HOUSE OF LORDS

Select Committee on Science and Technology

Corrected oral evidence: Life Sciences and the Industrial Strategy

Tuesday 5 December 2017

10.15 am

Watch the meeting

Members present: Lord Patel (The Chairman); Lord Borwick; Lord Griffiths of Fforestfach; Lord Hunt of Chesterton; Lord Kakkar; Lord Mair; Lord Maxton; Baroness Morgan of Huyton; Baroness Neville-Jones; Lord Oxburgh; Lord Renfrew of Kaimsthorn; Lord Vallance of Tummel; Baroness Young of Old Scone.

Evidence Session No. 22 Heard in Public Questions 197 - 238

Witness

Professor Sir John Bell, Regius Professor of Medicine, University of Oxford and Chair, Office for Strategic Coordination of Health Research (OSCHR).

USE OF THE TRANSCRIPT

This is a corrected transcript of evidence taken in public and webcast on www.parliamentlive.tv.

Examination of witness

Professor Sir John Bell.

Q197 **The Chairman:** Good morning, Sir John, and thank you for coming to help us today. You are our key witness in this inquiry, as you are the author of the report that led up to this. If you do not mind introducing yourself for the record, then we will get on to questions. Before we do that, if you have a statement or any introductory comments to make, please do so.

***Professor Sir John Bell*:** Thanks very much, Lord Patel. I am John Bell. My day job is Regius Professor of Medicine in Oxford, but I am also chairman of the Office for Strategic Coordination of Health Research, which is the body that co-ordinates and supports the government funders of health research in the UK. I have also been life sciences champion since about 2009, responsible for supporting the industry in the UK, and engaging with government and industry, to see whether we can make that relationship work better.

I was asked a bit more than a year ago to bring together the industry to produce the life sciences industrial strategy, which we did over about 10 months. That was released at the end of August. An embargoed press statement will go out today, with the plan that we will launch the sector deal tomorrow, which is the first step in describing a set of deals between the various parties. The parties involved in these discussions are government, industry in its broadest definition in terms of the health-related life sciences disciplines—digital diagnostics, pharma and medtech—the charities and the wider academic research community.

I was asked in about May what I would like to get out of the life sciences industrial strategy. The one thing we have sort of achieved is an increased collaboration and a much better relationship between the actors in the health-related life sciences disciplines. The NHS, the government funders of research, the academic community, the charities and industry across the whole health sector are working much better than they ever were before. They are talking to each other, doing projects together and lining up to, I hope, deliver innovations that will have a big impact on healthcare and benefits for patients, as well as for the UK economy.

The Chairman: The first question relates to life sciences being biomedical sciences. It has been pointed out to us in evidence that this strategy focuses mostly on biomedical sciences, and not on other life sciences: animal sciences, agrisciences et cetera. I wonder if you would like to make a comment about that. You have briefly said what the process was that led up to your report, but you might expand a bit on that, too.

***Professor Sir John Bell*:** There are wide areas of life sciences that this report does not include. The real issue we had to address early on was where we would set the boundaries. There is a whole piece around agritech and the wider life sciences agenda that needs an industrial

strategy. I am not the right person to lead that; it is not my field. In addition, although the potential impact on the Department of Health is real, the Department of Health was a co-sponsor of this report, so we stuck with the things that would impact it and human health. It is purely definitional. There are huge opportunities for agritech in the UK. I give it huge support and hope it will get on and deliver an equivalent strategy.

The background of the report probably helps in understanding why we drew the boundaries where we did. There are two departments involved in this: Greg Clark's department, BEIS, and the Department of Health. The USP in this report is the ability to work with the NHS. We are competitive in the life sciences across the domains, but the thing that differentiates us in global terms is a single-payer healthcare system that looks after 60 million people. The Department of Health was crucial to this report, and we have engaged it all the way along. I have to say it has been enormously supportive as we have gone through the development of the report.

We also ran into a little confusion at the beginning about what exactly I was doing. That was clarified part way through the process, to be honest. It was not really clear at the beginning. I had been asked by Greg Clark and Jeremy Hunt to bring together a group of the key industries in an advisory capacity, to help advise what they would like to see done. This is an industrial strategy: it is not my strategy; it is theirs. I assembled a group of 30 or 35 people who came together to start formulating what the report would look like. They came from all the health-related disciplines. I had suggestions from the Department of Health and BEIS, but we chose to bring those people together. That group wrote the strategy.

Importantly, that strategy is not necessarily the government strategy. It is the industry strategy. That needs to be quite clear. Having said that, I did not want it to end up on the floor minutes after it had arrived, so I spent a lot of time doing the shuttle diplomacy with DH, the Treasury and BEIS, to make sure that what we said in the report would be acceptable to them. There is no point in producing a report if the other side says, "That is not what we want".

The report landed pretty enthusiastically on both sides of the fence. But it is important for your Committee to recognise that the industrial strategy was written by me on behalf of industry, and to some extent the third sector, the charity sector, was involved in that. That is basically the history of how we got to where we got to.

Q198 **Lord Hunt of Chesterton:** The industrial strategy Green Paper said that you were offering to "lead work on a new strategy to make the UK the best place in the world to invest in life sciences". I wondered about your response to that. You can pick up different bits in that sentence: "place in the world". Is there a comparison with the development of great technology in the United States, for example through DARPA, or in Germany with Bosch? What do you feel will be special about what the UK can do in life sciences? There have been a good number of failures in certain areas of British technology, such as nuclear power. What is so

special about the UK that gives us some chance of success?

***Professor Sir John Bell*:** That was really central to the report. First, we asked, "How special are we?". The answer is that we are pretty good. We are about three times as productive as Germany for every pound put into the system.

Lord Hunt of Chesterton: Is that in the pharmaceutical industry?

***Professor Sir John Bell*:** No, it is in terms of the life sciences. You can define it in a variety of ways: by citations, by the number of small companies produced and by the number of patents. If you define it by pure scientific output, for the amount of money that goes in the top of the hopper, we are significantly more productive than the US, Germany and almost all countries. That is a tick in a world where productivity is an issue for us. We do not do so well in the production of patents, based on the money that goes in the top of the hopper; America does much better than we do. You have rightly identified that America has been much more successful in creating new mid-sized pharmaceutical companies than we have.

On the unique side, one of America's problems is that it does not have a single-payer healthcare system. It has real issues about operating in a world where digital has become really important for healthcare. If you take any health insurance system, some of which are as big as the NHS, the turnover is about 15% a year, so five years later there is almost nobody left standing. If you are interested in longitudinal data, you simply cannot get that in a North American insurance system. That is why the NHS is potentially a huge differentiator.

We concentrated on a number of things, but let me just pull two out, because your point is really valuable. What about this issue of scaling companies? It is a real issue for us. We have more biotech companies than anywhere else in Europe, but we have not turned any of them into a mid-sized company. The analysis of that, in which we have been greatly enabled by the work that the Treasury has done over the course of the last six to nine months, points to the availability of large pools of risk capital. The key differentiator with the US, and increasingly places such as Canada, is that those places use their pension funds much more effectively to support this sector. As you will have heard, there have been a number of news items about that recently.

The Treasury has been very supportive of the idea that we take a slightly more relaxed approach to allowing pensions not to invest in gilts. If any of you are wondering why your pensions are so small, it is because the pension industry invests in gilts at 2%, rather than in scaled high-tech companies, private equity, hedge funds and the other things that most endowment managers will. We have a regulatory problem, because that is dictated by the FCA. The FCA needs to back off and let these guys do what pension funds in Canada and the US do, which is invest in that sector. When the Americans changed the prudent man rule in 1974, a flood of venture capital into this sector occurred. I hope we will be moving towards that in the UK in the near future.

You raised the DARPA point. I totally understand that, and we have modelled part of the life sciences strategy around DARPA. How do you take big bets in high-risk science to see whether you can generate whole new types of industry? We had a programme that we called HARP—the Health Advanced Research Programme—in the report.

Lord Hunt of Chesterton: That question is going to be asked by another colleague.

***Professor Sir John Bell*:** Okay. That is my answer to the DARPA question. We totally get DARPA and we think it is terrific.

The Chairman: We will come to that a couple of questions down.

Q199 **Lord Renfrew of Kaimsthorn:** It would be helpful if you could say a little more about how the life sciences strategy should be implemented. You were not very detailed in the report on who does what and who has responsibility, and it may be a crucial aspect if it is not to be lost as good intentions.

***Professor Sir John Bell*:** Thank you for that. I welcome that question. A risk when you do a report like this, particularly when it is not a government report but an industry report, is that people say, "That was an interesting report" and stick it on the shelf, and that is the end of that conversation. One of the crucial things is to make sure that we maintain momentum; deliver the things in the report; create opportunities for interactions and collaborations with the industry; make this a great place for the industry to invest; fix some of the problems, such as how we scale small companies; and create a better environment for manufacturing, as we pointed out in the report. The UK has lost the plot on life sciences manufacturing.

We can do all that. The crucial bit is who is accountable and responsible for it, and that is where these things often fall down. Active discussions are going on in both the Department of Health and BEIS about how we can create a governance structure over this, with at the top end the Secretaries of State, who have to take responsibility for the government side, and the CEOs of a few major life sciences partners. They could take responsibility for a set of strands of work.

There are about eight strands of work, and we would like to have an accountability framework for each one. For example, manufacturing is very different from the innovative science at the front end. It would be nice to have an accountable person in charge of each of those seven or eight strands. That is how we are proposing to deliver that, and a bit of that will be in the sector deal, when it is announced today and tomorrow. It is a key question, because it could easily be that this drifts away and we see nothing of it. That is probably the biggest risk with the report.

Lord Renfrew of Kaimsthorn: Representation at Cabinet level is really important in keeping it up front.

***Professor Sir John Bell*:** Yes, exactly. That is why I feel, if the two Secretaries of State do not have the time to commit to this, it was probably not worth doing. If we drop the ball on this, the risk of

significant reduction in engagement with the life sciences industry, given the issues associated with Brexit, economic growth and the like, is quite large. If we charge at it and do a good job, they will come. They have shown real evidence that they are keen to invest in the UK if we can keep going.

Q200 **Baroness Young of Old Scone:** You are seeing this as being led with a strong industry flavour. There has been loose talk about OSCHR, OfS and UKRI potentially having leadership roles. Are they the wrong folk?

***Professor Sir John Bell*:** I come back to the point that this is an industrial strategy. If you want to do things for industry, you should talk to industry, not anybody else. That gets lost in the discussion. Keeping a strong grip on this, with industry represented all the way along, is the only way to do what it would like to have done. It has been very good at acknowledging the great strengths of the UK academic base, the strong universities and the great academic hospitals, so industry is not going to run off and do something in a corner. It wants to work with those. If you cannot craft the programmes it would like to do, do not be surprised if it loses interest. That is the most important message. Sir Mark Walport and Sir John Kingman get that completely, and they will be very responsive. Not everybody on the football pitch understands that, but they do.

