?

A I thought it had substantial

weaknesses, and I thought it was unfortunate that this particular reference was utilised in several points in the HAD document. It seemed to have acquired a substantial status when, if you read the paper, it has a number of weaknesses, some of which are recognised by the authors of the paper themselves. You know, I mean, it's good practice for authors of research papers to critique their homework by saying, "What are the strengths and weaknesses of this paper?" And they did that very nicely, and they pointed out-- and, you know, I felt that it was an inflation of the value-- I'm not saying that there's nothing there. I'm just saying that it has inflated value.

Q I think what you did at the time when you prepared this rebuttal was you went and looked for other literature which might or might not be of assistance, and you set that out over the next few pages. We've had other evidence about meropenem. We've had evidence about whether there was a shortage of other antibiotics which impacted on the availability of meropenem other than on that particular unit. We've had evidence from Professor Gibson, who was in charge of the unit essentially that a worldwide shortage didn't bother them because they were protected in a way that she explained. You looked at the policies – is that right – as well that were

in place for prescription of antibiotics?

A Yes.

Q I think you deal with that on page 151, near the foot. Now, you then set out what that policy was, and I don't think I need to take you to the reference to the worldwide shortage because we've already dealt with that through other witnesses, including in fairness Professor Hawkey, but just, I suppose, to complete the meropenem story, I think you're aware we've evidence from Professor Gibson, with some evidence in the Harvey Wood graphs, about meropenem usage per incident. But you were looking at this theory at the time of increased meropenem usage. Can you just explain what it was you were doing on page 152 and what your conclusion was because you obviously decided to take a look at this in a particular way? You end up with a table, and you say near the foot of 152, "The analysis shows no difference." Now, just help us to understand what the analysis was.

A There's an unfortunate page break where Table-- the header of 14-- of Table 4.1 is at the bottom of 152, but the meat is on 153, so if we could see 153. So essentially what we did, we took the population of patients with Stenotrophomonas, which is the population of interest in terms of driving-- You know, the hypothesis is that meropenem usage drives the occurrence of this particular organism, and as a control group of significant infection, we took the patients with Enterobacter, and these are patients' infection episodes within the Case Note Review. And then we looked to see whether patients had received meropenem for whatever reason within 30 or 60 days prior to the diagnosis of either a Stenotrophomonas infection or an Enterobacter infection.

Now, these are very small numbers. We could only use the information we had in front of us, and I wasn't able to-- I didn't-- we don't have a database of all antibiotics given to every patient in the Case Note Review, but I could go back and look at the individual clinical synopsis that we'd presented-- we had created for each of these patients to pull out this information. And essentially, what you see on the table on page 153, if you look at the line that says "S. maltophilia", we had 18 records that we considered informative out of 23 records in total, and that's an important term. "Informative" meant that the records for the patient span the period we were looking at because of course if the patient had an infection very early in their experience in the hospital, they wouldn't be eligible for this analysis, but essentially, did we have informative records?

We did in 18 cases, and of those 18

cases, 5 had had prior experience of meropenem in the previous 30 days and 13 hadn't. And if you look at the 60-day data, which is the right-hand side of the chart, there were 14 informative records, and 5 had had prior meropenem and 9 hadn't in the 60 days prior to the diagnosis of the infection. And we repeated the same analysis in the line underneath for Enterobacter cloacae, and you can see it's 4 versus 18 out of 22 in 30 days, and 5 versus 7 out of 12 in 60 days. Essentially, if you apply a simple statistical comparison test, a chi-squared test, it demonstrates there's absolutely no difference between these two populations in terms of their meropenem exposure.

What does that tell us? Well, it doesn't tell us anything very much except that, in this very small analysis, there's no evidence these patients had excessive exposure to meropenem, the patients who had Stenotrophomonas. So that was the best I could do with the data we'd got. You know, I mean I think if it had shown something differently, then perhaps we would've had to trim our narrative slightly differently.

Q Thank you.

THE CHAIR: That seems to demonstrate that if one has a hypothesis that infection rates are in some driven by meropenem administration, there was a method available on the basis of available data to check that hypothesis.

A Yes, and the patient-- the literature that we looked at-- and, you know, we didn't do a systematic review, as I was describing from some little while ago. The literature that we selected to look essentially did that. I mean all the other studies we looked at did the same thing. They just took a cohort of patients and looked back in their records and said, "Well, did these patients get exposed to meropenem or not?" And then there was the question whether they had an effective control group to compare because inevitably patients who get antibiotics like meropenem are pretty sick, so they're likely to have been exposed to many other antibiotics too.

THE CHAIR: Mm.

MR CONNAL: Just before we move on to a different topic – I may need to come back to this later – in the course of very recent discussions, another antibiotic has cropped up, which has the shortened name of cipro or chipro.

A Ciprofloxacin, yes, I saw----

Q Ciprofloxacin.

A I heard Professor Hawkey discuss it yesterday.

Q Now, at this stage, all I need to ask you is this. When you were doing your work, did you have any indication that an issue over the prescription of ciprofloxacin was driving any of the

results you were seeing?

A No, and I think it would have been difficult for us to do that because-- Let me try and explain why, because in the Case Note Review we were able to interrogate the clinical story of patients who had had an infection, and we knew therefore that some patients had received prophylactic ciprofloxacin because it became a policy decision of the unit to give ciprofloxacin to patients, I think in 2018 or so, because of the concern about infections. What we didn't have is a parallel group of patients from the same unit who'd received ciprofloxacin who didn't get an infection to put them into the Case Note Review, so actually we weren't in a position to make a comparison.

What we do know is that the use of prophylactic antibiotics, particularly using ciprofloxacin, is variable across different units. It is more typically seen in patients who are intensively treated, particularly patients undergoing stem cell transplantation. It is known to be associated-- the use of aggressive antibiotic therapy is known to be associated with driving in general the risk of antibiotic resistance. Whether ciprofloxacin selectively drives a population of a specific bacterium, I have no idea, whereas there is a hypothesis that meropenem drives the appearance

of Stenotrophomonas. I just don't know. I've never encountered a reference. The generality of the risk is well known, and I think the department at Greater Glasgow and Clyde took very seriously the decision to use ciprofloxacin prophylaxis and that there was an evaluation at some point sometime afterwards about whether it should continue or whether it was now safe or appropriate to stop giving it to patients, and I know it caused some concern to parents, too.

Q Yes. I've tried to find something that might assist us on this. You may remember that at one point Ms Harvey-Wood and Dr Peters had produced a series of graphs and one of these graphs showed antibiotic use which peaked and so on and so forth, and also showed in a dotted line the presence of organisms resistant to the particular antibiotic running at a much lower level on the graph. Now, one of the antibiotics on that graph was cipro and unfortunately for us the line that's supposed to represent the presence of resistant organisms simply runs along the zero, so there's nothing much to interrogate because it's not moving.

A Right.

Q So I'm unable to put to you at this point anything that would assist further, but it's possible I might have to come back to this later, at which point my

Lord, this might be an appropriate point to break?

THE CHAIR: I wonder if I could just take the opportunity, Professor, to make sure that I've understood what you were telling us about Enterobacter. It might be helpful if we could put on the screen bundle 44, volume 1, page 26. This is the part in the HAD report, in part of chapter 3, which includes the description of the Enterobacter, and the SPP, if I'm remembering correctly, is the abbreviation for species.

A Yes.

THE CHAIR: Right. Now, we see in the second line that Enterobacter cloacae has a complex taxonomy and if we go into the second paragraph, looking at the second sentence, we have:

"When outbreaks of Enterobacter cloacae involving environmental sources occur, molecular typing using WGS usually demonstrates a clear cluster of a specific strain type."

Well, so be it.

A Yes.

THE CHAIR: Now, if I understood what you were saying was that, "Well, it may very well be that Enterobacter has many strains, but it's not of particular interest to the clinician because, as far as is known, the same antibiotic response would appear to have the same impact on – assuming there are a variety of strains – that variety of strains." Now, point one, did I understand what you were saying correctly?

A Yes, you absolutely did, my Lord. I mean, perhaps if you look at the first paragraph under section 3.1.2, following after the sentence where it says "Complex taxonomy", it says:

> "The next most common species encountered in hospitals is Enterobacter homaceae, which used to be classified as Enterobacter cloacae."

And I think, you know, what this telling us is that they're already-- they've broken off, as it were, a separate subset, but they're still part of the same family. So from the clinical perspective, the label "Enterobacter species" is probably-- is probably correct. I don't want to conflate that with the potential for identifying source of infection by using matched whole genome sequencing, which clearly seems to be important and is a-- is a separate argument, and so I hope I didn't conflate them.

