Transcript for Decoding the genetics of inherited retinal diseases - Fight for Sight webinar

**Emma Blamont, Host:** [00:00:00] Emma Blamont and I'm head of research and programs at Fight for Sight

I used to be a lab scientist back in the day, an immunologist specifically. And since leaving the lab, I've worked in, within other funders like Breast Cancer Now, the National Institute of Health and Research. and Scleroderma and Raynaud's UK. And I'm really happy to be at Fight the Sight and working with the research and cial change programs in advancing the great work that we do and in hosting this webinar and allowing people to discover more about the work or learn more about the work that Gavin has done.

 We fund brilliant minds and the bright ideas that put the change in sight. And for anyone impacted by vision loss. And we do this through investing in sustainable projects that deliver equity and fund science that will help us better understand, diagnose, prevent and treat vision loss.

 This slide shows one of our researchers, Dr. Matteo [00:01:00] Rizzi from UCL, at work analyzing me images that have come out of his research. Dr. Rizzi and his colleague, Profesr Omar Maru, undertaken research into Stargardt disease, which is an inherited eye condition, and they received a project grant to do this from Fight for Sight last year.

 Research funding has a really important place in the research ecosystem. Research into preventing and treating sight loss is chronically underfunding and receives a mere 1. 2 percent of publicly funded health grants. The researchers that we fund really are at the cutting edge, making breakthroughs and discoveries that will help us better understand, diagnose, and prevent and treat eye disease.

We're not just a research funder, we al fund projects that can help drive cial change for people who are blind or visually impaired. And this is an example of one of our cial change projects, which features Jamie's father [00:02:00] in Hareford. And the picture on the slide shows a group of young vision impaired people sitting together around a kitchen table with Dave, the head farmer at Jamie's Farm.

And this is part of our loneliness and ilation funding, where we funded farm visits for young people to experience the benefits of being in nature and build connections between each other. These partnerships are really pivotal for changing the lives of blind and vision impaired people.

Research shows that people who are blind or vision impaired are three times more likely to experience loneliness and ilation than the general population, which makes these types of projects really rewarding for us as a charity.

 This brings us on to our research. Strategy. We don't just invest in [00:03:00] projects, we invest in people, and we aspire to build a vibrant community of vision researchers, foster collaboration, and accelerate partnership and progress. And the diagram on this slide really represents this. And at the center of our diagram, and as our activities and organization of people who have vision impaired and living with sight loss.

Thank you As illustrated by the man in the picture who's listening to his phone screen reader with the text around him reading patient and public involvement and engagement. Our grant funding, which really drives a lot of this work, is divided into four key themes, each with significant impact on our activities to understanding the biology of vision loss and eye disease.

Prevention, diagnosis, and treatment.

I think it's enough from me. And now it's really [00:04:00] time for Gavin to take the center stage. I'd like to give Gavin a big welcome and thank him for joining us today from uth Carolina. He's an honorary profesr as well at the UCL Institute of Ophthalmology, as well as being an asciate director of research at Greenwood Genetic Center in uth Carolina.

And Dr. Arno is particularly interested in identifying the genetic defects leading to rare diseases, particularly inherited eye disease. Over to you, Gavin. Hi, thank you very much. I hope you weren't expecting me to have an American accent, by the way. I am here in uth Carolina, but I was born and raised in, in London in the UK.

 It's nice to be here. It's it's just the afternoon now, good afternoon to everyone. And thanks for joining us for this session. You're going to start with me questions for me, is that right? Yeah. [00:05:00] Yeah I suppose aside from the welcome, which we've already done, could you introduce yourself and explain your current role and your previous role, please?

Yeah, sure. I guess we'll start now and go backwards from there. I am the Asciate Director for Research at Greenwood Genetic Center in uth Carolina, in the US. We are a a clinical and research Institute. We're a nonprofit organization. And the aim of our work is to provide genetic testing and genetic care for patients in the state of uth Carolina and beyond, um, much of the work that we do is on clinical genetic testing for ID, autism developmental delay and and severe inherited dirders My role here, or one of the biggest reans that, that I was recruited [00:06:00] here is as a director of research for innovation.

 The aim is to bring new technologies to advance genetic testing and advance the care for patients here. That's why I came. And with that much of the research that I'm doing now. is focused on new technologies and those are around a technology called long read sequencing which is hopefully a transformative technology that will push forward clinical diagnostics for patients with heritable diseases including patients with inherited eye diseases in that.

