Norfolk Deaf Association Friends lecture, April 2018

“The Future of Hearing Implantation”.

ALIONA DERRETT:

Good evening, it's lovely to see you all, I'm sure I have met a great majority of you, but those that don't know me I'm Aliona Derrett, NDA’s Chief Executive.

We are going to have a very interesting lecture in a minute, which I am very excited about it, because I've seen the slides and I know that they contain some very fascinating information.

Before we start just a few practicalities, we do not expect the fire alarm to go off, the students, since they moved in September behave excellent, so they haven't set it off so far, hopefully not tonight. If the fire alarm does go off then we just exit the building through the door you came in, or the door in the office opposite this room, and go into the car park of the hotel next to us, okay.

Have you discovered the bathrooms by now? As you go through the office door to the right and you will find two of them there.

If you would like still to get some refreshments, you still have a few minutes whilst I do a little sales pitch, so go and get, because there is plenty of food left, please help yourself, or at the end help yourself to some more otherwise it will be wasted.

Now, the sales pitch. Last time we met I was talking about the fact the NDA is 120 years old this year, been around for quite some time doing lots of good work and we have decided to celebrate this anniversary. On your seats, you will have found a few flyers. Now the first one looks like this. This has the list of all four key events for the year with the first one being in June, which I'll come to in a minute. Then we have a charity golf day in August, then a parachute jump for those that are very brave, I wasn't last year! I will never be! But if you are very brave and you have relatives and friends that are, please take part in the parachute jump and help us raise some funds. For those of you that like to increase their red blood cells count we have a wine tasting evening in October. So, four interesting events for the year, but the first one is an unusual one and I refer now to this flyer. You will see, you will think of how can you run a music event with loud music for those that have hearing loss, that's sort of the point of it, because we know that there is enough hearing loss which is acquired

through noise and we also know that lots of young people and not so young, like listening to music quite loudly. Of course, that doesn't do much good to our ears. Through a combination of ideas generated by a group of young musicians and 'not so young' staff members we came up with this idea of running a music event at the Epic Studios in Norwich in June, whereby we will have a talk from an expert on noise-induced hearing loss, discussing: how it happens, why it happens, what is safe, what isn't and the currently recommended good safety and protection for our ears. It looks to be an interesting talk which then will be followed by a performance from The O'Fenders, who cover music from fifties, sixties and seventies, and followed by musicians who are all 18, 19 and 20, called The Visitors, with a slightly more modern music written by the band members themselves, however it's still 'tolerable' [Laughter]. I'm listening to them every week, as one of them is my son, so I have no choice really! [*Laughter*]

Also, to make the evening more interesting we'll have a Hogg roast and refreshments, a welcome drink when you come, so please, please encourage your friends and your family to buy the tickets and join us.

Specifically for the friends of NDA, each year we have two events, one is the lecture like tonight, the second one is a theatre trip. We have been running the trip to the Theatre Royal for a number of years, they kindly give us one of their rooms for refreshments and cakes during the interval. This year we have 30 tickets for Miss Saigon performance on September 5, half price, and you are the first ones to get the information tonight. The form for the event in September is also on year seats, though we will circulate it again later in the year.

I think that's all from me, I'll pass on now to Peter to introduce our speaker. Thank you.

PETER PRINSLEY: Thank you Aliona, good evening everybody, nice to see you. You have brought the spring with you, it's actually really warm outside all of a sudden, I came here by bike, did anyone else come here by bike? Shame on you! [*Laughter*].

Anyway, it's pleasure to introduce Patrick Axon from Cambridge. I've known him for a long time, he first came up to speak in Norwich when we used to run the audiology symposium and he gave a fantastic talk about cochlear implantation then, which I think must be about 20 years ago certainly almost 20 years ago. I remember that it was an excellent talk then, I'm expecting something better this evening.

We do have some cochlear implant users in the audience is that correct.

FROM THE FLOOR: Yes.

PETER PRINSLEY: I see one, excellent, good evening. In Norwich we have many, many cochlear implant users now, I mean, probably numbers 100 or more, probably a 100 or more. Of course, we are very dependent on our colleagues in Cambridge for helping us with this service, I'm interested to hear what the future maybe. I do hope there will be a future in Norwich for at least to be able to provide post-operative on-going support for cochlear implant users. I'm very interested to hear what Patrick says this evening, so welcome Sir. [Applause].

PATRICK AXON: So, well first, can everybody hear me, am I...? Yeah, is this working, hopefully it is.

FROM THE FLOOR: Are you able to come forward so we can see your face, lipreading.

PATRICK AXON: Yes, that's okay.

So, I'm Patrick Axon, I'm one of the implant surgeons in Cambridge and I've been an implant surgeon in Cambridge for about 16, 17 years now. I trained in Manchester with a chap called Dick Ramsden who was very much at the forefront of cochlear implantation at the time. He ran a lot of charity events, raised a lot of money in those days to set up cochlear implantation in the North of England, at the same time as down in the East of England Roger Grey was working very hard to set up the implant programme in Cambridge. In fact, he was appointed on the back of his desire to set up the implant programme and that is something that Addenbrooke's wanted at the time.