THE CHAIR: Right. At risk of simplification, that is what I picked up from what you were saying. Identifying a particular strain might have a utility for forensic purposes. By that, I mean if one is particularly focusing on cause and effect it doesn't necessarily have an impact on clinical practice. Now, again,

did I get that right?

A Absolutely.

THE CHAIR: Now, my second question is was there an additional point you were wishing to make?

A Well, I think it's-- I mean, I think it's essentially further down that page, when they refer to-- and this was the publication by Nurjadi which was discussed with Professor Hawkey yesterday.

THE CHAIR: Yes.

A About seven or eight lines from the bottom, it says:

> "Sequence typing of all Enterobacter cloacae isolates across the hospital revealed many ST types."

And then it gives a list of ST numbers, and so what it is demonstrating is that there is, in a sense, a diffusion of genetically identifiable subtypes of Enterobacter cloacae and, you know, your use of the word forensic is-- is helpful in that setting. It's that if you're trying to identify a source for an infection, knowing its genetic characteristics is very helpful, and we've never denied that. All we're saying is that it's not something that's practicable in real world time.

THE CHAIR: Right, but there was no additional point that I missed?

A No, I-- No, no.

THE CHAIR: Right. Well, as proposed by Mr Connal, we'll take our coffee break now and if I could ask you to be back for five to twelve?

A Yes, certainly. Thank you very much.

(<u>Short break</u>)

THE CHAIR: Mr Connal.

MR CONNAL: Thank you, my Lord. Professor, ciprofloxacin, just to try and see if we can finish what little we can do on this at the moment. Correct what I'm saying if it's wrong: you think you may have an issue; you may have an issue which may relate to the environment; you may then decide to prescribe something like ciprofloxacin as a prophylaxis to deal with that issue. Is that the kind of scenario that you understand arose?

A I think it's the scenario that applied here, but in standard clinical practice ciprofloxacin is also used as prophylaxis for very high-risk patients without there necessarily being any particular reason to be concerned about the environment.

Q Yes, but your understanding was that what applied here was it applied, as it were, reactively to there being an issue.

A It was, and it was applied-- I understood it to be given to all patients. I don't know the detail.

Q Thank you. We've tried to find material, but we've only managed to find material from 2019 when we're in a different ward, so I won't take you to that. Let me see if we can deal with another few points reasonably shortly. Page 154, the heading here is, "Defining the population". Now, your point, if I'm picking it up correctly, seems to be, "Well, we set out what we were looking at quite clearly in the Overview Report". Is that right?

A Yes. I mean, absolutely, and then-- and then it did occur to me that he perhaps wanted to know what-- all the other infections that we didn't consider in the Overview Report had been counted. I mean, I don't-- I don't know exactly.

Q But you had a protocol that you were working to.

A Yes, I mean, I felt that, you know, we described-- we described the population, we described the number of infections, of each individual infections that were found in the population.

Q When you say it was a "predefined protocol"----

A Well, it was a protocol that essentially preceded the formation of the Case Note Review team. I mean, it was-- We were presented with a protocol. We had an opportunity to comment on it, but we didn't make any changes to it.

Q Thank you. So that was part of the setting up of what became the Case Note Review.

A Yes, yes.

Q Thank you. Now, you pick up the Mycobacterium chelonae point. I needn't ask you about that at this stage. Then there's some discussion about clusters. This is perhaps just referring back to something that you said earlier. You were talking about routes of transmission and ways in which a patient may be exposed, and you said you'd set it out later. Now, would I be right in thinking that that's what you do at the top of page 156?

A Yes, I think-- I think, yes, that's exactly it. We tried just here to summarise opportunities for environmental contamination, I suppose, and-- and how infection could get into patients.

Q Yes.

A Directly into the bloodstream, principally, yeah.

Q But defining in any individual case precisely where and what may be more difficult?

A Yeah, absolutely, yeah.

Q Now, I want to ask you a question, or I've been asked to ask you a question, about something on the next page, page 157. On 157, you describe concerns about the quality of data and about data from whole genome sequencing, and you make there a

comment about an electronic database. You say:

"... despite over 5 years of experience in investigation of outbreaks of GNE bacteria and concerns about the hospital environment, NHS GGC had not established an electronic database of microbiological typing results..."

And you say that's a criticism you stand by. Now, I think I'm right in understanding that that point about a database made its way into the recommendations of the Case Note Review, is it?

A I think it's there, yes.

Q Yes. I don't think we need to dig it out and put it up on the screen. I can just read you briefly what it says. Recommendation 10:

"NHS GGC must continue to develop a comprehensive and searchable database that allows details of microbiology reference laboratory reports to be compared between samples of the same bacteria obtained from different patients or environmental sites."

And then the second part is:

"The system for integrating microbiology reference laboratory reports into the patient microbiology record needs to be reviewed and strengthened. Similarly, the system for ensuring that microbiology reference lab information is available to and used by the IMT process, including the investigation of clusters and outbreaks, needs to be reviewed and strengthened."

Just pausing there, why was this important enough to put it in a recommendation?

A I think-- I think one of our frustrations was that we recognised that attempts had been made to obtain a genetic analysis of samples from patient infections earlier in the era of the Case Note Review by sending specimens from the laboratory in Glasgow to the reference laboratory in Colindale in London. The results of those findings were sometimes, but not always, noted in the microbiology records of the patient, but-- but there didn't appear to be a place at which knowledge of those results could be identified. So you couldn't go to a database and say, "Give me all the genetic-- genetic analysis of infections for patients on Ward 2A in 2019."

And it seemed to us that, at a relatively simple level, just having a database that said, "This patient had this infection on this date," which was either sent to the labs in Collindale or more latterly dealt with internally in Glasgow, and that there had been an attempt made to look at whole genome sequencing or perhaps one of the earlier, less comprehensive techniques, would have been extraordinarily helpful. And the

database ideally would also have recorded whether samples that were positive for environmental bacteria had been subject to the same types of investigation and identified by date and by site, and so you could then interrogate a database and say, “Give me all the environmental isolates that have been subject to whole genome sequencing in 2019.”

Now, the results of genome sequencing, as we’ve seen from the paper, are very complicated, and so you couldn’t-- I don’t think you could put the data into the database. What you could do is essentially create a register of what those samples were available. What we found in the Case Note Review is we asked for this material and there was no consistent way of knowing whether we were getting all the material or some of the material, whether some of it was missing or whether it related in any way to environmental sampling. It was-- it was a bit murky.

Q One of the issues the Inquiry has looked at from time to time is whether the recommendations of various bodies, including the Case Note Review, have been complied with. What I’ve been asked to do is to put certain characteristics of what has been said to have been created to you and ask you whether that meets what you had envisaged in your recommendation, the characteristics being that the database includes only PDF copies of microbiology reference laboratory results. To access the report and results, you have to open and read the document, and the database therefore does not, it is suggested, permit easy searching of results. Now, is that the kind of resulting database that you had in mind when you formulated these recommendations?

A Yes, you know, just perhaps to reiterate, what I think we would have found helpful, and I am suggesting that NHSGGC would find helpful moving forward – as would, I think, any hospital – is that you have a database that is able to say, “This test was done on this date,” and gives you an indication of where you find the result because, as I just said, the data is complicated and you can’t readily put it in a-- you can’t summarise it in a-- in a readily accessible form in a simple spreadsheet, for example.

I understand the challenge of PDF reports. That’s how they were provided. I’m not saying that you necessarily have to translate what’s on the PDF report into the spreadsheet, but there wasn’t at the time – and I hope there is now – a database you can go to which you can say, “Well, was there a report on that date? In which case, I can then go to an index and look it up.”

THE CHAIR: Right. So, assuming that what Mr Connal has put to you was a criticism of what GGC has put in place, you would not regard that as a fair criticism?

A No, I can understand the challenge. I mean, you can embed a PDF into a database. I don't think that's too difficult, but it does in the end become cumbersome. I think what we were suggesting is you must know what you've got, and I think our criticism was really focused on the fact that they didn't really know what they had and it hadn't been-- it hadn't been consistently recorded in the patient's microbiology record.

THE CHAIR: I think I only have one-- well, I have two questions to follow that. In the course of an earlier part of your answer, you talked about interrogating the database. Now, another way of putting that might be "searching".

A Yes.

THE CHAIR: If, in order to find out what's in any particular document, you have to find the PDF, open it, read it, and so on, it might suggest interrogating or searching is challenging. Would you agree?

A Well, I'm-- I guess what I'm really suggesting is the first step is you have to be able to search for whether there is a report or not, and if you ascertain there's a report, then there's the possibility that you may have to go somewhere else to find it to reveal its contents. The frustration we had was that we didn't feel that there was any-- we weren't convinced that there was any way of being absolutely sure that all these reports were available, let alone what they contained.

