Improving Accessibility to Hearing Healthcare: Only Smartphones Have the Answer, presented in partnership with Seminars in Hearing

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Presenter: David Maidment, PhD

- [Christy] It is my pleasure to introduce our guest speaker today Dr. David Maidment. He's going to present for us "Improving Accessibility to Hearing Healthcare: Only Smartphones Have the Answer." And in this course, it's presented in partnership with Seminars in Hearing. I'll hand the mic over to you, Dr. Maidment.

- Thank you, Christy, can you hear me okay?

- [Christy] Yes, we can.

- Perfect, thank you. Thank you for that lovely introduction as well, Christy. And also, thank you to Kimberly, who I believe is also in the call for helping to organize today. I do apologize. I am in a very echo-y lecture room, but hopefully, you can still hear me all right. So as Christie mentioned, I'm Dr. David Maidment. I'm a lecturer in psychology within the School of Sport, Exercise, and Health Sciences at Loughborough. And that's how you pronounce that. It's as a bit of a weird spelling, and even myself have difficulty pronouncing that. I think I said good morning, I'm not too sure, but for me in the UK it is actually the early evening. And today, the aim of the presentation, of this webinar is to give you an overview of some of the current literature, some of which that I've been been lucky to contribute to, assessing the application and benefits of smartphone connected hearing technologies, as well as their potential to improve accessibility to hearing healthcare in adults.

So I'm just going to advance the slide now. Hopefully, this works. I do have a tendency to carry on talking and nothing works. So if there are any issues, please do as Christy said. Either email those or place those in the Q and A. So this is just a mandatory slide that I've been asked to include in terms of disclosures personal or otherwise. You don't need to read that. The basic take home message is that there's nothing really for me to declare. So in terms of today's learning outcomes there were three key learning objectives that I'd like for us to address today so that by the end of this webinar you're

going to be able to summarize some of the key evidence assessing different connected hearing devices.

You'll also be able to explain how connected hearing devices compare to conventional or traditional hearing aids that don't connect to smartphones. And you'll also be able to discuss whether connected hearing devices can improve accessibility to hearing healthcare specifically in adults, mainly those that are older in age. And as Christie mentioned, throughout this webinar there will be some opportunities if you're joining us live to take part in something called Vevox. It's a polling software. And I quite enjoy using this with my students, particularly given that we have to sit and kind of watch online presentations now. And I find myself, kind of my brain, wandering every now and again, particularly at five o'clock in the afternoon. So you can either download the app.

What I would recommend actually is that you just log in via your web browser on a device such as a smartphone or tablet, and you can just type vevox.app into your web browser. And the meeting ID is there for you. And I'll just leave that on the screen for you for just a moment. So you don't have to put in the dashes. If you go vevox.app into your web browser and just type in 190783015, what should happen, and here's one that I have, is that you should be able to see something like this on your screen. So if you have that, excellent. And for those of you who might not be joining us live who might be watching a prerecording, don't panic.

I think there might be other opportunities for you to take part by some alternative means. So I'm just gonna advance that slide now. Don't panic about the ID. It is on the next slide, and I'd like us to start with a quick practice. So this isn't related to the presentation per se, but I'd like to know where everyone on the call is joining us from today. So for me, for instance, I put in Loughborough. So you're gonna be asked to type in one word, if you can. And I'll begin that countdown clock in just a moment. So

it's about 45 seconds you have, so you don't need to rush by any means. So hopefully, everyone's ready, and I'm really hoping this works.

So I'm just gonna press enter. And I just want you to place where joining us from online today. So I've opened that poll. I can see that there are 20 people joining us. We've already received our first response, which is exciting. Thank you, everybody. If we max out our responses, I'll close the poll early. So I've got 20 out of 20. So I'm assuming everyone who wants, ooh. I've got another one, sorry. 21, ooh, it's increased to 22. I'll give everyone a few moments more. Someone else has joined us, which is excellent. I feel like a sport commentator giving commentary. Okay, so we've got about five seconds left. Excellent, thank you, everyone. So that should generate a word cloud for us so I can see where you're all calling in from.

I never know whether it's presented, oh, brilliant. It's done it here for me. So some of the text is a bit harder to see. So I can see Bangor, Maine. I hope that's how you pronounce it. That's how you pronounce it in Wales in the UK. San Jose, San Diego, Indiana, Colorado. Lots of people calling in from LA, Los Angeles, amazing. I actually was wearing a jumper yesterday that had that on, weirdly, California. Welcome, everybody, it's great to see lots of people from North America here nice and early. I'm sure like me you're enjoying your morning coffee, or this is my evening coffee. Brilliant, so I've got one more poll for you, and that's actually is related to today's presentation.

