And now, could I ask Stefan and Daniel to come up and join us. We're running a bit late, so we'll take just five minutes for questions. But before we start the questions, I did want to give you a sense of what it is like to be a Biobank participant. We heard from one early in the afternoon. We all depend on them to an enormous extent and Andrew [?Tahern 0:00:27.3] has prepared a short video from one participant, the 25,000th. Let's run the video now.

F: I think it's very important to contribute to the UK Biobank. Looking at diseases and going forward in the future, the more information that's available to scientists now, where they can study and identify key diseases and look at ways of preventing in the future is invaluable to assist the population as a whole. I think it's a beneficial experience coming down here and going through all the tests, finding out more about what it is that they're using to look into medical conditions and it's nice to meet new people, too. They're a very friendly bunch.

[Round of applause]

These people are really the backbone of this entire resource, so thank you to them from all of us. Now, we have just about five minutes for some questions for the speakers. Andrew has a microphone here. Are there any questions from the floor? Ewan?

Daniel, I thought this use of machine learning that features to skip the two-steps and put them into one-step. You left us with this question about how to interpret the black box. Do you believe it's impossible or do you believe there's going to be hope to interpret these black boxes? If you do end-to-end training from images to outcomes, how do we pick apart these black boxes?

I think that's a very good question. I think at the moment, I don't think there are many techniques who can do that, but there's a huge community of people working on this. For example, these are the same techniques you use in a self-driving car to work out whether it would detect a pedestrian and in order to understand whether you can guarantee that it would detect a pedestrian, if there is one, you also need to interpret these features. So, I think the answer is at the moment, no, but I think there is the Google's, the Facebook's of this world, all work on effectively, what is a very similar problem and I think what we can do is, we can take some of these techniques they might develop and actually then, use it in the context of deriving information which we can interpret, for example, for Biobank.

Yes, there's no question, the next frontier is going to be how we can open up this data resource and develop much more sophisticated ways of deriving information from it. Are there any other questions? One at the back.

F: Hi, there. My name is Julia Lee from Southern Bridges. I have a question for the panellists, in presenting your research today, you showcased things that when the Biobank was first established was not envisioned, just as new technologies come and new techniques are applied. I wonder if you could offer some predictions on what would be coming next in the new wave of technologies that would harness Biobank's data?

I like that everybody is pointing at me! I guess, one of the things is - I think Nick already made that point as well that actually, the data, for example, is also an incredibly valuable resource for engineers to develop new ways of interpreting images, new ways of building models, virtual models for example, of the anatomy, the physiology and the function, and I think that is an incredibly rich resource. Especially, because it's not only containing the images but actually, as you suggested, it contains a lot of information which actually otherwise, is very difficult to correlate with the imaging.

Yes, I think I would just add to that - and I'm not a technology person, so I wouldn't like to predict too much the future, but what I would say is that, just on the data that has been derived so far, there are things that have come out of this and things that are being done that I just had no idea could be done. For example, pixel-level analysis of the DXA scans. The things that are coming at us from the engineers, from the computer scientists and then, I think this is the way so much of biomedical research is going. But I think that is bound to drive so much innovation going forward.

Stefan, do you have a comment?

I think when we started thinking about 100,000 cardiac MR scans, absolutely no way would I have ever imagined that we'd have tools like we now have for the automatic segmentation. I think we had discussions but everybody said, no, that's not possible because the heart's moving, it's really complex and unlike, the brain, the resolution is different, so it's a completely different beast, and now, we can do it. So, I think there will be lots of things that we can't imagine today, so I think that's one statement. The other thing is I think that, in the images that we have acquired, I think I had one slide there on radiomics, which is in a simple way, it's to look at lots of things or let the computer look for features in the images that we can't see with our eye, really, or can't measure. I think there's a lot of information in there and I'm really intrigued to see what we learn when we start looking at this and outcomes. Just one example, I think maybe there is something in blurriness in the images, in the cardiac images, which may reflect that people can't hold their breath as well or they're moving a little bit or more uncomfortable, and maybe that will become a fantastic marker for outcome. It's just one of the thoughts that we have and you wouldn't be able to measure that in any simple way currently.

No, it's fantastic. Let me also stress, it's not all just about finding new things in the data. It's about people who are organ-specific in their focus, like a neurologist, rethinking about how important it is to know about what's

happening in the rest of the body and how that influences the brain. There was another question in the middle and this is our final one and then we'll move on after this.

F: Thanks. Eliza [?Ginny 0:07:15.4] from the [unclear word 0:07:15.6] Institute. It's really wonderful to see all this work on musculoskeletal disease. I wonder if there are any plans to link through to the national joint register and therefore, bolster the types of clinical phenotypes around arthroplasty?

Yes, I think that is a really good point and that's one of the things we're working on through the augment study and with the national hip fracture database as well. It's not done yet, but it's something we're looking at.

Well, thank you very much, all of our panel members and the audience for the questions.

**[END OF TRANSCRIPT]**