Now it's a pleasure to ask Professor Paul Foster from University College London to come up and tell us about the achievements of the UK Biobank eye and vision consortium, and as someone who's watched the activity of this consortium for many years, I think what they've achieved is really fantastic and a real model for productive collaboration, Paul.

So good afternoon, I'm going to try to give you a short summary of the scope and potential of the eye data in UK Biobank and report on some of the publications that we've seen in the last 12 months, both within our consortium and outside. Showing that the data is available to all and the potential for that data to be used by many research groups. Now, that's not my first slide, so if we can maybe get my slides up, I'm not talking about that. Paul Foster and it should have eye in the title slide. Okay, so while we're waiting, I was going to start off by telling you about the size of the, or the activity within the eye and vision sector in the UK. Eye and vision is a very big part of the NHS, eye departments are the second busiest departments within the NHS, and that's because there are about six million people in the UK who have sight threatening conditions and unfortunately about two million of those have lost enough sight to bar them from driving. In the over 75s, ten per cent of people are partially sighted, again, they couldn't drive, and one person in 50 is severely sight impaired or blind.

The direct costs of vision loss, £3 billion and indirect costs £25 billion, so a very profound problem in terms of the financial cost and the cost to human quality of life. Sixteen million people have eye tests per year in NHS funded opticians. There are eight million appointments in hospital eye departments, 400,000 cataract operations done per year, it's the commonest operation done in the UK. As I was saying, this figure puts us just behind orthopaedics, trauma, accident and emergency, as the busiest NHS service. Three million diabetics are under regular photographic screening review.

If you ask the public, sight is the one sense that they most fear losing, you can see here, it's about 77 per cent of people say they value their sight most and I've put up some panels from Rembrandts series of the senses pictures, and the sight one here features somebody selling glasses and actually the sound one here of people singing, and the chap there is wearing some glasses as well. So sight is important for many different aspects of life.

The eye and vision data was included relatively late in the process of data collection, but we've ended up with about 130,000 people who have had measures of visual acuity chart reading, measures of spectacle correction and curvature of the cornea, the anterior refracting surface of the eye. Intraocular pressure and corneal collagen biomechanics, intraocular pressure is important because it's the main modifiable risk factor for glaucoma, the commonest primary neurodegenerative disease there is. Eighty seven thousand people had retinal photographs including the optic disc the cardinal retinal vessels, the macular retina and then an OCT, an optical coherence tomography examination of the centre part of the retina and we're able to segment out individual cellular layers there and look at them individually.

So coming to some of the results, we had a period last summer, lasting about four months where each
month there was another major publication using UK Biobank in major medical journals. This was one of the first and it relates to the genetic determinants of myopia, now myopia is one of the commonest diseases there is in some parts of the world. The prevalence is over 90 per cent and it's associated with many other diseases, cataracts glaucoma, retinal bleeding, etc., which are all serious in their own right. Now, it's always been assumed that myopia is a direct result of how much you read. Now, the emerging evidence points more towards the exposure to outdoor natural light, and so it was interesting in this paper where there was UK Biobank data being used to fully develop the results that the authors suggest that refractive errors are caused by a light dependent retinal-to-scleral signalling cascade and so I think that helps to consolidate the idea that light exposure is the driving factor in this very important disease.

Then the next month we had this report looking at the genetics of interocular pressure, the main modifiable risk factor for glaucoma and also looking at the ability to risk predict primary open-angled glaucoma, which affects about one person in 50 in the over 40s, and one person in ten in the over 80s. So this was led by my Moorfields colleague Anthony Khawaja and Pirro Hysi at Kings College London and incorporated a large number of collaborators around the world. Colleagues in Boston, in Cambridge, the Boston group contributed 30,000 cases of disease to this analysis and basically, what we've been able to determine is that from the genetics, we can identify more than 75 per cent of the risk of people developing glaucoma. Now, glaucoma as I said, it's a primary neurodegenerative condition, the neural tissue in the optic nerve head here is gradually eroded away giving this punched out pale appearance in the centre of the optic nerve. I think this is the first time that we really feel we've got a firm handle on the etiological mechanisms around this disease and it's pointing to new regions of the eye where the disease is having its effect.

The following month, a group in Australia, so the last one I showed you was a UK based group, this is an Australian group who have used UK Biobank and they've identified even more snips that are associated with the aetiology of glaucoma.

So it's been a very fruitful collaboration that we've been able to develop. My colleague Anthony Khawaja here, who was the lead UK author for the first glaucoma study I told you about, has built links with Ewan Birney's group at EBI in Hinxton in Cambridge. Hannah Currant, one of Ewan's pre-doctoral fellows, is working with Anthony on looking at the genetics of retinal anatomy and particularly focusing on the features that we saw in the glaucoma analysis and trying to untangle the biological mechanisms behind those. So we watch that with interest. Hannah actually has a poster outside if any of you are interested to see that.

It's important to remember that the eye, we're not just interested in diseases that affect the eye, the eye can tell us much about systemic health. There isn't a single major systemic disease that does not have an eye sign, and colleagues, Chris Owen and Alicja Rudnicka at St George's and Sarah Barman at Kingston have developed a software system that tries to quantify the variation in the retinal vascular network, it will give measures of calibre, tortuosity and branch angle, and this will give us insights into cardiovascular risk. Chris and Alicja and Sarah have looked at the associations for the arterials and the venules and you see different disease associations with the arterials showing a more atherosclerotic picture, and the venules showing a more
metabolic disease picture. So that's interesting work going on, looking more towards cardiovascular disease than eye disease. Don't

One of the most fascinating results that UK Biobank eye data has been used to generate, is this work from the Google group in Mountain View, California. Again, looking at the cardiovascular risk factor spectrum and using deep learning algorithms to try to identify previously unquantifiable features. Now, what they've done is, they've trained the deep learning algorithm on a series of photos and they tested it and tested its ability to identify some of these risk factors and remarkably, just from looking at the retinal photograph, this system can identify the age of the individual within three years, the gender and my apologies, that decimal point shouldn't be there. So that's 97 per cent certainty of identifying from the retinal photo, whether this is a man or a woman. There's no way that a human can do that unless the person is sitting in front of you, and you can see them, but from the photo, humans cannot do this, this is something completely new. It can tell you with 71 per cent accuracy the smoking status, the blood pressure and with 70 per cent accuracy whether they've had a major cardiovascular event.

So although it's somewhat less strong in identifying the major health outcomes, this stuff up here, the age, gender, smoking status is all really very interesting and new stuff. So if you're interested in any of the work that we're doing in the eye and vision consortium, you can find the details on our website, it's got details of all of the research groups. Currently we have 80 members spread across 22 health scientist centres in the UK. As I've said, this is one of our annual meetings, so you can see some of the group there. It's not just the UK, and it's not just academics that are using the data. I've told you about the myopia work led by Caroline Klaver at Erasmus University in Rotterdam, the QIMR, Queensland Institute of Medical Research in Brisbane, doing some of the genetics work, University of Chicago doing genetics work as well. Then Google, I've told you about, DeepMind, the artificial intelligence group near Kings Cross also have the data and are using it to look at eye and vision characteristics, some of our funders and short summary, so thank you very much for your attention and I'll leave it there.

[END OF TRANSCRIPT]