So what I'd like you to answer is this multiple choice question. And I wanted to ask whether you're aware of the percentage of adults in the United States of America that actually adopt hearing aids. If you think it's 8.5%, you just put a mark there. 17%, 34% or 68%. And I'll open that poll, and you've got 15 seconds to respond. Brilliant and welcome, everyone. I can see that lots of you were able to answer on time. That's brilliant, thank you. So I can see, also, the majority saying 17 or 34%. So well done, those who went with option number three. It is indeed 34%. So as we can see here a

high proportion of adults in the US that would benefit from hearing aids don't actually go on to adopt them.

Now, interestingly, in countries such as the UK where hearing aids are provided or subsidized by the publicly funded National Health Service, hearing aid adoption rates aren't even much higher. So in the UK, it's around 40%, so about 6% difference. So clearly price point isn't just the only answer. Why is it then the hearing aid adoption is so low globally and that actually a large majority of people who would benefit from hearing aids don't actually go on to take them up. Now, there's a whole host of different reasons that have been identified in the literature that can explain low hearing aid adoption. So these factors can include things such as individuals, not perceiving having a hearing difficulty or not even perceiving that their hearing difficulty is bad enough to warrant actually getting hearing aids.

Additionally, low acceptance of hearing aids acquisition is associated with a lack of social support from friends and from family to manage hearing loss, as well as negative stigma that might be associated with hearing loss and hearing aids more generally. Now, these can include things like discomfort. So people often assume that they're uncomfortable to wear, and actually they might achieve very limited benefit in those noisy situations that can be very problematic for people with hearing difficulties. Now, in addition, before COVID 19, but actually very much during the pandemic, what we've also seen is that limited or reduced accessibility to hearing healthcare can also have a huge impact on hearing aid adoption rates. And as I mentioned, this was really obvious during the COVID-19 pandemic, particularly in the UK and I'm sure globally, as well.

That highlighted that there's a real need to address this sudden and unprecedented disruption that can be caused to accessing audiological care. So what I want to argue today is that health practices that are actually supported by mobile devices, such as mobile phones, tablets, laptops, for instance, as well as patient monitoring devices,

which we can refer to as mHealth, may actually provide a means of addressing some of the key barriers that I just discussed on the previous slide, may actually be able to improve access to hearing healthcare. And indeed, in the last 10 to 15 years, there's been a huge rise or proliferation of hearing devices that connect wirelessly either directly or indirectly by some interim device to smartphone technologies.

Now, what I did want to touch upon here is a common misconception that I hear from colleagues and from other researchers that I sometimes have to battle against. And that's the actually smartphone connected devices aren't suitable for older adults with hearing loss, our typical first time hearing aid user age group. Now, while I certainly acknowledge and accept that these devices might not be suitable for every patient that comes into the clinic, it's worth noting that smartphone and tablet ownership in this older age group is growing exponentially, very rapidly. So if we look at some statistics in the UK, so these were provided by Ofcom, so they govern television and advertising in the UK. They surveyed a national sample, and in 2012, it was estimated that around 19% of older adults in the 55 to 65 year-old age bracket owned or used a smartphone regularly.

However, more recent statistics in 2021 shows that there's been a huge rise in the past nine years. And the smartphone ownership in this group has grown at a faster rate than any other age group. We now estimate smartphone ownership to be around 83% in this group. So the take home message here is that the majority of older adults now appear to be owning or using a smartphone regularly. And really what I want to suggest is that older adults that are coming into the clinic are probably more likely than not to be suitable candidates for smartphone connected hearing technologies. Now, what I'd like to do is to move on and discuss some of these technologies that are either available within a clinic or elsewhere.

And I've clustered these into three very broad categories. These categories include smartphone connected hearing aids, direct-to-consumer devices, such as personal sound amplification products, and a final third category, smartphone-based hearing aid applications or apps that can be downloaded from any suitable app store. So first, I want to describe what I mean by smartphone connected hearing aids. Now, these can also be known as, or referred to as made for iPhone, or made for Android, or made for all MFI or A devices. So they have multiple names, but this is what I mean by smartphone connected hearing aids. And one of the things that people commonly say to me is that these hearing aids that connect wirelessly via Bluetooth, say, to smart technologies, they're just a gimmick or a fad.

And they don't really offer anything more than, say, what existing conventional hearing aids already provide. Digital hearing aids for some time have already been, it's already been possible for users to conveniently adjust their volume and programs via the switch of a button on the reverse of their hearing aids or, say, via a remote-controlled or interim device, which can be enabled by audiologists. But what I'm gonna argue that's kind of novel or unique with these devices is that, as well as user adjustment, smartphone connected hearing aids offer a huge amount of functionality. Now, these include things like fall detection, audio streaming, as well as activity tracking. And the latter, as an aside, is something that I'm very interested in.