So, Roger has retired from the NHS, but he's been, because he operated and was such a fantastic surgeon, he's been replaced by three others -- [*Laughter*] -- so Roger has now been replaced by Neil Donnelly, James Tyson and the Professor of hearing implantation, Manohar Banss from Halifax, Canada who been with us for nine or ten months, he's going to be a fantastic addition to our team in the future.

Anyway, I'm here to talk about hearing implantation. I've just come from Addenbrooke's, where I had a cochlear implant clinic this morning. I think one of our audience here is, was always at the implant clinic although I didn't see you there, but it's a busy time for us at the moment. I'll show you why in a little while.

So, I'll be covering the following areas the following topics. I'm going to give you a little bit of background on the anatomy of the ear and also of hearing loss and why we lose our hearing, and although this is meant to be predominantly about cochlear

implantation, I'm going to talk a lot about hearing implantation in general, so that's for hearing implants that are there for people who maybe don't meet criteria for cochlear implantation, but might benefit from a hearing implant if they are struggling with conventional hearing-aids.

I'm also going to talk a little bit about hearing restoration from a surgical point of view. The reason why I mention that, a lot of patients, if they have got a middle ear hearing loss will, which is a bit of the ear that can be corrected, can be corrected by surgery, I'm going to show you one video of an operation, so if you don't want to see it -- [*Laughter*] -- close your eyes!

Okay. So, I'm going to talk about cochlear implants, and I'm going to talk a little bit about the future and also a bit about the research that we are doing currently in Cambridge.

Am I speaking at about the right level, am I clear to everybody? Yep, great.

So, this is an ear. What you can see here is an eardrum and the eardrum is at the end of your ear canal. I'm going to sort of start at a basic level, I'm sure you all know this, I'm just going to start at this level. The eardrum is there to pick up vibration and send it into your inner ear. It does that by this bone here, which is called the Malleus and that picks up the vibration generated in the eardrum and pass them through some bones. So, this is the Malleus without the eardrum, so the eardrum has been taken away and the eardrum was connected to the, to the handle or the part of the Malleus there and the Malleus is attached to the Incus, the conned bone and eventually to the Stapes. That whole process of taking vibrations from me to you, it concentrates them down and it amplifies them significantly to deliver them into your inner ear. That piston, that Stapes is driving the sound into your inner ear.

Now, normal hearing, this is normal hearing, I'm just going to show you an audiogram, because I'm going to show you different audiograms as we go through the talk. This is an audiogram, it's from low frequency to high frequency and increasing sound intensity is played into your ear with your microphones on your ear and behind your ear. We regard hearing as normal across all frequencies if it is better than 20, or 25dBs. So, we would regard you as having normal hearing. The zero, is the hearing of people who are completely normal when they are young, about the age of 18, on average. So, we regard a little bit of difference between normal and maybe down to 20dBs, 25dBs is normal.

This is what is called the 'speech banana' solo frequency to high frequency, this

is what you would expect to hear. So, at 30dBs, if you put your watch to your ear you should be able to hear your watch ticking. If you can't hear your watch ticking your hearing in this particular area is probably a little bit down.

Baby crying and as you go down you can see the band that is going to be playing to you -- [*Laughter*] -- is at about 110/120dBs and that's very loud. Okay. The consonants are usually at this end of the speech banana and the vowels and the Os are usually at this side, that's why people who lose their hearing, often in the high frequencies, what you tend to get the speech slightly changes and becomes a little bit more vowely.

We have dropped down from normal and it's a conductive hearing loss and the reason why you might get a mild hearing loss, you might find you have got lots of wax in your ear or you might have a hole in your eardrum, so that's a hole, tympanic membrane perforation, we repair those, Peter and I will spend lots of time repairing those holes to make sure that your ear remains dry, because it can leads to infection, also it boosts your hearing by closing the hole.

This is a moderate hearing loss, and this is a conductive hearing loss and so sometimes you have that level of hearing loss. If you have some, some children have glue ear, often it doesn't cause as severe hearing loss as that, sometimes some children can get glue ear, fluid, you can see the fluid behind the eardrum, that's where it's sitting. So, that's glue ear, children get this, or adults can get this as well. That's also a picture of glue ear.

These are pictures of ear drums that have collapsed into the ear and what has happened here, is that it's caused -- that's a collapsed drum and Malleus, Incus and Stapes, but on this side the Incus has dissolved away and there is a gap between those three bones and so the sound cannot transmit through from the eardrum as easily into the inner ear, so the hearing has dropped down. We can repair that.

We talked about the middle ear here and I'm going to talk now about the inner ear. So, a little bit more anatomy, a little bit more about deafness, I apologies about that, then I'll come on to what we do to restore the hearing.

So, the cochlea, this is the balance organ at the top, you have got the three canals of your balance, that when you do ‘this or that or that’ your brain knows what your head is doing. This is also part of the balance organ, the vestibule it monitors the gravity acting on your body, also acceleration, so you know you are accelerating away then you have the hearing part of your cochlea. Now the cochlea is a very clever piece of

kit. Okay, what it can do? It can take sound and it can divide it up into different frequencies, by a couple of different methods but I'm just going to explain one of them.

