

Science and Technology Committee

Oral evidence: UK Science, Research and Technology Capability and Influence in Global Disease Outbreaks, HC 136

Thursday 16 July 2020

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Science and Technology Committee members present: Greg Clark (Chair); Aaron Bell; Dawn Butler; Katherine Fletcher; Andrew Griffith; Mark Logan; Carol Monaghan; Graham Stringer; Zarah Sultana.

Petitions Committee member present: Catherine McKinnell, Chair.

Questions 1037 - 1159

Witness

I: Sir Patrick Vallance, Government Chief Scientific Adviser.



Examination of witness

Witness: Sir Patrick Vallance.

Q1037 Chair: The Science and Technology Committee has been taking evidence throughout the pandemic for two principal reasons. The first is to capture evidence in real time during the course of the pandemic, to be able to inform whatever conclusions and reviews are subsequently undertaken; secondly, and importantly, to draw out lessons during the pandemic that may be relevant to decisions to be taken during the course of the pandemic itself. Following this week's session and next week's session, we will be making a report of our lessons learned to date.

We were going to have two sessions today. The second session was with the Secretary of State for Health and Social Care, Matt Hancock, and his permanent secretary, Sir Chris Wormald. We are very grateful that Matt has agreed to appear before us next week, because he has to make a statement in the House of Commons this afternoon that would have limited the time that he had with us. We are very grateful for his flexibility on that.

I am very pleased to welcome our witness today. He will be familiar to the Committee. He is the Government's Chief Scientific Adviser, Sir Patrick Vallance. In addition to members of the Science and Technology Committee, we are very pleased to welcome Catherine McKinnell, Chair of the House of Commons Petitions Committee, who is joining us today.

Sir Patrick, welcome, and thank you for coming before us today.

Sir Patrick Vallance: Thank you. I am going to take off my mask because I can see that we are well separated by 2 metres and in a well-ventilated room.

Q1038 Chair: We are indeed. We have at least 2 metres between us all, and probably more. I will start, Sir Patrick, by putting on record our appreciation of your dedication and public service throughout the whole pandemic. You have appeared regularly before the Committee, and you have engaged very constructively, both in person and through correspondence, with the Committee. You have acted on many of our suggestions and recommendations, such as the publication of the names of attendees at SAGE and of papers that SAGE has considered. We are very grateful to you for that.

Perhaps through you, the Committee can put on record our thanks and gratitude to the scientific community, who have been working tirelessly and deploying their great expertise throughout. We are very grateful.

Sir Patrick Vallance: That is much appreciated. I am glad the Select Committee is looking into this, because it is important that we learn lessons as we go along.

Q1039 Chair: Absolutely. In the spirit of learning as we go, and starting with some general questions about the way that scientific advice is taken, we



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have, as we know, some of the very best scientists in the world. You invited many of them to participate in SAGE discussions. Have you found that they were willing to accept? Have people responded to the call?

Sir Patrick Vallance: Yes. Everyone we have invited to participate has accepted. Clearly, we have different people at different meetings. It is not a membership organisation; it is an organisation that we invite people to join as we need them. Some have been at virtually every meeting. Others have been at fewer. In general, and this was my experience before as well, when people are asked if they would help in a Government emergency, the answer is yes. They turn up and work extremely hard at it. The people who have worked on this epidemic from various universities have worked incredibly hard. One of the questions, of course, is how we keep that sustainable for them as the new academic term starts.

Q1040 **Chair:** Indeed. You have had the pick of British science, which is one of the strongest forces in the world. When you last appeared before the Committee, Sir Patrick, you said that there were no significant instances in which the Government had chosen to go against SAGE's advice. You quite rightly made a distinction between policy decisions and the advice, but you reflected, as did the chief medical officer subsequently, that you could think of no significant instances in which the Government had chosen to go away from that advice.

Is that still true? Does that assessment still hold true? Are there any instances in which the Government have gone against SAGE's advice?

Sir Patrick Vallance: You are absolutely right to draw the distinction that SAGE is an advisory body. Of course, the ultimate decisions are a mixture of policy and timing, which are not in our control. Those are things that others have to make decisions around. In general, what I can be absolutely clear about is that those making policy and decisions have heard and understood the scientific advice. That I am in no doubt about.

Clearly, as the pandemic progresses, and indeed as we get into release measures from lockdown, there are many other considerations that need to be taken into account as well as the science. Therefore, the ultimate policy position and decisions will need to weigh all sorts of different factors. It is difficult to say, "Yes, that is based entirely on science advice," because it is not; it is based on other things as well. We have given advice. It has been heard; it has been understood; and it has been incorporated into decision making.

Q1041 **Chair:** We will come on to some of the other sources of policy advice. In terms of recommendations of SAGE, earlier in the year you could not think of any significant aspect in which the Government had taken a different view from that recommended by SAGE. Is that still the case?

Sir Patrick Vallance: It is absolutely the case that Government have taken the advice and understood it. I am trying to think of an example to express why, as you go into more complicated discussions, it is not a



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straightforward yes or no. What we are doing is laying out scientific reasons behind options, from which people can choose. Overlaying that with economic and other considerations is the job of Government.

Clearly, if the Government had done something about which we said, "You should not do that," we would stand up and say, "You absolutely should not do that, in our opinion, from the science."

Q1042 **Chair:** That is part of the independence of SAGE.

Sir Patrick Vallance: It is part of the independence. It is worth remembering that the membership of SAGE is a group of people who, largely, come from outside Government. They are independent and are not paid or contracted. Therefore, they give their views freely and frankly.

Q1043 **Chair:** You are personally one of the most eminent scientists in the country; you are a lifelong scientist. Science is rigorous in confronting theory with evidence. If we look at the structure of the taking of scientific advice, we have one of the strongest science bases in the world. People have been willing to serve. The Government have explicitly said that they would follow and be guided by the advice. There has not been an occasion on which SAGE has felt moved to speak out in public because the Government were proceeding without that.

All of that would imply a very strong system for navigating through the pandemic, yet the UK's response to the pandemic is not the most admired in the world, if I can put it that way. In your role, have you begun to think about what might be the reasons for that?

Sir Patrick Vallance: Yes, we think about that a lot. Clearly, there are things that we do as we go along to keep learning from what is going on. We are in regular contact with many international partners.

As Chris Whitty has said before, it is very difficult to know exactly where we stand at the moment. It is clear that the outcome in the UK has not been good. We can be absolutely clear about that. It is also clear that you can see a band of countries that have done less well—countries in the temperate zone, countries that are very well connected internationally and countries that have population structures of a certain type. There are many factors that play in as we look at that and say, "Well, what is it that makes some countries do worse than others?" There will be decisions made that will turn out not to have been the right decisions at the time. I am sure about that as well. There are going to be a number of factors that need to be taken into account.

The other thing is this. One lesson that is very important to learn from this pandemic, and for emergencies in general, is that data flows and data systems are incredibly important. You need the information in order to be able to make the decisions. Therefore, for any emergency situation those data systems need to be in place up front to be able to give the information to make the analysis and make the decisions.



Q1044 **Chair:** In order to gather data you need to have tests, do you not?

Sir Patrick Vallance: Yes.

Q1045 **Chair:** Therefore, the lack of testing capacity—we might talk more about that—obviously has a medical dimension as to knowing who has the disease or not, but it has an information dimension as well to understand the spread, the patterns, who the virus affects and how. Is that the implication?

Sir Patrick Vallance: That is certainly one. It is absolutely the case, as I have said before, that it would have been preferable to have had a much greater testing capacity early on. But it is not just testing. It is basic information flows around patients in hospital, rates of admission and rates of movement. Those sorts of things are important parts of it as well, and making sure all of those systems work. Going forward, there will need to be a number of things from local areas to make sure that we have the right information flows to make decisions. Those are critical things to be able to get right.

If you go back and look at the minutes, testing was a preoccupation right at the beginning. We kept saying that we needed to get more testing capacity in place.

Q1046 **Chair:** Within SAGE?

Sir Patrick Vallance: Within SAGE. We needed to have more testing capacity in place. Of course, it is important to note that the capacity and capability of the public health system needs to be right as well in order to do that.

Q1047 **Chair:** On data flows, one might have expected, given that we have a national health service, that we would be advantaged in this country in having data flow, yet you cite it as one of the reasons why our performance might not have been as good as it otherwise could be. Is that right?

Sir Patrick Vallance: The national health service provides a fantastic opportunity to do that. The data flows are getting much better now, but at the beginning there were definitely times when we would have liked data that was difficult to get. That is not surprising in a way. Although it is a national health system, it does not have centralised data flows on everything you need. I doubt that is true in many other countries as well. An improvement in data flows is a key part of management of this and, indeed, other emergencies as we look forward.

Q1048 **Chair:** Thank you. That is very helpful to know when it comes to making recommendations for the future. We will come on to this in more detail, but who is responsible for the testing strategy?

Sir Patrick Vallance: Testing strategy is the responsibility of both Public Health England and the Department of Health. In terms of how the



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testing was used and what the priorities were, the CMO took accountability for organising that.

Q1049 **Chair:** When you said that “we”, which you clarified to be SAGE, had said consistently that we needed more testing capacity, as is clear from some of the minutes of SAGE meetings, did you make that case explicitly to Public Health England and the Department of Health?

Sir Patrick Vallance: Public Health England and DH were obviously both attendees and observers at SAGE.

Q1050 **Chair:** Was SAGE sufficiently muscular, if I can put it that way, in saying, “We need more testing capacity and it is not coming through quickly enough”?