Q201 **Lord Vallance of Tummel:** I would like to explore a little how this form of governance would fit in with the governance of the industrial strategy as a whole. We are beginning to see it through a glass darkly. We know at the top there will an economy and industrial strategy committee chaired by the Prime Minister with, I think, 14 other Cabinet Ministers. If you look in the very small print of the industrial strategy White Paper that has come out, it says, "We will ensure our industrial strategy will endure by creating an independent industrial strategy council that will assess our progress and make recommendations to the Government".

We do not know whether that will be statutory, although I would argue it probably should be. We do not know who will be on it, and we do not know what the terms of reference are. Looking at it from your point of view, there is something up there that will look at the strategy as a whole. How do you fit a sectoral strategy governance review underneath that superstructure? How does it work?

***Professor Sir John Bell*:** That is a very good question. We could not wait for all that because we were out the door, so we decided just to get on and build something that works, get this strategy implemented, get the first wave of deals out of the door and start looking for the second and third waves. It is highly appropriate that there is an oversight of the broader industrial strategy at a very senior level, reporting to wherever in government. I would have no problem with that. But I hope they would have the wisdom that the people who know best what to do about life sciences are those in the life sciences industry, not anybody else. I would trust the judgment of such a body to devolve responsibility for that to a lower-level governance structure around each of the sector strategies.

Lord Vallance of Tummel: It would be, again, some kind of independent council.

***Professor Sir John Bell*:** Yes. The independent council probably has to be the senior body you have just described. The council I am thinking of is a mixture of government, industry and other parties. The strategy I put together is very much about collaboration. They jointly have to take responsibility for holding each other to account—"You said you would do this; why have you not done it?"—and agreeing ways to work together more effectively. Ultimately, that will be the success of the strategy.

Lord Vallance of Tummel: You stressed CEOs and being industry-led, which resonates with me, but what kind of CEOs? Are we talking about the usual culprits or something that looks at smaller and more up-and-coming organisations?

***Professor Sir John Bell*:** The details of this life sciences body have not been worked out, but you will want somebody representing the medtech sector and somebody representing the pharma sector. You will also probably want somebody representing the scaling SME sectors in particular, because they are a major focus of our report. You want somebody who can put their hand up and say, "This is what we need out of the sector deal. This is what we need out of the collaboration".

Lord Vallance of Tummel: Absolutely. One of your main objectives is producing these £20 billion-sized things in 10 years. They are not going to come from the usual suspects; they are going to come from somewhere else.

***Professor Sir John Bell*:** You are absolutely right. Saying four £20 billion companies was fairly bold.

Lord Vallance of Tummel: I am sure we will come back to that later.

Q202 **Baroness Neville-Jones:** Sir John, you paint a picture, if I understand you rightly, of a partnership between government and industry to lead this thing. If I had been asked the question about the kind of governance mechanism, I would probably have put research in there; I would have had some academics. Where does the academic fit? You said that you need other parties, so how do you see this? Are other parties less important because it is an industrial strategy? How do you see the thing linking together? It seems to me that they have to feed into the system.

***Professor Sir John Bell*:** Remember that, from Greg Clark's position, he is responsible for the university sector, so there is senior ministerial responsibility on the top board at Secretary of State level. Some of these strands of activity are more appropriate for academic input than others. If you take the innovation and discovery piece, it is absolutely driven by the great success of our major universities, our academic health science centres and the like. That needs very significant academic involvement.

Baroness Neville-Jones: You see this breaking down into separate strands.

***Professor Sir John Bell*:** Yes. In truth, I am not sure how it would help to have a load of academics on a manufacturing subgroup. I would see their involvement as being at the next level down. Well, you know academics. I have to be careful; I am being streamed.

The Chairman: Some are better than others.

***Professor Sir John Bell*:** That is exactly what I would have said.

Q203 **Baroness Morgan of Huyton:** Can I pick up on the same point? Last week or the week before, we had pretty clear evidence from pharma where it described the relationship in the UK at the moment as being transactional rather than a partnership. I am interested in the extent to which you think the Government understand that it needs to change from transactional to partnership? To what extent do you have buy-in to what you are describing?

***Professor Sir John Bell*:** We have moved on a lot. As you are well aware, the industry and the NHS did nothing but fight with each other for the last five years. We have moved on from that. Last week, we had a very helpful meeting with Ministers and the industry, where there was complete unanimity that they saw the strategy as the blueprint for how they would like to move forward. Both sides of the table agreed that they needed to work together if that was to be delivered. We have moved a long way.

Like everything, it has to be substantiated by real evidence. It is all very well to wave your hands around and say it is terrific but, unless there is really clear evidence that people are working together much more coherently, industry will have a pretty short timeframe to make its mind up. If it does not work, it will not work. Everybody should be on alert that we need to do what we have said we will do, but early evidence is that we will get that kind of support on both sides.

Q204 **Lord Griffiths of Fforestfach:** In the past, industrial strategy, picking companies such as British Leyland, has had a fairly mixed response in the UK. In selling what you are doing, you want to make the point that we are not going to be picking winners. If you go from a transactional approach to a partnership approach, can you do it without somebody ultimately picking winners? To make it even more granular, we have a very high-level committee; there are various levels in all this. I can see your conversations with Secretaries of State and even the Prime Minister. That is terrific, and that is the big picture.

Assume that I am an executive of a pharma company and I come to a meeting just like this. Around the table, there are people from government departments, the NHS and me. As a result of what we decide, I have to go back to my chief executive and say, "They want us to commit capital". The capital is quite expensive. Other companies may come in and say exactly the same. Who ultimately decides how much capital each company should be putting in to one of these deals that you are proposing?

***Professor Sir John Bell*:** Let me deal with the first question first. This strategy is about picking winners; it is not about not picking winners. But it is not picking winners in terms of individual companies; it is picking winners in terms of domains of activity that will change the industry and change healthcare over time. For example, we strongly believe that artificial intelligence will have a profound effect on health, more than almost any other domain. The biggest issues in healthcare, as you know because I am sure you have talked about the good old NHS, is a workforce problem: 70% of the money goes on people. If you can reduce and reprofile the workforce in the NHS, you can save very substantial amounts of money. The only way I can think of to do that is to use AI.

We have chosen AI as something we want to do. We have chosen AI in some of the easy, low-hanging domains such as radiology and digital pathology. Digital tools are really easy. We could all, if you wanted, develop algorithms like that around digital data this morning. Machine learning is not as complicated as people like to tell you. You can learn it off the web. You can generate those assets. Then we have a place where we can put them, test them out in real life and show that we can reduce the workforce and make it more efficient. We have not yet chosen a company. We have said, "Who wants to play in the sandbox?" Interestingly, all three producers of digital pathology scanning equipment have rocked up and said, "We want to work together to do the pilot studies to show that that can happen". We have the major radiology providers from around the world all rocking up to say, "We want to play in this sandpit".

We have not said, "You are better than you". We have said, "We think this is an area for substantial growth. Come and do your R&D. Come and evaluate your stuff here. Help us transform the NHS, and we will all be winners". That is our approach. We are picking winners, but we are picking subject winners. We have chosen AI as opposed to rectal thermometers or something. We have chosen things that we think are going to move on in the next 20 years.

Who decides who puts in what amount of capital? We have tried to bring the industry together and, where possible, do pre-competitive things where it decides itself. In the AI space, companies have come forward with different amounts of capital. Government has come forward to match that capital, but we have let the industry work out how much capital it wants to bring. If people do not want to play, they do not have to play. From a commercial perspective, there is an opportunity to be in the game in the health service as you start to deploy digital pathology kit. That is basically the methodology we have used. There has not been somebody at the top saying, "You have to put in this and this". It is a voluntary thing.

Baroness Neville-Jones: Are the participating companies going to bring the funding?

***Professor Sir John Bell*:** They are bringing funding, bringing kit and bringing in kind. There is a whole range of different approaches. For example, in digital pathology, they are bringing all the scanning

equipment, so we are going to enable the NHS to get up to speed with digital pathology scanning kit. The company is going to provide it; it is going to help install it; we are going create a cloud; we are going to put the data in the cloud; we are going to make it accessible for people to do machine learning and generate algorithms. That is the kind of thing that we are doing.

Lord Griffiths of Fforestfach: As an economist or somebody who works in the Treasury, I can imagine one objection being made: is this not slightly anti-competitive? You are not creating a cartel, but you are creating a relationship where you are reducing the amount of competition.

***Professor Sir John Bell*:** There are two answers to that. First, we are letting everybody who wants to play in the sandpit play in the sandpit. If they want to come to invest and put things in here, we are letting them. Secondly, we are, on the whole, creating open-source things at the end of that. For example, there is a big project around the UK Biobank. All that data will be made available to the entire world. Some of the companies will help us generate more data. They will probably get a first look at it, but in truth it will all be publicly available. The idea is that this is a feeding trough, so companies say, "You have the best assets, so we are going to come to work and do our R&D in the UK".

The Chairman: Did you just say that all the data in the biobank will be available to the whole world for free?

***Professor Sir John Bell*:** It already is, to everybody. It is the most successful open-source project on the planet.

Lord Maxton: It is all in there.

Professor Sir John Bell: It is all in there. Anybody can access it. It has transformed the whole world of cohort and genomic epidemiology. The last American Society of Human Genetics meeting was entirely a biobank meeting. Almost every speaker who got up just talked about the biobank data. It is the most remarkable resource there has ever been.

The Chairman: Is that not an opportunity lost to take it to innovation?

Professor Sir John Bell: No. Out of that, people will discover targets. They can patent those and run for those targets. They can understand better how to profile their drugs in precision medicine. They are absolutely entitled to do that, but those are second-order intellectual property pieces that they can generate from biobank data and other data, which they can then patent. If you look in the world of pharmaceuticals, the biggest problem is getting really good targets. In a sense, if you have good targets, that is almost pre-competitive, because the patents are around the composition of matter and drugs that you make to those targets. The biobank thing has worked, and it has worked incredibly well for industry.

Q205 **Lord Maxton:** First, could I ask a question that everybody will expect of me? There are four NHSs in the United Kingdom, not one. In Scotland, the academic world and the universities are devolved. To what extent

does that influence the way the companies work and so on?

Secondly, computer companies and life sciences are increasingly dependent, as you rightly say, on the digital world and computer science. First, computer companies are international, not national. Secondly, they work much beyond just the life sciences. To what extent did you calculate that into your report?