I'm very interested in getting older adults, particularly those with hearing loss, to engage in physical activity. And maybe that's something I can talk on in a future seminar. But what I want to make clear is that this isn't an exhaustive list of all the things that smartphone connected hearing aids can do. And just is there to provide you a flavor of what they can provide. And I'm sure that actually going forward as technology changes and improves there'll be even more developments and other functions that are available in the not so distant future. And I'm sure if there are any

hearing aid manufacturers out there in the audience they'll already have a heads-up of what those might be.

Now, in addition to smartphone connected hearing aids, our second category that I'd like to focus on is direct-to-consumer amplification products. And these can sometimes also be referred to as PSAPs, or personal sound amplification products. Now, these types of devices are available to purchase without the supervision of a clinician or a hearing healthcare professional. And in the literature, we've noticed that these have become one of the main, low cost, alternative amplification devices to conventional hearing aids. Now, in the US, which many of you are joining us from, they're not FDA regulated, and they're, therefore, not designed to accentuate listening in, sorry. They're designed to accentuate listening in certain environments such as bird watching or listening to a lecture with a distant speaker, for instance, rather than actually being a direct treatment for hearing loss.

So consequently, unlike the forthcoming category of over-the-counter hearing aids, these devices aren't currently being marketed or can't be marketed due to FDA regulations, those devices that help people to overcome hearing loss. As I mentioned, they're only designed to accentuate certain listening environments. And finally, the last category of device is hearing aid smartphone applications or apps as I'm going to continue to refer to those. And those operate on a smartphone and can be coupled with either wired earphones or a wireless hearable, even AirPods, for instance. And arguably, these provide a potentially more affordable and accessible alternative to traditional aids. Now, some apps provide in-situ hearing tests, so they can be kind of tailored to an individual's prescribed hearing loss as something similar to pure-tone audiometry.

And that's really an attempt to provide amplification that's almost tailored to an individual's target gate. And they also permit the user to make certain adjustments in

particular listening situations. So an even more low cost alternative to those PSAPs or DTC devices that I just spoke about. So those are our three categories of device. Now, what I want to do, and what I'm going to focus on for the majority of this presentation now is to really explain the current evidence that's available that assesses all of these different connected hearing devices. I'm gonna start by focusing on evidence for smartphone connected hearing aids of which there's quite a considerable amount. And then, I'll move on to direct-to-consumer amplification products and smartphone hearing aid apps, and I'll discuss the pros and cons of the current evidence that exists for those.

Let's have a look at smartphone connected hearing aids then. And actually, one of the first studies in this area was undertaken by Stella and colleagues in the United States, and it was published in 2017 in the journal of, in JAAA. Now, what these researchers did is they completed a qualitative collective case study design in order to investigate both clinicians and patients experiences of smartphone connected hearing aids. Now, what I view as a key advantage of these authors' approach is that they drew upon multiple perspectives, so clinicians and patients, as well as lots of different sources in order to provide an in-depth insight into the benefits of this technology. So in total, they sampled eight clinicians and 11 patients.

They interviewed those individuals, and they also triangulated that data with 10 great literature sources such as from news media reports, professional magazines, and so forth. Now, from these sources, a very complex picture of findings was apparent. And actually, there's some positives, but also some negatives. So if we have a look at the first point here, it was found that clinicians reported that their aural rehabilitation practices were improved by the provision of these devices. And this was because they reported spending more time getting to know their patients' listening and communication needs. Now, in addition to that, both clinicians and patients reported that connecting smartphones with hearing aids had the potential to reduce stigma.

Now, this was because smartphone technologies were perceived as more socially acceptable, or the authors used to determine normalized, in comparison to more conventional hearing aids.

It was also stated that smartphone connected hearing aids provided great opportunities for patients to participate more fully in their everyday lives, because they could make those fine-tune adjustments in any listening situation. However, as I said, not all the findings were positive, and it was frequently reported the patients experienced technical issues in relation to Bluetooth connectivity and troubleshooting. And what this often resulted in is patients experiencing feelings of frustration, as well as increased burden to not only get used to their hearing aids, but also then, to connect via Bluetooth their devices, also. So moving on then. The findings of Stella in study have been supported in a more recent mixed-methods study that I was involved in where we assess the benefits of a smartphone app used in conjunction with smartphone connected hearing aids.