Sir Patrick Vallance: You are straying into operational and management matters. SAGE is an advisory body. Advisers can advise, and decisions need to be made as to what the outcomes are. SAGE cannot get into trying to manage things. It does not have the right constituency. It does not have the right make-up or authority to do that.

Q1051 **Chair:** Could it not advise that we need to have more testing capacity, based on looking at other countries around the world?

Sir Patrick Vallance: It did. In fact, if I go back to papers from early February, for example in the contact tracing and isolation paper—I think it was on 12 or 24 February—we said that current PHE capacity to provide it “can be expected to be not sufficient, or sustainable, at the limits of controlling higher rates of incursions...We recommend that a practical and reasonable level of enhancement should be to enable a 10-fold increase in capacity.” There was clearly an under-capacity issue, which was well recognised, that it is important to get right. That is what is happening now with the ramp-up around test and trace and the JBC and other organisations.

Q1052 **Chair:** I want to explore some other reasons why our performance, at least provisionally, does not seem to be at the level of our international reputation in this area. You have mentioned data flows and testing.

Let me explore another possibility. The scientific method relies on evidence; it prizes evidence, as we know. Sometimes evidence takes time to acquire, and time can be lost on the way. Might it be the case that some countries—particularly in Europe—made policy decisions, perhaps in advance of conclusive evidence in an academic paper, which allowed those countries to act more quickly than a country that, depending on a very scientific approach, waited for the evidence?

One example is something that was published just last week, which was the Vivaldi study of asymptomatic transmission in care homes. The conclusion of the study, reported last week, said that, “the Vivaldi study suggests that care home staff may be at increased risk of contracting the virus, which they may then pass on to others if they have no symptoms.” On the basis of that evidential conclusion, a change in policy was made



last week, which was to have weekly testing of all care home staff.

Is it not the case that without the study being completed one could have had a pretty good intuition that transmission among care home staff, given that we know it can be transmitted asymptotically, was likely to be important? Therefore, couldn't we have acted in anticipation of that, rather than waiting for the Vivaldi study to report?

Sir Patrick Vallance: Again, if you go back and look at the minutes, it is very clear that care homes were flagged up very early on. The first record I can find of care homes being flagged up was in February, and there were many after that as well. It was always the case that there was a worry about people moving between care homes, for example, as a way to spread infection.

What you are describing are the policy choices and how those policy choices are made. That is not a decision for me. It is a decision for others as to when and how to make policy.

Q1053 **Chair:** But if we have a body—SAGE—that is very eminent, and the Government have said for very understandable and high-minded reasons that they will follow the science, and they wait for definitive conclusions, is that not, paradoxically, a potential source of disadvantage, compared with a country in which policymakers were able to make reasonable assessments of what seemed plausible and likely?

Sir Patrick Vallance: There are two bits to the way you are framing the question. There is the assumption that somehow SAGE has policymakers in its grasp, and policymakers will not move until SAGE does something. That is not the method. SAGE provides advice. As I say, if you look at the care home advice, it went back right the way to February.

We are never dealing with certainty. We are not dealing with a body of evidence that says, "It is absolutely the case, X or Y." We are always dealing with uncertainty. Our job is to express that uncertainty to allow Ministers and others to make decisions as to which policies they wish to follow. I do not accept the premise that SAGE takes the position: "Only when we are 100% certain, do we go out and give a recommendation." You can see from the minutes that that is not the case. We say, "There is uncertainty here, but within the bounds of this uncertainty here is some advice."

Q1054 **Chair:** Did SAGE advise at an earlier stage that care home workers should be routinely tested?

Sir Patrick Vallance: I cannot remember exactly what we recommended on individual measures. I do not know when we recommended that. We certainly made advice around moving between care homes and other things quite early on.

Q1055 **Chair:** Finally from me at this stage, SAGE has met very frequently—I think weekly during the pandemic—and we have had our bespoke



system. What if we had not followed the approach that we took in terms of the structure of scientific advice, and had simply taken a decision to follow the World Health Organisation advice at every point? In February, the WHO advice was to have a mass regime of testing—I am looking at a statement in March—and to isolate, test and treat every case to break the chain of transmission. We would have adopted a social distancing rule of 1 metre. We would have indicated the use of face masks since 6 June. Is there any evidence that we would have fared worse if we had followed current WHO advice rather than having our own bespoke system of advice?

Sir Patrick Vallance: There is no evidence to suggest one way or the other. I want to pick up a few things on that. There were obviously earlier things as well, such as countries that were affected by MERS back in 2015, or looked at MERS in 2015, taking actions to get their public health systems and other things ready for this type of thing. There were signals that could have been looked at.

Your face mask one is very interesting. If you go back, our advice on face masks was in April. We said that face masks are of marginal positive value when used in enclosed spaces where crowding may occur and you cannot keep 2 metres' distance. That is, essentially, the advice that WHO have come out with and is, essentially, the advice that now forms the basis of policy. I do not think it is the case that we have deviated from WHO in terms of the advice. We were rather ahead of it in terms of that particular piece of advice. Similarly on testing, it was clear very early on that we wanted testing ramped up, but again I think there is a danger of confusing operational accountability with scientific advice.

Q1056 **Chair:** In terms of the face masks, there has been the announcement that they are to be mandatory in shops. Are you saying that the SAGE advice was there in April and the policy decision has only just caught up with that advice?

Sir Patrick Vallance: The SAGE advice is in the public domain to read. It says when face masks can be of value. It is true that in April and during lockdown, of course, the value of the face mask was rather minimal because most people were not going out. It is sensible to think about timing. It comes back to the point you raised earlier about material differences between SAGE advice and action.

Timing is a different question. As we go into the release of measures, it is a sensible time to start thinking about what other mitigating factors you want to put in place. For example, making the workplace completely Covid secure in the middle of lockdown would have made no difference because nobody was going into workplaces, but it clearly is important now. The timing, again, is a policy question.

Chair: Thank you.

Q1057 **Aaron Bell:** Sir Patrick, I reiterate the thanks of the Chair to you, your colleagues and the scientific community. I would like to briefly follow up



the face masks point that you were making. We all recall the deputy chief medical officer sitting down with the Prime Minister and saying how face masks could be not beneficial. That was before we went into lockdown. Was that based on SAGE advice as well? Therefore, has the science changed?

Sir Patrick Vallance: I am not sure that the science has changed dramatically. There is accumulating evidence. It is still not overwhelming evidence. There are really three lines of evidence on face coverings. One is experimental mechanistic work; in other words, if I take a mask and start looking at droplets and so on, do droplets go through it, how do droplets get distributed or how does aerosol get distributed? Those studies all tend to show that, yes, masks can stop things going through them. They show a high level of protection.

A second level of evidence is around clinical trials, and what happens when people do or do not wear masks. There, the evidence is much weaker. In other words, you do not get 95% protection as you might do if you tested that mechanistically. You get some protection and it varies according to settings.

There are observational studies, which we are now seeing, on what the impact was when masks were introduced in country A or country B, or in environment A or B. Could you see a difference in the rates of infection? They are quite difficult to interpret because, usually, the intervention is not a single thing like a mask. All sorts of other things changed at the same time.

If you put those three lines of evidence together, you reach the conclusion that we did, back in April, that on balance masks have a positive effect in stopping other people catching it from you—not from you catching it from other people; there is less evidence around that—and therefore in certain environments there is a role in wearing them. I do not exactly know the context, but one of the things that the deputy CMO may have been worried about, and it remains an issue, is that if you wear masks for very prolonged periods people tend to fiddle with them, fiddle with their face a lot, move them around, take them off and so on. It is actually a bit trickier then to see what the benefit is.

Q1058 **Aaron Bell:** There has been some suggestion that one of the reasons that the deputy CMO, and presumably by extension SAGE, was setting out that position in the first place was to discourage people from buying up all the supplies of face masks at the time. Is that not the case? Was it purely a scientific decision rather than an operational one?

Sir Patrick Vallance: Again, it is quite important to recognise that SAGE does not give all of the scientific advice. SAGE is a group to give certain aspects of scientific advice in certain settings. Not every utterance on science comes through SAGE or is approved by SAGE. There is a whole system of public health and other things that make decisions based on science, and they have all sorts of reasons to do that.



I think it is the case that there was a real concern, and the CMO was clear about it, that the situation in which medical-grade masks are clearly of value and very important is in healthcare settings. Therefore, there was a priority to make sure that healthcare settings had those masks. I think that is clear.

Q1059 **Aaron Bell:** Turning to immunity going forward, what is the latest scientific evidence? What is the latest understanding of SAGE on how long the immune response lasts? What are the implications for our future strategy?

Sir Patrick Vallance: What has become much clearer over the course of the outbreak is that the vast majority of people who get Covid get an antibody response. In, for example, an outbreak setting, it looks like it is probably 95% of people who get antibodies. There are papers suggesting a bit less, but it depends on the sensitivity of assays. The vast majority of people get an antibody response.

It looks like most of those antibody responses contain so-called neutralising antibodies, which are antibodies that would be expected to reduce the ability of the virus to cause an effect. It also appears that in some cases—it is not clear what proportion—antibody levels seem to drop after about three months or so, or in the run-up to three months. Antibody responses may not be long lasting.

That does not mean that some form of immunity is not long lasting. We have other parts of the immune system. We may have memory cells on the B-cell side of things. We may also have T-cell responses that are important. We do not know. There is much that we still do not understand about immunity. We do not know to what extent a positive antibody means that you are protected against the virus or, indeed, protected against carriage of the virus. We know more, but there are lots of things that we still do not understand about immunity. As I say, we know now that most people get an antibody response.

Aaron Bell: Thank you.