Professor Sir John Bell: On the first point, we were totally relaxed about the devolveds. They have been involved in all the discussions. In fact, some of our great powerhouses in life sciences are in the devolved nations. There is a terrific cluster in south Wales; there are huge, powerful companies based in Scotland. Thermo Fisher, for example, has several thousand people in Glasgow; it is a great asset. Of course, the academic bases in all those places are good. Northern Ireland also has a very important part to play in digital pathology and diagnostics. We view them all as parts of the same story. It is also important to remember that, although the universities are devolved, research funding is not devolved. That goes through UKRI. When we get a pot of money, it goes to everybody.

Lord Maxton: Yes, at the moment.

Professor Sir John Bell: That is not my job; it is somebody else's job to decide how that works. I am operating on today's rules. We would want to be very inclusive of the whole of the UK.

Q206 **Lord Hunt of Chesterton:** In reply to my earlier question and to what Lord Griffiths said, you have talked about the players in this. The body you did not repeat was the Treasury. I have been a civil servant; I ran the Met Office. You have the government department you are dealing with and then you have these mysterious visits from the Treasury, but you have no idea what it will ask you, what its brief is or what it will do afterwards. It is the joker in the pack. I noticed that when you talked about this sandpit you did not mention the Treasury. Is the Treasury in the sandpit? Why is it there? What is it doing? Can you enlighten us on this great mystery?

Professor Sir John Bell: First, I get on really well with the Treasury; it is terrific. I go in and out all the time; I talk to it all the time. It has been very involved in the development of the strategy. It has been enormously supportive. As far as the sandpit is concerned, it is like the little boy who does not play in the sandpit. It stands at the side and watches what is going on, which is fine. In some of these domains, we cannot fix the problem without the Treasury. On this issue of trying to grow our R&D budget so that we are in the top quartile of countries with R&D budgets, some of that has to be public sector money and some has to be private sector money, and the Treasury is crucial to both.

It is crucial to both because of the point I made about the ability to release private sector funds that are currently invested in things that are not driving any economic growth whatever. The Treasury has been very active in the discussion about patient capital and how to get pension fund

support for these sectors. If you look at the gap between where we are now and where we need to be in R&D spend, you will fill that really quickly if you release even a small fraction of pension funds, a few per cent, to be invested in high-tech companies where every penny that goes in goes into R&D. That is what the Americans have done and we have never done. I am really confident we will get to 2.4% of GDP on R&D, but it will rely on the Treasury helping us with the regulations.

Lord Hunt of Chesterton: There is no index to this document, the industrial strategy, and certainly you cannot see "Treasury", for example.

Professor Sir John Bell: No, but I am sure you have seen its consultation on providing capital for innovative firms. It is a spectacularly well thought out document. It is really good and it is having an impact already on our sector.

Q207 **Lord Kakkar:** To come back to the participation of government, you have developed a framework where industry can collaborate well. It seems to have collaborated in the development of this report and in turning out the sector deals. Do you think that, beyond the Treasury, the other government departments involved have philosophically got themselves to a place where they understand that this type of collaboration is the future and can mobilise themselves in a practical way to deliver it?

Professor Sir John Bell: We are on a journey, it is fair to say. It would be wrong for me to say that everybody has got to the destination. Industry gets it. The NHS is one of the big unknowns. At the very highest level, it totally supports collaboration and trying to work with industry much more effectively. Whether that is true throughout the organisation I doubt, but we can get there, because there are many upsides for the NHS in participating in this programme in an active way, not least that it will deliver important innovations to its patients much more quickly and effectively.

The Chairman: We have a series of questions for you on the NHS.

Professor Sir John Bell: Lord Kakkar, what was your other question?

Lord Kakkar: You have answered it: it was whether the departments have got to that place. There is one little point, if I may. For them to really get it, because, as you rightly say, they are on a journey, how long do they have before industry starts to feel that it is too far ahead of the game for this to be a plausible proposition?

Professor Sir John Bell: They certainly do not have for ever. One of the things that I like to point out to people is that we are trying to create a sustainable innovation cycle, which starts with our great universities' discovery programmes, such as the one Merck is going to bring to the UK, which was announced last week, and works its way through clinical development and manufacturing. To complete the circle, the best ones have to be adopted, and that is where there is a break in the cycle at the moment. The NHS has to work hard to think about how to adopt innovation much more effectively. If you are talking about a sustainable

system, if you do not have that whole circle working, industry will say, "What is this all about?" and will probably back away.

Q208 **Baroness Neville-Jones:** Sir John, in reply to Lord Maxton, you said you want to see the strategy being inclusive and I think you were thinking of that in geographical terms. In designing how this will go forward, have you taken explicit account of one of the Government's objectives in its industrial strategy, which they call "place", which is to say regional distribution of seeding activity and wealth creation?

Professor Sir John Bell: Yes, we have. In fact, when the Green Paper was announced a year ago, place had a very prominent feature in it, as it has in the White Paper. We thought, "Do we have a problem with place?". We are all well aware that there is a very dense aggregation of the high-tech sector in the south-east, co-located with the major universities. Many of the pharma companies are there; the cutting edge of biotech is there; it is the world's third-biggest cluster. There is much to be proud of there, but it does not really solve the place problem.

As we looked further around the country, we became much more relaxed that we did not, in life sciences, have this issue of place. Although the sector looks different in different bits of the country—so you cannot go to Nottingham or Birmingham and see what you see in Cambridge or in Oxford—you see a lot of medtech. There is a lot of consumer health product stuff done in the Midlands. There is lots of medtech in the north. Manufacturing is almost entirely in the north. The north-east manufactures more life sciences products in terms of value than it does cars. People forget that; it is a very dominant play in that bit of that world. It is similar in Scotland. Scotland has quite a good mix. It has some high-tech stuff, but it also has some heavy manufacturing.

I cannot engineer that solution, but I can reinforce and develop what is already good. Reckitt Benckiser has a big facility in Hull. Boots has its main office in Nottingham. There is a lot of really big and chunky stuff around the country. We need to reinforce and develop that, but not assume that the whole country is going to look like the golden triangle, because it is not and it never will. Can there still be jobs? Yes. Can we still have economic growth? Absolutely, yes. It just needs to be appropriate to the different geographies.

Q209 **Baroness Young of Old Scone:** We have heard you talk about some of the challenges to the strategy: manufacturing, scaling up companies, adoption by the NHS. If you were lying awake screaming in the middle of the night, what would be the big ones that you were worried about?

Professor Sir John Bell: Fortunately, I do not scream at night; my wife would not be too pleased. Let me pick out a couple. I have talked a little about scaling companies and we have a line on that, so I worry less about that now. I know you are sceptical, but I can get to four £20 billion companies in 10 years; I can tell you that.

The Chairman: We will come to that, to see how you are going to do it.

Professor Sir John Bell: The most revealing thing about this analysis is that, although we have a terrific science base, we do not do high-risk science. One of the ways the Americans have won is by doing high-risk science. Let us take the DARPA example referred to earlier. DARPA is all about using brand new technologies to address brand new missions, not using recycled technology to address old missions; it is new technology for new missions. What can we change in the world that will create a new environment 20 years from now? Too often, the way we have gone about the distribution of research funding for both the charities and the government agencies has been to say, "Let's make it all really fair. Let's get all the experts in the room". The experts bring with them a very substantial problem, and that is the perceived wisdom of what is right and what is wrong. The DARPA model is very interesting, because it avoids experts like the plague and works very hard to create novel approaches to really novel problems. We do not do that very well.

The Chairman: They had one massive industry that would use whatever they produced: defence.

Professor Sir John Bell: Yes. Their solution was to have an in-built procurement model that went straight back into defence, which meant that when they discovered satellites they were immediately deployed for defence purposes, and the same with GPS. Do not forget that we have a massive industry that could procure innovation of a new kind: it is called the NHS.

Lord Kakkar: We will come to the NHS in a moment, but that is at the heart of this question. The DARPA model is a very impressive model because there is that cycle. Will that cycle exist here?

The Chairman: Reserve that until we come back to the NHS.

Baroness Young of Old Scone: May I press you slightly on HARP? I bear the scars of coming in to Diabetes UK about eight years ago and proposing that we do a moonshot. I was jumped on from a great height by the MRC, Wellcome and anybody else who felt like jumping at the time. We had to do it under the radar because, frankly, if we gussied it up as that, it would have just hit a brick wall. Do the MRC, Wellcome, the big medical charities, the NHS and some of the other players now see moonshots and picking winners as a possibility?

Professor Sir John Bell: Partly because of the dialogue we have had over the past year, the Wellcome is completely up for this. It has brought people in from DARPA to advise on how you create an agency that looks like this. I believe it has set a significant amount of money aside to help fund this stuff. So has CRUK. I met with Harpal Kumar, its chief executive, last week.

The Chairman: We have Mark Walport next week.

Professor Sir John Bell: I think Mark will espouse the advantages of taking a different approach to thinking about what you do and doing some bold, moonshot-like experiments. Your experience reflects the status quo in the sector. I have two interesting stories. First, we completely missed immuno-oncology. Probably the biggest breakthrough

in oncology in 50 years was the use of the immune system. The UK had no play in immuno-oncology, and I do not believe people had not asked for grant funding to support it, so that is a real problem. Secondly, another transformative information is gene editing, which I am sure you will have talked about here. When you read the Eric Lander history of how gene editing and CRISPR-Cas9 occurred, every country in the western world was involved in that except one, which was the UK. It was not good.

Q210 **Baroness Neville-Jones:** You paint a picture of deliberate and active promotion of disruption, which you want to see turning quite a lot over. How does a sectoral deal fit into your vision of what you are trying to do? A deal is going to be announced this afternoon and I do not know how much you can tell us about that. This Committee has not been invited but I do not want to embarrass you. What are your thoughts on what a sectoral deal means in the context of the picture that you have been creating and how many sectoral deals do you see as the way forward with the various strands in your mind's eye? It would be very helpful to have that picture from you.

Professor Sir John Bell: Just to get back, and to help address the first bit of the question on why we did not do everything in life sciences, there is a tonne of different strands in our health-related life sciences activities. You have to think about how industry gets involved in different ways in each of the different strands. For example, in discovery research, there was the Merck announcement last week, and we will see more of those. Not today, but in the not-too-distant future, we will see more very significant investments in discovery science in the UK. They will park research institutes close to great academic science; they will work together; we hope they will create value; they will, we hope, put the patents in the patent box; we hope they will manufacture things. That is at one extreme.

There are other ways in which you can see engagement across the piece, which is sometimes disruptive. Take the ideas that have come out of the brainstorming about what healthcare will look like 20 years from now. We have gone back to industry and said, "Do you believe this and, if you do, do you have a research programme thinking about it? If you do not, do you want to do it with us?." It said, "Of course we do. We think it is terrific. It is pre-competitive; we cannot commit a lot of R&D in our own shop to that, but we would love to work with you to explore, for example, what early diagnosis means for how you run healthcare systems". If you diagnose all the chronic diseases 20 years before we do at the moment, it has a completely disruptive influence.