Now, in this study, it was a prospective observational study where we recruited first time and existing hearing aid users from one adult audiology department in the UK publicly funded National Health Service. And that was based in Nottingham, which is in the Midlands of the UK. Now, critically, in order to take part, participants had to own an iPhone 5 or above. So they had to have quite an advanced phone. Now, this was because the app didn't work on any earlier operating systems. So it had to work on version 10 or greater. Now, I did think initially when we were recruiting this would be somewhat difficult. However, I soon realize that many older adults coming into the clinic had better smartphones than I did.

So I currently have an iPhone 7, but many of these had the latest iPhone out there, which like I said, came as somewhat of surprise to me. Now, in terms of the design, this side will provide you a schematic of the overall design of the study. So following

initial eligibility screening and consent, participants attended an initial hearing fitting appointment within the laboratory where they were also shown how to download and use the app, and they completed outcome measures, so patient reported outcome measures. And we refer to that as baseline. After a week of using the device, they came back to the lab and returned for a further session where the patients could request, or the participants, sorry, could request that the clinical audiologist make fine-tune adjustments to their hearing aids, if necessary, as well as the completion of some additional patient-reported outcome measures.

Now, then participants went away for six weeks and used those devices in the real world. We were able to monitor and observe their behavior with the app and how they were getting on. And we asked them to collect a diary. And then, participants then returned to complete some, what we referred to as follow-up outcomes to see if there was any change from baseline and that first week of using the devices. Now, in addition, I mentioned that it was a mixed-method study. So in addition to self-reported quantitative outcomes, we also completed qualitative focus groups where we wanted to gain a more in-depth insight into the barriers and facilitators to app use. What I want to first do is to report what we found in terms of the validated patient reporteded outcomes.

And they actually revealed several benefits to using the smartphone connected hearing aids, including improvements in social participation. So people were more likely to take part in social gatherings. There was lower hearing related reported fatigue. They reported greater quality of listening through their hearing aids, as well as improved hearing aid benefit and satisfaction. And critically, for our existing hearing aid users, these outcomes were all significantly better for the smartphone connected, for connected hearing aids in comparison to their conventional NHS hearing aids, which they couldn't adjust via a smartphone. Or they were arguably comparable in all other functionality. If we just focus on a purpose-made feedback survey specifically looking

at the app, what we see here is that following the seven-week trial, participants reported that they would rate the app four out of five stars, suggesting that there was some very marginal room for improvement.

And this was actually reflected in a whole host of things that we asked. And so we asked questions and received good responses about whether the app sufficiently met user's needs with most of participants reporting that the app met their needs either somewhat or extremely well. The best reported feature of the app was their ability to make adjustments to their hearing aid settings to improve their listening abilities in any situation but particularly environments that were very noisy or difficult, such as where there's background noise. So a busy pub or a restaurant. And the app was also considered most useful in having a conversation in noise, as well as when watching the TV at a much quieter volume, which are some key complaints that older adults with hearing loss normally present with when they come into the clinic.

So basically, this provides a positive view of the app and smartphone connected hearing aids, but as I said, we did follow up with some patient focus groups. So we have two focus groups with four individuals, and we wanted to gain a real in-depth insight into the barriers and facilitators to using the app. And this was underpinned by a framework and a behavior change framework called the behavior change wheel. Now, for those of you who aren't familiar with that framework, at its core is a model called the COM-B, which stands for capability, opportunity, motivation, and behavior. And that's what I'm showing you here. So this is how we conceptualized the focus group interview schedule, as well as analyzed the data accordingly.

Now, what this model stipulates is that in order to undertake a target behavior, such as using smartphone connected hearing aids and individual has to have psychological and physical capability to enact that behavior, physical and social opportunity that enables the target behavior, as well as reflective or automatic motivation that activate

or inhibit the behavior. So using that framework, what did we find? So we found some positive and some negatives. So some barriers and facilitators to using smartphone connected hearing aids. And this just gives you a flavor of what they said. So overall, patients provided support for many of the findings shown by Stella in the study that I mentioned earlier such as smartphones, smartphone hearing aids increasing participation but also leading to some increased burden, decisional burden in relation to making adjustments via the app, as well as some burden and frustration with Bluetooth connectivity.

The study also showed that the most useful feature of smartphone connected hearing aids was their ability to adjust the sound quality via the app, and was also particularly advantageous when conversing with others in background noise. So basically, supporting the findings from our quantitative outcomes. And now, in addition, what I quite liked here is the participants reported that user controllability actually empowered them to successfully manage their hearing loss, providing them with a greater sense of confidence or autonomy or independence, which ultimately led to greater social participation. And what I really like is this quote here from a participant who said, "I think it's great to be able to control of these things. It's nice to feel that you're in control."