THE CHAIR: I see. I can just ask you, then, a general question which follows on from my raising this point, which is: have you – and, I mean, treat that as the CNR – had any opportunity of reviewing whether your recommendations have been complied with?

A No. It was a point I-- it was a point I raised, and I can't remember whether formally or informally, with the Oversight Board. I think we made the point when we completed our work that we would be interested to know whether our recommendations had been enacted or rejected. You know, recommendations can be rejected, of course. But we've never heard anything. We've never received any feedback.

That's perhaps not strictly true because Greater Glasgow and Clyde did say in their rebuttal of our draft Case Note Review report, "Well, we've already done some of these things," but, you know, clearly there were things that-- that hadn't been done.

THE CHAIR: I see. Thank you.

MR CONNAL: Just see if we could move on a little more quickly through some of the other issues, given where we've come to. At 158, you pick up a general question about comparison of rates with other institutions and point out that you'd looked at some work by HPS, and I don't think I need to get you to read that, although your conclusion to the end of the section which arises-- starts there is that, for your purposes, you weren't convinced that comparisons with other populations from other units was of much assistance in answering the question you'd been asked to answer.

A No, I think on the next page there's a quote from the Case Note Review, isn't there?

A Yeah, I think on the next page, there's a quote from the Case Note Review, isn't there?

Q Right.

A Yes, it said, our conclusion is:

"We do not see that this report would have provided any clear message of either reassurance or concern about past events"----

Q That was the HPS report?

A That's the HPS report. So, we're saying that we don't think that the report was either of reassurance-- it generated either reassurance or concern to GGC at the time, and nor did we see it offered a clearly interpretable and favourable comparison with other children's hospitals-- other Scottish children's hospitals and, you know, so we read it with some interest, but we didn't think that the-- that it was-- that it essentially pointed us in either direction, and we certainly hadn't been charged with doing a comparative piece of work and I think that would have been quite challenging, but it could have been done. But we didn't pursue it further than looking at these data.

THE CHAIR: It may be my fault. I'm just wondering, from Mr Connal's question, and I may be wrong about this, I thought he was intending to explore the generality of whether comparing institutions with other institutions was useful for the purposes of the CNR report. However, if my recollection is correct, the quotation from the CNR report, which we see at 159, is your reflection or the review group's reflection on a specific study comparing three Scottish hospitals and we see there that you didn't feel that that specific comparator exercise was either, on the one hand, reassuring or, on the other hand, concerning. Again, I'm sorry if that's a rather elaborate----

A No, no. Absolutely. I understand your point that-- you know, you're absolutely right. This was a critique of that specific piece of work by

HPS----

THE CHAIR: Yes.

A -- in general terms, and I think my memory is that Mr Mackintosh took me through this last time, it was about the more general issues of comparative evaluation-- well, comparisons with other children's hospitals. Because when I gave evidence last time, we talked a little bit of length about, well, were the comparisons that were, I think, chosen in Mr Mookerjee's report the right kind of comparisons to make? We talked about, well, you've got to make sure you've got the case mix similar and some of the institutions that have been compared are not directly similar. Some, you know, are, and so on. You need to take into consideration the factor of size, because small numbers distort the situation. You would also, if you were doing it very carefully, want to look at issues to do with clinical practice and the use of antibiotics and so on. You know, there are many potential confounding issues in making comparisons between different institutions.

THE CHAIR: In the document that we're looking at now, that's your rebuttal to the HAD----

A Yes.

THE CHAIR: -- report, you're responding to, I think, a comment in the HAD report. An adverse comment on the CNR report is that you did not----

A That we didn't do it.

THE CHAIR: You didn't do it.

A We didn't do it, and our rebuttal is, well, we didn't do it but there was some-- there were some data which we looked at, although we didn't find them particularly helpful.

THE CHAIR: Thank you. Sorry, Mr Connal.

MR CONNAL: Yes. Just, to complete the narrative, what you then go on to do is to point out that there was another review----

A Yes.

Q -- which looked at comparisons with other paediatric hospitals in comparison, in Scotland and advised, you know, "Use caution when interpreting these results" You then reach a conclusion on page 160 of this document. So, this is your final response, which is:

"…comparisons of populations from different units offer limited assistance in responding to the question asked of the CNR…"

Which you then specify.

A Yes, and I think-- I think that's the position that we would maintain. I think just for completeness, the reference to the further document, I think, essentially still deals with the three children's-- the same three hospitals, Glasgow, Edinburgh and Aberdeen.

Q Yes, yes. Let's see if we can move on again. Page 161, we turn on to a chapter headed , "Water". I don't want to take you through all of this. There's a lot of quotation from the HAD report. For instance, on page 161 you set out a piece of narrative from the HAD report about regression contamination and other associated issues with which you agree. Top of page 162. Then, I think, you have described a little more contentious statement on 162, particularly perhaps the latter part of the quoted paragraph, which is that:

"It should be remembered that though one can find a source in a hospital environment of potentially pathogenic bacteria, without a route of transmission and a portal of entry into the patient these sources are of little consequence."

You described that as a bit odd in----

A I think essentially we're reiterating what we've already said, that there are many-- there are-- it says here, at the end of the second paragraph:

"There are multiple potential ways in which bacteria may be transmitted…and…cause infection."

I-- you know, I-- perhaps it was a slightly tetchy tone, but I think we'd already dealt with that earlier in our document.

Q Yes, because the point being made in the HAD report as well, "You can find the bacteria, but unless you can find a way in which it can get to the patient, it doesn't matter." You're saying, "Well, there are lots of ways."

A Yeah, there are----

Q Is that a reasonable summary?

A -- lots of ways and I think we-- and, you know, then we-- for good measure, we threw in the illustration on the next page which just describes-- I mean, this was a-- this actually relates to care homes but nevertheless it describes the cycle of infection transmission.

Q I think just beneath that we start to get to a point which is perhaps a little clearer now than it was a few days ago of the, "Who is claiming what?" debate. Are you claiming everything's, you know, environmental? Someone else claiming nothing is environmental. Neither of these is correct. Because you say, "Well, they're not necessarily the dominant source, but they are a source." Sinks are a clear source of----

A Yes.

Q -- gram-negative bacteria.

A Yes.

Q Right, well, let's move on to 164. This starts to touch on the question of testing. One of the issues, as you've probably gathered from listening to the evidence, Professor, is that there's been a real debate that the quantity and nature of testing changed dramatically from

2018 onwards once these issues emerged. We find on 164 the heading, "What if there was 'widespread contamination of the hospital water system?" Now, I'm not going to get into a debate with you about the meaning of the word "contamination," on which there are varying views. But you quote us a section of the HAD report which says:

"In our experience significant problems of increased rates of infection caused by bacteria capable of coming from an environmental source are identified when intensive testing of water is undertaken when an outbreak is suspected, rather than from routine or prospective testing."

Now, that might, I suppose, depend on the level and extent of the routine and prospective testing. We've heard a lot about much increased testing levels now. But taking it as referencing past, you just say, well, you agree, and that's what you thought was happening here.

A Well, yes. I mean, I think we're saying-- I mean, I think the point we're making is, essentially, GGC clearly suspected there was a problem, and they took the mitigation action they did. But earlier in the year of the Case Note Review, there really wasn't very much testing going on.

Q Yes.

A I think that's been established. You know, I mean----

Q I think I heard the word, probably yesterday, "sporadic" to reference some of the testing, but the details are all laid out in other documents.

A Well, it wasn't just sporadic. It-- they were-- it wasn't sporadic in-- it wasn't just sporadic in time. It was relatively few in number, too.

Q Thank you. On 165, we're starting to edge towards the whole genome sequencing proving a negative topic, and you introduce, halfway down 165, the needle in the haystack. Now, analogies can be dangerous things – particularly in the wrong hands, which might be mine – but I suppose if you imagine the haystack in which you are searching for the needle, if you put your hand in and something jabs you and you bring it out, lo and behold, it's a needle, everybody's happy. So, that's the theoretical positive result. If you put your hand into the haystack in three or four random places and you don't find a needle, can you conclude whether the needle is there? Is that the point?

A Yes, I think-- Mark Wilcox's-- this is Mark Wilcox's analogy. I think we're absolutely aligned with him on the use of the analogy in that the absence of the finding doesn't negate the possibility that it's there. I mean, I think that's-- I think that's the shortest way to describe a

lot of what's written here and has been discussed in other places.

Q I'm trying to see other places where this had been discussed, and I might put this statement to you, see whether you agree. This was Dr Chaput, who said that what you find in a biofilm sample tells you nothing about what is in the biofilm one centimetre away from that sample, never mind further away. Does that sound like something you would agree with?

A I mean, I can accept the premise. I mean, I don't have the background to, you know, challenge it. I mean, I'm not-- I'm not entirely clear what the relevance of the statement is because what you find in the biofilm still matters.