As you read the five-year forward view, Simon Stevens talks about public health, and that is public health. It is identifying disease at an early enough stage that you can do something about it to produce cures and long-term effects. That is all about early diagnosis. It is true about cancer, cardio-metabolic disease, cardiovascular disease, mental health, neurodegenerative disease. We want to be the place in the world where

people can come, work on methodologies to do that and change the entire healthcare system, first in the UK and then globally.

The Chairman: It is called ageing.

Professor Sir John Bell: It is called ageing, but we are going to catch it earlier and you will age more slowly.

Baroness Neville-Jones: You see this as being a question of how we approach different parts of the biomedical world.

Professor Sir John Bell: That is right. Some of the original ideas were: "Let us have a sector deal. Industry will put $1 billion into the middle of the table. Government will put £500 million into the middle of the table and then you can go off and spend it". Industry is not going to do that. Industry is fundamentally, and rightly, interested in the value it generates for shareholders, so it will have very specific ideas about what it wants to do. Where they align with things that we want to do, let us do them together. Where they do not, it should go off and do them on its own.

Baroness Neville-Jones: Who chooses these issues that you have selected?

Professor Sir John Bell: This board I set up was responsible for the document I produced. That has come straight from industry, and industry of all kinds. We saw hundreds of people. We took views from hundreds and hundreds of people and/or organisations, to try to distil it down in a reasonably readable form, which I suspect it probably was not.

Baroness Neville-Jones: If we read the strategy with care and detail, we will see where you are going to go.

Professor Sir John Bell: You will, although you should do it at bedtime so that it helps you off to sleep.

Q211 **Baroness Morgan of Huyton:** I am thinking back to the governance conversation we had earlier. You have this really good group of people you have been working with, but that has stopped, so what is there now?

Professor Sir John Bell: This goes back to the governance question. We have not reassembled the group since the report was launched. I would like to get that group together as an advisory body, because it was terrific in providing us with steers about what is red hot and what industry is interested in, and as a group to brainstorm ideas. That idea about early diagnosis came from Cancer Research UK, but, when we fed it to the industry, it said, "Of course we want to do that, but none of us is doing it at the moment". That is where you get disruption: in getting people to work together like that.

The Chairman: The next move is with whom, in terms of implementing the strategy, or are we going to hear about that today?

Professor Sir John Bell: You will hear about that today. I sought advice. I said, "I would like to tell these guys all about the sector deal today" and they said, "No, you are being streamed; you are not allowed to say anything", so there we are. I am sorry.

Q212 **Lord Kakkar:** You speak about this advisory group that advised "us". There was the industry group; who was the "us", apart from you?

Professor Sir John Bell: It was government more widely. I fed that advice through to the Government to say, "What do you think about this?" and "What do you think about that?". There were some things about which the NHS said, "We can't really do that. We can't line up the players. If they ask to do that, we are going to have a hard time". There were other things where it said, "Yes, that would be good. If they suggest that, we can find a way to work together".

Lord Kakkar: The "us" was government departments, so BEIS, the Department of Health, Treasury and the NHS executive?

Professor Sir John Bell: Yes.

Lord Kakkar: Those were the four principal elements.

Professor Sir John Bell: They were the principals. To some extent, the charities were on both sides of the table, because charities in this country put a lot of their money into the pot. I kept both Harpal and Jeremy Farrar closely involved in all the discussions. I have subsequently met the Association of Medical Research Charities to talk about what is going on. I have been trying to keep all those people in the loop.

Q213 **The Chairman:** To be clear, today we will hear about how the whole of the life sciences industrial strategy will be driven and who will be leading it.

Professor Sir John Bell: No, I am so sorry. You will not. What you will hear is the sector deal, which will be a couple of billion pounds' worth, and I cannot say any more than that, of investment in the sector, which is the first wave of a series of waves of interactions between the various parties.

The Chairman: That includes the one we already heard from MSD.

Professor Sir John Bell: That includes last week. I am not going to keep that off the balance sheet; come on. That is a big one.

Baroness Morgan of Huyton: Does it include governance?

Professor Sir John Bell: They were still working on the paper late last night, so I do not know. It is not my paper; it is a government paper.

The Chairman: You have two previous advisers here. They understand how the system works; we do not.

Q214 **Baroness Young of Old Scone:** I am really worried about how the NHS will respond to this and how the forces of darkness in the NHS will typify it. Is there a degree of cynicism that says this is just a dodge for the pharmas to get their mitts on bits of the NHS and sell lots of stuff that makes profit for them, in a global sense, but does not do that much for the NHS? There has been a lot of talk in the accelerated access review about giving priority to things that will have no net cost to the NHS and not things that may deliver huge benefits in patient care but cost some money. There is that question.

Linked with it, there is also the thing that I was worried about in terms of the pharma companies. They get very enthusiastic about things where they can see a global market and what it is going to do for their bottom line and business, but it was like pulling teeth to get them to focus on things that would reduce cost to the NHS. For example, why would you find a cure for type 2 diabetes when you could flog metformin for ever and a day to zillions of people globally? Are there tensions between the NHS and the pharma leadership of the process, as a result of this focus on things that have to show that they save money for the NHS?

Professor Sir John Bell: The relationship between the NHSs around the country, DH and the pharmaceutical industry has been strained at times over the years and challenging to manage. There is no disputing that. They are about to enter a new pricing agreement.

The Chairman: We have four or five questions, and the question is referring to what Lord Oxburgh has to ask.

Professor Sir John Bell: This issue of the NHS will come up again.

The Chairman: Yes, so we will combine Baroness Young's question with that.

Q215 **Lord Mair:** May I come back to HARP, which we have spoken about already? In your report, you make it very clear that this is about a coalition of funders creating a new programme for large research infrastructure projects and high-risk moonshot programmes, along the lines of DARPA, as you have already outlined. A large amount of funding is needed for that. Can you tell us more about it? What do you envisage? How achievable is it?

Professor Sir John Bell: First, it is a large amount of funding. It is not reasonable for even the majority of that funding to come from government. These will be really high-risk projects, and I suspect Ministers will say, "I would prefer not to appear on the front of the *Daily Mail* when that thing crashes", so a lot of the money will come from industry and charities. They are the bodies I have been working most closely with. Government will have a role, but it will not necessarily be the dominant player for those reasons. It is reasonable that these high-risk things are done by the others. I do not pretend that the list in the report is a definitive list of the things you might do, but it sets the stage for thinking about what to do to solve the healthcare problems 20 years from now.

Those have already brought in very substantial amounts of money. For example, there is a project, which is immensely bold, to do whole-genome sequencing on the whole of UK Biobank. That is a big project, and we already have industry partners to the tune of several hundred million pounds to help us support it. It will be handling data at a scale no one has ever handled before. It will require analytical tools that no one has developed before. It is a real moonshot, but the yield could be enormous for our understanding of disease. That gives you some sense. Government will be contributing to that, but will not be the majority funder.

Lord Mair: When you say "government contributing", is that through the Industrial Strategy Challenge Fund?

Professor Sir John Bell: Yes, UKRI and the Industrial Strategy Challenge Fund.

Lord Mair: Is this this part of what will be announced in the sector deal?

Professor Sir John Bell: It has to be approved by the Treasury and others, but do not worry; they will cough up.

Q216 **Lord Kakkar:** In the United States, DARPA has a fundamental federal funding base, but your view is that HARP should not have a fundamental UK government funding base.

Professor Sir John Bell: We are still working out exactly what this entity is going to be. There are lots of interested parties. UKRI is interested, as are the Wellcome Trust and CRUK. Other charities are interested, because there is a lot of interest there for other charities. That is another governance issue that we have not solved, but we have been taking quite a lot of evidence from people who have been at DARPA to see whether we can create something that is culturally the same: it takes high-risk experiments, a lot of which fail, but when it wins you win for ever and you win big.

Lord Kakkar: In terms of the sequencing of the entire UK Biobank, even with all the industrial participation in funding that, will that remain entirely publicly available?

Professor Sir John Bell: Yes, absolutely.

Q217 **The Chairman:** We will come back to that. I worry about us spending taxpayers' money to sequence the genomes of 500,000 people—or the charity, the Wellcome Trust, presumably will spend that money. It is an enormous amount of resource that nobody else in the world can possibly have, and yet we are saying it is an open resource. Maybe you are telling me that the open resource is the genetic information, which cannot be patented, but outside that everything could go in a patent box.

Professor Sir John Bell: No. Ever since the beginning, when we set up UK Biobank 15 years ago, there has been lost of discussion about it being a goldmine for creating income streams and so forth. Companies are willing to spend money to enhance the resource so they can use it for research purposes, but they are unlikely to extract a lot of individual patents from the resource itself. The information will give us a remarkable insight into the causes of disease—an insight that no one has ever had before, to be honest—and that is the starting point for pharmaceutical discovery. I am still convinced that making it an open-source public sector resource is the right answer.

The Chairman: We are going into the realms of science now and we should not, but the resource is much more valuable because it is not just genetic information; it is the phenotypic information that goes with it, which nobody else can collect.

Professor Sir John Bell: That is absolutely true. There are two problems. First, we have started down the road of having it as an open source. It is rather difficult to make it a closed source after you have started with an open source. Secondly, I am not sure you would get the wider benefits of UK Biobank, where it is being used by lots of people to advance their own projects. It is globally acknowledged as the prospective cohort on the planet. It is a thought experiment about what it would look like if we closed the doors and said, "You have to pay to get access" or, "We want a share of the royalties that come out of it". It is a thought experiment; it is probably not practical at this stage.

Q218 **Lord Vallance of Tummel:** I am sorry; I am going back to the NHS. To make the changes that are required, the NHS will need some kind of incentive and it will have to be financial. It is unlikely to get that from the Treasury, so it will be looking for new sources, and it has on its doorstep this valuable data. I do not understand, from an economics point of view, why that data should be free. It is an obvious source for ring-fenced finance as an incentive to the NHS to invest in innovation.

Professor Sir John Bell: We refer to that in the report, in terms of the benefits emerging from the data. We have argued that, in this process, in a world of AI and machine learning, the valuable bit is the data; it is not the AI or the technology. As a result, when NHS data is being used there needs to be a tangible return to the NHS. I say it in the report. There have been interesting discussions over that, some in the press, that got me into a bit of trouble, but I still believe it is absolutely true. The crucial thing is how you structure that. Is it a royalty stream? My biggest fear is that one of the great monoliths of the west coast of California comes over here, soaks the best dataset in the world for a whole tonne of algorithms, ships the algorithms back to California, sells them from there, does not pay any tax in the UK and does not employ anybody in the UK, and we have been taken to the cleaners. That is the risk. I have asked the Department of Health to think quite hard about how it wants to manage that. It needs attention, frankly.