So, this is the cochlea, so sound that Stapes, bashes onto something called the oval window and it forces sound to go down a tube. That tube is filled with fluid the vibrations pass down your ear, your inner ear and when a sound of a particular frequency gets to a particular part of your cochlea it causes a really big vibration of the ear at that point. So, here you have got a sound, probably around 2 kilohertz, so about the speech frequencies and it's going into the ear and getting to two or three kilohertz and it's causing the membrane to flap around a lot. That's what causes the electrical pulses to pass to the brain. So, this bit here is stimulated by a vibration of around two to three kilohertz, the sound then comes back out through another window.

So, this is the -- getting deeper into the ear now, this going even deeper, what we have got is a structure here that transmits or converts vibration into electrical pulses, the absolutely important bit of this whole system is the hair cells, the hair cells of your inner ear.

These are normal hair cells, they are outer hair cells and those hair cells, when they are stimulated, they stimulate it even more, give an even bigger shake to your ear to get that vibration really... you know... loud. If these hair cells breakdown, then you become deaf. So, people who have age related hearing loss, people who have problems from childhood with problems with deafness from birth, these are the things that are broken. These little things here.

I'm going to show you a video of how they work. So, this is a video of one hair cell having music played at it. With that music it is responding by movement, it's vibrating, what you will see is that this hair cell will move to the sound of music.

[AV - Main Screen]

(Music played).

So, that is a hair cell, that's an outer hair cell, that's moving, it's generating power in your ear to create sound, or electrical pulses that then pass down the cochlea nerve and here are the cochlea nerves, that's the cochlea nerve, all these little branches are nerves, supplying different bits of your cochlea and sending branches down. So, here, this little bit here, picks up high frequencies, in all the nerves, all these nerves are sending electrical pulses to the part of the brain that responds to high frequency. These bits here are the apex, the last turn are sending electrical pulses to parts of your brain that monitors low frequency. Okay. Those hair cells are working very well.

Now, what happens if they go wrong? So, this is what happens. Theseare hair cells damaged by noise, this is when your ear gets shaken for long, long periods of time, you need high intensity sound to cause these, these hair cells are damaged, and they cannot respond in the way that they need to shake at the membrane. Okay. These hair cells are damaged by age, as you get older your hair cells start to go. This should be three lines of outer hair cells, three lines. This patient has lost one almost totally, there is gaps in the others and if they aren't there they cannot shake your ear and get these inner hair cells which are sending information to the brain.

You can see that they're all damaged. So, that is, I don't know how quickly I did that, but that is hearing in a nutshell, okay, we have got the outer ear, the middle ear and the inner ear. We can do a lot for that. When I started training 20 years ago, I was involved not in the first cochlear implants, but a little bit after they were adopted. People used to wear cochlear implants, one cochlear implant and they had a body-worn device to take in the sound, it would go into this big device that they would have to carry around and send it up to the ear. At that time it was a huge change to get something that fitted completely behind the ear, it was a big change. I was in Manchester when that happened. Cochlea Nucleus were the first company to bring that along, along with Medel. Since then we have got a huge increase in the amount of opportunity we have for improving hearing. I'm going to go through them now.

So, this is going down in increasing severity of hearing loss as we work down this list. So, if you have got a problem with your Ossicles, those bones in your ear, then we can perform an ossiculoplasty, if we can't do anything and say for example, you have got a problem when you wear a hearing-aid and it causes an infection and you can't wear a hearing-aid, you can wear these devices and I'll come on to them in a little bit more detail.

If you have got a problem with inner ear hearing and you still can't wear hearing-aids for other reasons, we have much more powerful solutions with the bone anchored hearing-aid that we perform with Norwich. Here - cochlea Carina, is a fully implanted hearing-aid, even a microphone is implanted in your ear, I'll show you a picture of that in a minutes, then we come down to cochlear implant.

The next video I'm going to show you is one of an operation, it's an operation I did quite some time ago, it's on a chap who had a problem with his Incus and I took his Incus out, I changed the shape of it and I placed it back into the ear, so that it connected the eardrum to the Stapes. I'm going to show you the video of that now, so

if you are a squeamish, look away. Here it comes… I'm drilling part of the Incus, that drill is 2mm, I'm looking down at it in a microscope, you can see my fingers, now I'm drilling a little bit of hole into the Incus, very hard bone. Now I'm in the ear. That's the Incus, that's the Stapes, that's the Malleus, I'm going to take that piece of Incus and I'm going to place it on the Stapes, and the eardrum. So, now the sound can pass from the eardrum into the inner ear, okay. So, we can do that and people who have a conductive hearing loss can have this type of surgery, in most hospitals around the country, to improve their hearing without the need for any hearing implant at all. I put this in, because I wanted to let you know that there are other options other than hearing implants before I then talk about lots of hearing implants.