 That's where I'm now. I've been here for six months now. And my lab is up and running. I've actually got my PhD student from London here at the moment. He's he's with me for the next four months. And I've I've got my lab set up here. I al hold an honorary post at the Institute of Ophthalmology, which was mentioned earlier.

 I have a research [00:07:00] lab based there. And I work closely still with my colleagues at Moorfields Eye Hospital Profesr Andrew Webster, who I think is on the session today. And others in more fields. We still work on genetic data from more fields patients by collaboration across the ocean.

And I guess that takes me to my previous role. Before I came here. I was the senior scientist for the genetics department at Moorfields Eye Hospital where all of the genome testing for patients with with genetic eye diseases came through our department and and we helped to analyze and interpret those results for patients and families.

I have a research lab in, in the UK where we were. developing new methods of analyzing that data, particularly around the 100, 000 Genomes Project, which I'm sure we'll talk about in a bit more detail later to advance the diagnostics in the [00:08:00] UK for patients with inherited eye diseases. And then going back a bit, Before then before I became the senior scientist at Moorfields, I had, I held the Fight4Sci Early Career Investigator Award, which was what enabled me to establish my own laboratory at the Institute of Ophthalmology and develop my research program.

Looking for new causes of retinal diseases and characterizing new mechanisms of retinal diseases. And before that, I was a postdoc scientist in the lab of Rolf Webster and Rolf Moore, previous to that. And beyond that is ancient history. Thank you, Gavin. You mentioned your early career research award that you have received from White for Sight.

 How instrumental do you think that was in terms of really setting up and accelerating your career? Yeah that was awarded in 2017 and it [00:09:00] funded, firstly enabled me to establish my own research program. Previous to that, I was a postdoc scientist doing me really exciting work. But I was working on other people's projects and developing my own ideas towards independence.

And that's how the Early Career Investigator Award came about. benefited me. It enabled me to set up my lab and to start exploring those new avenues of research under my own funding and develop those ideas further. And that award funded my laboratory at least in part for five years.

And during those five years that's when I established myself as a leader in ophthalmic genetics. I could establish a global collaborative network with lots of other labs in Europe, in the States, in Japan, and develop ideas with those and develop collaborative [00:10:00] projects. And essentially it really launched my both my academic and my professional career.

 It was a huge benefit to me, for sure. Thank you. You've mentioned in your introduction when you were explaining your previous roles. That you've worked a lot with public initiatives like the 100, 000 Genomes Project. How important do you feel these are to advancing research and how can newer prospective studies like our future health play further, really further benefit research?

Where do you see the potentials? Yeah I was privileged to, to work on kind of the precurr to the 100, 000 Genomes Project, which was the NIHR BioReurce Rare Disease Study. And this was, this is going back to around about 2013 2014 when that project was launched. And it was the first [00:11:00] of its kind.

It was a large scale whole genome sequencing project to look at the causes of rare diseases and included in that were around about 700. patients from Moorfields Eye Hospital. The benefit of working on that for our research and and the patients at Moorfields was that several gene discoveries were made from that project.

 Many new diagnoses were made, many new genes were found that cause retinal dystrophies. And And these all fed back into the diagnostic lab and were included from that point onwards in all clinical testing for inherited eye diseases. And that kind of that was a global leading project.

That was the first. project of its kind to use whole genome sequencing in a diagnostic setting. And from that, really, the 100, 000 Genomes Project came about, which was much larger, spanned many [00:12:00] more disease areas and included many more patients with retinal dystrophy and across rare disease.

 I think there were mewhere around about two to three thousand patients with retinal dystrophy included in that project. And when we get into these large scale projects that enable these discoveries to be made, obviously we can all see the benefit for researchers from that and we can extrapolate the benefit for patients.

Patients are individually getting diagnoses from these projects, but it's al building towards a better diagnostic pipeline for all patients who are subsequently tested. And we see that in our diagnostic yields over the years. If you go back to Before whole genome sequencing was available at all, we had a diagnostic yield of mewhere around about 40 percent of [00:13:00] patients were getting a positive genetic test back from gene panel testing.

We're now up to mewhere around about 70 to 80 percent of patients with a retinal dystrophy get a positive genetic test. Now, due to All of the advances made through these projects and others, and then looking forward to, larger scale population based projects like our future health and using integrating genomic data with public health data.

These are going to be transformative for many disease areas, many areas of research in general public health, but al in rare disease as well. And really need people to volunteer, we need people to participate in these, otherwise they simply won't be big enough to be able to generate meaningful data sets.