Chair: Andrew has a question on the structure of scientific advice.

Q1060 **Andrew Griffith:** Sir Patrick, you have been central to a unique set of circumstances. Obviously, it is the first time we have dealt with this matter. What lessons have you learned to date, as you reflect about the next stage that we have to manage, or indeed future pandemics?

Sir Patrick Vallance: Lots of things. We are in the process of taking a deep look to see what things we must concentrate on and get right. The things that I would reflect on are these. No. 1, as I say, in any emergency, and an important lesson across not just pandemics but every emergency, is data; you must have the data flows and you must understand data ownership and how data is going to get to people for the information you require. That is point No. 1.



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The second is that, when I look at the structure and the way that SAGE operates, it has never been set up to work for 47 meetings. We have been meeting twice a week for most of this time, and we need to think about how to make that work. It is largely volunteer academics who have helped out. They have gone over and above to put their advice into the system and to help in all sorts of ways. We need to think about the resilience of that system.

The third point, which speaks to the last question to some extent, is that the science system across Government and across agencies needs to be robust. SAGE is not the science system; it is a science advisory body. Science in Public Health England needs to be in the right place. Science in Departments needs to be in the right place. There needs to be enough in order to be able to take the science advice or, indeed, other science advice to feed in.

There are two other things. It has been really important that other bodies have stood up to give science advice as well. For example, it has been incredibly helpful that the Royal Society has set up its groups to feed in. The report from the Academy of Medical Sciences that we commissioned on winter was very valuable. The Royal Academy of Engineering has been fantastically helpful around aspects of engineering advice and so on—really useful.

My final comment speaks to some extent to the point that the Chairman was raising on the docking mechanism of science into policy and operations. It is really important that that works effectively. Traditionally for SAGE, that mechanism has been via the civil continuities secretariat and into Cobra. Obviously, in a long-lasting episode like this, other mechanisms have had to be invented in order to make that happen. That is a crucial area.

Q1061 Andrew Griffith: We look forward to hearing more about that another time. I will ask one more question, and then we will move on. Is there any part of you as a champion and an esteemed scientist in your own right that makes you worried that science has perhaps been overweighted in the conversations around how we, as a Government and as a Parliament, have managed the pandemic? To cast a thought on that, have we lacked a business or an economic SAGE? Have you felt that science as one limb has been strong and has had a strong voice at the table, perhaps in the initial stages of managing the crisis, but there are other constituencies that lacked a similar structure?

Sir Patrick Vallance: We thought hard about that. We thought about to what extent, for example, economics should be integrated in SAGE. It was quite a difficult thing to do. Treasury, of course, has its very strong economic advice, so that comes together through another route. It gets integrated in Cabinet Office procedures in order to get the two things joined up.



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I am not in doubt that there has been an extremely strong economic voice that has been heard throughout, and a business voice as well. As both the Chancellor and the Prime Minister have said, you do not get economic success unless you also get control of the epidemic. There was a first order thing, which was to get control of the epidemic.

Q1062 **Chair:** Professor Mark Woolhouse gave evidence to the Committee. He has advised on the modelling side, the epidemiological side, of SAGE. He told the Committee: "I do think scientific advice is driven far too much by epidemiology—and I'm an epidemiologist." He said: "I was particularly concerned that we were looking at only one side of the equation when assessing the costs and benefits of lockdown...The other side is the harms done by lockdown. By those, I mean the harms in terms of reduced access to healthcare provision...harms to our mental health and...our economy."

Would it now be better to have within the structure of scientific advice what Professor Woolhouse refers to as "that side of the equation"?

Sir Patrick Vallance: I think it was there. It was not only there in some of the representation at SAGE. We have a Treasury economist on SAGE. We also have several people who have a background in that area, but it is not the purpose of SAGE to look at that.

I point to the very clear comments that the chief medical officer has made about it. He was very clear very early on, actually, that there were downsides from an economic perspective that would have significant health effects. He talked about the ways in which damage could occur as being direct from the virus, indirect from the virus, because you have overwhelming of the healthcare system that leads to problems, and indirect because of economic consequences of lockdown. There are ways in which that was discussed very early on as a risk. We have been worried a lot about the consequences and I think those worries are right.

Could the economic input be different? Could it be stronger? Could the science input merge with economic input in a more effective way? The answer has to be yes; there must be some way in which you could look at that and make it better. I am not arguing that things are perfect, but I think it is incorrect to say that they were not there at quite a prominent position even quite early on.

Q1063 **Chair:** Has SAGE made an assessment of the impact of the indirect impact of the lockdown in terms of lives and health?

Sir Patrick Vallance: The CMO has been pretty clear about that. The way that it should be looked at is overall excess deaths. If you look at overall excess deaths, you are looking at the integrated effect of the virus itself with all the other reasons that people may have suffered as a result. There is a lot of work going on trying to get a good handle on that. It is not an easy thing to look at when you compare across countries because people measure these things differently, but I think it is crucially important. We need to understand the impact of that. It is very clear that



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lockdown itself carries risks, and those risks are both to physical health and mental health.

Q1064 **Chair:** And presumably they express themselves, in terms of excess deaths, sometimes over the very long term.

Sir Patrick Vallance: They may be very long term. We have had groups looking at that led from both ONS and other parts of the SAGE group to say, "How do we get a handle on the excess deaths and what their origins are?"

Q1065 **Dawn Butler:** Sir Patrick, thank you for all the work that you are doing. The World Health Organisation is rethinking how Covid-19 spreads in the air, and 239 scientists from 32 countries talk about floating virus particles that infect people who breathe them in. Do you agree with that science?

Sir Patrick Vallance: We do, because we said that in April. One of the signatories to that letter is the chair of our environmental modelling group, Cath Noakes. If you look at the papers, we have argued from the beginning that there are three potential routes of transmission: aerosol, which is the one that the WHO is talking about now; droplets; and surface contact. It is clear that all three are things that need to be taken into account.

What we do not know—interestingly we do not know this for flu yet either—is what the relative importance of the three different routes is. That is the really crucial thing. If it turns out that 90% is aerosol, which I think is unlikely, that would change things in how you approach it. It is the relative contribution rather than whether any one of them is important. We think that all three are important. The advice that we have given, with bounds of uncertainty, has been based on an assumption that all three routes can occur.

The one that we do not think is such a big area, and the WHO does not either, is very widespread airborne transmission of the type you can get with measles and so on. We think that is less likely to be an important factor.

Q1066 **Dawn Butler:** I understand that it can stay in the air for up to an hour. If there was a queue of 300 people in a line, would you want to be at the front of the line or at the back of the line?

Sir Patrick Vallance: There are all sorts of questions there about whether you want to be in a line anyway. If it is outdoors, the risk of transmission is low. We see that from some of the demonstrations and so on that have taken place over the last couple of months. So far, we have not seen an uptick in cases as a result of that. The risk of transmission outside, particularly if you keep your distance, is pretty low. Inside, if you were in a big queue and that queue was not distanced, it should not be taking place.

Q1067 **Dawn Butler:** Can you rate three actions for me? I am specifically



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referring to Parliament and how it is currently voting. If you could advise the Government, would you advise them that Members of Parliament should vote online, wear masks or stay in a line of 300 people while voting? How would you rate that advice to Government?

Sir Patrick Vallance: Science advice here is not policy advice. Therefore, my advice is, as is laid out in our papers, that when you are indoors, if you cannot distance and you run a risk of being crowded, you have to have other mitigating measures. Those mitigating measures can include ventilation, wearing a face covering—hence I was wearing a face covering when I came in because I did not know what the situation was when I walked into this room—hand hygiene and making sure that you are apart from people; ideally, 2 metres apart still remains the optimum if you can do that. Those are the sorts of measures that can be put in place in situations where you cannot avoid an activity. The policy on how you do that is not my decision.

Dawn Butler: I understand that. The scientific advice is clear.

Q1068 **Mark Logan:** Sir Patrick, my thanks to you for everything you and the science community have been doing throughout the pandemic. I have a few questions around face coverings or face masks.

Out of interest, what sort of special features did the face covering have that you were wearing at the beginning of this session?

Sir Patrick Vallance: It is a fairly standard cloth face covering. It has a nose thing to make sure it does not slip off my nose, and it has several layers.

Q1069 **Mark Logan:** How long would you suggest wearing that for? Do you wash it, or is it just single usage?

Sir Patrick Vallance: I think you should wear them for short periods. I do not think it is something you can wear all day in indoor environments. There is some evidence for that. Yes, like my other clothes, I wash it.

Q1070 **Mark Logan:** Is there a placebo effect or psychological boost from wearing a mask that might positively impact immunity?

Sir Patrick Vallance: It is a reminder. When people are wearing a mask, it reminds you that there are things you need to do. I think there are positive benefits to the messaging that might come with that sometimes.

Q1071 **Mark Logan:** YouGov and Imperial College London did polling recently that showed that the uptake of wearing masks in the UK was much lower than in a lot of countries they polled. I did my own polling on Facebook overnight. In Bolton, out of 470 people 71% support wearing a face mask in shops, for example. What do you think explains the divergence between the actual practice of wearing masks in the UK and people's intentions?

Sir Patrick Vallance: I am not sure that I have a clear answer to that. There is something about messaging, to make sure that people are aware



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of what the importance is and in which circumstances. It is important that people understand about the duration of wearing them. As I said, it is very difficult to wear them all day and, therefore, you need to think about how to manage that. Some of the polling on what is happening in some other countries does not quite seem to align with what you see. Some of the figures suggested that 70% of the US was wearing them. I am not sure that that quite fits with some of the pictures you see.