Q Well, indeed, but it may not tell you what environmental bacteria are in the next centimetre.

A No, absolutely.

Q Or in the next centimetre or a foot away.

A No, and this was rehearsed in, I think, a conversation that took place yesterday about pseudomonas not being-- the finding of low counts of pseudomonas don't tell you that there isn't anything else there.

Q Yes. Yes, I'll maybe come back to that point, but the point that you were making where you say you were all aligned, and I have to keep reminding myself that this is a jointly produced document, is possibly just shortly summarised on page 166. It's in the third paragraph which appears on that page. The paragraph starting, "We concur":

"…put simply, the absence of DNA based typing links between microbes in the hospital environment and those causing patient infections does not exclude the possibility that the former is a source of the latter."

A I mean, I think-- you know, that remains-- that remains our position.

Q One of the challenges, presumably, is if you've got a problem, you try to work out where it might have come from in practice, and you think how you might deal with that, and that might lead you to take a number of interventions rather than simply one, depending on the nature of the potential issue? Would that be right?

A Yes, I mean, you know, I think-- I think if you've got a serious problem, then you do everything you can to mitigate it. I think it was illustrated in relation to an outbreak of some Enterobacter infections, and I don't remember the number, but the PAG IMT system looked at this and identified growth of bacteria, the same bacteria in drains, and clean the drains. This was back in '16 or '17, something like that, and it's referenced in-- you know, I think

there's specific reference to it in the Case Note Review. So we see that approach took place. What I don't know is whether those samples in the drains were matched with the samples in the patient.

Q The point, I think, as I understood it, Dr Chaput took was, well, if you have interventions A, B and C and the problem goes away-- I'm being over simplistic, but----

A Mm-hmm.

Q -- you understand my point. Well, first of all, if there's cause and effect, you don't know which intervention has worked, or it may be A and B or C and A. You just don't have that information. Is that the reality?

A Yes, I mean, I think you're absolutely right. It is the reality, but, I mean, if we take the case of Enterobacter in the drains, I mean, if you find Enterobacter in the drains, then you clean the drains, but you also don't ignore the fact that the potential for patient infection can come from poor hand washing and, you know-- so I would've thought that if you have a problem with an infection on the ward, you treat what you might see as the most obvious reason for it, but you would, I think in terms of good practice, also pay attention to ensuring that some of the basics of protection are also being carried out appropriately. So I think you can do-- I mean, when you get to the point at which GGC-- I mean, the point GGC were forced to consider, which is to comprehensively retreat the water system and eventually to decant patients from a ward, then of course you're taking decisions that have far greater consequences. But you are an ability-- you do have the ability to implement lower-level interventions at the same time without any great cost because you wouldn't necessarily want to unpick them anyway.

Q Then you have the reality that, if you appear to solve the problem, you don't know what particular one of the solutions has worked.

A That's true, but at the level we're talking about in terms of drains and handwashing, I don't think it matters. If you've solved the problem, you know, that's good because it's not just Enterobacter that could be in the drains. It could be something else, and so you actually-- what you've done is you've moved forward in terms of protecting the patients that you're responsible for.

Q I think you make the point, which we can, if need be, drag back to the haystack analysis, that if you're going to have this positive identification of source and patient, you may need very intensive sampling. So in the haystack analysis, you'd need to check, you know, pretty much every handful of that

haystack.

A Well, I think some of the literature to which we refer in our rebuttal actually makes that point, that you do have to do-- there was a sample from the-- there was a study from the John Radcliffe Hospital in Oxford. Was it Halstead? It was referred to by Professor Hawkey yesterday and it's also in our paper, talking about the identification of environmental contamination, and there was very intensive water sampling and other-- I think possibly other environmental sampling. I mean, the lessons are there, and, you know, I mean, it's not a trivial burden to undertake, but if you're an organisation that's faced with these challenges, then it would seem a sensible thing to do.

Q Again, just so we can reference where we've got to, 167, which follows immediately after the Halstead quotation that you've just mentioned which, as you say, was discussed to some extent yesterday. You reference the question of intensive sampling just before you turn to the next topic. Now, you go on to consider similar elements in the remainder of that chapter, and I suspect it will simply become repetitive if I take you to everything that you say because we end up talking about meropenem again, which I don't particularly wish to do, so I think we'll try and move on to a different topic. You move past ventilation very rapidly because that wasn't something you evaluated as such. Is that right?

A I think there's two things to say briefly about that. One is I think we've put in this report that we really didn't pay any attention to ventilation because, in our initial informal discussions, we agreed that we didn't believe that ventilation per se had a tremendous impact on gram-negative environmental infection. And there's an argument that's been rehearsed, I think, about how much aerosolisation can be affected by adequate ventilation, but I think everyone seems to agree, if it is affected, it's a very small component. The second point, which we did put in the Case Note Review, related to the cold beam technology. I think there is a bit of a dispute about whether chilled beams are appropriate for this kind of environment, and there were certainly reports of condensation dripping from the chilled beams, dust collection on the chilled beams, essentially whether these just added to the potential wet risks of the environment in which the children were cared for.

Q I think we know that the guidance on the use of chilled beams in clinical areas has changed since the incident there, so we needn't pause too

long on that. So on page 171, you have a heading “WATER – ANALYSIS OF INFECTION RATES AND DATA FROM QEUH & RHC”, and you say----

A That’s-- We used their chapter titles.

Q Right, I was about to say that what you then immediately go on to say is, well, that’s what the heading says, but what it actually does is slightly different because you have an examination of testing for----

A Pseudomonas.

Q -- Pseudomonas aeruginosa, an epidemiological review of bacteraemia, and whole genome sequencing in sort of three separate chapters. Now, I think I can probably move past the first of these reasonably quickly. Testing for Pseudomonas aeruginosa, the quotation you have from the HAD report says that:

> “Inspection of water testing results for [this particular organism] should give a good indication as to whether there was extensive contamination of the hospital water system and particularly in the high risk areas…”

Your immediate response is, well, there’s no real evidence to support the proposition that the results from one organism tell you much other about that organism. Now, I have another quotation, this time from, I think, for my colleagues, 153A of the transcript from Dr Chaput, when she was asked, you know, does testing for Pseudomonas aeruginosa tell you nothing about other organisms, and she agreed with that proposition. Do you agree with that proposition?

A So she said that testing for Pseudomonas doesn’t----

Q Testing doesn’t tell you anything about other organisms.

A I think that’s the point we’re making.

Q I think you actually say that at the end of the second paragraph under that subheading, where you say that, “The levels of [that organism] in water tell us about one bacterium and not about others.” Then there’s some discussion about the levels of testing and how TVCs are sometimes used as a means of gauging levels of bacterium in water.

A I’m familiar with all these concepts, but they’re some distance from my practice.

Q Thank you. So what you’ve done in the end of this section of your discussion is you’ve gone to your overview report, and at the foot of 172 you’ve quoted from your overview report and said, “There did not appear to be a systematic water sampling process in place, or a consistent water system

related response to clusters of infection", and then there's some discussion about how communications went and whether results were always available and so on and so forth. You were a bit concerned about all of that, given what was going on. Is that fair?

A Perhaps we-- could be-- sorry, I-- Could we go to the next page to see it?

Q Yes, 173.

A Thank you very much. Well, yes, I mean, this is a very specific point that we were told by staff within GGC that they had requested access to water sampling data but had not been given it, which struck us as slightly unusual-- well, very unusual. I mean, you know, we couldn't understand why anyone would withhold the use of data which is available in the organisation, particularly when it is people involved in the microbiology and Infection Prevention Control service.

Q Your conclusion immediately follows that quotation from the overview report, which you say you stand by, that you conclude:

> "… that the levels of [this organism] reported by [HAD] have little or no bearing on the likelihood of water contamination by other Gram-negative material relevant to our case series."

That's your position, is it?

A Yeah, that's the-- yes, that's our position. I-- Yeah.

Q In the next section of the report, you deal with a number of issues, including inter-institution comparison and so on and so forth. I suspect again it'll become repetitive if we go back to all of that, particularly given the way some of the issues that we're talking about have moved on. Can I just ask you, just so we're understanding the rebuttal properly, to go to page 178? Just so the Chair and others understand what you were looking at here and why you took the trouble to look at it, what was the issue here? This is paediatrics and adults being looked at together.

A Ah. Yes, I understand that. Well, I think if you go back to the previous page----

Q 177, please.

A -- the second to bottom paragraph, where it says "Hawkey et al.", I think this is the relevant paragraph because essentially what we're saying here is that Professor Hawkey and colleagues provided no data on the size of the patient populations from which their incidence data derive. And, you know, what we're really pointing out is that there would've been very many more adults in their analysis than there were children. There would have been, you know, a

substantial difference in the size of the two populations, and that's because there are more adults than children in our population and also there is more malignant disease, more cancer and leukaemia in adults than there are in children.