Lord Vallance of Tummel: It needs attention from the Treasury too.

Professor Sir John Bell: Yes, it does.

The Chairman: We are getting on now to a set of questions related to the NHS. In our evidence sessions, this is the key issue that has come up. This has been the Achilles heel, so to speak.

Q219 **Baroness Morgan of Huyton:** You have heard already where we are coming from, and there are lots of questions around this. You have been clear, as have others, that the biggest differentiator for the UK is the NHS, so that is where we start. We also have heard and know that, for any of this to be real, it is going to take investment in people, in tech, in the drugs fund. Particularly, it is going to need a capacity in the system, which collectively we are pretty sceptical about at the moment, to think and to take risk, rather than deal with the day-to-day crises. I am not speaking out of turn to say that the evidence we have had, as a Committee, from the NHS centrally up to now was pretty depressing.

There was a willingness to tick the box in terms of understanding that this is really important, but absolutely no clarity about how it was going to happen, no explanation of budgetary possibilities and no ability to think about the incentives we were just talking about, in terms of data, to make any of that real. How do you see us moving forward from where your report is? Bluntly, the idea that the NHS is going to have the capacity to take the work forward on data is a bit hard to believe.

Baroness Neville-Jones: We get the impression of a service absolutely overburdened by the day-to-day preoccupations, and the ability it has to think outside that is very limited.

Baroness Morgan of Huyton: How is the brokerage that you were describing going to happen?

Professor Sir John Bell: I live and work in the NHS, and I know exactly the problem. I have probably never seen it in a worse state than it is at the moment, struggling to do even simple things well. The idea that you are going to put a whole lot of this really sexy tech-related stuff on top is challenging. Let me give you a couple of narratives, which will be driven by self-interest in the NHS to deliver them in a sensible way. Just because there is self-interest does not mean that it can deliver, so I do not want to get those two things confused, and we can come back to that.

Five years ago, I was able to persuade the Government that there was an enormous opportunity in greatly improving the genetic services for patients around the NHS, because we had 23 small, underpowered genetics labs using stone age technology to make diagnoses of complex diseases. Lots of people with children who had single-gene disorders were spending years trekking around the country on these diagnostic odysseys trying to get diagnoses.

In my view, the way to solve that was to create a pipeline of high-throughput genomic sequencing, and I knew you could not do it in the NHS. Therefore, we created a company called Genomics England, wholly owned by the Department of Health. It had its own board, which I sit on; it had its own structure; it created a pipeline; and then we worked with the NHS to get the patient flows to work. It has now gone back into a fully commissioned service in the NHS; it will be announced, I think, in the first half of 2018. It is a huge success. There are very substantial savings to be had from that process, because those labs cost about half a billion a year.

Is the NHS capable of taking up opportunity? That is the most highly innovative genetics service on the entire planet, so the answer must be, yes, it can do it. The point you make is that, because it is so busy with the day job, if we tried to do Genomics England inside the NHS, it never would have worked. We had to do it outside, force the process there and drop it back in afterwards. I can see opportunities to do that for digital pathology. That is exactly what we are proposing to do: create a structure outside that will do all the piloting work and then embed it as a second-order question in pathology services.

The single biggest crisis for hospitals at the moment is that they have too many people in beds who should not be in beds; they should be in community care. That problem can be relatively easily solved by digital monitoring. There are devices now where you put a little cup on the finger of a patient; it records pulse rate, respiratory rate, temperature, oxygen saturations, all the things you need to monitor. You are better monitored with that than you are in most hospitals, frankly.

Is there a system where you use digital tools to monitor patients at home, go and look after them if they need to be looked after, maybe use local pharmacies to help support them, create a new system to operate like that? There is a huge self-interest: hospitals are going broke on the fact they cannot get people home. There is a relationship between the technology sector and what the NHS really needs. It is a question of whether people have the headroom to implement. In some cases it will work, and in other cases it will fail.

Q220 **The Chairman:** When we talk about the NHS, we always think of the tertiary and secondary care sector, but a huge amount is our primary care sector. What you just described, using digitalisation and technology to monitor at home, will require a strong primary care sector.

Professor Sir John Bell: It might. It also might involve a whole set of new people who are not doctors, because properly digitally enabled tools should give you digitally enabled decision-making that allows you to look after most common conditions. That is why I raised the issue of the pharmacies. Within about 200 yards of most people's homes, there is a pharmacy that will sell all the usual things. Can you use a moderately d but not highly skilled staff to monitor and help? You do not want to use digital tools to find that all the people whose numbers go out of whack end up in the A&E department. That is not a win.

Baroness Morgan of Huyton: You are right about the approach that was very successfully taken on genomics. Are you saying that the proposal is to use that method of working for some of these new areas of work?

Professor Sir John Bell: Yes, exactly the same model.

Q221 **Lord Vallance of Tummel:** Would that include IT as a whole? At the moment, the IT of the NHS, even if you are looking just at the tertiary sector, is balkanised by trust; it is all very different. How would one take that out from the day-to-day running, so that data could be available, consistently recorded and coded?

Professor Sir John Bell: If you had asked me two years ago, I would have said, "You will never get it to work in the NHS; it is a complete road crash". I do not think that is true any more. Advances in IT interoperability have allowed datasets to be joined up at real pace around the NHS. It is happening regionally, so it is not happening nationally. It is not all going to Leeds, and one reason is that it is rather difficult to persuade some woman who lives in Didcot that her records should be in Leeds. She will say, "Hang on a minute; what's that all about?". It is not

unreasonable to say, "We want to share these records with the local district general hospital, with the tertiary hospital and, if need be, with social care". It is good for the patients, because their records get known. There are large bits of the country where there are a million or more people hooked up through primary, secondary, tertiary and social care, in an integrated record.

The real question is how many of those we can dock together and how many we need to dock together to answer the really fundamental questions: "What is the right way to treat this or that disease?", "How good is the response to this therapy using this drug?", and so on. One of the recommendations in the report is to create those geographical islands of coherence in IT, so that you can ask those questions in those domains. They are regions of 3 million to 5 million people, a bit like Scotland. Scotland is a here because it is about the right size. Denmark is about the right size. They are the ones that have made a really good go of their IT.

You cannot say, "I am going to pull this lever and the whole country is going to be fine and connected". They have pulled the lever about four times and all that happens is they fall through the floor, so that is not the right way to do it. I am a bit of an optimist about where we might get to with health IT. The data is still pretty scrappy; a lot of it needs to be cleaned and standardised if you are going to use it for any sensible purpose, but that is achievable too.

Q222 **Lord Oxburgh:** To pick up the most recent comments on the enormous disparity of IT systems that one finds around the country, it may be that AI is the way of handling that. The topics that I was going to discuss with you we have touched on and explored already in the previous question. We cannot avoid the impression, which Baroness Neville-Jones referred to, that you have all sorts of good intentions at the top of the NHS, but when you get down to the coalface people are just too preoccupied with staying alive. This is what you see every day. The lifeboat is sinking and people are bailing like mad. They are not very receptive to salesmen who come by and say, "By the way, you could have this brand new motorboat". They are keeping their heads down, getting on with the job at hand and looking after their patients.

There are a range of problems, some of which you have touched on, with the NHS, but the comments we got from a whole range of innovators, primarily medicines but also other things, said, "We just cannot get any traction with the people who need to buy these things or do these things"; these are the local trusts. Would you agree—and I think you have implicitly said this—that there has to be an outside mechanism of some kind, which is supratrust, to kick-start these things?

I wonder whether there is scope for a fund within or beside the NHS—I do not know; call it a "pathfinder fund" or something like that—that offers trusts a menu of new devices or medications, which have been through all the regulatory procedures, which NICE has approved and what have you, and that facilitates their take up. In other words, it says, "The deal

for a local trust is that we will meet four-fifths of the cost from this fund, if you will provide the other fifth". You cannot offer these things free. It just does not work; there are too many examples. But, if you offer big support and say, "We will support this, as a pilot, for a year, if you are willing to come on board", can something like that work?

Professor Sir John Bell: While I was working on the accelerated access review, we entertained exactly that idea. It was a really interesting idea and I think it is still live. There are pretty substantial antibodies to funds, probably because of the Cancer Drugs Fund, which ended up not being what it was intended to be, so people are worried about squirreling amounts of money away. But the observation you make is right. The activation energy to get innovation into a system is very real and it costs money. Even though the effectiveness of savings may be seen over time, it costs money to get it in place. That is one model you could choose, but there are other models.

The problem that the pharmaceutical industry and innovators in the medtech sector have, where they run into a wall because people have no money, is partly due to the fact that the one thing the NHS can get its arms around in terms of cost is medicines and technologies, because it knows exactly what it costs.

There is a sea of inefficiency out there, which you could change to create money to bring innovations into the system. Anyone who believes the NHS is efficient has not been in the NHS; it is hugely inefficient. There are interesting questions. I am very attracted by this concept of value-based healthcare. Think about care pathways and therapeutic domains; let us say diabetes or musculoskeletal disease. If you have a really good drug that has a big impact on musculoskeletal disease, you should look at all the things you spend money on—knee arthroscopy, a complete waste of time; most shoulder surgery, a complete waste of time—and decide how much money you spend on them and whether you please stop doing that to free the money up for the new drug.

Making those decisions is part of the business of getting value out of your healthcare system. Our structure, at the moment, does not really allow that to happen. It is to your point, Ron. We do not have a structure that allows those grown up conversations. "You want the new drug. Okay. If you, the doctors, want the new drug, what are you going to give up? It must add better value than you get from the existing thing". I do not think we do that.

Lord Oxburgh: The other problem, which came up in parallel with this, is that in many cases the people who held the budgets and made the decisions were not in the bit of the organisation that would benefit by the adoption of the new technique.

Professor Sir John Bell: That is one of the most serious problems. What is the advantage to people of doing stuff that saves money if they get no benefit from the money that is saved? That story gets reiterated over and over again in the system. You have to have some system of gain share.

Q223 **The Chairman:** John, the subject of the NHS is crucial and an important part of this life sciences industrial strategy. The evidence that we heard from most parties, week after week, has identified that the NHS is not geared up to it. To develop digitalisation and AI for radiology outside of the NHS is one aspect that may well work, but when you get to the next bit, which is the innovation from that being adopted, even in simple cases, it falls down. Nobody in the NHS seems to be in charge overall, with the responsibility to say, "No, I am responsible for making sure we identify innovations that are appropriate to improving patient care and have to be adopted".