I do not know whether we are different in that, but you hit on an important point. Many of the responses to measures are quite culturally determined. Therefore, we need to make sure, not just as the UK as a whole but in different communities in the UK, that both the messaging and the awareness of the cultural issues are taken into account in that messaging and the engagement.

Q1072 Mark Logan: Roughly how many masks do you think we will use as a country on a weekly or monthly basis, given this new advice? How many do we need?

Sir Patrick Vallance: I don't know. I am sorry; I do not have a figure for that.

Q1073 Mark Logan: Low millions? Tens of millions?

Sir Patrick Vallance: It is likely to be many millions.

Q1074 Mark Logan: This morning, I visited Eden Boys' School, Canon Slade School and The Valley Community School in Bolton. The head teachers had some questions specifically around whether schools can permit staff and pupils to wear face coverings if they wish to do so in some circumstances; and can they ask for face coverings to be worn?

Sir Patrick Vallance: I didn't catch the last part of the question.

Q1075 Chair: Can they ask for them to be worn for prolonged periods? I think that was right. Is it, Mark?

Mark Logan: Yes, Chair.

Sir Patrick Vallance: It is not really a science question. It seems to me that it is a straight policy question, and one for the schools. There is nothing scientifically that says, "Don't wear a face mask." There is lots of science that says that there are certain situations in which it is beneficial.

There is a problem, and it is an important one. Clearly, it is not practical to ask small children to wear face masks, and it is not sensible to do so. The evidence on the role of children, both as to their susceptibility and potentially their lower role in transmission, suggests that that would not be a sensible route to go down.

Q1076 Mark Logan: The UK advice is that, at the age of 11 and below, there is no guidance to wear face masks, but I think that in Spain the age limit is around six years old. Is there any reason for that? Is there a risk in younger children having a face covering?



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Sir Patrick Vallance: They just do not tolerate it, but it is quite an important discussion, in the sense of what we are straying into. It is worth me drawing a distinction. SAGE is not giving advice on detailed operational things. That will come straight out of DHSC and the chief medical officer's office, and in many cases for businesses it will come out of BEIS and so on. Those are operational matters. We have not looked specifically at an age cut-off at which masks become not usable in children. We have said that for small children it does not work for all the reasons you know, but we have not given a precise age cut-off.

Q1077 **Chair:** I think you said that prolonged use indoors was not recommended.

Sir Patrick Vallance: Prolonged use indoors for routine workers is very difficult and comes with all sorts of problems.

Q1078 **Chair:** I am interested in what you said about not getting into detailed advice and that it is not for SAGE. SAGE has a broad set of advice on decisions, so when the Prime Minister asks for scientific advice on whether a cricket ball is a vector of the disease, it does not go to SAGE; it goes to somewhere else.

Sir Patrick Vallance: I will give you two examples. If you take the advice given on Covid-safe environments, we have produced a number of papers, which are in the public domain, giving a series of principles around that and how it could be applied. What we did not do was say, "In this particular office configuration, it needs to look like this." Obviously, that is a much more detailed operational matter inside a department or a business. That is where the science advice in Departments needs to step in. In terms of a cricket ball, that did not come to SAGE.

Q1079 **Graham Stringer:** As a scientist, I was always taught to forget hypotheses, theories and ideas and look at the data, because having preconceived ideas can distort the way you look at things. When we went into this, scientists in this country were looking at data from China that showed a doubling of the infection every six or seven days. When you looked at our data closely, the infection death rates were doubling every 30 to 36 hours. Why didn't you and SAGE advise the Government to change their attitude because, if you had looked at that and given that advice, the lockdown might have happened earlier?

Sir Patrick Vallance: There are two things on that. The first quite important one is that, as we look back and decide what should or should not have happened, we focus on lockdown, whereas there was a series of steps in the run-up to lockdown, which started with the isolation of people who had come from China, but the main ones were: case isolation; household isolation; and recommendations not to go to pubs, theatres and so on. If you look at the behaviour change, it was quite extreme over that period, so a number of things happened.

Your point about timing is absolutely right. When the SAGE sub-group on modelling, SPI-M, saw that the doubling time had gone down to three



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days, which was in the middle of March, that was when the advice SAGE issued was that the remainder of the measures should be introduced as soon as possible. I think that advice was given on 16 or 18 March, and that was when those data became available. Looking back, you can see that the data may have preceded that, but the data were not available before that. Knowledge of the three-day doubling rate became evident during the week before.

Q1080 Graham Stringer: Did it immediately affect the recommendations on what to do?

Sir Patrick Vallance: It absolutely affected the recommendations on what to do, which was that the remaining measures should be implemented as soon as possible. I think that was the advice given.

Q1081 Graham Stringer: You also said at one stage, in early March, that we did not need to take such drastic action immediately—I am paraphrasing; that might not have been your exact phrase—because we were four weeks behind Italy. At that time, our deaths were quite low and deaths in Italy were at about 1,000. About 12 days later, we reached that number of deaths, so it was clear then that we were not 28 days behind Italy. Did you respond to that change in the data and, if so, how?

Sir Patrick Vallance: I think it is exactly the same timing. I do not have the exact numbers you are talking about, but in mid-March it became obvious that it was accelerating faster and we were closer than it had seemed, and that moment was when the advice changed to say, “Implement the measures as soon as possible.”

Q1082 Graham Stringer: The advice changed because we realised we were not four weeks behind Italy and the infection rate was about twice what we thought it was to start with.

Sir Patrick Vallance: The advice changed because the doubling rate of the epidemic was seen to be down to three days instead of six or seven days. We did not explicitly say how many weeks we were behind Italy as a reason to change; it was the doubling time, and the realisation that, on the basis of the data, we were further ahead in the epidemic than had been thought by the modelling groups up until that time.

Q1083 Graham Stringer: Those figures indicated what was always being stated by people like us—who couldn’t define what exponential meant—which was that the disease was increasing exponentially. Michael Levitt, a Nobel prize winner, has recently done some work in which he concluded that, while the virus starts spreading exponentially, it levels off and follows the Gompertz curve, which is a well-known biological curve. Are you aware of that work, and has it informed any of the recommendations?

Sir Patrick Vallance: At the time, it did not inform those recommendations because it was exponential at the time; it was doubling every three days.



Q1084 **Graham Stringer:** At the start, but he believes—

Sir Patrick Vallance: That at some point it slows down. At some point it would slow down. That's right. But we did not get anywhere close to that, so no is the answer.

Q1085 **Graham Stringer:** No, you were not aware of the work, or no, you did not take it into account?

Sir Patrick Vallance: We did not consider that we were anywhere close to its moving from an exponential to a non-exponential curve at that moment. The modellers look at all of these things the whole time and give information on them, but in order to do that you need to be much higher up the epidemic curve before you start to level off, and we were nowhere near that.

Q1086 **Graham Stringer:** I have a question related to your first answers to Greg. You said there was some information not available in the NHS—you didn't give any examples—that would have been useful had the information flows been there. Can you give us some examples?

Sir Patrick Vallance: Probably the best thing to do is to get you something from the SPI-M modelling group on the data flows that would have been helpful earlier on but took a while to get together, and then we have a record of those things. That is absolutely not to say that people were not trying very hard to do it, but these things are difficult to get right. There were definitely some data flows that they would have liked to see earlier that they could not get.

Q1087 **Graham Stringer:** Can you give us an example?

Sir Patrick Vallance: I would rather give it in writing. They are the detailed inputs to models—things like the exact time-bound admission rates, death rates, hospitalisation rates, ICU rates and so on. It becomes really important to get those things accurately from all sources. Information from care homes and so on become important information flows to be able to get the models right. Rather than me giving you a list now, we will get SPI-M to say, "These are the things we would have liked to have had but could not have at the right time. This is when we would have liked to see them."

Q1088 **Chair:** We would be grateful to have that in the next few days.

Sir Patrick Vallance: We will do that.

Q1089 **Carol Monaghan:** In the last 24 hours, we have heard that the Radox tests have been removed due to queries regarding safety standards. Are you able to tell us anything about that?

Sir Patrick Vallance: No, I am sorry. It is not part of what I look after. That is part of testing in DHSC.

Q1090 **Carol Monaghan:** Have you any idea at all—if not, that is okay—how big an impact the removal of the tests will have on the whole test and trace



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system?

Sir Patrick Vallance: I am sorry, I do not have that information. Again, that is one for DHSC and the testing and tracing people.

Q1091 **Carol Monaghan:** A lot of my questions are about testing and tracing. Any information you can give us is useful. We hear from people working in the tracing centres that many of them are struggling to get contacts to answer phones, possibly because the call is coming up as a withheld number. Are you aware of that, and are there any moves to allow callers to see the number calling them?

Sir Patrick Vallance: Those are operational matters for test and trace; they are not things that would come to me as chief scientist and are not part of the SAGE area.

Q1092 **Chair:** To be clear, that is the responsibility of Public Health England and the Department of Health and Social Care.

Sir Patrick Vallance: Yes.

Chair: The permanent secretary and the Secretary of State will be appearing before us on Tuesday, so we will be able to pursue that.

Q1093 **Carol Monaghan:** Sir Patrick, SAGE advice states that at least 80% of contacts of a confirmed case need to self-isolate for the system to be effective. Currently, 77% of positive cases are identified and only 76 of their close contacts have been asked to self-isolate. I reckon that means we are hitting only about 50% of the contacts. Can the system currently be described as effective?

Sir Patrick Vallance: We put forward what we thought was a target that should be aimed for because we think that is a way in which you get control of this. I agree with what Dido Harding has said, which is that the absolutely key thing is to get anyone who has anything they are worried about in terms of symptoms to be tested, because increasing the number of people identified who are positive with symptoms will allow the rest of the system of contact tracing to work as well.