Okay. So, these are the two most recent additions to the hearing implants. This one is from Medel, which is a hearing implant company, and this is from Cochlea another one. Cochlea is based in Australia and Medel is based in Austria, okay, there is a third, well two others, Oticon and there is also Advanced Bionics but I'm going to talk about these first. Now these are bone conducting hearing implants. This one here, which sits behind the ear transmits vibrations through a sticky pad, so like a little pad you stick it behind your ear and you place this hearing implant on, you attach it to the sticky pad and that vibrates and whenever you have had, whenever you have touched something or something has vibrated or put you tuning fork on your head you can hear sound, that's how this one works, it vibrates the skin and some of those vibrations go through the skin into the bone and past the cochlea. It's quite good. I am not sure it's great, I'm not sure how many people have benefited from it, but it might be a solution for children who have problems with conductive, glue ear, it might be worth it for them to avoid say grommets.

This is the Attract. What we do with that one, we make it an incision behind the ear and we put, we screw a piece of metal on to the bone. That is magnetic. This, outer bit, we then close up and this can just be taken on and off and it's held on with a magnet, it also stimulates the bone by a vibration. Sending the sound through.

You might have seen a bone anchored hearing-aid, that's where you have got a Titanium screw going into the bone, that's actually connected directly into the bone and we can connect a vibrating mechanism on to that bolt and it vibrates the skull, it's a more powerful than the other two. This one is the most powerful vibrating implant and is called the Bonebridge, again from Medel. This has a floating mass transducer, it's a bit of a metal inside, it vibrates the skull and drives vibration into the inner ear, by

passing the inner ear canal, that's stimulating the cochlea directly, it's not doing anything down the ear or through the Ossicles, it's stimulating a bone.

Moving on a little bit. We have now got this, is called the vibrant sound bridge, which attaches to the bones in your ear, it also has a little bit of metal that vibrates very hard, it makes that Stapes drive even harder than normal and bushes lots of sound. Your hearing aid can get to a certain level by sending air vibrations through your ear, this bypasses that and sends even more vibration through your ear. That's for people who have got a moderate to severe hearing loss, so people who are not quite in cochlear implant territory.

Lastly, before I move on to cochlear implants, this is the Carina, that's totally implantable, you have nothing on the outside at all. That is placed under the skin, that is a microphone that sits under the skin. That is attached to your Ossicles to vibrate the Ossicles and that is a battery pack. So, what you do is, for a couple of hours a day you attach something to your head, the side of your head and it charges the battery. You can hear with that microphone through the skin. That's for people who have got severe hearing loss, not quite cochlear implant territory and is a relatively new import.

Sorry, that's lot of implants, but what I was trying to give you here was an understanding, that if you aren't doing very well with hearing aids there are often other solutions open to you that might help.

So, I'm going to talk about cochlear implants now. That is true. It is absolutely transformational. This, if you have a cochlear implant you are either severe, profound, or totally deaf. Okay. Now, before cochlear implants we relied on hearing aids, until hearing aids weren't powerful enough to drive hearing, but with these you can have no hearing and it brings back near normal level intensity levels of hearing the cochlear implants our getting better and better as you will see.

So, back to the audiogram. This is somebody who has got a very bad hearing loss, so you are looking at hearing thresholds below or greater than, I should say, 90dBs. This person, with this hearing test, would be eligible for a cochlear implant. So, they have got some low frequency hearing, but they are at 2 kilohertz and 4 kilohertz, their hearing is below 90dBs. Now cochlear implants are very expensive, you know, what happens with very expensive bits of kit is that they have got to meet the criteria the government set for being able to be given to patients. So, these are around 19, 20, 23 thousand pounds cochlear implants and, so it's got to give patients

enough benefit for us to be able to use your money, your taxpayers' money on these.

Now cochlear implants are probably seen as the most, or the best spent money of any intervention you could think of, equal with a hip replacement. It gives you that degree of benefit. So, the government have said that we are able to implant anybody with, adult, with a unilateral cochlear implant they will pay for it if they meet the criteria that I've just mentioned, and they'll give children two implants, because they believe that children should have bilateral implants, adults can get one and children can get two implants. If you are blind as well as deaf, and meet the criteria, you can also have two implants.

So, this is a young girl who was implanted around the age of nine months. At the time she had one implant, as you can see, the speech processer and the magnet holding the cochlear implant in place. She's implanted at a very young age because of newborn hearing screening, so all the children in the country will have a newborn hearing screening around the age of two weeks, well before, hopefully, before they go home from hospital, but if not they are picked up within five weeks. Because of that single screening protocol, we now capture pretty much 95%, over 95% of children who are born deaf. Before this screening programme we missed a lot of children. They would come to us later for implants. The later you leave cochlear implantation, the worst the outcome. So, you want to implant children, preferably with two implants, at the age of 12 months, if possible.

So, a cochlear implant has that, that bit there and it's attached across the skin to the cochlear implant that sits under the skin and it's held in place by a magnet. So, sound goes in through the microphone, there is a bit of analysing of the sound and splitting it up and taking bits that are important for speech and it fires at the information across the skin and down into the electrode array that we insert into the cochlea. The electrode array is fed into the cochlea, winds around the cochlea. So, if you remember when I was talking about the hair cells, it's like a piano keyboard, low frequency high frequency, those electrodes are sending high frequency sound to those electrodes and low frequency sounds to the apex, are you with me? Peter is worried I'm going...

PETER PRINSLEY: I think we can all understand it very well, it's very clear.