And one area we really need help with is to encourage individuals of black and ethnic [00:14:00] minorities to contribute data to these projects because historically these groups have been poorly represented in, in not only disease data sets, but in, in population based data sets. And we do worse understanding the cause of genetic disease in black and ethnic minorities because of that.

it will be through large scale studies like this that we will start to better understand the the genetic variation across many different populations in the UK and around the world as well. And to follow on, do you think that might eventually hold hold hope for treatments or interventions?

Yeah, I think much of the development of therapies at the moment is around things like gene therapy. This is a really exciting area of research and there are lots of different gene targeted therapies in trial at the moment, but as we [00:15:00] can understand the genetics, not only the individual genetic cause of disease, but all of the other genetic contributors to that disease, then this will open new pathways to things like genetic modifiers and not necessarily having to target the individual gene, but being able to target modifiers that will work across many different retinal dystrophies, for example.

 These are the things that we can start to think about looking forward to in the future, I think. Thank you so you mentioned you've got in a way, a dual position. You have two labs, one in the UK and one in the US. And how do you think, do you really see that's important in driving together international collaboration to accelerate outcomes for patients?

Or do you think there's still barriers to doing this? I think the future and [00:16:00] really the present day is that we do share data across the globe. For example, the 100, 000 Genomes Project data, we've just signed an agreement with Genomics England from here, from Greenwood, to allow us to access that data and start interrogating that data.

 Researchers here. We'll be able to register and access that data now. We already do collaborate across the world and international collaboration is essential for driving discoveries, We are part of a european conrtium on retinal dystrophy genetics. We are part of a global conrtium on retinal dystrophy genetics And when it comes to things like gene discovery Now Collaboration is key to enable that.

 The discoveries that we're making now [00:17:00] are exponentially rarer, or they affect very much fewer patients and individuals, broadly speaking, and to be able to validate and see the real effect of those genes on patient populations, we need to be able to broaden those patient populations to include patients.

collaborative groups all over the globe, really. And but there are barriers, obviously, there are barriers particularly between the US and the UK, because the way that genetics are done, the way that clinical genetics are done are very different. In the US, in the UK, it's all done within the NHS Genomic Medicine Service.

In the U. S. it's very much disjointed. Individual institutes will do their own testing. Data sharing is a bit more complicated, but we, we work towards doing better there for sure. Great. That's a good answer. [00:18:00] You've clearly had a brilliant career to date and, you've got many more years ahead of you researching.

But what would you say is your rt of career highlight today? Yeah, that's a, it's an interesting question. I think, I can talk about the discoveries that, that we've made, a gene discovery is a very exciting point in your career. And I've been lucky enough to make several and to, the impact of those discoveries is significant on the knowledge base for rare disease genetics.

Um, for me though, it's been it's been a unique experience, a privilege to have been part of these groundbreaking projects like the NIHR Bioreurce, which was the first in its of its kind in the world. And to be the lead scientist for the retinal dystrophy part of that project was a privilege.

And then to go on from [00:19:00] there and play a significant role in the genetics England, a hundred thousand genomes pilot and main study was al a privilege. But I think really that the highlight for me is probably now, because we are in a time where genomics is changing rapidly. And for a scientist to be working now in genomic scientists is the most exciting moment in my career.

 The new technology that we are using, things like long read sequencing, Oxford nanopore technologies sequencing to be able to answer questions and see things in the human genome that simply were not possible before now is hugely exciting. I think, if you ask me next year, it might be a different answer, but I think.

 Today that's my answer is it's an amazing time now to be a scientist working on the human genome. Okay. Thank you. I think that's proof you're in an exciting field. I [00:20:00] think we're now going to move on to the Q and A's. Please we, we'll come on to the questions which have been put into the Q& A function.

**Emma Blamont, Host:** And, we have a couple of free questions that have been sent in and we've selected me of those to get us started, but please type any questions you'd like to answer by Gavin into the Q& A channel. The first question is, my father and n are expected, suspected to have choroid uremia.

However, genetic testing is not has far not identified the gene. Are more phisticated genetic tests likely to be available in the near future? Yes, the I guess one answer to that is that currently, although we are doing whole genome sequencing for patients in the UK in the genetic medicine service the knowledge is a little bit behind in that it, we don't quite understand very well what's happening [00:21:00] outside of the parts of the gene that code for proteins.

A little bit of genetics is that genes are made up of exons and introns. The exons are the parts of the gene that make the protein. They directly code for the amino acids that put together the CHM, the Rep1 protein. And the introns are gaps between those between those exons.