I would concentrate on getting up the number of people tested with symptoms, however mild those symptoms. You can see why it has been difficult, because at the beginning the message was, "Don't get tested; just isolate yourself," because there wasn't testing capacity. Now the message is, "Even if you've got something mild, go and get tested." That is the important thing we need to get across.

Q1094 **Carol Monaghan:** One of the difficulties is that a large proportion of people who are testing positive for Covid appear to show no symptoms at all. Is there any way that a test and trace system can more proactively seek out positive cases, rather than relying on those that are symptomatic to come forward?



Sir Patrick Vallance: Yes. We have given advice on testing high-risk environments and high-contact occupations as ways to do it. We know that some occupations are much more likely to come into contact with lots of people. There is also evidence from the ONS survey that those occupations end up with a higher risk. There are occupations and environments. The obvious ones are meat packing and so on where we know there is an increased chance. Those are places to go and look for cases, and where you have an outbreak or see an increase in numbers, in a city, region or locality, that is also a time to go and test more in terms of asymptomatics.

Q1095 **Carol Monaghan:** Will a more proactive approach be taken when schools return? Scottish schools are currently on summer holidays; they will be returning in mid-August. English schools will be returning, hopefully, to a more normal situation in September. Are there any plans in place to test staff working in the schools, and frontline staff, for example, in care homes or in shops?

Sir Patrick Vallance: Again, you are talking about testing policy. I think the current situation is that testing is taking place in care homes of both staff and patients once a week, so that is happening. What we have recommended, and is under way in schools, is a surveillance study to try to understand the incidence and prevalence in schools. That is going on already to try to get measurements on that. Then there would need to be a policy that makes sense on the basis of that survey in terms of testing.

I reiterate the point that the evidence about children in this disease is that, first, they get a much, much milder disease. The evidence of severe disease, except in a very small minority, is extremely rare in children. Secondly, there is some evidence that they may get infected less. Here the evidence is less strong, but the report from the president of the Royal College of Paediatricians, Roz Eggo from the London School of Hygiene and Tropical Medicine and others suggests that, overall, children are at reduced risk of catching it. There is some controversy around that because the antibody tests do not always support that conclusion, but there is some evidence of reduced infection.

There is also some evidence that children have reduced transmission. When you look at countries that have reopened schools, schools are very seldom the cause of the outbreak. They are quite often the consequence; in other words, you get an outbreak in an area and a school gets infected, but schools do not seem to be a major cause of the outbreak wherever they have been looked at.

Q1096 **Zarah Sultana:** How would you define a second wave of Covid-19?

Sir Patrick Vallance: When people talk about a second wave now, I think they are really talking about a re-emergence of the first wave. All we have done is suppress the first wave and, when you take the brakes off, you expect it to come back.



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That is not the same as the classic way people think of a second wave, which is when the whole thing has gone away, down to low levels, and it comes back again next year. That is the seasonal thing that has been seen with pandemic flu, for example, in 1918. We do not yet know whether this is a seasonal virus, but there are some pretty strong hints that it may well be, so a second wave is more like the thing going round the world and coming back again. I think what we are dealing with now is a suppressed first wave.

Q1097 Zarah Sultana: What is the likelihood that the UK will experience a second wave, and what would you recommend as the single most important thing to avoid that situation?

Sir Patrick Vallance: There is a very high likelihood that come winter we will see an increase in cases. That was described very effectively in the Academy of Medical Sciences report that we commissioned. I think that is likely. You could argue that it is the tail end of the first wave still there and coming back. It is quite probable that we will see the virus coming back in different waves over a number of years.

Q1098 Zarah Sultana: UCL and the London School of Hygiene and Tropical Medicine researchers argue that fully reopening schools in September and parents returning to work, without an effective test and trace programme, could trigger a second wave. Do you personally agree with those findings, and do you think schools are adequately prepared with contingency planning for a second wave, or even localised lockdowns?

Sir Patrick Vallance: It depends on the definition of second wave. I do not think schools will trigger a second wave, but any measures that you release could allow recurrence of the first wave, as it were. Everyone, including the representative from the London School of Hygiene and Tropical Medicine on SAGE and the modellers from there, believes that schools are relatively lower risk than other things in terms of opening.

One of the important areas we need to look at is to make sure that there is enough room for schools to open, because we absolutely know there are risks in keeping schools shut. SAGE, the modellers and the consideration from the sub-group working on schools are very clear that reopening schools is a priority and is important for children. The president of the Royal College of Paediatricians, Russell Viner, has been clear that there are unwanted mental and physical health problems in keeping schools shut. For the reasons I have said, children are at lower risk, and teachers are more likely to be at risk sitting in small coffee rooms and so on with other adults than they are from the children themselves.

Q1099 Zarah Sultana: In the Committee session we held on 24 April, Professor Whitty said that contact tracing done the old-fashioned way, not using an app that takes a lot of the heavy lifting, was unbelievably labour-intensive. Do you agree? How can a test and trace system effectively be worked without an app?



Sir Patrick Vallance: Contact tracing is very labour-intensive, and this goes back to exactly the point I made earlier. The tracing system in place in February was not one that we did not like; we wanted more of it, but it was very difficult to scale that on the basis of what Public Health England was able to do at the time.

The app can help. You can imagine that a well-designed app that works could help, but it is worth reflecting that the modelling that has been done suggests that, if 30% of people were using it, you would have roughly a 9% increased detection rate. You have to get very high levels of usage to get significant effects, which is obvious, because what you are trying to do is pick up the contacts you would not pick up from memory but you would pick up because your phone, or whatever, had told you that you were close to somebody. There is absolutely a role for it, provided it can be done properly. It has not been easy anyway. The idea that lots of people have got great apps working is not correct. They have some aspects of great apps working.

Q1100 **Zarah Sultana:** The NHS has spent £11.8 million developing and testing the NHSX app. It has faced technical problems, severe delays and was eventually abandoned. We have also seen £32 million handed to a pest control company to source surgical gowns, and in April £16 million was spent to get antibody tests from China that were shelved because they did not work accurately. I appreciate that this is not a scientific question, but do you share my concerns on how public funds have been used during this pandemic?

Sir Patrick Vallance: That sounds to me like a question for the Secretary of State from DHSC.

Q1101 **Chair:** Fortunately, he is coming on Tuesday, so I am sure that Zarah will ask about that.

Sir Patrick, do you think people should no longer work from home if they are not vulnerable or living with vulnerable people?

Sir Patrick Vallance: My view on this, which I think is shared by SAGE, is that we are still at a time when distancing measures are important. Of the various distancing measures, working from home remains a perfectly good option for many companies because it is easy to do. A number of companies do not think it is detrimental to productivity, and in that situation I see absolutely no reason to change it.

Q1102 **Chair:** We have discussed the importance of the indirect effects on the economy. The Governor of the Bank of England is reported to be concerned about people working from home. Companies may be able to manage, but, if their workers are at home, they are not in shops and cafes and using public transport. Has that been part of your assessment in making the statement you made?

Sir Patrick Vallance: We have not been asked specifically to look at that question, but clearly it is part of the assessment. That is where the

integration of economics, business and science comes together, and I have certainly been involved in those discussions.

Q1103 **Chair:** That assessment is urgently needed, isn't it?

Sir Patrick Vallance: That is exactly what is going on in the Cabinet Office with Treasury, and those things are fed into the decision-making process.

Q1104 **Chair:** It is outside SAGE.

Sir Patrick Vallance: SAGE cannot advise on that. In a way, the principle is quite easy. The likelihood of the spread of the virus is dependent on contacts, so the more contacts you have at close range, the more likely it is to spread, and that principle underpins a lot of the advice. For all the reasons we have talked about, including the economic impact and the impact of that on health, that needs to be integrated in the final policy decisions.

Q1105 **Chair:** But the assessment of the economic impact is relevant to lives and health.

Sir Patrick Vallance: Correct.

Q1106 **Chair:** Is it right that that should not be part of SAGE, and SAGE should look at just the transmission and not the health consequences of some of the measures?

Sir Patrick Vallance: The CMO has been absolutely clear about this from very early on. We consider the health impact of lockdown measures, but not in a modelling sense. We are not modelling that—we can't—because we do not have the economic modelling, but that is done and then integrated at Cabinet Office level in terms of the people round the table, who always include the CMO, me, or both of us or other scientific representatives to make sure that the epidemiology, the other side of it, is properly understood in relation to the business and economic decisions that need to be made. It would be wrong to think that SAGE should do that. I think it will become a very big distraction from what SAGE needs to concentrate on.

Q1107 **Chair:** As long as someone is doing it.

Sir Patrick Vallance: Yes; it is being done.

Chair: Catherine McKinnell.

Catherine McKinnell: Sorry, I have just come back having totally lost all connection. I am sorry if I have just missed a bit.

Chair: Do you want me to come back to you, Catherine?

Q1108 **Catherine McKinnell:** If I repeat something somebody has said, I apologise. I am grateful to be here. A huge number of petitioners are interested in and concerned about the issue, so it is good to be here in that capacity to represent some of their concerns.



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I want to follow up some of the questions that Zarah asked about the track and trace system. I am sorry that I missed the answer you have just given about the app taking away some of the heavy lifting out of the old-fashioned way, as Professor Whitty described it. I want to explore how, in the absence of an app, we maximise our ability to track and trace, because clearly that is one of the most important things we can do to get ahead of the virus now.