Now, in addition to assessing smartphone connected hearing aids and user controllability via an app, several recently published studies have also evaluated the usability and effectiveness of making remote requests in order to tweak and adjust their hearing aid programs and to receive new settings from their audiologist. Now, there are two studies that have been published that specifically compared the quality of fine-tuning hearing aids that are performed by an audiologist either in person at a follow-up appointment or via remote software. And that's kind of what this diagram here on the left is kind of illustrating. And specifically, what was evaluated was an asynchronous smartphone app-based tele-audiology service for fine-tuning hearing

aids. So what this basically means is that an individual has the hearing aids, they have the app, they report an issue, or maybe an adjustment that they quite like, and that, then, goes to the audiologist, and they pick that up whenever they're ready, hence it being asynchronous.

They then upload that request. They may make some fine-tune adjustments, and then they ping that back to their patient for them to download again in their own time. The patient can then try that out and rate whether they like it or not and then feed that back to their clinician. And the whole loop starts again. Now, interestingly, what these studies have shown is that there's no significant difference between the groups, so remote fine-tuning and in-person fine-tuning, in terms of hearing aid outcomes that are measured. So things like hearing aid use benefits and satisfaction, as well as speech, understanding, and noise. And what this may suggest is that remote communication between patients and audiologists via an app is equally as effective as face-to-face follow-up appointments, at least in the short term.

So these were studies completed within six weeks. No studies have looked at kind of longer term outcomes. And what these findings have led the authors to recommend is including this tele-audiology tool for use after the initial hearing aid fitting appointments that can be used in conjunction or in combination with in-person follow-up care as part of routine clinical protocol, where the two methods ultimately supplement one another in order to improve accessibility. So appointment availability, for instance. So what I want to do here in this slide is just to summarize the evidence that I've just covered regarding smartphone connected hearing aids and what those studies have ultimately showed. And as I said, these devices are showing both positives and negatives of the smartphone connected hearing aids.

So if we look at some of the pros or some of the positives, clearly these studies have consistently shown that they can help to improve or build upon existing rehabilitation

practices. They enable greater social participation in patients, as well as lead to feelings of reduced stigma. They can often lead to greater hearing aid use, benefit, and satisfaction or at least equivalent in terms of in-person care. They can also show improved speech in noise perception and also lead to that feeling of empowerment to manage hearing loss. But as I said, it's not all positive. There are some negatives. So what has been consistently shown throughout the literature is that clearly patients require sufficient digital literacy and access to the devices to get benefit from them.

There can often be frustration and extra decisional burden resulting from self-adjustment and connectivity via Bluetooth. Interestingly, some participants report that these might actually be better suited to a younger demographic. And they sometimes feel embarrassed, because it's kind of like they're trying to be young and kind of down with the kids, I think, as one participant said to me once in the past. And still, some participants have reported that, even though they come make some adjustments, they want to be able to make more and that they find that the personalization is still insufficient and could be better. So based on all of that evidence, I want to pass this over to you. So again, I want us all to join Vevox, and I'm going to open another poll.

So based on that tour of the evidence that I've just just outlined to you, I want you to rate out of five stars whether you would recommend smartphone connected hearing aids to adults with hearing loss. So if you're absolutely, "No, no, we shouldn't recommend them, one star." Somewhere in between, so maybe three stars. I've noticed there's a mistake. It should be five stars at that one there. My picture is wrong, I apologize. I want you to put five stars, absolutely amazing. So hopefully, you've all been able to join the poll again. The code is there for you in case it's dropped out. And I'm just going to press enter now for you put your response. Excellent, thank you, everybody.

So perfect, so excellent. So what we can see here is there is some ambivalence. So there's a small proportion who are somewhere in the middle, but the vast majority are either four or five stars. And that doesn't really surprise me given that much of this technology is already out there and being implemented in clinical practice. So thank you for engaging in that. As you might have guessed, I'll also be asking you that question again a little bit later on for the other devices. Okay, let me just see if I can advance the slide. Sorry about that, it didn't seem to advance. So let's move on then to our studies assessing direct-to-consumer amplification products or PSAPs I might refer to them.

Now, previous studies assessing these devices have investigated their electroacoustic characteristics, their speech and noise performance, as well as self-reported benefit and satisfaction. And these are typically compared to conventional hearing aids. Now, there's a clear distinction here between economy and premium based products. And I'm citing evidence by Nick Reed and colleagues that kind of were at the forefront of this work. Now, what has been shown is that, compared to conventional hearing aids, lower priced products provide varying degrees of performance. And in most cases, the electroacoustic performance of them fails to meet prescribed target gains for age-related sloping hearing losses. They also appear to provide insufficient high-frequency amplification and often too much low frequency amplification for moderate degrees of hearing losses relative to the prescriptive target.