Professor Sir John Bell: We have a very robust system of working out which innovations are cost effective. Most other countries do not have that system. We have that anchor. Lots of the stuff that companies and the life sciences industry make and say is innovative and earth-shattering is not earth-shattering or hugely innovative, frankly. You do not want to be the bunny who ends up buying all that stuff, but, for the stuff that really works, you want to make sure you adopt it quickly, at scale. In another of my rather bold statements in the document, which has caused some difficulties, I argue that we should get to the top quartile of OECD countries for the adoption of cost-effective innovations. Why would we not want to do this? It is a national health system.

If you go out and say to the guy on the street, "We will not even try to bring in at speed the things that will really work, are cost effective and will make you better", what do you think he is going to say? He is not going to like that very much, so the pressure is on. Can they do that? They will not be able to do that in a year or two, but they should set a trajectory so that, over five years, they get closer to that objective. It is a bit like my four £20 billion companies. Let us set a trajectory and see if we can get close.

Q224 **Lord Griffiths of Fforestfach:** Because of the short-term demands on the NHS—let us just take NHS England—and the organisational complexities in a huge organisation with many dimensions, what if somebody said, "Could you divide the budget that comes from the Treasury into NHS Services, which deals with day-to-day, and NHS Innovation"? You would have to work out relations between the two, but you would have a chief executive of NHS Innovation working alongside the chief executive of NHS Services.

Professor Sir John Bell: You are absolutely right. That is another model that we have been talking about. The real question is whether you could get headroom from Treasury to ring-fence that and use it in that way. It is a bit like Lord Oxburgh's issue. You need a pot of money that is not immediately diffused into a system where you do not know where it went, what it was spent on or whether you have any left. I have to regularly remind people that we spend £140 billion a year on the NHS. You can see why the guys from Treasury get a bit short-tempered when you start talking to them about this stuff; it is understandable.

Q225 **Baroness Young of Old Scone:** My scars are revealed again, because

trying to get the NHS to implement agreed, cost-effective technologies in diabetes was like pulling teeth. Eventually, we bribed it. Diabetes UK paid for health economies to implement the right care pathways, and they paid us back through their savings further down the line. It ought not to be beyond the wit of man to devise a bond system that would allow a shift of time and investment up front that can be repaid at a later date. The only alternative is mandation. My 48 years in the NHS showed that, if you tell the NHS to do something, it goes and does it. This is too important; it is too expensive to carry on muddling through with local decisions being made in an extremely poor way. Why do we not just mandate the top 40 effective, cost-effective healthcare technologies that should be introduced?

Professor Sir John Bell: These are all terrific ideas and you will not be surprised to hear that I have thought about them before, but I am not running the NHS.

I just want to make one really important point. The senior people I have interacted with—namely Lord O'Shaughnessy, Jeremy Hunt, Simon, Ian Dodge, Sally Davies—want to see the health service deal with this issue; they really do. The problem is that, as I am sure you are aware, it is not clear who is driving the bus. That is the question. Whoever is driving the bus, the windscreen wipers do not work and the exhaust is falling off, so it is not an easy story for anybody to run with. We have terrific good will at the moment from people in real positions of authority across it. We will not be able to deliver everything, but we will be able to deliver some things, I am sure.

To your point about gain share, you will see in the sector deal that we have brought companies that know how to do things in a way that hospitals do not and we have said to them, "Why do you not just run the orthopaedic service here and make it faster, more efficient, reducing length of stay, and all of the rest of it? Then by all means sell your joints into the system, make some money, take the gain share, half the share in the savings and off you go". It is good for business, but it is also good for the NHS. There are a number of those examples. There are ways for industry, which is very good at project management in a way that the NHS has never been, to squeeze cost out of the system. There will be examples in the sector deal, as you will see.

Q226 **Lord Vallance of Tummel:** I am very taken by the Treasury being heavily involved in the patient capital review. It has produced something, it has its imprimatur and it is very good. Is there not a case for the Treasury trying to unlock the dysfunctional budgetary and financial planning system of the NHS? That is what it is all about. It inhibits investment in innovation as it is at the moment. If you had the Treasury leading it, in the same way as it led the patient capital review, maybe you would get an answer that could be bought into.

Professor Sir John Bell: You are absolutely right: it is one of the few actors in government that could make a significant difference. The problem is that everybody is a bit anxious about reorganisation, either financial or structural, because there have been so many less than

successful efforts to do that. As you may have noticed, it is not on anybody's top five list of things to fix in government. That is a shame, because it is one of our huge assets.

Q227 **Lord Kakkar:** I would like to turn back to the accelerated access review. Do you think that the Government's response, bearing in mind that this is a journey, has gone far enough? Are these five adoptions sending a sufficiently ambitious message and how, in terms of what we have just heard, is that going to be achieved given this underpinning cost-neutral obligation?

Professor Sir John Bell: You are right. The Government's response to the AAR was good at one level, because there were points at which I thought they were never going to respond and the AAR has been going on for three or four years now. The choice of a chairman in Andrew Witty was a good one, because he knows the industry and the NHS, so having him in charge is helpful. The number five was always intended to be a starter for 10 that would expand as they got good at it. The crucial thing was that they did not get inundated with trying to deal with a million different things. To be honest, that number came from me and it is not evidence-based in any way, except that I said to a number of people, "Tell me what you think is the average number of really important, cost-effective innovations that hit the system every year". Interestingly, the number was around five. The biggest number anybody produced was eight and the lowest number was one or two, so five is not a bad number.

This gets to my point that the innovations that really impact people and the effectiveness of the healthcare system are not coming over the hill in battalions; they are coming over one at a time. Managing them actively and getting them into the system seems possible. The financial issue is the crucial one, because it is going to be really hard to do that if there is no funding that would allow their adoption and diffusion in a rapid way. There are risks that people will get quite angry if they have produced an innovative medicine that has an impact on a particular disease area, they enter the AAR process and, at the end, nobody in the system adopts it. That will cause trouble, so that needs to be thought through.

Lord Kakkar: To take that point forward, why do you think industry has been so enthusiastic and decided to join you on this journey of the life sciences strategy?

Professor Sir John Bell: One reason is that we have a terrific reputation on the clinical research and basic research side, so it goes without saying that it is very enthusiastic about that. There is an opportunity around a large single-payer system to get adoption and diffusion at a pace that nobody else can achieve. It is important to remember that it is not all bad in terms of adoption and diffusion in the NHS. Some of this depends on the conservatism of the clinical community that operates in this space. It is very interesting. The breast cancer clinical community is very keen to get new innovations to patients with breast cancer. It is motived by the severe consequences of 40-year-old women with three kids with bad breast cancer, and wants the best for them.

Once you have gone through the regulatory hurdles and the NICE hurdles, when those drugs get into the NHS, they get adopted faster than almost any other country to complete diffusion in the system. You can look at the numbers around Herceptin and adjuvant Perjeta: these are drugs that get adopted at scale around the country; it is terrific. But that does not happen universally; sometimes it is really slow. Companies say, "If it worked, even if it worked at a relatively low price point, the volumes you could get very quickly in the UK for really innovative products would be extremely attractive commercially". The companies that have been most enthusiastic are the ones most likely to produce those products.

Lord Kakkar: That comes to a broader question of the culture within the NHS, specifically, for this strategy, with regard to collaboration with industry. Do you think that the culture is there for the strategy to land successfully in the NHS? If not, what beyond all the mechanistic, structural and funding issues we have discussed needs to be done to address that question?

Professor Sir John Bell: I have said before that the culture across the system is not primed and ready to go in this space. It would be a fallacy to imagine that that is what the world looks like. There are pockets of enthusiasm and support for what we are trying to do, and they exist in lots of different places. Not everybody out there trying to run a hospital is completely ignorant of the benefits you can get from innovation. They want to work with industry; they want to see whether they can get stuff to happen in a very different way. At a hospital level, there is a set of hospitals that are incredibly ambitious. Many of them are our big academic centres, because the clinicians are the ones who are most interested in innovation, how it occurs and gets adopted.

Elsewhere in the system, there are also people who are keen to get their hands on adoption and work coherently with industry, but there are also people who say, "Oh, those guys are just coming to take our money. We would be better using it on social care. We do not need any more clever drugs because they just cost us money and do not really help". I am sorry to say it is not a very good answer. It is patchy, and fixing it will probably be best achieved by partnering with people who get it, rather than trying to force people who do not get it to do things.

Lord Kakkar: There have been previous life sciences strategies, for instance the 2011 one and David Nicholson's *Innovation, Health and Wealth*. What has been learnt from those previous strategies and their implementations to inform the way that this might be implemented more successfully?

Professor Sir John Bell: You are quite right; those strategies were an attempt to do what we have done today. There were two problems. First, the life sciences strategy did not engage industry the way we have done and, once you do that, you get a very different document and a very different plan. Genomics England came out of that strategy, so it is not as if it did not deliver anything. The biggest problem was that the NHS said, "We get it, but we are going to write our document over there, it is going to be completely separate from your document and, by the way, we are

not going to show anybody what we have written until the day we launch it". There was the problem and, to be honest, you have seen the reports. *Innovation, Health and Wealth* was pretty much a complete bust.

This time, it has been quite different. We have been trying to work with the NHS to say, "Be realistic. If you can't do these things, tell us now, because it would be better to know that you could not do them than to come out with a report that says what we are going to do and then find you fall over in the first 15 metres". We have had those conversations with the NHS England board and others. We said, "This is the draft; if you cannot do it, say so and say so now". Everything that is in that document they have seen and implicitly agreed to try to help us with.

Lord Kakkar: I have one final point on the general data protection regulation, now to be transposed into domestic legislation. In terms of the questions we have previously rehearsed with regard to the value of data within the NHS, does the way we are going to go about implementing this legislation potentially run a risk of undermining that hugely valuable asset in relation to your life sciences strategy?

Professor Sir John Bell: The GDPR legislation on data started in a terrible place and the biomedical research community fought really hard to make it better. It is important to remember that continental Europe has had a very different experience with data from the UK, which goes back a very long time. It is culturally much more protective about data than the UK. We have brought that legislation to a better place, but if applied inappropriately it will be a great inhibitor of innovation and progress in the life sciences, and will damage the benefits that we can deliver to patients. That is the most important thing.

Q228 **The Chairman:** I may have some better news for you, because we are half way through the legislation issues and we will go to the Report stage next. It may be that the Government have listened to the concerns expressed by Baroness Neville-Jones and others about the research community being able to use information. There are some positive signs that the Government will address that.

Professor Sir John Bell: I would really grateful if you weighed in on this, because applied properly it will be fine, but in its current form, applied with a stick, it is going to be a real problem for everybody.

The Chairman: From what I have seen, they have listened to it.

Professor Sir John Bell: I am grateful for that. That is really helpful.