FROM THE FLOOR: Yes.

PATRICK AXON: Okay, okay. So, this is the latest Advanced Bionics cochlear implant, it's just come out, it's brand new. I'm going to take you through the cochlear implant.

So, this is a Titanium case and that holds all the speech processing capability. We've got a magnet, that's the magnet that holds your cochlear implant on to the skin. So, that's that bit that sits up there. Then what we have got is the antenna coil, that picks up the sound from the speech processer and sends it into the bit of kit that analyses the sound. That sends it along to the electrode, that's called the slim J electrode, the latest electrode out from Advanced Bionics, it's a very delicate electrode, it's designed so we can insert at the electrode causing the minimum amount of damage to an ear and that's important. We don't know what is going to happen in the future. We don't know whether it's going to be new therapies that come out that allows us to mend ears at a later stage, so we don't want to cause any damage. So, this is especially designed, and we in Cambridge were very much involved in this process in designing of the electrode, to make it as gentle as possible on the inner ear. With that we can implant people who have hearing in their low frequencies and we can maintain at the hearing in the low frequencies, so they can use a hearing aid and a cochlear implant. So, they get their low frequencies from the hearing aid and the high frequencies from the cochlear implant. So, it's bimodal.

So, this is your electrode, this called the SlimJ electrode, there are two from Advanced Bionics both very good, this is the SlimJ, you can see the electrodes, 16 of them that send sound to the cochlea. That's the bit that stimulates, those electrodes are there to give you low frequency and these ones give you high frequency. So, and mid-frequency. It's 23mm long, they designed it to be 23mm long because cochleas vary in length. Some are as short as 23mm others can be long as 32mm, so it varies the length of it. So, what we don't want to do is insert it too far and cause damage. So, that's the perfect length.

It's got a slight bend for it to go round the cochlea without going through important structures and causing damage. It's tiny. It's less than half a millimetre in diameter at the tip. Okay. It gets a little bit bigger, just over half a millimetre at the base.

So, I'm going to show you a video now, I'm going to show you a video dating back to 1993 and this is a young girl who was implanted at that time. As you will see she's deaf and she was born deaf, but she's quite old, she's not nine months old, she's quite old. That's because we didn't have newborn hearing screening, so she came a bit late. She only got one implant at that time and that was raised through charitable funding.

This is a video and what it does, it shows you progression over time as she's gone

from having no hearing, through to being a young girl, young -- you know teenager - with hearing. So, you are going to hear how she's benefited. No, you're not!! I thought my slide was cabled in!!!. This is what I'm talking about the piano keyboard, high frequency, low frequency, those electrodes. What we are trying to do, we are trying to take this hearing, somebody suitable for cochlear implants and give them hearing at this level. It brings hearing up across the frequency, all those electrodes doing that.

This is an operation we did just recently by preserving hearing. So, that was the hearing in the black before the operation, we've put in two cochlear implants, one in the right, one in the left. This is the blue post-operatively, you can see there is a little bit of drop in the hearing, but we maintained the function of the cochlea, despite putting an electrode array in it.

So, this is it.

[AV - Main Screen]

Hello... hello...

PATRICK AXON: So, this is the switch on, "You heard something, did you."

PATRICK AXON: That's the first sound she's heard. "Orange."

PATRICK AXON: Her speech is now starting to develop, "Thank you. Car. Car. Car. Shoe."

NEW SPEAKER: A friend came for lunch.

NEW SPEAKER: My friend came to lunch.

NEW SPEAKER: The match boxes are empty.

NEW SPEAKER: The match boxes are empty.

NEW SPEAKER: Good. He climbed his ladder.

NEW SPEAKER: He climbed his ladder.

PATRICK AXON: So, that's 18 years ago. Now the developments in cochlear implants since then has been tremendous. So, she was implanted late, she only has one cochlear implant and I was in my clinic today, there is a young girl came in, had a little bit of discomfort behind one ear, she was implanted at, I think it was just over, about 18 months for her first implant and then she's had a bilateral, we were allowed, the government allowed us to do second-side implantation. She came to me and said, "I've got a bit of pain", I was just asking how she was getting on, her mother was with her, "She's doing really well, she's going to University next year, she's got 12GCSEs ", speaking to her I didn't have to make any account for my voice and we were having a normal three-way conversation, speech was absolutely normal. So, that's what you

can achieve with a cochlear implant in childhood.

I'm going to show you now another video of an elderly patient who also got a cochlear implant and she's going to explain what it's like for her

[AV - Main Screen]

"The difference it made to you having a cochlear implant?"

NEW SPEAKER: Having a cochlear implant took me out of a dark, lonely world into the wonderful world of sound, it's giving me back my confidence, enthusiasm and my zest for life. It enables me to hear the telephone clearly and though music is not brilliant, I can hear enough music to be able to dance.

NEW SPEAKER: Thank you, that's lovely, thank you for talking to us.

PATRICK AXON: The last video I've got of somebody who has got a cochlear implant is somebody who was born blind and lost their hearing. She's explaining to the person who is asking the questions, without any sight at all what it's like, so she can understand. It's another elderly lady.