It would be helpful to understand from you, Sir Patrick, what level of data we need to have available to local public health. I know it is a responsibility of Public Health England, but perhaps you could explain how we ensure that the track and trace system is as effective as possible in the absence of an app that would be doing some of that work for us.

Sir Patrick Vallance: There are two different questions in that. I will repeat what I said about the app.

The app is potentially an important part, but it is worth remembering that, if 30% of us were using it, you would increase the number by about 9%. We should not think of the app as the answer to the problem. I am afraid some rather boring and old-fashioned boots on the ground-type thing needs to happen in contact tracing, which is what is happening now. The app would be a useful supplement to that, were it able to be fully functional. It is not easy to get these things fully functional anywhere in the world. That is the first point. I have slightly forgotten the other part of the question. It was the data flow—sorry.

Q1109 **Catherine McKinnell:** On maximising the boots on the ground, so to speak, it was very effective when local public health teams were able to do what they do very effectively in tracking down public health issues. They were doing that in relation to coronavirus. It then became much larger and it needed to be scaled up, which was why it became a national effort. There are now 18,000 track and tracers. The problem seems to be—this seems to be coming from a number of directors of public health—that the two do not seem to be working together necessarily, so we are not getting the adding together of the national ability to track and trace and the local intelligence that is vital for understanding how best to tackle it in local areas. Perhaps you would comment on that.

Sir Patrick Vallance: I strongly agree that this is a very important thing to get right locally and the information flows need to be right. The new Joint Biosecurity Centre was set up precisely to try to make sure that the data flows are there and that they work and get out to where they need to be, which is local areas. You are quite right that local public health teams and directors are absolutely critical in that.

We have moved from a stage of thinking of blunt lockdown across the whole population to being able to release some of those measures and rely on much more local action. Local action can be as local as one building needing to be looked at. That requires really good information flows, and Public Health England on the ground and JBC to be linked to



that. I know that is what people are working on, and those are very key operational matters to get right.

Q1110 Catherine McKinnell: We are not there yet, and one of the challenges is that the data being provided is at postcode level. That is as granular as it gets. Even if you live in the same postcode, you do not necessarily attend the same church, you will not have been in the same swimming pool and you will not go to the same pub, so the ability to get ahead of the virus seems to be hampered by the data at the moment.

Sir Patrick Vallance: I agree on the granularity of the data. Where you live is not necessarily where you work, and those sorts of bits of information are really important.

Catherine McKinnell: And speed as well.

Q1111 Graham Stringer: I have some questions on testing, Sir Patrick. Before that, I want to ask a couple of questions on your previous answers. Right at the beginning, you talked about the problems in care homes and that that was discussed at SAGE. We were told right at the start of the epidemic that, if the bug got into care homes, we were likely to have 30% to 40% deaths in care homes, based on evidence from Washington state in America. Did you do a risk analysis? Most of the reasons given for not providing better protection have been about testing in asymptomatic people, but was there not a risk analysis done at the start of the process?

Sir Patrick Vallance: That is really a matter for DHSC and is not a scientific question.

Q1112 Graham Stringer: Why?

Sir Patrick Vallance: We flagged up care homes. They have accountability for that sector. SAGE is not the organisation that manages these things. We can give science advice. The science advice we gave—

Q1113 Graham Stringer: I am not asking a management question, Sir Patrick; I am asking a question about understanding what the risk might be. That is a data question and a question about understanding what potential damage might be done.

Sir Patrick Vallance: I misunderstood. I thought you meant a risk assessment of care homes, literally going in to do a risk assessment, which is—

Q1114 Graham Stringer: No, not individually. Professor Ferguson told us right at the start of the process that care homes were not part of his models; they did not go down to that level of granularity. What I am asking you, given that it was known among advisers that this would be catastrophic—we have had 25,000 deaths—is why a general risk analysis was not done so that policy options could be put forward to say what would be the best way of ameliorating the risk.



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Sir Patrick Vallance: On the first point about models, the reason they are not in the models is that they did not have the data. The data from care homes were not available to put into models. It comes back to my general point about data. You cannot model something if you do not have the data.

As to whether risk was identified, risk was identified and there are papers showing the sorts of risks. It comes back to basic principles, such as people working between care homes is a risk; imported cases are a risk; spread within care homes is a risk. Those principles of risks were described. Therefore, those are things that need to be taken into account. You can see that that was clearly the case right the way across Europe.

Q1115 **Graham Stringer:** But there were no policy decisions and no action was taken, was there? What were the recommendations? We know there was a risk. We were told that, if the virus got into care homes, there were likely to be very many deaths, but there seemed to be no process between knowing that basic fact and people on SAGE and scientific advisers saying, "If that happens, what policy options are we going to recommend to Government?"

Sir Patrick Vallance: We do not recommend policy options.

Q1116 **Graham Stringer:** I do not want to fence about words but what advice we can give to Government.

Sir Patrick Vallance: I have just listed some of the advice we gave, and how that is utilised is not the responsibility of SAGE. We give the advice; the advice is laid out clearly; the advice is in the public domain and people can see the advice we have given in these matters. Then it is a matter of operationalising it. Clearly, that is not an accountability of SAGE.

Q1117 **Graham Stringer:** I will move on. I am not sure I completely understand that. Perhaps I could ask the question that Greg asked in a blunter way. Everybody has been clear that the decisions that were taken would damage people's health because of the withdrawal of health services and the economic dimension. Did you as the Government's chief scientific adviser recommend that there should be a paper that tried to quantify that across different areas, because, basically, when the decisions were being taken, you were deciding that people who had onset cancer and people who needed transplants were going to die? It is as simple and blunt as that. Did you say that we should try to model that and work out the numbers?

Sir Patrick Vallance: We definitely flagged that the economic risks to health were significant. The CMO flagged that on numerous occasions and it was well understood by Treasury. We pulled together groups of economists and epidemiological economists to talk about measures for preventing spread that take into account both economics and epidemiology. We had a number of meetings. I do not think we ever said that somebody needed to crunch those numbers on the economic side.



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We did, however, ask for a piece of work on excess deaths, taking into account the economic impact. That was commissioned as a piece of work for SAGE.

Q1118 **Graham Stringer:** Has it been done?

Sir Patrick Vallance: Yes, it was done.

Q1119 **Graham Stringer:** In order for the Government to make sensible decisions—excess deaths at the moment are predicted to be about 65,000—they need to know what the other side of that equation is. I would have thought it was the role of scientific advisers to say at the start, “This is likely to lead to so many deaths because of direct infection,” and, “This will lead to so many deaths because large chunks of the health service are shut down, and poverty kills if people lose their jobs.”

Sir Patrick Vallance: Yes.

Q1120 **Graham Stringer:** Was that quantified?

Sir Patrick Vallance: Yes, a piece of work was done on that by the national—

Q1121 **Graham Stringer:** What were the numbers?

Sir Patrick Vallance: I can’t remember the numbers off the top of my head. The national statistician did a piece of work on that for SAGE. I think it must be in the public domain already.

Graham Stringer: We will find it. I have a couple of questions on testing, but we can come back to it.

Q1122 **Aaron Bell:** Referring to monitoring and surveillance, what is the current time lag in R values for the country as a whole and for individual regions? To put that into an example, are we already able to detect the effects of the relaxations we made on 4 July?

Sir Patrick Vallance: The time lag for the R values that are published is roughly two to three weeks. They rely on a number of inputs, including hospital admissions, ICU deaths and so on, on which there is an obvious time lag. The R is a lag indicator.

There are ways in which you can do R that are more concurrent. For example, there is one particular approach run from the London School of Hygiene and Tropical Medicine called CMMID that looks at contacts. It is not looking at outcomes; it is a contact survey that gives a more proximal measure of R. The ONS, survey which is measuring infections, again gives a more proximal measure of R. It depends on which value you take.

As numbers come down and are much, much lower, R becomes progressively less useful as a measure, for the simple reason that it jumps around a lot, with a few cases here or there or an outbreak, and it becomes a very blunt and lagging tool with which to judge effects.



Q1123 **Aaron Bell:** In communicating with the public, is overall prevalence at a given time a better measure for people to understand what is going on with the current decline and potentially the future spread of a second wave?

Sir Patrick Vallance: We think that prevalence, incidence and outbreak measures—those sorts of things—are more relevant going into a lower overall prevalence state than R or growth rates.

Q1124 **Aaron Bell:** Given the time lags you spoke about and the alternative measures, what is our best early warning signal of a second wave? Would it be through the data you have just spoken about, or are we going to have a time lag before we realise we might be in a second wave?

Sir Patrick Vallance: It is looking for things like increased numbers of positive tests as a proportion of total testing, which is the sort of thing that was done in Leicester. That was exactly why the Joint Biosecurity Centre was put in place, to monitor those sorts of numbers through test and trace. SAGE recommended that a number of different data streams should be used to look at this going forward including that, but you can imagine other things as well, such as monitoring absenteeism rates and so on. That gives you early signals as to where something is happening, but at the moment it is based on testing.

Q1125 **Aaron Bell:** Are some or all of those datasets and data streams publicly available, or is it mostly private?

Sir Patrick Vallance: I think the intention is that they should be public, but that is for JBC and test and trace to comment on.

Q1126 **Chair:** On the R number, if we get to a position where one person is infected with Covid in the country and that person infected five people—perhaps they are on the Isles of Scilly—the national R number will be 5.

Sir Patrick Vallance: Correct.

Q1127 **Chair:** Therefore, it seems to me a poor guide to policy. What you want to know is prevalence—the number of people, where they are and how containable it is. Why has R had this iconic, almost mythical, status?