So if you look at the table on the next page, 178, what we're really doing is something that's very basic. We're just totting up the number of environmentally relevant bacteria in the adult series, counting only the data available-- well, counting the data for the adults from 2013 to 2023. And if we just take the example of Pseudomonas there, third from the bottom of the table, there were 32 episodes of Pseudomonas bacteraemia in the adult population, and in the next column, there were 8 episodes of Pseudomonas aeruginosa in the paediatric data, but we only extracted this from the same year as the Case Note Review. That, compared with the 9 patients we found in the Case Note Review, I have pointed out there are some minor numerical discrepancies between the two, but the point we're making here is that 8 out of a rather small number of children may be actually quite significant compared to 32 out of a vastly larger population of adults, but that data is not available to us. If you then go to-- So there's a four-fold difference in the adult and paediatric Pseudomonas infections. Is there a four-fold difference in the size of the population? I don't know. We'd have to get the data, but I'm sure there would be.

If you go to Stenotrophomonas in this table, what you see is that in the adult data, albeit it was-- this is over a slightly longer period of years and we should perhaps have brought it back, but there were 45 Stenotrophomonas infections in the adult population and there were 22 in the childhood population. That's a factor of two. Now, it strikes me that that's just a very-- in terms of the size of the relevant populations, that's a relative excess of Stenotrophomonas in the population and I think we argue the same for Enterobacter, 24 versus 36. So, the sentence at the end of that paragraph underneath the table is "This observation of itself would have been useful for Professor Hawkey to have discerned and explored." So it's just a very simple comparison. It's difficult to know whether it's significant. My strong feeling is it's highly significant.

Q And the significance is what you say is the disproportionate number in paediatric----

A Well, I would suggest that this data implies that there are disproportionately greater number of

children experiencing Enterobacter and Stenotrophomonas infections than there were adults, but to do that you need the size of the-- you know, you need to know the number of patients who were-- who were exposed to the risk.

Q Now, while we've got numbers, I think you know by now that the charting of infection numbers as between Yorkhill and the Queen Elizabeth by HAD authors, having had further discussions, has now led to some new charts which weren't available to you at the time that you wrote this rebuttal. So, at various points, you're rebutting suggestions made in the original report which perhaps have slightly moved on, so what I'd now like to just do is go at least briefly to bundle 44, volume 5, page 50.

Now, first of all, I gather there's a point about presentation which I understand you want to make, so let's allow you to do that first. If we look at page 50, this is environmental paediatric BSI and – for the sake of argument – it shows a rise from somewhere around 2016 up to 2018-ish and then down again, and I'm not going to get into the epidemiological definitions of what that is. Now, if we look at page 51, we then see what, at least at first glance, seems to be a very similar chart, non-environmental bloodstream infections, but am I right in understanding, Professor, that the point here is that the scales are different? So although at first glance on a sheet of paper of A4 size they look similarish in general appearance, the scales are different on the left-hand axis, is that right?

A Is it possible to have the two pages projected side by side, or is that feasible?

Q No idea. No, I'm being told.

A No?

THE CHAIR: There's a technical challenge which I'm----

A Okay, well, I mean-- I----

THE CHAIR: However, it can't be beyond us to achieve that one way or the other, maybe simply by printing off copies.

A Well, I have the hard copy in front of me.

MR CONNAL: He has a hard copy there.

A I just thought perhaps it would be helpful to talk about it together, but we can-- I can-- I'm very happy to talk about it without it being projected together, so----

THE CHAIR: See how we progress on that----

A Okay, thank you.

THE CHAIR: -- but I can see the importance of being able to----

A Well, the point I want to make is that the-- this is----

MR CONNAL: They call one page 50 and one page 51 and that'll keep us right----

A The-- 2f3, which is the previous graph, which is environmental paediatric BSI, the y-axis gives an-- a predicted rate of up to 25----

Q And we see the peak, very roughly, just under the 10 mark?

A Yes.

Q Is that right?

A But if you go to the non-environmental paediatric BSI in figure 2f4, the y-axis goes to 40 and the difficulty with the GAM analysis is that the statistical significance of what it tells you is about the pink line moving out of the range of the blue line, but it's also a very visual way of displaying data and so that the visual comparison between these charts would lend you to believe that the frequency of environmental and non-environmental bloodstream infections is broadly the same cos the peak-- the lumps-- the humps look the same size, but if you----

Q Yes, whereas the hump on 2f4 goes up. Now----

A Yes, but if you----

Q I'm not intending to precise, but say 22 or something like that.

A If you plotted them-- if you plotted them on the same axis, you would see visually that the number of non-environmental BSIs is rather substantially greater than environmental BSI, and that may be an important point in terms of understanding what's going on here because predominantly non-environmental bloodstream infections in this type of population are contributed to by Gram-positive organisms – so what we call staphylococci – and there are different types of staphylococci, but Gram-- coagulase-negative staphylococci and Staphylococcus aureus-- Coagulase-negative staphylococci in particular account for a very substantial number of bloodstream infections in children.

And it has a bearing on understanding why the work done by the GGC team, the haem-onc team, on CLABSI improvement matters because the work that's done on central line associated bloodstream infections is largely targeted towards reducing the occurrence of Gram-positive infections, because staphylococci of various forms are typically found on the skin and very classically affect the line site and sometimes the track in-- under which the catheter flows under the skin. And so if you-- if you have a lot of those infections, which you do, and you implement measures to reduce it, you'll see a reduction.

Cos I understood in discussion of

these curves, people were saying, “Well, you’ve shown there was a peak in environmental bacteraemia, but why is there also a peak in non-environmental bacteria-- bacteraemia?” Now, it’s a little difficult to understand that, except if you look at the non -environmental figure 2f4 you see that it’s never near zero. It’s always-- I mean, the central line associated infections from staphylococci are always with us and that’s what this data shows, that the dots are never along the bottom, whereas with the environmental ones there are times when the dots run along the bottom of the graph and that’s because environmental bacteraemia is so much less common than non-environmental, but the work of the CLABSI group would undoubtedly have had a significant impact on the non-environmental bacteria and it would have a relatively less great impact on the environmental.

Q I think you, in the narrative of your own report-- We’ll just leave these graphs up, if we may, for the moment. Just take it from me: you mentioned the CLABSI group, i.e. the Quality Improvement Group, work in 2017 which led to what you describe as a highly creditable diminution in the rates of line infections to a standard that was regarded as very good and which you specifically mentioned in your overview report. Is that right?

A Yeah, absolutely. Absolutely. I mean, they did have a problem. It was quite clear. They had high rates, I think as high as six per 1000 line days, and which would be considered very high, but they drove it down to under 1, which is internationally very competitive. But that didn’t diminish the fact that there was a problem with-- I don’t think you can say that that got rid of all your environmental infections, but there were other things going on, of course, which was the treatment of the water and moving the patients out of the environment.

Q Your first point to us is that if we’re looking at these documents, we need to remember that the scales are quite significantly different, so that the peak of the----

A I think visually, I think it would----

Q They look the same, but----

A They do look the same, but I think if you saw them plotted on the same y-axis, they would look different, and I think that would assist in understanding what the challenge was. And-- you know, and it’s not quite clear why that wasn’t done for the children, because it was done for the adults. All the adults are on the same-- Oh, possibly they’re not, actually. I’ve just seen-- I may have got that wrong, but anyway, I think it’s----

THE CHAIR: I'm assuming, but I could be wrong about this, Professor, the reason the y-axis goes up to 40 in the non-environmental paediatrics is that it's the result of the nature of the data. It's in order to accommodate the scatter.

A You're right, the values do go up to that point, but the difference between-- if you measure the difference between 0 and 5 and 10 on the y-axis, it's further apart on the environmental than the non-environmental, so it will distort the visual effect of the curve.

THE CHAIR: (After a pause) I would find it quite useful if you just talked me through the point again because I have to confess I had not thought about this before. I think I've got the visual presentation point that if you have a greater or lesser y-axis, a trend can appear one way or the other; I think I get the potential for being misled. Now, what additional observations would you make?

A Well, I don't think it changes the message of the shape of the curve where there is a rise and a fall, and it doesn't change the information which both these diagrams show, which is where the pink line moves out away from the blue line and therefore you know there is some deviation. But what it does, I think, do is it-- it obscures the fact that non-environmental bloodstream infections are much more common than environmental bloodstream infections and I think, therefore, potentially it affects the way we think about, "Well, how come they both reduced and was it for the same reason?" and I'm suggesting that actually the impact of the CLABSI Quality Improvement Group is clearly transmitted into the reduction of the non-environmentals, but the change in the environmentals, I believe, comes from the work done to the water supply and the relocation of patients. That would be my interpretation.