[AV - Main Screen]

, "Good afternoon. I'd like you to tell me a little bit about what having a cochlear implant has done for you. I know that you were blinded at a young age and you lost your hearing more recently. So what difference has it made getting your hearing back?

NEW SPEAKER: It's made my life worth living. I can talk to people, hear people when I'm talking to them instead of them doing the deafblind manual.

NEW SPEAKER: That's great, so people find it easier to talk to you now?

NEW SPEAKER: Yes, it's less umm... I'm not quite...

NEW SPEAKER: It's less cumbersome to talk to you, don't have to use the manual alphabet?

NEW SPEAKER: They find it easier to talk to me than use manual, when you are going they can tell me, talk to me about more interesting things, what's going on.

NEW SPEAKER: Of course, yes.

NEW SPEAKER: Because I can't see.

NEW SPEAKER: Yes. Are you able to use the telephone?

NEW SPEAKER: Yes, I have chats with some friends on the telephone, they have to repeat a little bit, but not too much.

NEW SPEAKER: Great. I think you also like Cliff Richard?

NEW SPEAKER: Yes, it is always great to hear Cliff Richard singing, I can hear the words of songs that he sings now, I enjoy hearing him.

NEW SPEAKER: Oh great. Thank you for talking to us."

PATRICK AXON: That's three people, child, an adult that's just got deafness and deafblind. Clearly cochlear implant is working very effectively for her, because otherwise the only way of communicating as I said is through deafblind manual.

So, what would happen to somebody who comes to Cambridge for a referral? Well if you felt that you would benefit from a hearing implant it's your right to come and be assessed, and often there are many treatments at Norwich and Cambridge that are available to you. We would assess your hearing in detail. We wouldn't just go straight for a hearing implant, what we want to do is see if we can get the most out of your implant – hearing aid or give you a better hearing aid to get the very best out of it. If still your hearing was not good enough we would have a conversation in our multidisciplinary team, if we felt that you should go for a cochlear implant then we would bring you in and advise you, yes, you can go. We would usually implant your poorer-hearing ear so you can keep your better hearing aid in the other ear.

There are some cochlear implants now that can communicate, so a cochlear implant from Phonak or from Advanced Bionics, communicates with a hearing aid from Phonak, Anida. What happens is, when you are driving, or if you have noise coming in this side to your hearing aid, it can switch off your hearing aid and only concentrate on the cochlear implant, or it can, if all the noise is coming into the cochlear implant, it can switch the cochlear implant off, take the sound in from the hearing aid, pass it across to the cochlear implant and put it in through the cochlear implant.

The technology that is developing now is all designed to improve speech understanding in noise, in difficult situations and also to allow you to be aware of where the sound is coming from.]

So, a day case procedure, the operation takes about 40 minutes, you might feel a little dizzy. You get discharged the same day and switched on in six weeks.

We have done quite a few, 220 cochlear implants last year, we're the largest centre in the UK, third largest in Europe, we're a big centre, we do lots of cochlear implants at Addenbrooke’s.

So, the future. Well, the government have realised that things aren't great, we aren't implanting enough people. It realises that what is happening is that we are

leaving people to lose their hearing, often lose their job, they need to communicate, often become dependent on their families and then we offer cochlear implantation, well that's not great. So, what they are looking at decreasing the thresholds so that patients who come into this category, 80dBs and worse will be able to get a cochlear implantation that will roughly double the amount of patients that might well head for cochlear implantation. That's currently being discussed and is likely to go through towards the end of the year.

So, the criteria are going to change. As I say, it will drop to 80dBs and a few other things are going to happen, but one thing we are doing is we are implanting more and more elderly patients. More and more patients are feeling confident enough to have this surgery. Last week we implanted two patients who are 95 years or age. So, we do that because NHS is not ageist, we can implant those who we believe will get the benefit.

So, cochlear implants are improving, speech processing strategies are getting better all the time, and the cochlear implant companies are very clever. What they have done is they have taken all the complex stuff and put it on the outside, the bit you can take off and put all the dummy stuff, the simple stuff inside. It means that every five years you get a new outer bit with better speech strategies, so we don't need to change the inside bit, that can stay for decades and decades, that bit changes and is up-graded. So the latest implants have now got Bluetooth technology, so you can listen to your phone on the Bluetooth, Apple, Samsung whatever you have, they can connect and communicate, listen to music or whatever you want to listen to.

Of course, the electrode development is happening quite quickly, so those electrodes are continuing to develop. What we are trying to do is reduce the amount of trauma and to stimulate new growth, nerve growth into the cochlea implant, so you get better and better hearing. It's an amazing piece of kit to think that there is nothing else like it in the human body, other than maybe a pacemaker for changing people's lives with technology.

There are other things that are coming along, I won't go into them, they are quite complicated, things like stem cell implantation. That's looking at trying to regenerate hearing and there is lots of work being done by teams around the world, including the UK in Sheffield and other places, to look at these therapies.

Drug therapies, we currently are running a number of research topics in Cambridge, looking at ways that maybe we can either improve the quality of the

hearing or restore, to a degree, hearing.