In addition, speech perception performance has also been shown to decline or be worse than, say, nothing or conventional hearing aids for those lower priced direct-to-consumer products. Now, in comparison, higher priced products seem to perform a little bit closer to those conventional hearing aids. They also appear to allow for prescribed gains targets, meet most mild to moderate hearing losses. And in addition, they've been shown to result in similar speech understanding performance in noise when compared to those traditional hearing aids. So what we can see here is a

clear distinction between more economy, cheaper products versus more premium, more expensive products. Now, in a more recent study completed by colleagues in Manchester in the United Kingdom, they actually assessed 28 direct-to-consumer products that could be purchased online for less than 400 pounds, which is I think about 300, 350 US dollars.

And they evaluated those on a range of different outcomes. And what they found is that the electroacoustic performance, again, to match to the gain slope targets, as well as cosmetic appearance and willingness to wear was evaluated and was much poorer when compared to the hearing aid that's provided free of charge by the UK National Health Service. And this really reflects similar research that I just outlined by Nicholas Reed. So what they found is that the higher priced products were associated with better performance in terms of electroacoustic characteristics matching to target gains and slopes, as well as cosmetic accessibility and willingness to wear. And interestingly, if you read the whole article, it was also noted that those products that could actually be customized via an accompanying smartphone application actually performed better than any of the other devices.

Even so, all of the devices were found to produce uncomfortably loud sounds, and also had low cosmetic appeal ratings in comparison to that conventional hearing aid. So to summarize then, I did say that there's slightly less evidence in this area in comparison to smartphone connected hearing aids. The current evidence in this domain suggests that performance of these products is associated with purchase price. In addition, the availability of user adjusted controls via a smartphone app does appear to improve some performance, particularly in terms of frequency gain and overall speech intelligibility when compared to more conventional hearing aids. So it could be concluded that they may, these devices, these direct-to-consumer amplification products could serve as an accessible, lower cost amplification alternative for some

individuals, because they can be purchased at much lower price points, and they don't necessarily need a clinician's supervision.

So interesting then, as I said, I'd like you to rate again based on that evidence whether you would recommend these products to adults with hearing loss. So again, one for no; three, maybe; and five for absolutely. So I'm going to open that poll for you again to vote. So again, open for 15 seconds. Excellent, oh, okay. I'm actually very surprised by that result. Due to the less evidence and the varying degrees of strengths showing effectiveness, I was expecting most people to be in the ones and twos, but I'm very interested that there are some people even as high as four with the majority of you just over half, voting around three stars. So maybe, again, some ambivalence.

Some people just aren't sure. And I'll be interested to see how you rate the smartphone applications in just a moment. So finally, let's take a look at the evidence assessing smartphone hearing aid apps, many of which are freely available on app stores whether it be Android or Apple. Now, there was a very early study in 2013, assessing the utility of smartphone hearing aid apps. So Amin Amlani recruited 18 adults between the ages of 50 and 90 years with mild to moderate hearing losses. And these were compared to traditional hearing aids, and they compared two hearing aid applications, apps, with the hearing aid in terms of the electroacoustic characteristics, the MPOs, or the maximum power output. And what they found here is that both of these factors were significantly higher or poorer for both the smartphone apps relative to the hearing aid.

However, when they looked at speech and noise perception as well as self-reported benefit and satisfaction, interestingly, the apps performed equivalent to the conventional hearing aids. So they were comparable across all of the devices assessed. Now, in a more recent study that I completed, I wanted to examine the everyday experiences of existing hearing aid users. So I recruited 20 with mild to moderate hearing loss toward a range of connected hearing devices. So this included a

smartphone connected hearing aid. Also, a direct-to-consumer amplification product, a PSAP, as well as a smartphone hearing aid app that could be either used with a wireless hearable or wired earphones. And all of these devices could be individually programmed to the patient's prescribed target.

And then, they came into the lab. These devices were provided. They were shown how to use them. They could adjust every device using a smartphone app if they wished. And then, we then assessed their everyday use in a two-week field study. Again, it was mixed-method. So participants completed self-reported outcome measures of use, benefit, and satisfaction, as well as completed individual semi-structured interviews. So what I first want to do is summarize those self-reported outcomes. So what we did here is we used an outcome measure that assessed benefits. Because it was existing hearing aid users, we wanted to assess how different were these devices in comparison to their conventional hearing aids, again, provided by the National Health Service.