THE CHAIR: Right. Thank you.

MR CONNAL: When you wrote your rebuttal, you weren't looking at these graphs----

A No, unfortunately, this is-- we only saw these in the last couple of weeks.

Q You were looking at different graphs, but just for the record, on page 179 of your rebuttal, you highlight the Quality Improvement Group from 2017, the reduction that you've just mentioned, and then you say, "Well, yes, very good, but," as you put it in the middle paragraph:

"... we caution that, although good central line care can reduce the incidence of Gram-negative BSI, its principal benefit is in driving down the frequency of staphylococcal line site infections..."

Is that the point you were trying to

make a little earlier?

A Yes, yes.

Q Thank you. (After a pause) I think this might be as good a point as any to pause, my Lord, subject to anything that my Lord wishes to take.

THE CHAIR: No. We'll take our lunch break now, professor, and if I could ask you to be back for two o'clock?

THE WITNESS: Certainly. Thank you very much.

(Adjourned for a short time)

THE CHAIR: Good afternoon, professor.

THE WITNESS: Good afternoon.

MR CONNAL: Thank you, my Lord.

THE CHAIR: Mr Connell.

MR CONNAL: With apologies to Professor Stevens, can I just confirm now that tomorrow's session with the next witness will start at 9.30 rather than 10?

THE CHAIR: 9.30. Very well. Now.

MR CONNAL: Professor Stevens, I've been asked to raise these points with you. If you're not able to assist us, please just say.

A Certainly.

Q They arise from the graph of increase in non-environmental organisms.

A Yes.

Q You've explained the importance of looking at these properly and so on and why the axes are different, but there is an increase in non-environmental organisms which peaks somewhere around 2017 and then falls away.

A Yes.

Q Is it possible that the increase could be explained by a number of things such as, I'm told, that there was a switch to a new central line, new type of central line, without sort of prior warning or training on that new line? Is that a possible cause?

A I don't know, is the answer. I know that they changed the caps on the central line, the little screw caps to seal them off, and that was thought to have contributed to the reduction in CLABSI at one point. I didn't know that they had changed their central lines, but I don't know.

Q Another possibility is, I'm told, there was at one point a dedicated nurse providing support with training on line care, and that nurse was lost. I won't use the word "removed" because that might be pejorative, but you don't know about that.

A I don't know, although Jennifer Rodgers' statement, I think, did refer to a training role, I thought, but I would have to go back and look it up.

Q What about possible changes

in hand hygiene practices because of all the water problems that were going on?

A Well, I'm quite sure that must have helped. I'm sure it must have helped.

Q Thank you. I won't ask you any more about that, so we'll move on to a different topic. This is sort of by way of a preliminary to a question as much as a question. If we go to page 180 of your rebuttal statement. (After a pause) I'm bearing in mind when I'm looking at this document that it was prepared at a particular point in time in the series of communications and exchanges and so on which, we touched on earlier, might suggest that there is a narrowing of gaps rather than a widening of gaps.

Therefore, my preliminary question is this: that on page 80, having made some comments about some of the ways data had been plotted, you then said you'd revisited your data to reassess the likelihood of clustering using criteria established by HAD and then looked at your own conclusions. Now, there then follows several pages of highly colourful blocks in different reds, greens and yellows----

A Yes.

Q -- with some narrative. Now, the preliminary question I have is: given where we are now in the scheme of things, do we need to look at these? Do they help us at all or are they now superseded?

A No, I don't think they're superseded. I think-- I think essentially this issue of clustering is about the individual episode of infection rather than the overall rate of infection. So-- so the concern remains the same, I think.

Q I'm not going to ask you to go through these charts line by line because we'll be here till Christmas, never mind later this afternoon. What were you trying to do when you put together this material?

A I think what we were interested in seeing is whether our assessment of clusters or potential for clustering roughly aligned with the data that the-- that Professor Hawkey and colleagues had extracted. I mean, would it help if I took you through in steps what we did, just briefly?

Q Well, just if we can try and do that in a manner comprehensible to the layman, that would be very helpful. Just take me through in----

THE CHAIR: I'm sure that was the professor's intention.

A I'll do my best.

THE CHAIR: Thank you.

A Well, essentially, if you look at any one of Tables 11 in this document, and perhaps we could just bring one of them up on the screen.

THE CHAIR: So we're going to bundle 44, volume 1, page----

A It's part of that document. Oh, no, it's the other document. Sorry, yes that's right.

THE CHAIR: So it's in the rebuttal document, is it?

A No, it's not, beg your pardon. It's my fault. I'm completely wrong.

THE CHAIR: Let's see if I can find the----

MR CONNAL: What you have in the rebuttal document are these coloured charts.

A Yes, yes, but if-- I think I just wanted to show you something in the HAD document, 44, volume 1.

THE CHAIR: Oh, right.

MR CONNAL: Right.

THE CHAIR: All right, so that's----

MR CONNAL: Let's do that then. 44, volume 1----

THE CHAIR: Bundle 44, volume 1, maybe starting at page 84. No, not starting at page 84.

A Well, if you go to-- if you go to page 100, that's just the one I've got open here. Okay. So, what the HAD authors did was they listed by different bacteria the occurrence of infections, and they gave the location in terms of which hospital, they gave the year and the month in which the infection occurred, and they also gave more detail about the ward.

But in the final column of all these different Graphs 11, it says, "Clustering", and this was their judgment in-- in relation to the data that they had collected using the criteria which they had set out themselves, which I summarised, if we go back to the rebuttal document.

MR CONNAL: Yes.

A And you go to page 182.

Q Yes.

A So, essentially, I summarised and added this colour-coding for visual effect, and if we look very quickly at the first box, they broadly describe two clustering criteria: one for patients whose infections occurred in the same hospital and the same ward, and one for patients who were in the same hospital but different wards. And so you can see that if two or more cases were between 0 and 30 days apart, whether or not you're in the same ward, so long as you're in the same hospital, the HAD team considered that the potential for a clustering was probable, okay?

So I thought it would be interesting-- we thought it would be interesting if we took our data and applied their criteria, and so we went back to our old-- our own records. So I went-- I did this work. I went back systematically to all the individual records of the patients with infections, but I only-- I didn't do all 118

episodes. I selected just the principal subtypes of bacteria that we were interested in, Klebsiella, Enterobacter, Pseudomonas and Stenotrophomonas.

And I pulled out the date, the location of the infections that we had recorded, and I coded them using their coding criteria. And I did that by coding them against the preceding infection, if there was one-- well, there was-- there would have been one at some interval, or the succeeding one. And I present that, if you could go to perhaps-- well, just the next chart, 7.3.

Q Page 184.

A Thank you very much. So, this is a not particularly interesting chart because it's a subgroup of Klebsiella, Klebsiella oxytoca. It's one of the species of Klebsiella. So, what you see here is our data, and I've identified in the first column the location of the patient and, if-- if available, the bed number at the time the culture was taken.

Now, we might wish to come back to whether that's a, you know, critical piece of information, but you have to assign it to something. So the first patient, you can see, was in Ward 2A in Bed 7. Was there a clustering with another patient within the same ward and room within 90 days? So, I just-- I took-- I took an empirical gap for this. I said 90 days having the patient in the same ward and room might be

significant. There wasn't. So, we were able to check that no other patient had an infection with Klebsiella oxytoca within or after 90 days of this infection.

Then you come to the column, "Days from preceding infection". Well, there was no-- it's not relevant because this is the first patient in the series and so there wasn't in our dataset a preceding infection. But there was a succeeding infection, and you can see that that was 104 days later. Okay, and so then I applied the HAD team's clustering criteria to that line of data. So, where it says non-attributable in the days of preceding infection, I didn't apply a clustering definition because there isn't one. But in the second coloured column, it says, "Possible" and it's coloured yellow. That's because if you were in the same ward and the same hospital and you had an infection between 31 and 120 days – this is their criteria, not mine – they called that a possible clustering. There was a possible clustering, okay?

So, I repeated that on each line. So, if you come down to, so, the fourth line of data, patient in ward 2A, bed 9, you read across and you can see this patient, there was-- had a Klebsiella-- there was a Klebsiella oxytoca infection in a previous patient 20 days before, and there was a

patient who had the same infection two days later. The proximity of those times means that both of those, the preceding relationship and the succeeding relationship, are coded probable.

Now, the third coloured column is essentially me trying to say, "Well, what's the highest likelihood?" Because you can either cluster with something before or something after. You can see in this table that some things were-- for example, the third line down, it was unlikely that it clustered with the preceding, but it was probable that it clustered with the succeeding. So, I took the highest score in that third column, and what you're left with there is about eight records, two of which are possible, three of which are probable and three of which are unlikely. So, that's just straight data lifted from our time sequence and scored with the HAD data.