So, this is the team in Cambridge, both research and clinical. This is James Tyson, James is a, he's exactly the same as me, skull-based surgeon. Neil Donnelly, both have been with us for a little while, younger and better looking than me. This is a very good Professor Banks, he's from Halifax Nova Scotia, he's a whiz, he's driving the research in Cambridge at the moment. We've got the largest engineering department, University engineering department in the world but we have never had a communication with, now Professor Banks, is in engineer and is involved in developing new developments coming on. These are the team around research, this is a very famous chap, fellow of the Royal Society, a chap called Brian Moore, all hearing aids you are currently wearing or you have, his work has led to the improvement, he's been at the basis of pretty much all major developments of hearing aid research for the last few decades. Bob Carline, a cochlear implant, he's probably the foremost researcher in the world at the moment and Rich Turner, he's unfortunately moving away from hearing implants, he works on machine learning, thins I don't know anything about. If you manage to get a PhD with this chap, then you are hoovered up by Google, Facebook, or any other, and paid squillions to work for them.

I want to finish on one patient. This gentleman suffered meningitis, South African, 52 years old and he lost his hearing overnight. He was referred along to us, I remember him coming into the room, sitting down opposite me. I had to have a conversation, we couldn't communicate at all, he had no lipreading, no capability of lipreading, I had to write everything down, he was in a dreadful state. He was referred to us back in 2010.

So, my colleague, Neil Donnelly, operated on the right ear. We tried to put a cochlear implant on the right side and we failed, we couldn't get it in. Meningitis can cause ossification of the cochlea, it blocks the tube so you can get the electrode down, he couldn't get it in. I thought maybe I could do better, so I operated on the left ear, I tried to get it in, I couldn't, full of soft tissue. I couldn't get the electrode to go down, it's such a delicate structure the electrode. If there is anything in the cochlea we just can't get it in. This is his x-ray, there should be nice curls where the electrodes have gone in and you can see they're not, they are straight, we've not been able to get them in, and they have not been able to pick up any of the sound. So, we made the decision that we were going to put in something called an auditory brainstem implant An auditory brainstem implant is an implant that goes even deeper so you remember this

picture, you have got the bit on that side, the bit under the skin and instead of this line going into the cochlea, it's going all the way and it's inserted into the brainstem. I did have a picture of it being inserted, but I thought that might be a little bit too much for you, so I removed that! [*Laughter*].

Suffice to say we inserted it into the brain. What we do, we take a paddle, an electrode array and we place it on to the surface of the brain over the cochlea nucleus, these electrodes, similar to the cochlear implant stimulate the cochlea nucleus at different places.

I'm going to show you a video of this gentleman, at home with his wife, lovely chap, you will see what an auditory brainstem implant can achieve

[AV - Main Screen]

"Paul and I have been asked to give a little bit of information regarding his ABI and how he is getting along with it today. So, he's just placed it on his ear, I'm going to see his reaction. Hello Paul, 123, 123.

NEW SPEAKER: I'm ready! [*Laughter*]

NEW SPEAKER: Right, that was -- we have a few questions that Z would like us to answer, well for you. So, your first question is: why were you offered the ABI?

NEW SPEAKER: I became deaf in 2010. After a bout of meningitis, lost all my hearing completely, was sudden and total. I've had two cochlear implants, but they didn't work because of ossification of the cochlea. So, I was considered for the ABI as an alternative.

NEW SPEAKER: Okay. What would you say to somebody who was in the position of having the option of an ABI what would you say to them?

NEW SPEAKER: Well, for me it's been a massive difference, because I was faced with the prospect of not hearing at all. I've had two cochlear implants and they never worked, at all. So, really this was my last attempt for hearing anything, otherwise I would have been consigned to deafness for the rest of my life. At least now I have some semblance of sound I can hear cars and from a safety perspective it's really important to me. So, if there is no option go for it, you have got nothing to lose.

NEW SPEAKER: Thank you Paul. You have been a wonderful---

NEW SPEAKER: Thank you to the centre.

NEW SPEAKER: Ah, thank you from me too. Bye-bye."

PATRICK AXON: So, he has no way of hearing, his cochlea is completely dead, we can't get anything to his cochlea. So, we have had to by-pass that and go straight to the brain and stimulate the brain. I thought I'd leave you with that last picture.

These there are leads of the different teams, audiology lead, led by Judith Bird, there is more people, the balance team, vestibular team, tinnitus team and all those operating in skull base, hearing implants and neuro fibromatosis Type 2.

I'll leave you with one thing, this is Helen Keller, died in 1968, famous author, very famous for lots of things, that's her view on deafness and blindness, she was blind and then became deaf. So, thank you very much. [Applause].

PETER PRINSLEY: So, Patrick, thank you very much. I was right, I thought things have come on a bit in 20 years! [*Laughter*] Since you last came to Norwich to speak. Thank you very much for coming, I wonder if you would be kind enough to take questions from the audience.

PATRICK AXON: Of course, yes, that will be fine.

PETER PRINSLEY: That's Jane.

FROM THE FLOOR: I was very interested when you said about children and how important it is to operate at a very young age. Are there occasions when parents won't allow you to operate?