Sir Patrick Vallance: It did early on in the epidemic because it was the right thing to measure then. As you may have noticed from the language I have used at the podium several times, it is not the right thing to be using now. It has been true in every country. I had an exasperated call from a colleague in Germany who was being asked to give R values every day, and how they jumped around and did not make any sense. The latest bit we have on our website is, "Low case numbers and/or a high degree of variability in transmission across the regions mean that the estimates are insufficiently robust to inform policy decisions," so we agree.

Q1128 **Katherine Fletcher:** You have been at this since half-past two, Sir Patrick, and I am aware that it has not been the quietest four months of



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your life, so I very much appreciate your time.

I was hoping to pick up where we are currently on treatments and vaccines, to understand what SAGE's view is on the likelihood of those and what we can look forward to as additional measures, apart from just transmission spread. If I start with therapeutics, is SAGE working on anything in the therapeutics space, or is it just receiving data and feeding that in?

Sir Patrick Vallance: Can I give you my views and the views of other scientists who are feeding into this? There are specific taskforces working on it and they are not topics that are coming to SAGE? SAGE is not looking specifically at therapeutics or vaccines.

Q1129 **Katherine Fletcher:** That would be helpful.

Sir Patrick Vallance: On therapeutics, as of today we have one antiviral, remdesivir, which has some effect. It seems to shorten hospital stay but has not yet shown a decrease in mortality. You might expect that, if it were to be used earlier, it is possible that its antiviral effect would show some bigger action, but that has not been done yet.

Dexamethasone, which was the outcome from the RECOVERY study, reduces mortality in patients in hospital requiring oxygen therapy; you get a reduction in mortality of about 25%. That is a very important finding that can be applied across the world.

There are more studies to read out. There are studies from, generally, existing drugs that have been repurposed. Those should read out over the next few months, which may give further examples of where you can use drugs to try to reduce mortality. Then there are new drugs coming along. For example, there are antiviral drugs that are now much more designed for this virus rather than the other ones, which were designed for another virus and have just been tried on this one. There are protease inhibitors and RNA polymerase inhibitors that are coming along and may have a bigger effect.

In the therapeutics space, there is a lot to be done. One of the things we need to do in this country for the winter—I am absolutely sure about this—is to make sure that as many patients as possible are enrolled in clinical trials, because that is the way we get the answer; it is the way we found out hydroxychloroquine did not work and that dexamethasone did, so clinical trials are very important for the winter.

Vaccines—

Q1130 **Katherine Fletcher:** I apologise for interrupting you, but it is worth highlighting what a remarkable effort the British public have made in participating in these trials to date, and how their contribution to science is helping not just the British public but the world. I am sure that you would want to put your thanks to them on record as well.



Sir Patrick Vallance: Absolutely. It is brilliant. The RECOVERY study had 12,000 or more patients enrolled—I cannot remember exactly what the numbers are now. That is absolutely impressive, and that is people volunteering to be in trials, which is a fantastic sacrifice, to say, “I want to help somebody else by being in this trial.” That compares, for example, with the WHO solidarity study, a multinational study that has currently enrolled about 6,000 people. What has been done in RECOVERY is incredibly impressive.

There are over 100 vaccine projects across the world; some are in the clinic and are leading. The one that is at the front at the moment is the vaccine from Oxford, which is in phase 3 of clinical trials in thousands of patients, which is a fantastic position to be in. The UK has got itself well sorted out—I was very involved in this at the beginning and stayed close to it—in making sure that we have a wide range of vaccine options with different mechanisms and different approaches, because we do not know which one is going to win or, indeed, whether more than one will win. All you can say is—and this is a bit gloomy, but it is true—that the most likely thing for any single vaccine programme is that it won’t work. So you need to make sure that you have enough of them in order to do it, and I think we are in a pretty good position.

Q1131 **Katherine Fletcher:** Just let me understand very quickly: are you making any assumptions about any one of those multivariant bets coming off in how the scientific advice is being structured to Government?

Sir Patrick Vallance: The UK Vaccine Taskforce, which Kate Bingham leads, is absolutely looking at the options and modalities, and where they are in the proof stage—how far advanced they are—as well as the manufacturing implications and how that feeds through into vaccination policy. It is a very integrated approach to looking at the overall options and making sure that we get the chance not only to be part of testing them but also, of course, access and application of these vaccines. That does not mean that we are going to get a vaccine and it does not mean that we are going to get one soon, but we have the bets covered in a very strong, strategic way, and we are giving ourselves the best chance of getting something.

Q1132 **Katherine Fletcher:** But our approach right now is not making an assumption that something is going to appear over the horizon.

Sir Patrick Vallance: No.

Q1133 **Katherine Fletcher:** We know that we are well placed for it, but we are planning as if we do not have it.

Sir Patrick Vallance: I think our assumption is that we will not have it, and then, when we get it, we will be thrilled.

Q1134 **Chair:** Before we go to Dawn Butler, on vaccines, you mentioned the Oxford study, which I think is being conducted by the Jenner Institute. The director of the Jenner Institute today has called for challenge trials to



take place in which healthy young volunteers will be deliberately given coronavirus after receiving the vaccine. He said: "If challenge trials can safely and effectively speed the vaccine development process, then there is a formidable presumption in favour of their use, which would require a very compelling ethical justification to overcome." Do you share that assessment?

Sir Patrick Vallance: Human challenge studies for vaccinology are well established. There is nothing new in that concept—it is a well-established way in which to test vaccines. What are the two big challenges for this virus? They are dose and rescue. The prerequisites that you need to have to do human challenge studies are to understand what dose causes a safe infection and whether you can rescue it if you get it wrong.

Q1135 **Chair:** What is the current answer to those questions?

Sir Patrick Vallance: We do not know the dose, and we do not yet know that remdesivir will rescue the infection.

Q1136 **Chair:** So not yet.

Sir Patrick Vallance: It is absolutely the right thing to explore, but we are not there yet in terms of having the answers, and we need to make sure that we progress safely in terms of understanding. You will not know the dose just because you dream it up. You need to find out the dose, but there are ways to do that, and you could test whether remdesivir could rescue. But those are the ethical considerations that people will need to think about.

Q1137 **Chair:** And work is going on to be able to answer those questions.

Sir Patrick Vallance: Yes.

Q1138 **Andrew Griffith:** When you spoke to this Committee previously, I was certainly left with the impression that therapeutics might be more proximate and likely than a vaccine. At that point, a vaccine was the moon shot, whereas therapeutics was potentially down the road. What else is going on in therapeutics?

Sir Patrick Vallance: Just to say a word on vaccines first, it is also important to recognise that the chances of having a totally sterilising vaccine—that is, one that 100% protects you from this—are low. It is much more likely that you would have a vaccine that reduces the severity of the illness and reduces spread a bit. That is the more likely outcome on vaccines.

On therapeutics, there is a lot going on now in two main areas, or maybe three. One is how you deal with the inflammatory response, which are the studies that should read out relatively soon, and there are more starting there. Then there are antivirals. I have mentioned two classes that are being pursued, and there are many others as well. Then, potentially, there are preventive medicines as well, which are being looked at. Those are the three big buckets, which are all being looked at.



I think it is right that the therapeutics are more proximate: we have dexamethasone and remdesivir, and we will see what comes next.

Q1139 **Andrew Griffith:** I understand what Kate is doing on the vaccine side, and various witnesses have given us a good sense that almost every stone is being turned and Sir John Bell is leading a lot of work about how we do that. On the therapeutics side, is there an equivalent of that initiative, or is it by its nature much more difficult?

Sir Patrick Vallance: It is different. Just to be clear, it is Kate on the vaccine taskforce who is leading the vaccine work. On the therapeutics side it is different. The reason why we set up the vaccine taskforce is because vaccines require manufacturing capability in a way that is a bit different. They have a different need for clinical trials, and in a way you are more likely to end up with something that can come through different routes, such as academia, than you are with some of the drug things. The drug things are largely in the area of big companies, innovative SMEs and so on, with therapeutics. So they will come up wherever they come up. Manufacturing is a different issue; it is really about trials. So the question there is whether you can get the trials right to be part of getting the answer.

Q1140 **Dawn Butler:** Thank you, Sir Patrick. We took some evidence on vaccines, and it was really quite interesting to hear that we are ahead of the game compared to any other country. Health literacy is absolutely vital in fighting coronavirus and the spread of it, so people understanding what their role needs to be in fighting this virus.

Can I know your views on a couple of things? First, can we ensure that we have all information translated into various languages? That includes British Sign Language. We know that there are 11 million people in the UK who are deaf and hard of hearing, and now that face masks are compulsory they will not be able to lip read. Also, we understand that the UK Government's virus taskforce has 47,000 British Bangladeshi and British Pakistani volunteers.

What are your views on making sure that all the information is provided in different languages to help the science and help to combat the virus?

Sir Patrick Vallance: We have said, and our behavioural science sub-group has been very clear, that that is absolutely essential. We have gone a little bit further in saying that many of those things need to be co-created with those communities. In other words, it is not a translation problem; it is about how you get proper co-creation. The third thing is that very often community leaders need to be engaged with this as well. It is not simply about saying that you have given somebody information and it is done; it is an engagement process. So we strongly agree with that.

The report from the Academy of Medical Sciences made a very important recommendation, which is that there needs to be a strong and



comprehensive public information and engagement campaign in early autumn in preparation for winter. So I strongly agree with your point.

Q1141 **Chair:** What about people being able to lip read when face masks are widespread?