And what the results showed from our patient reported outcome measures is that use, benefit, satisfaction, and residual disability for the smartphone connected hearing aids were all significantly better relative to the conventional hearing aid, but also, relative to all of the other devices trialed. But what I want to show you on this figure here on the right is we've got smartphone connected hearing aids, we've got the PSAP, the smartphone app with wireless earphones, and the app with wired earphones. And I don't know if you can see, but that app and wire earphones actually shows that this was also rated very highly. So I'm just showing you the benefit, but this was equivalent across all of the outcomes measured.

And what we speculated here is that what is happening is that the reason that this was rated highly is because individuals still have the ability to adjust the volume and frequency response in any listening situation very conveniently. In comparison to the

other devices, the PSAP was considered suboptimal. So it didn't provide sufficient amplification. And the app with wireless earphones, there was actually a delay because of the Bluetooth connectivity, which most participants reported as being very prohibitive. So an interesting finding, nonetheless, that actually the smartphone app with wired earphones still provided quite high ratings on those outcomes. And this was also reflected in our semi-structured interviews. And then, what I want to do here is to provide you results across all of the devices trialed, because it showed some interesting results.

But if you want to look at the paper, I also divide those by the specific devices, also. And what we found here is that the most useful feature of the smartphone connected hearing devices was that ability to make adjustments to the sound quality via an app. And this feature was particularly advantageous, provided lots of benefits when conversing with others in the presence of background noise such as a busy restaurant or pub. Now, in addition, similar to our existing findings, patients reported that the user controllability, again, empowered them to manage their hearing loss, providing them with autonomy, independence, and again, leading to greater social participation. So this is a message that we've seen throughout all of our research, irrespective of the hearing device we've trialed.

It's that smartphone connectivity that's key. And again, I wanted to give you a really nice quote that really resonated with me from a participant. And I still remember the interview to this day where this individual said, "It gives me that bit of control, and it's not just other people running my life, it's me. It's not quality of life, it's just having a life." Now, in addition to that evidence, in 2019, De Sousa and colleagues investigated the electroacoustic characteristic and self-reported characteristics and self-reported performance for smartphone hearing aid apps that are available on the Android and Apple app stores, vis-a-vis different operating systems. And what they compared to

here was the delay or the latency of the amplified signal across wired and wireless earphones.

And what was interesting here is the shortest latency was found across all apps when used with an iPhone in comparison to an Android smartphone and also for wired earphones were much shorter latencies than the wireless earphones, because obviously, their transmitting via that wireless Bluetooth signal. So what we can see here is there are clear differences between operating systems and the types of headphones used. So the most optimal would appear to be Apple with wired earphones. So let's have a look at a summary of the evidence again. So taken together what the evidence is suggesting here is that hearing aid apps might actually be a suitable alternative to hearing aids, but there should be some caution in terms of the variation that arises because of the types of app, operating system and earphones used.

Not all apps are equivalent. We need to be mindful of that. So last rating of today then. I want to know the likelihood that you would recommend these to older adults with hearing loss. So again, one star, no; three, in the middle; five, absolutely. Excellent, oh, so there's actually a quite broad range. So some people I've not managed to convince at all, so two stars. None saying one star, which is interesting. We've got some people even edging towards four or five stars, which is excellent. And I think that's really interesting given that many of these hearing aid apps are freely available. They come at no cost to the individual. So thank you all for engaging. That's our last poll of today.

So thank you all for doing that and bearing with me. Now, I have a bit of time. I've just checked the time. I'm not running over, which is good. So I've got some time to actually look at some other research. So we've looked at it from the patient perspective and a little bit from the professional position, but now, I'm going to focus exclusively on evidence that's assessed the attitudes of these technologies in hearing healthcare professionals, particularly with regard to potential implementation of connected devices

in their practices. Now, in a quantitative survey, so this was based in the US, based with US audiologists Kimball and colleagues found the clinicians were actually very highly supportive of the integration of smartphone connected hearing aids, specifically in their adult aural rehabilitation practices and advocated the use of smartphone apps by patients in order to make fine-tune adjustments and personalize their amplification settings.

So they were very supportive. So this study, presumably, was undertaken a few years before it was published in 2018. So in the mid 2010s, we were seeing here that in the US certainly clinicians were very supportive. However, what was found by these researchers is that they were less supportive of allowing their patients to make more permanent alterations or adjustments to their devices. So there was a limit to how much personalization clinicians were happy to allow their patients to do. Now, in a study that was based in the UK that I worked with a colleague Anne Olson while she was on sabbatical working with our research team, we actually found very similar results in the UK where we completed a Delphi survey.