Baroness Neville-Jones: It will be very important that they do. As seen from where we sit, the Government appear not to be taking advantage of some of the derogations that are permitted by GDPR, but rather tightening the system quite unnecessarily, so that already gathered data will have to be destroyed. That cannot be a sensible outcome.

Professor Sir John Bell: No, exactly. You are quite right. There is flexibility in this legislation and we need to think about the appropriate level at which to apply it, in terms of its day-to-day application. We talk a lot of about Brexit, but GDPR will have to be the standard that is applied

widely. Its interpretation and implementation will be very different across different countries. If we get ourselves in the right place, it is a huge advantage to us.

The Chairman: The ideal would have been if the ICO was directed, in the Bill, to give guidance.

Professor Sir John Bell: Yes.

The Chairman: But they are afraid that all kinds of other people will get on the same bandwagon. I hope we will get to a stage where data that is collected could be used for research purposes in medicine and in the development of drugs.

Q229 **Baroness Morgan of Huyton:** You feel you have buy-in from the top of NHS England. It is a very simple question: have you also had that level of discussion and agreement with NHS Improvement? If it micromanages every little bit of a hospital budget in a tight way, the scope for having a more holistic view of how to manage the budget better is not there.

Professor Sir John Bell: I have had conversations with NHS Improvement and I can give you one example. If we get the pilot for digital pathology to work, there are enormous savings, because every little hospital will not have to have a breast pathologist and prostate pathologist; you can transfer images around and consolidate that. There are enormous savings. Of course, Lord Carter pointed that out in the Carter report a decade ago, so it has taken its time to get here. NHSI is standing waiting to see the results of the pilot so it can roll out a programme with substantially more technology to make it work, so we have been in those discussions.

Q230 **Lord Hunt of Chesterton:** To follow that point up, you are saying that some of the developments in the NHS require different types of technology; AI is an example. In all organisations, as I have experienced myself, when you are introducing new technology and it has a very important strategic role, you have to find ways of handling that, organisationally and otherwise. Just to go back, the NHS had difficulties introducing the idea of diet. I went to my doctor this morning and I had to have a memory test. There are all sorts of parallel methods, rather than the traditional methods. Are industry and the high-level committee interested in that? The money savings of the new approaches are going to be very considerable.

Professor Sir John Bell: There is a very important rider to that. Healthcare, of all the domains of activity, has been the very worst at using innovation to save money. It layers innovation on top of innovation on top of innovation on top of a load of stuff it should have got rid of, and that is a real problem. For example, I heard the other day that the costs of radiology are going up 10% a year. Well, hang on a minute. We have all kinds of new kit; you do not need all the old kit; we have AI coming in at scale. Why in the world would that be happening? If you introduce innovation, you have to have a clear and ruthless plan to take stuff out of the system that you do not need any more.

It is not just the NHS, but healthcare generally is terrible at that. That is one of the things that we have to get right if we are going to use innovation to make it more cost effective and save the money that we can refuel into the innovation.

Lord Hunt of Chesterton: Will industry support that?

Professor Sir John Bell: Industry supports this.

Lord Hunt of Chesterton: It may see this as a way of taking money away from its drugs.

Professor Sir John Bell: That battle will go on. Industry knows that not everything it makes is going to be bought at scale. What it would like is a much faster and much smoother decision-making process that is not so baroque that nobody knows where to put these products to make decisions. Get to a decision about cost effectiveness. Then it is either in, in which case it needs to be adopted and diffused, or it is out, in which case it needs to sit on the shelf. It is pretty simple.

The Chairman: It is exactly that point: we have an organisation that decides it is cost-effective and outcome-effective, so we should adopt it, but we do not have an organisation that says, "On the other hand, you discard all the other stuff".

Professor Sir John Bell: No. I agree with that. We have a gatekeeper for cost-effectiveness, but we do not have a system for chucking the other stuff out.

The Chairman: Originally, it was designed to do both.

Professor Sir John Bell: I agree, and it is a fatal flaw.

Q231 **Lord Griffiths of Fforestfach:** I have two questions, which have been touched on. First, we clearly have a problem scaling up to medium-sized and large companies. Could you tell us about your view of how we compare to, on the one hand, the US and, on the other, countries such as Singapore, Sweden and Belgium, which have done quite well in this field? Is the key difference scale, culture or industrial strategy? I would love to hear your views on that.

Secondly, you mentioned, in a very welcoming way, the patient capital review from the Treasury. What in particular is going to sort out this problem there?

Professor Sir John Bell: In international terms—in terms of getting innovation out of universities and starting companies up—we are pretty good. It focuses on the country's great higher education institutions, of which there are four or five in the top 20. They have different approaches, but they have been very productive at spinning out companies. At my institution, in the last two years, we have spun out 40 companies, which is as good as anybody on the planet, so that is terrific. We have a pretty good and skilled workforce, but we are a bit light on entrepreneurs, to be honest, so the leaders of these companies. We still do not have enough, and we particularly do not have enough of those who scale the companies. We have a lot of people who have taken

companies from their initial funding round of £1 million up to a valuation of £100 million or £400 million. We have almost no one who has taken a company over £1 billion; we have one or two, so that is a problem.

America has a huge advantage, because it has these deep pools of venture capital, often subsidised by the pension funds, but also by other sources of funding. It has risk capital that allows it to scale its companies. It also has equity markets, public markets, particularly Nasdaq, that really work. We have neither. We have very thin levels of venture capital. They tend to be short-term funds, so as soon as they are in they want to get out. They are quite good for starting companies, but not good for scaling and developing companies. The public markets in the health domain do not work in the UK or, indeed, in Europe. There are some serious financial issues that we have to face.

Lord Griffiths of Fforestfach: Why is that?

Professor Sir John Bell: There is a variety of reasons. One is that Nasdaq has been available for people to float on, but also, because of this problem with the lifecycle, when we get to a company valued at £400 million or £500 million, we sell it because nobody has the energy or the resource to take it to be worth £1 billion, £2 billion or £5 billion. If that happens, you never create the companies that fuel the public markets. Then you do not have analysts to follow them in the public markets; you do not have any expertise, so the whole system just does not click.

The management issue is an issue that we could come back to, but the key bit to this is whether there are substantial sources of private capital that could be used to scale companies from the £500 million point to the £1 billion, £2 billion or £3 billion point, where they are making products, employing people, paying tax and generating a cycle of income that fuels their R&D business to grow to a larger size? That takes 20 years, so if you have venture funds that are seven-year funds you are never going to get there; you have to have patient capital. It is not going to work unless you have that. It is also quite hard to do if you do not have viable public markets.

The key to the recommendations from the Treasury and the work that the Treasury is so ably doing is to change some of the stuff upfront. The EIS scheme has been modified and focused on high technology companies. I understand that people were buying pizza shops and crematoria as a way of preserving wealth, rather than investing it in the latest biotech company out of Cambridge, so that is a problem that it has fixed.

It has given the British Business Bank quite a lot of money to crowdsource in and leverage other money. It will be interesting to see if that works. I think it might, and it could bring multiple billions of risk capital. You will see an announcement tomorrow about that. We are attracting now very large funds to come to the UK to play in our sandpit.

The thing that I alluded to earlier is this issue about pensions. Direct contribution pension schemes are an almost perfect source of long-term capital for these kinds of ventures, and they have been prohibited from

investing in this space, which is completely nuts. The FCA needs to understand that this is not an unreasonable investment to take, to invest in companies at scale. I am not saying they should get involved in the start-up business, which is extremely high-risk and they would not have the expertise. By going to companies that are worth £400 million with things that could clearly be products, where all they need to do is scale and stay in the marketplace for another five years, ideally privately, not publicly, you will create some real companies. That is why I am quite confident about my £20 billion companies. Whether I can get there in 10 years, I am not sure, but the pensions industry in the City has £3 trillion worth of money. I do not need all that, I just need a little tiny bit to make this work; £5 billion or £6 billion a year would make all the difference.

Lord Griffiths of Fforestfach: As you know, there are real problems with pensions in this country, because of BHS and all of that. Another private company might go bust. I can see people immediately saying, "But you are taking pensions into a pretty high-risk business", because to get a winner it is very high return, very high risk. You are saying that we could scale up if we have enough there without people saying that you are putting the pensions industry at too much risk.

Professor Sir John Bell: The sweet spot for them is companies that have had the risk capital to get to a valuation of £100 million, £200 million or £300 million. Cambridge Antibody Technology is a really good example. That was sold to AstraZeneca for less than £1 billion. Its lead product, which is Humira, sells £18 billion a year. If it had just survived through that next step, we would have another major pharmaceutical company in the UK. I can tell you there was absolutely no risk in investing in that. We knew what its clinical data was; it was so obvious. I am not suggesting a very, very high-risk strategy for pension funds. When I talk to the pension industry, it is frustrated that that is limited to gilts and really low-return vehicles.

The Chairman:, To give an example, a company in California that launches for venture capital to fund cell-free DNA for early diagnosis of cancers—the technology does not exist now, as you and I both know; it requires expansion—gets a $1 billion investment straightaway. How does that happen?

Professor Sir John Bell: That is exactly the point I am trying to make. There are such deep pools of venture capital in America, and they are deep pools because they have been enormously successful. They have IRRs that make people desperate to join their new funds. You know the names of the companies, and they are terrific companies run by really good people who have a very long-term view on value. If you take the three, four or five companies that the US has turned from fledging organisations into major pharmaceutical companies—Genentech, Celgene, Vertex, Gilead—these are now some of the top companies in this space in the world. They have been created over a 25-year period, with continued investment over a long timeframe until they start to kick and get their first major project, and then they soar. We have to fix this

bit of the cycle, because otherwise this life sciences strategy will falter, and I am not asking for a lot; I just want one or two.

Q232 **Lord Vallance of Tummel:** The patient capital review is first rate and the "getting out the pension fund" side of it is also first rate. There is just one missing ingredient, to my mind, and it was not in the terms of reference. It is the cultural one of what I call the "multilinguists", those who speak science, finance and business. It is about how we promote that as well, because if you do not have that then the other stuff will not work. Is there a role for our business schools, particularly those that are affiliated to universities, in that?

Lord Griffiths of Fforestfach At Goldman Sachs, we put something like £7 billion into the life sciences sector reasonably successfully. When I talk to Americans in our offices in London, that issue comes up time and again. They say, compared to the US, we do not have people who know enough about science and technology to really help us with investment.

Professor Sir John Bell: That is definitely a weakness. The US has been very good at convergent training, in a sense, where people will get a science degree, then get an MBA, then go out into industry. They exist here, but you have to put a lot of them in the top of the funnel to get the few real stars who emerge at the bottom. It is definitely a weakness and something that we need to think about how we can fix.