Then, with a slight note of caution, I added a final column which was-- I went to our records for each of these individual episodes of infection and said, "Well, what did we actually say about these patients?" and you can see that for the first two patients, we said, well, there was a possible chance of a cluster of infection. For the next three patients, we said there was a probable chance of a cluster in the infection and, for the next three patients, we said there was possible, although, using the HAD scoring, it scored unlikely.

So, I hope that's understandable, and the colouring is just a visual cue, really, to see what the overlap is between those last two columns, if there is at all, and so what you see is that there is some synergy between the columns. It's not entirely precise, and my note of caution is, of course, that the coding according to the HAD criteria is just very specifically clustering based on patient location and interval from another infection. The final CNR decision incorporated all the other factors that we looked at, the kind of softer or more holistic things that we considered. So, you wouldn't expect them to align completely and they're not quite the same. So, I'm sorry if I've taken too long.

Q No, no----

THE CHAIR: No, no, no.

MR CONNAL: I was just about-- if I may, my Lord, just to get the reference to that last point so we have it for the notes.

THE CHAIR: Yes.

MR CONNAL: The note of caution that you've just described, I think, is set out on page 192----

A I think it is somewhere, yes.

Q -- of your rebuttal.

A I think we did put in, yes.

Q Yes, thank you.

A So, if you wanted-- if you just want to put the other coloured tables up on the screen, you can see-- I mean maybe you don't know what to choose, but, you know, perhaps choose-- you could choose Stenotrophomonas, because that's very interesting to everyone. 191, page 191.

THE CHAIR: But just before we leave 184----

A I'm sorry.

THE CHAIR: Now, you started us with table 11C in the HAD report.

A Yes.

THE CHAIR: Now, do we see, and I apologise for not having followed this, in your table 7.3----

A Yes.

THE CHAIR: -- on page 184----

A Yes.

THE CHAIR: -- a representation of the HAD report's clustering assessments?

A No, because that comes at the very end in table 7.8.

THE CHAIR: Right, okay. So, these----

A These are our CNR data.

THE CHAIR: Right. You're using CNR data, which is subject to medical confidentiality. But you've used the HAD criteria, which, again, if I'm following it, is simply twofold. It's time and place.

A Yes.

THE CHAIR: Whereas the CNR criteria include time and place, but other----

A Other elements of judgement.

THE CHAIR: Other elements of judgment.

A Yes.

THE CHAIR: Right, okay. Now, you were going to take us to----

A Well, I didn't know whether you-- Mr Connal suggested perhaps we didn't need to go through every chart but----

THE CHAIR: No.

A -- I didn't know whether you wanted to see one more.

THE CHAIR: You were offering one other chart? 191.

A Well, I just wondered whether you'd like to look at the Stenotrophomonas chart on page 191 because----

THE CHAIR: Yes.

A -- I think there is a comment that I could make that might be useful. Yes, thank you very much. I'm sorry, the page breaks are misaligned slightly. The only point I want to make on this chart-- well, first of all, it's a larger data series. There are a couple of other small points here. For example, in the first column, if you go down towards the bottom, it says,

"Miscoded to 2B". That's a shorthand for me, really, to say that we encountered some difficulties with the coding of place because when that patient had an infection, in fact, 2B was closed, so clearly couldn't have been on 2B but that's what the information we received was. So, we were unable to be entirely sure about whether there was congruence with ward and bed.

Perhaps the most relevant thing on this chart is if you look at the two righthand coloured columns, where-- the second to end one, where it says the, "Highest likelihood of clustering", this is the CNR time and place data clustered by the HAD criteria, and what's very apparent is that most of it's red. Most of it's probable. So, here we're producing the data that's in the Case Note Review and we've classified the clustering intervals using the criteria set by the HAD team, and two-thirds, probably slightly more, of the patients appear to have probable clusters. That aligns, broadly speaking, with the prominence that we give to Stenotrophomonas in the Case Note Review.

If, however, you look at the final column, where it says, "Final CNR decision", you see there's rather more yellows creeping in. It's not all as much-- there isn't as much red as yellow-- as there was in the previous column. I would like to believe that this manifests the moderation of the Case Note Review process in not simply saying-- I mean, I'd like to say we weren't simply saying, "Well, you know, there was another infection eight days later, therefore, it has to be a probable link to the environment." What I'd like to say is that we actually were moderating these and, in a sense, moderating them downward a little, and I think it's a kind of-- a rather loose way of demonstrating that we were possibly more conservative than perhaps people thought we were being. But that is, of course, a judgment.

MR CONNAL: What you've done with the colourful charts is you've taken the information that produces and applied some numbers to them and put them, I think, in table 7.8. Is that right?

A Yes. Now, table 7.8 is a little different because what we've incorporated here is the HAD data because all these colourful charts relate to the CNR data.

Q Yes.

A So, what we've got is on-- perhaps, page 193, if we could have that? So, you have five subgroups of bacteria, two Klebsiella, Pseudomonas, Enterobacter and Stenotrophomonas, and the first block of data relates to the Case Note Review data scored by the

HAD criteria, which is what we've just been looking at. The second, the middle block of data relates to the HAD data itself. So, that goes back to table 11 in the HAD report, where we simply extracted their judgments about the possible or probable likelihood of a cluster. Then, for good measure, in the final block of data, we've re-expressed the Case Note Review final decision, albeit with the caveat that they're not entirely the same thing, and then we offer on page----

Q 194?

A -- 194, I think, a little bit of a commentary about that. But our general point is that there is quite a lot of alignment here, and there is a little bit more variability with Klebsiella but with Stenotrophomonas and Enterobacter in particular, there's really quite a lot of comparable outcomes. So, if we read along the----

THE CHAIR: Just for the sake of absolute certainty, when you say, "Quite a lot of alignment and comparative outcomes"----

A With the outcomes. I was just going to----

THE CHAIR: Sorry, as between what and what?

A Between the total of probable and possible clustering in the two groups of data.

THE CHAIR: Right.

A So, if we were to look at the table on page 193 again, and if we'd simply go along the bottom line, which is Stenotrophomonas, and I-- I mean, I am very cautious. These are small numbers, you know. I do worry a little bit about this, so I don't want to overplay it. But essentially, if you look in the fourth box of data in each block, the total probably and possibly clustered in the CNR data scored with the HAD criteria is 22 or 96 per cent. In the HAD data itself it's 21 or 95 per cent. Now, actually in the Case Note Review final decision, it's 21, but that's 100 per cent of those that were informative because we had to exclude two patients, but they align.

What does that tell us? Well, I think it tells us that the HAD team were forming judgments about the value of clustering, which really were essentially the same as ours, and if they weren't pretty much the same as ours, you'd be surprised because there's broadly an overlap of the-- well, there's a-- they're pretty much aligned, the data sets, but there's also quite a lot of alignment with the Case Note Review final decision. I don't claim for a moment that his is statistically viable or proven, but what I'm saying is it points in a direction of consistency.

MR CONNAL: Your added point,

which is expressed on your narrative page, if I get it correctly, is that you think doing it this way may help to dispel any suggestion that you were very keen to just call the thing a cluster, if you possibly could, but in fact you were moderating some of the results----

A Well, I'd like to believe that's what people will conclude.

Q Thank you. I think we can move on from these charts. Let me turn to some other issues that have been raised about your report, particularly by Dr Chaput. What I'm going to try and do, and we'll see how it works, is put two documents on the screen at the same time so that we don't end up, you know, misquoting or selectively extracting or whatever, and what I'm going to use is the rebuttal document that we've been looking at----

A Mm-hmm.

Q -- where I'm going to go to, first of all, to page 198. I'm also looking at bundle 44, volume 3 at page 15, which is-- You can just take it from me; it's an annex to a response by GGC to the rebuttal document in which Dr Chaput was one of the authors, and it contains lots of material which----

A I have seen this document.

Q -- I'm not going to ask you that.

A Yes.

Q Now, the reason that I want these two to be available is that if you feel you need to see the full text at any time, you should please just indicate so that we're not being selective. The first issue that is raised that I just want to put to you is this. You see it starting in paragraph 14 in the left-hand document on your screen, i.e., the GGC document----

A Mm-hmm.

Q -- where there's a quotation from your document at page 198, and then there's a statement at paragraph 15, "This is incorrect and betrays a lack of knowledge of microbiological water testing, and of the purpose and scope of the NIPCM Appendix 13." Then there's a comment about Enterobacter being "coliforms, and testing specifically for coliforms is one of the most fundamental water tests". Now, can we scroll on to the next paragraph of that document, please? Is that feasible? So we look then at-- The point as I understand it here is that you say in your report, "Well, you're likely to be undercounting Enterobacter because there's likely to be other samples that were not specifically identified."