Now, until, the last decade or , the introns were pretty much ignored completely, and we didn't really understand what they did. And, we're now starting to be able to understand what the introns mean and what their function is and understand what variants within those introns do to the gene and how they actually affect the protein.

 That knowledge lags behind the technology a little bit in that, that we can sequence all of those introns without any problem now, but We can't fully interpret those, clinical [00:22:00] testing currently doesn't look too deeply into those introns, because we don't have the ability to interpret what variants may be.

For a gene like choroideremia, or a disease like choroideremia, which is, pretty much monogenic. Vast majority of cases who have a clinical diagnosis, the vast majority of individuals who have a clinical diagnosis of choroideremia should have a variant within that gene mewhere, but it may be a gene that has not been looked at.

where it may be a variant that has not been interpreted or it may be a variant that has not been detected. We don't know the answer to that yet, but as the technology advances, we will better understand those variants. And as we use new technologies like long read sequencing, which are coming to the clinical labs in the next few years, probably we will be able to detect more of those variants as well.

Rry, Gavin, just to clarify for me more late. Perhaps me lay members of the audience. [00:23:00] In terms of monogenic, you mean just one gene is responsible, is that correct? Exactly, yes. Yeah, one, one gene, one disease. There are a couple of other genes that look similar to choroideremia with a different inheritance pattern.

But broadly speaking, choroideremia is is caused by variants in the CHM gene on the X chromome. And when you talk about the non coding bits of the genome, would this be what me people might have heard of as being referred to as junk DNA? Yeah, exactly. That's how it was previously thought of.

Now we know it has a function. We know it's important and we know that variants are there and me of them lead to dysfunction of the protein made from that gene. There are variants like that reported in the CHM gene. In fact, one was detected several decades ago when the [00:24:00] gene was discovered.

And we found several more since then in, at the Institute of Ophthalmology. We know they exist, we know that's a mechanism of disease for the CHM gene, but being able to interpret those often needs a functional test, it needs a second blood sample to be taken from a, from the patient to use for RNA analysis, for example, to be able to understand what the effect of that non coding variant is.

Okay. We have another question, which is mebody's question. When you say a positive genetic test, could you explain what that means in lay terms, please? Yeah. Okay. When we do genetic testing, we find the human genome is 3 billion letters long, and we all carry around about 5 million variants in our genes that don't lead to disease, they don't, they're non pathogenic, they don't have a severe effect. And when we do that genetic testing, we focus specifically on the retinal [00:25:00] dystrophy genes.

We will always find variants in those genes. No genetic test comes back with no variants on it. That's not mething that's new. That's even possible. The interpretation of all those variants and finding the individual mutation or variant that is leading to disease is where it becomes very complicated.

And we now have a method of classifying all variants into five different categories. We go from benign, To likely benign, to a variant of uncertain significance, to likely pathogenic, to pathogenic being the strongest category. And for a positive genetic result, the variant or variants need to fall in the likely pathogenic or pathogenic category.

And this is based on lots of lots of different pieces of evidence to, to score those variants in terms of how damaging it is to the gene, how [00:26:00] rare it is in the population, whether we've seen it before in, in other patients and individuals, whether we've seen it in lots and lots of, people who are unaffected by disease.

 The way that the variants are classified is on the report that patients get from the clinical lab. It will say a likely pathogenic variant has been found in gene X or gene Y and only those where the variants I thought to fully explain the disease only those will be considered to be a positive genetic test result.

Okay. Thank you. That's helpful. Very clear answer. We've got another question, which is actually from one of the pre questions sent in which is my n who's 21 is diagnosed with X linked RP mutation on RP2. He al has astigmatism. The pern would like to know if there's been any research on the RP two gene and when we can expect this kind of [00:27:00] therapy to begin.

And, perhaps a topical question, can we mehow improve damage or fix up the astigmatism to help him see better? And what else could be done to slow down the retinal deterioration besides sitting and waiting for blindness to come? Yeah, that's, it's, that's a hard question there are lots of therapies that are being investigated for many different genes.

And we know that there are roughly 300 genes known to cause a retinal dystrophy. RP2 is is one of the more common ones that we come across in the genetic clinic. And there are therapy. investigations ongoing for that gene specifically. It's very hard to predict when specific therapies will make it into into clinic and be available for individual patients.

And as a molecular geneticist, that, that's the rt of work that, that [00:28:00] is done by colleagues downstream of my lab. My lab is concerned with discovery and improving diagnostics. And we work with other groups who are interested in therapeutics, but we don't do that rt of work ourselves.