PATRICK AXON: So, umm... as I mentioned I've been in this job now for about 20 years. It's an interesting, it's interesting. There are some cultural reasons why people won't want you to operate, that's more around religious beliefs. Some children are born into deaf families and the deafblind, the Deaf Community want their children to be part of the Deaf Community, but that's quite rare. Most children, vast, vast majority of children born into hearing families because most hearing loss is recessive, so they have normal hearing mum and normal hearing dad and it means they have a bit of gene in one side, and a bit of gene in the other, and they come together. So, 1 in 4 of their children will be born deaf, but they are part of a hearing family. In that situation it's very rare for somebody to turn a cochlear implant down, once they understand the process, but yes, it does occasionally happen.

FROM THE FLOOR: In 1992 I was working in Holland Park in London as a health visitor and my colleague and I did the 8 month hearing test and there was no response, we repeated it two or three times and I think the little girl was called Maddy, she had a cochlear implant at two and a half or three and it was actually on the television,

several years later, watching them actually turn it on. Amazing.

PATRICK AXON: I mean, just recounting a story about somebody who is implanted, in those days it was rare. You know it was charitable funding that raised the money, so we weren't able to, we only implanted a few children at that time.

FROM THE FLOOR: If the implant electrode, instead of having 16 contact points had 32 or 64, would it give a broader range of frequency blocks, each one being smaller and allow you to hear music and other things better?

PATRICK AXON: Now, that's a good question.

FROM THE FLOOR: I know my father-in-law loves opera -- [*Laughter*] -- he finds it very difficult with his implant, that's the reason for asking.

PATRICK AXON: It's a good question maybe in the future hope, but not at the moment. So, we don't need more than probably 8 electrodes to hear speech. The problem with understanding music is around octaves, so sound is played into your ear and your implant divides up the music, it divides it up and sends it to an electrode. Now, that electrode needs to be placed in the perfect position to hit the right note and that's impossible. So, although some people, as you heard, enjoy music, what they tend to do is they tend to enjoy the music that they have heard before so that they have an understanding of what it did sound like and also clearly certain types of music. So, something with a beat that they can hear and so for music, cochlear implants aren't great. Some people do gain benefit for music but the advances at the moment are not quite there. Interestingly, I'd say this as an interesting aside, that is that there is new technology coming that allows you to direct the current from the electrode. So, that when you stimulate an electrode the electrode stimulus spreads out, it's like you drop a pebble in a lake and the ripples spread out. Now, if you were to drop three pebbles simultaneously into a lake, what happens is you get concentration of waves and that is correct, is what we are looking at currently in Cambridge, by what's called tripolar stimulation, one electrode that stimulates positively and the two either side stimulate negatively. It allows you to concentrate it to a narrow area of the cochlea and direct it, and move it around. So, we are looking at that in trying to improve speech understanding. So, there are things in the future that are coming.

FROM THE FLOOR: Thank you.

FROM THE FLOOR: I wonder if I can give you another testimonial! [*Laughter*] I think, I was one of the very first people you operated on when you came to Cambridge,

March 2001.

PATRICK AXON: Yes.

FROM THE FLOOR: And I'm 72 and I was actually the eldest person, oldest man I believe to have been done at that time. Now I have no hearing whatever, but with my cochlear implant, with my apparatus on I can hear perfectly, heard every word you said, the whole of this evening. To me it's nothing short of a miracle, absolute miracle [Applause].

FROM THE FLOOR: Here, here!

PATRICK AXON: You probably were my first! [*Laughter*]

PETER PRINSLEY: And he had never done one before! [*Laughter*]

FROM THE FLOOR: It worked!! [*Laughter*] I didn't realise I was being experimented on?

PATRICK AXON: It's a bit of a worry, I'll tell you why… I started in April 2001, not March! I was doing a locum job at Addenbrooke's before I took up my consultant post, so you must have been in that time! [*Laughter*]

FROM THE FLOOR: Can I just say that we're not all rushing in with questions because you have given us a lot of information and it's been fantastic.

PATRICK AXON: Thank you.

FROM THE FLOOR: It's left me and I'm sure others, with a feeling of hope for the future, because sometimes you feel there is no improvement with hearing aids *et cetera*. Thank you. [Applause].

ALIONA DERRETT: any more questions? Well that was a wonderful...

FROM THE FLOOR: Something a little bit different, do people who have had cochlear implants suffer with tinnitus?

PATRICK AXON: So, another very good question. So, if somebody is bilaterally deafened, but they have got tinnitus in one ear, we will implant the tinnitus ear because when you switch on the cochlear implant it tends to reduce the intensity of the tinnitus.

FROM THE FLOOR: Thank you.

PATRICK AXON: So, we have some patients who have lost their hearing in one ear totally and have tinnitus in that ear and those patients -- we had funding to put an implant in just the one ear to try and reduce the intensity of tinnitus. It does, it does help reduce in the intensity.

ALIONA DERRETT: Thank you very much Patrick, a wonderful lecture very informative, thank you for coming. [Applause].

That's it. Now you can digest all of that. Thank you so much again for coming tonight and I hope we will see you at the forthcoming events and I would like to thank Pam and Stuart for helping tonight ..I would like to thank you all for coming, have a safe journey home, thank you again. [Applause].