Good afternoon esteemed guests and Golden Alumni. It's a great honour for me to stand on this stage today. But it's not the first time that I've stood here. I came to the University of Sydney and did a Bachelor of Medicine and Medical Science and then I graduated, and I stood here, and then I graduated from a Bachelor of Medicine and Bachelor of Surgery.

I went to Oxford to study neurology and Kenya to study ophthalmology. I then wandered up to Newtown one day and met Fred Hollows during a book signing and I thought I wanted to save sight as well. This then led me to the United Kingdom where I did my PHD and sub-specialty training.

I decided to focus, and excuse the pun there, my effort on the cornea, which is the eye's window and it's crucial for clear sight. And it's an important area to work on because corneal blindness is common. It is irreversible and it affects all ages. It imparts significant morbidity and mortality on the individual and society. So much so that blind children for example have a whole lifetime ahead of them of increased morbidity. And two-thirds will die within one year of becoming blind. The World Health Organisation has also recognised this by making corneal scarring a priority eye disease.

So I'd like to tell you a little bit more about the cornea. Well it's a bit like a sandwich, in that it has a number of layers one on top of the other. But the very top layer, it's like a layer of skin cells and it's there to protect the structure of the cornea. Every seven to 10 days that whole entire layer is replaced and this is done by stem cells. So the stem cells of the cornea live in a very special zone. They live between the white conjunctiva and the clear cornea and they live down the bottom of this zone which is known as the limbus. What happens is each stem cell divides to produce another stem cell that will go on and remain a stem cell, but also a whole series of other cells, daughter cells, which travel across the cornea to replace that layer and then are eventually shed.

And how I like to explain it to patients is that the stem cells, they're a little bit like seeds in a garden. And the flowers and the plants are forming that surface layer or forming most of the garden. But unfortunately for some patients the front of the eye is a bit like my garden, you know, full of those dead and dying plants, and their front surface cells are not intact. And this is because they have damage to their stem cells as a result of a number of causes and when the surface layer breaks down, the cornea becomes scarred and the eye is painful. And this is because the cornea is around 300 to 600 times more sensitive than skin.

Now one of the common causes of stem cell deficiency is chemical injury. And this affects a young working age population. I have a patient – Maclay – at age 24 he was injured with beer line cleaner. This is his right eye, which he can only just see light and he lost his left eye, it just dissolved in the injury. And this happened because for beer to taste good through a tap, the lines have to be flushed regularly with sodium hydroxide, which is a very powerful alkali, and it's done under pressure. The line exploded and his eye was injured and unfortunately it cannot be treated with standard grafting. So in order to treat stem cell deficiency we developed a technique which was a world first. And that's because the technique involved using substances only from the patient, we didn't use anything from animals. And what we did, we took some stem cells from the fellow good eye and we grew them on a contact lens in the patient's own serum and then we transplanted them back into the damaged eye. And the bottom images showing you an eye with an ulcer, the big green area. And after the procedure the front surface was stable and transparent.

In 63% of patients we achieve success, we restore their front surface and most improve their vision. We found the procedure to be safe. And it's since been recognised

internationally and at the time we received the new inventor's grand final award for the invention for the treatment. But, unfortunately, four out of 10 patients were not successful. We weren't happy with this. So we developed a model in collaboration with dermatology here at the University to study what happens with stem cell colonies. Now this is the model here, each different colour represents the progeny of a single stem cell. So the stem cells are pushing those daughter cells and they're travelling across the cornea in this whirl like pattern. And then we went back to look at what happens when we transplant cells using this model. And what we found is that even though we were taking cells from the fellow eye not all of these actually were stem cells. And so the implantation efficiency was low and we also lost cells onto the eyelid.

But it is not just the seeds that are needed in a garden. You also need good soil. So we went to have a look at the soil, the extracellular matrix underneath the stem cells and we found a substance called vitronectin which was able to promote the stem cells to proliferate and survive. So what we're doing now we're going to go back to the clinic with our optimized technique to try to treat those four out of 10 patients. But, in our sandwich it's not just the surface layer. Also the meat of the sandwich can be affected by disease and give patients' poor vision. And one of the common conditions that affects the meat it's called Keratoconus. Which means conical cornea. And what happens in this condition is the layers of the cornea slip on each other. And over time the cornea distorts and the vision becomes progressively blurred. Unfortunately this starts in childhood or young adulthood, at a very crucial time in these people's lives and so they have a great reduction in the quality of life. There's a treatment that's been developed to stop this condition getting worse and that's called corneal crosslinking. But it's gone into practice and people are doing it in many different ways. We don't know the total adverse event rate and we don't know how the patients really benefit from this.

So I've developed an international registry with sites across the globe collecting data on keratoconus and this procedure. We have about 13,000 patient visits and it's growing at a rate of about 10% per month. And we can now see what is the best practice. Doctors can also get benchmark reports so they can compare their practice to what's happening with others across the world. And importantly patients for the first time can see their own treatment journey. Now, why do we need registries? Why not clinical trials? Well when you do a clinical trial, you go out there and you find a very narrow range of patients and you treat them in a very specific way.

But once the treatment goes into the real-world, treatments are done in all sorts of different ways. And so we need to know what is really happening with our treatments and registries are now in fact being recognized as a way to recruit patients for clinical trials. But, it's not just about treating lost sight, we also need to prevent people losing sight in the first place.

An example of this is ocular trauma. A really common cause of corneal blindness and 90% of it is actually preventable. To address this my PHD student shown here Annette Hoskins, supported by the NHMRC, is leading an International Study. We're going to investigate the causes of trauma, come up with policies and advocate for change so people don't lose sight.

Now in this photo here is Cian Moore, at age 15 he lost sight from vitamin A deficiency, in Australia, he lives in Perth. Now this is incredible because vitamin A deficiency is normally associated with malnutrition and we only see it in developing countries. And he got vitamin A deficiency from eating just chips and Coke and unfortunately he's not the only child that I've seen go blind from vitamin A deficiency in Australia.

So to educate the public and warn people we had Cian's story featured in the Sydney Morning Herald. That was then syndicated in other sources and social media and had a final reach of over 8 million people across the world. His story is also going to feature in a science documentary film that will be released later this year called Vitamania by Gene Pool Production. But in order to save site you can't go it alone, I'm fortunate to be here at this University because it offers me a range of expert collaborators to work with and there's a number of disciplines that I currently collaborate with. I also work with organisations nationally and internationally. But for the future we also need to be training what I call the next generation experts and I've trained a number of scientists but also clinicians.

But, every hour the same number of people that are in this room today are still losing sight from the corneal blindness. The impact of this is severe and told by the fact that 70% of people would much rather die earlier or lose a limb than lose their sight. So what we need is some new technologies and we're looking at whether nano-robots can help treat corneal scarring. But we also need to continue to evaluate current practice and make sure it's meeting the needs of the patients and it is the best that it can be. Our collaborations need to develop into partnerships with networks of experts and we need to change policy so that we can transform many lives. Now in this photo is Macleay, I showed you his eye before, he was injured by the beer line cleaner in 2014. His wife is now pregnant with his second child and he's never seen his first child. So tomorrow I want to stand on this stage again. I don't want to be here alone, I want my next generation experts to be standing here, and my partners and collaborators here. But more importantly I hope that we have a solution for Macleay so that he can see his children and the future. I'd just like to close by thanking my mentors, collaborators, students, and funding agencies for their support.