 I'm afraid, It's hard to say when a therapy will be available, but patients and individuals should hopefully be reassured that there are many researchers and many that are funded by FITE for sites specifically who are interested in developing and trying to develop therapies for genes like RP2.

**Emma Blamont, Host:** And then in terms of what can be done to slow down regression I think, the Families are advised well by their clinical teams as to what lifestyle choices they can make. And it very much depends on the specific gene that's causing disease. What rt of lifestyle choices can be made to improve the or to slow down progression of disease.

And these will be things like [00:29:00] to avoid smoking, to avoid going out in very bright sunlight and don't take vitamin D and all of that rt of thing for patients with RP. But I would, I'm a scientist, I would refer you to your clinical team for the best advice on those things.

Okay we've got a question from the Q& A which is what do you see as the biggest breakthrough in the inherited eye diseases genetic pipeline in the next five years? What do you think is really close? But that's a that's the rt of question I love. I think it's going to be long read sequencing and the application of multi omics investigations to genetic disease.

 That's a complicated statement. And I'll just try and clarify a few of those things. Currently the way that we do genetic testing is we take the 3 billion letter long genome and we smash it up into tiny pieces that are 150 [00:30:00] letters long. We sequence those and then we try and put it all back together again.

And that's really hard to do. The putting it back together again fails. For very large regions of the genome, including genes that are very relevant to retinal dystrophy genetics. RPGR, another cause of X linked retinopathy, has a region in it that's really hard for us to put it back together again.

The opsin array, which causes blue cone monochromacy as well is very complicated. Now, long read sequencing. works differently, it doesn't smash the genome up at all. It means we can sequence very large chunks of DNA in the millions of base pairs long, the millions of letters long. We can sequence single molecules of DNA in that way.

And that means the assembly again, is much less complicated if you compare it if you imagine it to be like assembling a really [00:31:00] complicated difficult 5000 piece jigsaw to assembling the same jigsaw that only has nine pieces, for example, it's a much easier experiment to do. And it's a new technology that.

that we're working with. And I think it has huge advantages over the current technology and it will potentially transform the way that, that genetics research and further down the line diagnostics are done for patients. And then I mentioned multi omics, which is a broad term that, that basically means we, we are able to study genomics transcriptomics, which is the message of the genes before a protein is made but study that on a large scale, which is difficult for retinal dystrophies because many of those genes are only functional in the retina.

 Being able to look at those genes in. [00:32:00] easily accessible tissues is quite difficult. And then proteomics, which is looking at the proteins that are made and metabolomics, looking at the the metabolome of the cells affected by disease. Looking at pathways within cells, what's affected what's upregulated, downregulated, what's functioning and non functioning in those cells.

 I think those things will advance. Research the diagnostic impact of those will, will come very much later. But I think in the next five years for me, long read sequencing will change the way things are done completely. Thank you. It was a follow up question would be is about really how important how will this improve lives and, how important would it be to give patients these genetic and multi omic answers?

Yeah. We are, we're working towards being able to. Provide a positive genetic [00:33:00] result for every patient who is in clinic. That's the aim of my research. And we improve that by discovering new causes of disease, which is the rts of experiments we're doing now. Long read sequencing will help us to lve questions.

And lve problems for patients that can't be lved by the current technology. For example, one, one big problem that we see at a clinic in Moorfields is that patients who need family segregation to confirm their genetic, result for their report. And I'm sure people who are on the call have, may have experienced this when parental samples are needed to be able to confirm a genetic result through phasing, through segregation.

Lots of people's families are not available for that. Maybe they're overseas. They may have passed away. They may be people, patients may have been [00:34:00] adopted. There are lots of reans why. segregation studies can't be done. And, one, one very simple thing that long read sequencing will improve is the fact that we don't need parental samples to phase variants anymore.

We can do it all from a single sample. The availability of that technology coming to the diagnostic labs will mean that the way we approach those experiments will change completely. That will improve the state of diagnostics, which when we think about therapeutics and treatments for retinal dystrophies, one, One essential component of that is that patients will need a a a diagnostic report, a positive genetic test to be able to receive a treatment, whether it be a gene therapy or a gene modifier.

 Without that patients who, who can't get that through the inability to have. family [00:35:00] segregation done, they will not have access to therapeutics based on that. That's one way that we aim to be able to improve clinical care. And al, counseling and understanding prognosis and regression of disease relies on that genetic report as well.