Sir Patrick Vallance: I do not know what the answer to that is. Clearly, it is one of the many big issues. There are others as well. Respiratory physician colleagues have spoken to me to say that patients who have a chronic cough for other reasons find themselves being stared at and shunted out of shops and things, because people think that they should be at home, isolating, whereas they have a reason to have a chronic cough. So there are some quite important things to look at here in dealing with all these areas and how we make sure that we do not end up with people being selectively disadvantaged. It is striking and incredibly depressing that this virus has not only exposed inequalities but exaggerated them. That is a very important thing for us to keep in mind in everything we do.

Q1142 **Dawn Butler:** I have just one practical question. Should we not have mobile testing units at large workplaces where there are, say, 1,000 or 500 people? Would that not help with understanding the virus and how it spreads? To take Parliament, we have an issue with potentially creating super-spreaders, so having a mobile testing unit in Parliament, even if it is just on an ad hoc basis, will help you in tracking and tracing if there is an outbreak of the virus.

Sir Patrick Vallance: I am in favour of testing in occupational settings, as I said earlier. There are occupational settings that benefit from testing. We have also asked for a piece of work to be done looking at transmission in different environments, which is going to be led out of the Health and Safety Executive but with academics involved as well. One surprising unknown is that we do not really understand the roots of transmission of this virus, as I said. We have to do much more work on it, and occupational settings are a good place in which to do that.

Chair: I think Graham Stringer had a couple of questions on testing.

Q1143 **Graham Stringer:** Thank you very much, Sir Patrick. This afternoon, you have drawn the short straw, getting twice as long as you expected.

Sir Patrick Vallance: Yes.

Q1144 **Graham Stringer:** It has been very interesting. I have a couple of questions on testing, but you said something about a major public information campaign this autumn, which I think is important. Should that also include a major campaign on flu vaccination? If we get a major flu outbreak, it will make things worse. Along the same lines, do you think that there should be an intensified campaign to get the lifelong pneumonia vaccinations, which are given to the over-65s, which may help with this? I am sorry, this is a long question—it did not mean to be. Should we intensify pressure on care homes to make sure that their staff



are vaccinated for flu?

Chair: That is an operational point.

Sir Patrick Vallance: They are. We will agree to differ on the operational point, but these are important questions. On the flu vaccines, we flagged up a long time ago that this needed to be a big flu vaccine season. The HSE understood that and I think has taken steps to procure vaccines. You do not procure vaccines now for winter—you procure them several months ago. That was on our radar right at the beginning to say that flu vaccination this year was particularly important.

Q1145 **Chair:** When do you start vaccinating people?

Sir Patrick Vallance: Not now—it is later in the year.

Q1146 **Chair:** When? September, October?

Sir Patrick Vallance: You need to put the order in now to do it. For the normal flu vaccine, I cannot remember exactly when the programme starts—it is autumn time, in late autumn. So that, I think, is understood. The Joint Committee on Vaccination and Immunisation has given advice on what the vaccine group should be, on who should be vaccinated, and has looked at the whole breadth of vaccinations. So I think that is covered. You are right to raise it, as it is very important.

Q1147 **Graham Stringer:** Going on to testing for this particular virus, it has to be done in a sufficient number and has to be accurate and of sufficient quality. Do you believe that the polymerase chain reaction tests are good enough?

Sir Patrick Vallance: PCR is very accurate—there is no question about that—but that does not mean that the test is very accurate. What do I mean by that? We know that you get false negatives, and those false negatives can be quite high at certain times of the infection process. There are three main reasons for false negatives. One is that it is early in the infection and the person is not shedding enough virus to be infected; the second is that the swab itself has not been done adequately; and the third is that the PCR is a false negative, for some reason. Of those, the PCR false negative is by far the lowest. That test is pretty sensitive and pretty good. So it is really swabs and timing that are important. If you test somebody a few days—say, days two or three—after they are infected, I cannot remember exactly off the top of my head, but it is a 30% or 40% false negative at that point.

Q1148 **Graham Stringer:** That is very high.

Sir Patrick Vallance: But it is not the PCR. The other thing that is quite exciting are the new technologies coming along, such as the so-called LAMP technology, which allows a much faster and easier test, essentially measuring the same thing as the PCR. I know that studies are going on at the moment to see whether you can pick that up from saliva, which would make things much easier than the swab.



Q1149 **Graham Stringer:** Will we need extra capacity in the autumn, when children go back to school and the weather changes?

Sir Patrick Vallance: Yes.

Q1150 **Graham Stringer:** Can you put a figure on that?

Sir Patrick Vallance: I do not know exactly what the figure is, but we need to continue to ramp up testing. I cannot remember where we are at the moment; I do not know exactly what the numbers are. I think it is at least 200,000 a day, and it is going to go higher than that. We need very high levels of testing, which is why something like LAMP and saliva would be really good. If it was very easy and you could do it quickly, you could then really think about much more widespread testing.

Q1151 **Chair:** You mentioned the Academy of Medical Sciences report, which made the point that, as we get into the winter, people are going to be presenting with symptoms that may be Covid or may be other types of illness such as flu and, therefore, need to be tested. They put a figure of over 350,000 people a day being required to be tested. Have you made an assessment of whether we have the capacity to meet that?

Sir Patrick Vallance: We do not have the capacity to meet it at the moment.

Q1152 **Chair:** We do not?

Sir Patrick Vallance: At the moment, no.

Q1153 **Chair:** Have you seen a plan to develop it in a credible way?

Sir Patrick Vallance: I believe that plan is being developed.

Q1154 **Chair:** Because otherwise we are back to where we were in March.

Sir Patrick Vallance: It is essential. The other question on this is whether you can do what is called multiplex testing, doing something to test for multiple respiratory viruses at the same time, which would then allow you to say, "You've got flu. You've got flu plus Covid. You've just got Covid," and triage much more effectively. That comes back to the economic point, which is that there is a very big risk with multiple respiratory viruses circulating that you end up isolating lots of people who do not have Covid, and, because of the false negative point that we have just discussed, just because you are negative does not mean that you have not got it. That is why isolation is important. Multiplex testing, whereby you could also get a positive and say, "Yes, you've got flu," becomes quite an important part of this.

Q1155 **Chair:** Right at the beginning of our session, I said that part of the point of asking these questions is to be able to learn lessons that inform decisions on the way, and this seems to be a classic case of this. One thing that we have learned is that we did not have enough testing capacity early on, so it needed to be rationed and confined to hospitals in the first place. That seems to be a matter of consensus now. So we must



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learn that lesson and apply it, to make sure that we have more than enough testing capacity in time for the autumn and winter.

Sir Patrick Vallance: I completely agree.

Q1156 **Chair:** Do you think that is fully understood and being acted on?

Sir Patrick Vallance: It is fully understood, and it needs to be acted on. As an adviser and as SAGE, I cannot make that happen, but I think that it is important that it does happen, and I believe it is happening. I recognise that it is a crucial thing to do. I have talked to you about multiplex testing and about the LAMP approach, to try to get more widespread testing. I do not think that anyone is in any doubt that getting the testing right is important, and that is a fundamental reason why funding organisations such as the PHE and JBC is crucial. If you look at the countries that learned the lesson of MERS in 2015, they funded those systems well, and other countries around the world that saw what had happened funded those systems well. So the funding of our public health system is a very important part of preparation not only for this but for future problems.

Q1157 **Chair:** As you have made clear during this hearing, the responsibility for that is with NHS England and with the Department of Health and Social Care, and we will have the Secretary of State and permanent secretary next week and we will be sure to ask about that.

The final related question is that, early in the pandemic, the Committee took evidence about the modelling projections for the number of cases that we would have, and, obviously, one of the pivotal judgments was on whether NHS capacity would be swamped and exhausted. Has SAGE made that same assessment of where we are for the coming winter?

Sir Patrick Vallance: As you know, the Academy of Medical Sciences report, which we commissioned, has done that and has made some assumptions around that, and we are in the middle of doing further work on that at the moment. The one thing that I would say about the Academy of Medical Sciences report is that it made an assumption that R would be 1.7, just as a modelling assumption. Of course, that is literally just an assumption, so we are going to go through and make sure that we have got that ready.

Q1158 **Chair:** We read in the newspapers this morning that investment is to be put into the Nightingale hospitals. Are we to infer from that that the normal capacity of the NHS is not going to be sufficient, so we can expect a caseload that is in excess of that standing capacity?

Sir Patrick Vallance: It is reasonable to assume that, to be resilient, it is sensible to have that. We do not have any prediction at the moment as to what the numbers are, and, of course, there are other catch-up things that the NHS is dealing with as well. So, again, those are really questions for the NHS, but it seems to me entirely sensible to think about resilience in the system.



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Q1159 **Chair:** It has been very helpful to understand where SAGE can give advice and where it is not appropriate. To give a final example, does it give advice on, for example, whether it is safer to be in an aeroplane than a theatre?

Sir Patrick Vallance: We would not give that sort of comparative advice. We would give advice on the principles of environments and how one should do a risk assessment in environments. It may be then that the Health and Safety Executive or somebody would be able to take that down to the exact level of this environment versus that environment. However, we have asked whether it is possible to measure Covid security in an environment, and that is very difficult to do. We are looking at what the true assessment of that might look like, and I am not optimistic in coming up with a very concrete answer.

Chair: Sir Patrick, you have been very generous with your time and we are very grateful. I reiterate what I said at the outset. Our purpose in this inquiry is to try to draw lessons that will be of value during the pandemic and beyond. How science proceeds—and your eminent colleagues practise this all the time—is to ask some difficult questions and produce some answers that may require a change of practice. Right from the outset you have participated in that spirit, and we are very grateful for your continued engagement with the Committee and for the very important work that you do on behalf of the country with your colleagues. Thank you very much indeed.