Dr Chaput says, "Well, Enterobacter is a coliform. Strict tests are applied for coliforms. There's no way that the lab would not report a coliform, so it was missed out." So the criticism ultimately comes to be directed at – let me just get

the right reference – a statement on page 199, that the number of Enterobacter isolates likely were much higher. That's the essential point that. You're saying basically things have missed out or may not have been picked up, and Dr Chaput is saying, "No that wouldn't happen."

A I think that's essentially the state of play when looking at these two documents, but since then Professor Wilcox has provided a supplementary statement, which I hope and believe addresses this point as well as some other points about WGS----

Q Right, so----

A -- I believe, which might better replace the right-hand side perhaps. I don't know.

Q If it's not something you can help us with, you would defer to what Professor Wilcox says in his supplementary statement?

A Well, he's provided a statement which responds particularly, I think, to some of these criticisms, and I don't know if you want to look at that, but I rather defer to him in the response. My understanding is that there was the potential for incorrect totalling of the number of Enterobacter samples.

Q Right, well, we can take that from Professor Wilcox's witness statement in due course and check it against what's been asserted. Now, there's also a suggestion that the comments that you've made about the storage of sampling samples were also incorrect.

A This is storage of blood culture isolates.

Q Yes. Is that also a matter that you would defer to Professor Wilcox?

A Well, I would have to defer to him because he's a microbiologist. He understands the regimens that microbiology laboratories work under. I did, however, read in a document some reference to a lack of blood cultures in the early part of the Case Note Review, and I spent some time yesterday trying to track that document down, but I can't find it. So my conclusion is I really don't know. This is detail of the operation of microbiology departments. I mean, I would expect them to be stored, but I don't know how long they're stored for.

Q Thank you. Well, in that case, I won't ask you anything further about Dr Chaput's criticisms, and we can see what Professor Wilcox says. That I think just leaves me with one other topic – we can take these off the screen, thanks – to raise with you, which is also in a sense, at least my labelling, a new topic. That is something called counterfactuals----

A Mm-hmm.

Q -- which were I think introduced by Dr Drumright in the course

of exchanges during her evidence. Now, for a lay person such as myself, a counterfactual is usually the envisaging of something in circumstances which didn't happen, so, you know, let's imagine what would've happened if Germany had won the war or something and play out a scenario. That's not what happened as a matter of fact, but let's look at this, but my understanding of the epidemiological definition is it's something which is contrary to the primary hypothesis that you're working on. I just want to see if you can assist us at all on these issues. The primary hypothesis that I think was being suggested was that at least some of the infections were linked to – let me just call it continuously – the water. It doesn't matter what route we're looking at. Now, I suppose the question then is, do any of the counterfactuals in your view have any impact on-- you know, what likely impact on what we've seen, for instance, in the graph that we've looked at?

THE CHAIR: Mr Connal, I mean, at risk of being terribly pedestrian, would it be helpful just to identify the phenomenon that you, the supposed phenomenon that you have in mind when inviting the Professor to consider counterfactuals? I mean, it's maybe implied, but can we just spell it out?

MR CONNAL: Yes, I think what we're looking at, Professor, is the increase or apparent increase in environmental gram-negative bacteria that we looked at in page 50 of the two charts that we couldn't get up beside each other.

A Yes, yes, yes, no, the pink and blue lines.

Q Yes, indeed, and the pink area with a red line through it. Now, it may be that we've dealt with the first one that I have because I have a note here saying "line care".

A Mm-hmm.

Q Now, your evidence in your written material, and I think your evidence today, was that, certainly in terms of improvements in line care, that might reduce gram-negative bacteria, but it was mainly aimed at Staphylococcus.

A Yes, yes. I mean, there would be an overall benefit, but the overwhelming burden of line-associated infections are from gram-positive bacteria and principally Staphylococcus.

Q So if we looked at the possibility that something to do with line care was a cause of the apparent rise in gram-negative bacteria, is there anything in your research that suggested that that was the case?

A No. Poor line care, if there was a fall in standards of line care, you know, you couldn't dismiss the fact that it

could result in an increase in all types of infections, whether that was to-- could be to the extent of the surge, as it were, I don't know, and it's a little difficult to understand why that would happen at the time it did. But you can't dismiss it, but I wouldn't see it as a major factor.

Q Now, the next counterfactual – I have to be careful how I frame this – I have it under the head of "nursing behaviour". One could call it "nursing performance", and I must make it clear that I'm not suggesting directly that there was any laxity or failures, but it's just this general question of whether things like nursing shortages or pressure of the events and all the publicity or even, I think it was suggested previously, the fact that people were in single rooms and that makes some of the tasks that nurses have to do more difficult because they don't have the simplistic view of an entire ward that they might have. That's not necessarily exhaustive, but have you any view on whether anything in that kind of box might explain the apparent rise and then subsequent fall that we saw?

A Well, I think other witnesses have talked about the challenge of moving from multi-bed bays to single rooms and how that changes the nature of nursing practice. You know, it may generate a requirement for more or different nursing as part of the team, and I don't have any data on that, but I would be surprised, knowing as I do the quality of the nurses that work in this particular area of clinical practice, to believe that anything like that would've had a serious impact on the care of the patients. And indeed, if you look at the Case Note Review report, we have a chapter, Chapter 9, a short chapter on evidence of good practice, and we say here:

> "Nursing care records were especially comprehensive and clearly written. There was almost universal completion of vital signs in central venous line and peripheral venous catheter documentation."

So I can't say that the care of the line was exemplary, but what I can say is the documentary evidence of the care of the line was comprehensive and clearly written, so I think that's as close as I can get to refuting that there was a challenge from poor nursing performance.

THE CHAIR: So you're making a general point and then a more specific point, the general point being that, over many units, the quality of the nurses who take on these specific responsibilities, by which I mean paediatric haemato-oncology, tends to be a very high standard, but going to the specifics of the Royal Hospital of Children, insofar as you had data to inform yourself, which was their recording of their work, that

appeared to you to be of a high standard?

A Yes, absolutely.

MR CONNAL: Now, the next in the list that I've been provided of counterfactuals again I suspect we've probably dealt with insofar as we can. I think we've been dutifully chided for calling it “antibiotic resistance” because it's actually antibiotic prescription which may lead to antibiotic resistance. Now, we've looked at that in the context of whether there's any evidence of it in relation to meropenem, and we've sort of touched on it in relation to cipro. So is there anything that you can add as to whether anything to do with antibiotic prescribing might be regarded as explaining, contrary to the water hypothesis, what we saw?

A No, I think the only thing I can contribute really is I was reflecting about the use of ciprofloxacin, and there is a possibly helpful point in the Case Note Review, where we talk-- have a brief section on antibiotic prophylaxis. And it occurred to me that antibiotic prophylaxis continued to be given on a routine basis until December 2019, by which time the incidence of these infections was dropping. Now, it's an oblique point, but it suggests to me that it’s somewhat counter to the idea that antibiotic prescribing is driving the environmental infections.

Thank you. The final one, and I suspect this was dismissed fairly early in other discussions, was of issues around the laboratories, whether that’s contamination of samples or presumably inadequate handling in the labs or something of that kind. I’m not suggesting that’s a likely cause. I’m simply raising it as something for your comment. Have you any information to suggest that that would explain the figures that we saw on page 50?

A No. I mean, I can’t comment. I can’t comment at all. It’s about practice in the laboratories and if the laboratories drop their standards or are short staffed then I suppose you could have a problem but it’s-- I have no knowledge of it.

Q Thank you.

THE CHAIR: Well, these are the questions I have for this witness so perhaps we can work in the short break. As you may recollect, the procedure we have adopted is to allow an opportunity for the other legal representatives to propose questions. Perhaps if you allow us about 10 minutes or so, and can I invite you to return to the witness room.

THE WITNESS: Thank you very much. Thank you.

(<u>Short break</u>)

MR CONNAL: My Lord, no questions have been intimated to me.

THE WITNESS: Thank you.

THE CHAIR: Apparently, no further questions, Professor, and that means, of course, you're free to go but before you do go, could I just stress my gratitude for your attendance today and on the previous occasion, but also on the very considerable amount of work which goes behind that attendance and has gone behind your preparation of the documents responding to the comments from Professor Hawkey and his colleagues. So thank you very much indeed but you're free to go.

THE WITNESS: Thank you. Thank you, Mr Connal.

(The witness withdrew)

THE CHAIR: Well, as Mr Connal indicated, the plan would be to begin at half past nine tomorrow morning and I look forward to seeing you then, but in the meantime, can I wish you a good afternoon?

(Session ends)

14.55