 These are all things that rely on having a clear genetic report. And that's one area we're aiming to improve. Okay, we've got another question that's a bit linked to long read sequencing, which is on long read sequencing. And mebody's put that they would assume that long read sequencing could allow for the identification of me issues that help in identifying the cause of newer diseases.

But beyond that what benefits might it give to those For which the conditions as for the diseases where the mutations are already known. Yeah, that's another good question. The audience are on their [00:36:00] toes, I have to say. Yes, we can identify new causes with long read sequencing.

We can sequence parts of the genome that were previously unsequenceable. But another thing that we can do with bearing in mind that the segregation and the phasing that I've just been talking about. is that we can characterize the entire genetic background that the mutations are on.

 A mutation on its own may be enough to cause disease, but it may it may, its severity or how how bad the effect of that variant is on the gene may depend on lots of other variants around it. We call these modifiers. And we don't understand modifiers very well at all yet, but having the ability to characterize, we call them haplotypes, which is the chunk of DNA that carries all of those different [00:37:00] variants on it, the single chromome that carries all those variants on it.

Being able to understand those using a technique like, Long read sequencing, rather than trying to infer that from short read data means that we'll have a much better ability to understand the potential modifiers that lie around the pathogenic variant itself. They've got a follow up question, which is would long read sequencing perhaps help in developing disease models?

Yeah, ablutely. And, one example of that is is the gene PRPF31, which causes dominant retinitis pigmentosa. It's known that almost half of, individuals who are carriers of a mutation in that gene are unaffected. We call this non penetrance. Lots of people can be unaffected in [00:38:00] families that can skip generations in families, even though it's the dominant disease gene.

**Emma Blamont, Host:** Now, we think we know where the modifiers of that are, where the variants are that switch that on or off. And they're around that gene. A technology like long read sequencing will enable us to investigate that to a depth that we haven't been able to do far. Okay, thanks. I think we've got about five minutes left for questions.

Perhaps we could squeeze in one or two more depending on on the rt of responses. We've got a question here, which is ophthalmology the next exciting health area in which we can expect to see groundbreaking discoveries and thinking about the things that have come out of oncology, diabetes, and Parkinn's?

For me it's exciting. Yes. And I think, one, one area where it has proven to be groundbreaking is in the development of gene therapies. The first gene therapy [00:39:00] was, of course, for the RPE65. gene, which is a retinal dystrophy gene. It is leading the way for many areas of research.

And I think for genetics, for rare disease genetics, and I haven't mentioned this at all, but one of the reans why ophthalmic genetics is exciting for a researcher like me. I'm a molecular geneticist. I'm not an ophthalmologist, but the area of research that I've chosen is retinal dystrophy genetics because We have a very great understanding of the genetics of retinal dystrophy now, and that's partly due to the fact that, we work with we work with very closely with the clinic and we have the ability to see the cells that are affected in live patients in clinic, Which is a unique feature of retinal dystrophy.

You can't see the cells in, in cardiovascular disease and ask patients what the symptoms are of their disease. This kind [00:40:00] of drives discovery, this ability to combine that clinical data that the patient's biography and all of that stuff with the genome data drives discovery and it puts ophthalmology.

ophthalmic genetics at the forefront of genetics research. If you look at the 100, 000 genomes data results that were reported a few years ago, the pilot study results, the diagnostic yield was highest in ophthalmic genetics. That's partly due to the work that we did, but partly due to the fact that we have a greater understanding of the causes of retinal dystrophies compared to many other disease areas.

 That makes it a great model for future research. It's a great model for the long read sequencing research, which is why I continue to work in this paradigm going forwards. And discoveries are driven by that fact. Yes, I think it is exciting. I think there are lots of big [00:41:00] discoveries to be made and, the next.

the next target area is things like modifiers and being able to understand what the genetic background, the effect of the genetic background has on disease. And I think ophthalmic genetics is the perfect sphere for that work as well.

Thank you, Gavin. Thank you. And thank you to the audience for all of your questions. I think that's probably all that we have time for today. But we'll try and answer as many as we can after the webinar. If you'd like further information on either Dr. Arnaud or Gavin's research, which has been funded by Fight for Science, we'd like to know more about genetics and the eye condition, and find out more about our research funding.

You can do this by these Looking at these links later on after the webinar is finished Please don't scramble to write things down because these will be available to you in your follow up email Which will include [00:42:00] links to the recording transcript and this information thank you once again for attending and we hope you found it informative And we hope to see you at the next webinar in our series.

Thank you very much