Q233 **Lord Borwick:** You have talked about your big, hairy, audacious goal of four companies with a capitalisation of £20 billion. Can you tell us how you came to that goal? Is it just to get the headlines? Would it not be better to have 20 companies with a £4 billion capitalisation than four with £20 billion?

Professor Sir John Bell: It was not evidence-based, as you can imagine.

Lord Borwick: That I guessed, yes.

Professor Sir John Bell: I looked around the country and I said, "How many do we have that have a valuation of about £1 billion?" There are about five. Would it be possible for funds or entities to come and add to that five, to make it six or seven? At that point they are unlikely to disappear, but the real question is whether they will scale fast enough to get to that number in time. I took a view that, say, 60% or 70% of those get the scaling capital they need to get products in the market and then expand. We may not get to four, but if we get a couple I will be pretty happy. There was no point in saying let us make one, because everybody is going to say, "Well, that was pretty pathetic. That is not going anywhere". There was no point in saying 10, because nobody is going to believe that. Anyway, the number of four you can imagine came from those sorts of thoughts.

There are private companies that have those valuations around the country. There are also public companies that hover around the £1 billion mark, and they could scale quite quickly if they get products on the market. The crucial thing is sales, so you can then do discounted cash

flows and the value starts to go up. With a big product you can get there quite quickly, so I am optimistic we will be able to deliver on that promise, to some extent. It would be great if we got four, but if we got two or three I would be happy.

Lord Borwick: Would you not be better to concentrate on a lower goal with a larger number of players?

Professor Sir John Bell: Then you get into this issue of where the inflection points are. There are two inflection points. One inflection point sits between £500 million and £1 billion. Then how do you get from £1 billion to whatever number you want at the top end? I do not see an inflection point at £3 billion. There are other inflection points. You will say, "Well, you do not have any experience", because we have never had one of those and that is absolutely correct. When you look at America, if you look at the ones that go like that, they get to $1 billion; then, if you look at Kite, it was sold for $11.9 billion. It did that in four years. It started by getting a valuation in the hundreds of millions, and then it shot straight up to an enormous valuation. That was driven by the innovative nature of its products. That is why I believe that life sciences is one of those places where, if you get the right product, you can change the world, but it has to be different and differentiated.

Q234 **Lord Mair:** Going back to the HARP discussion earlier, in your report you talked about the strategic goal being two to three completely new industries. Does that tie in with what you have just been saying?

Professor Sir John Bell: It does. It would be a real shame to make two to three industries that ended up in California. That would be a real mistake. Those two notions are very closely hooked up together. We have to fix the patient capital piece and the management piece and, at the same time, fuel it with some of these ideas where everybody goes, "Oh my goodness me, you can diagnose these diseases 20 years before and change the whole paradigm for therapeutics". That is a £20 billion company, let me tell you, for sure.

Q235 **The Chairman:** Given where the science is, diagnostics is where the future lies, as you seem to suggest, with AI, pathology, immunology and early tests, as opposed to developing drugs, because that takes longer. Is that why the strategy is based on developing big new companies of a unicorn size?

Professor Sir John Bell: You want a mixture of both. Diagnostics is, at some level, lower risk, but you also cap out pretty quickly. There is always a lot of consolidation in the diagnostics business, so you run a risk, all the way along, of losing those companies. You want that mixed with novel therapeutics that differentiate themselves in the marketplace. One of the things we argue in the paper is that there is a really interesting place for novel drugs that approach targets that are involved in the generic ageing process, everything from heart disease to dementia and diabetes—all the diseases that ageing populations have. If you could get a single therapeutic molecule that approached those, which would probably have something to do with stem cell senescence or regeneration

as a systematic problem, that would be an enormous game-changer. You would have a £200 billion company in a millisecond.

People say that will never happen, but that is exactly the point I was trying to make before. The MRC said, "Well, that will never happen". It will definitely never happen if you never do the experiment; that is for sure. Can everybody just try to be a bit braver, please?

Lord Maxton: People will not be brave as long as there are political decisions on pensions, age groups and all the rest of it.

The Chairman: The next question is the question of the day, the year and the second.

Q236 **Baroness Neville-Jones:** We have a change of gear now, Sir John. One of the pictures you have been painting is that, in order to succeed, this life sciences strategy has to get its tentacles into many other bits of the economy. I want to ask you about the relationship between Brexit and the industrial strategy. One of the Government's answers to the question of how you reposition the UK post Brexit is the industrial strategy. Most people would agree it is something the UK ought to be doing anyway, but it becomes doubly important to succeed given some of the uncertainties that we are going to face. The question I wanted to ask you, in the area in which you have been the author, is this: what do you see as being the impact of Brexit on the possibilities of really good, speedy implementation?

Professor Sir John Bell: This topic came up in almost every conversation we had with industries that were thinking about investing in the UK. It is a subject of considerable concern for the industry, although it sees that, if we handle it properly, it will be fine. Brexit is not going to eliminate the terrific science base that exists in this country; we will always have that. Our great universities, which have been around for 800 or 900 years, have seen far worse than Brexit, so let us not worry about that. One issue that comes up repeatedly is the need to avoid lots of barriers between borders, because the supply chains from pharma go back and forth all the time. Products come in from Singapore, arrive in France, are formulated in France, are packaged in the UK, go back to Portugal, are stocked in Portugal and are sold back to Botswana. If you introduce lots of complexity in that, it is really disabling. It has been said, and I do not know whether it is true, that it may well even limit the supply of drugs across Europe and the UK. You would have to ask the industry that, but I would be worried about that.

The second thing that it worries about, alongside that, is some kind of regulatory alignment with Europe. If the UK sets itself out as a completely separate regulatory domain, we are too small to punch in that space, so that is an issue. The access to highly skilled people is crucial. This is a knowledge-based industry. If you cannot get smart people in and out, you will not have a knowledge-based industry. Those are the two or three things that come back over and over again.

Will it work in a UK outside the EU? My view is that it absolutely will, but there are some things that will make that much harder than others. This

is a very vibrant bit of the UK economy. It is the most productive bit of the UK economy, much more productive than financial services, so you need to pay attention because this is a bit you do not want to lose.

Baroness Neville-Jones: The companies are nevertheless going to join in the sector deal. What is their motivation, if that is the case? They can see the dangers.

Professor Sir John Bell: We will announce 25 companies today that are participating in the first wave, several billion pounds' worth of investment, including the one that I mentioned last week, and then there will be subsequent waves. I can see another wave about the same size coming through at the end of the first half of 2018. We have built quite a bit of momentum that is going to generate jobs and economic growth, and do all the things we need to do.

These companies just want to do the science. They want to get products out in the healthcare domain that are good, and that they can sell and make returns to shareholders, in an environment where they have access to great scientists, great clinicians, ideally some of the assets of a single-payer healthcare system and opportunities to access, sensibly and carefully, digitised data of one sort or another. They are interested in all those things. They have, at some level, voted with their feet. They have said, "We are in", but they are watching. They have not gone to sleep on this and, as you know, there have been things in the press this week.

Baroness Neville-Jones: What is your experience so far and what do you think about the potential threats to the skills base?

Professor Sir John Bell: All the uncertainty is causing some trouble with European scientists. The academic institutions are losing a few. More importantly, if you look at the piles of applicants for graduate studentships and so on, they are way down in terms of European applicants, so there is an issue. If it all gets squared around, those flows will come back. Historically, we have worked with lots of countries that you need visas to come from: the US, Canada, Australia, Singapore and China. We get students from all those places, so we can do all that stuff.

May I add one other really important issue? In the heart of all is the clinician scientist, a clinically qualified scientist with scientific skills. They are like gold dust. Our regulatory agency, i.e. the GMC, has made it almost impossible to recruit the most talented, skilled clinician scientists from around the world into the UK. The paperwork that people have to complete is awesome; it can stand four or five feet tall. They wait years to get approval. If we are going into a world where we are on our own, we had better sort that problem out, because it will completely stuff us. It is impossible.

The Chairman: I agree that the regulatory body needs to change.

Q237 **Lord Vallance of Tummel:** May I take you back to the first section of your answer on this question, which was to do with the supply chains? I think you were implying that the bit that was trickiest was coming out of the customs union.

Professor Sir John Bell: Yes.

Lord Vallance of Tummel: If one could find an answer, for example in Ireland, that might be applied elsewhere one might get round that. I am just thinking off the top of my head. The customs union is very important. It is something that people do not think about very much, but it is key in this.

Professor Sir John Bell: I am not going to get involved in a discussion about how we can solve that problem. I want to point out to people that supply chains for pharmaceuticals are really complicated and, because we have been in Europe for God knows how many years, they are fully integrated; the plant is in Ireland, but the formulation is here. The clinical trials are going on all over Europe. If you have to have different regulations and different entry criteria to do clinical trials here compared to anywhere else, that will just vaporise. There are really serious issues. The most serious issue, which everybody on both sides of this discussion needs to think about, is if the disruption to the supply chains means people do not get their drugs that is very serious. That means not just people here but globally: people in Botswana, in Africa or wherever. If the fooling around makes that impossible and people die, there is a problem.

Q238 **The Chairman:** Sir John, I was tempted to say we have probably drained you, but, knowing you, I know that would be wrong. I am going to end by asking you the last question. I am going to give you the opportunity to tell us three key recommendations you would like to see us make that will help drive your industrial strategy on life sciences. You can pick on the NHS, the finance side or anything else.

Professor Sir John Bell: The first one is governance and accountability. We have all been around long enough to see things drift after they have been delivered. It almost always occurs because there is nobody accountable for delivering it. Civil servants go off and do other things; Ministers turn over; people lose interest. For this to be sustainable, it has to have a proper governance framework. I would really welcome your input into that, because you, more than anybody, understand the importance of the governance piece.

The second thing is to think really hard about how we can get the NHS better engaged with at least some of these domains, to ensure that it does what it has agreed to do and that it continues to work in a collaborative fashion with the industry. Without that we have no USP. That means, in the NHS, there has to be accountability for who does what to whom. It cannot just say, "Yes, it is all fine; we will do it". Who is going to do it? Who is responsible if it does not work? Who is responsible if you do not deliver this? That would be really helpful.

The third thing, which is fundamental to the whole story, is capital. We have terrific science, terrific start-up companies and the opportunity to create some really substantial new industries in the UK, but we cannot do it without capital. Encouraging the Treasury to continue to be bold, to help the regulators understand the opportunities and to encourage

particularly the pensions industry to invest in this space could be a complete game-changer and, if handled properly, would boost this sector in a remarkable way. Those would be my three.

The Chairman: Thank you very much indeed. I am sorry to have gone on for so long, but we needed to make sure we gave you a chance to cover all aspects. Thank you very much indeed.