Now, this is a formalized process of gathering consensus amongst experts. And what we did here is we wanted to assess the perspectives of hearing healthcare professionals working in both the independent or private sector. So hearing aid dispensers, for instance, as well as those working in the National Health Service toward a range of different connected hearing technologies. Now, that Delphi survey process involved kind of three or four steps. We first start with round one, which is an open survey where we just ask some very broad questions to our expert panel. And from that, we then theme the responses to create closed ended survey questions where people can rate them on a five-point Likert scale from disagree to agree.

So that's round two. And then, we analyze those, bring all the data together. And then, we then feed back what everyone said to respondents in round three so they can see

how other people on average responded. And they, then, have an opportunity to make any adjustments to their scoring until consensus is then achieved. And we normally have a threshold of consensus, which was around 80% agreement, I believe, in this study. Or it might've been 75, I don't quite recall. Now, what we found here is that all respondents, irrespective of the sector, so we found that it was equivalent. There were no differences in sector views. They agreed that appropriate candidates for these types of technology should include adults who report communication difficulties but also who have a sufficient level of digital literacy to use smartphones and also have no other medical contraindication such as ear wax or any other more problematic issues.

There was some ambivalence concerning whether these devices should be provided, say, via the internet, so via an online store for instance, or via non-audiological healthcare providers. So there was mixed views with regards to that. And it was agreed that a direct-to-consumer service delivery model might improve accessibility, but there were also concerns about the patient's ability to assess their hearing loss accurately, as well as the potential delays that might occur as a consequence in the treatment of other most serious medical conditions. So there was uncertainty about how likely it was that they could identify their level of hearing loss, as well as other medical contraindications. And so what we can see here is there's a general mixed feeling certainly in the UK in support of some of these devices.

And I also wanted to draw everyone's attention to a much more recent study by Parmer and colleagues, again in the UK, who surveyed attitudes of 323 NHS and independent sector audiologists toward audiology in the context of the nationwide lockdown that arose due to COVID-19, which in the UK started in March, April of 2020. And it was found here that the lockdown resulted in variable changes in work status. So some services provided remote services that I described earlier, whereas other didn't. So there was some inconsistency in care. And most respondents from both the independent and the NHS sectors were moderately or very comfortable conducting

remote consultations. These were typically telephone based, and there was some but not very much video conferencing and even less remote fitting and adjustment being utilized.

Now, some of the key barriers that were identified in terms of this remote fitting differed according to sector. So there were concerns regarding equipment limitations stated by NHS-based respondents, whereas the independent sector were concerned about their patient's confidence toward using the technology, which they felt had a potential to make their services that they provided much more impersonal. So again, another mixed set of findings in the UK. So you'll be pleased to hear that that brings our session to an end. So going back to that question in the title. Are smartphones the answer? Hopefully, what I've been able to portray to you today is that connected hearing devices certainly provide an opportunity to improve access to hearing healthcare.

Nevertheless, each of the three categories of device have their own advantages, disadvantages, pros and cons that we need to be mindful of. In terms of evidence looking at the patient perspective, quite often than not, individuals report that they give, that these devices give them a greater sense of autonomy and control of their hearing loss and also result in reduced stigma. Nevertheless, there are issues surrounding digital competency, as well as decisional burden in relation to making adjustments and frustrations that arise as a result of connectivity. From a clinician's perspective, which I touched on at the end of today's presentation, there appears to be a high willingness both in the UK and the US to implement these technologies, but there is some ambivalence and uncertainty about how this can best be achieved.

Nevertheless, I think that we're kind of living in a very exciting era where we're seeing lots of advances in technology. In addition, when coupled with the global pandemic, where I think that as researchers, as clinicians practicing, we're gonna be compelled to continually reassess our practices so that we can meet the needs of individuals with

hearing loss to improve their overall quality of life. So I just wanted to provide a quick summary of all the references that I've covered today. They are also provided in the Seminars in Hearing paper that was published, which is kind of in collaboration with today's session. And I believe that these will be provided in a separate document to you, as well.

And finally, I just wanted to thank you all so much for your attention. If you have any questions or comments that you'd like to send across to me, please do send me an email, and that's there on the slide for you. So I believe, now, we do have some time, five minutes in fact, which is perfect timing. I haven't practiced this today. So I'm very impressed. I've got some time, maybe five minutes or so, to open up the Q and A. So do feel free to add those. I haven't checked today to see if there are any on there. Let me have a look. So no questions, oh, some have been answered already. So I'm assuming I don't need to look at those.

Ooh, I've got one question popped in. So I'm just gonna read this out for the benefit of those who can't see it or who might not be joining us live. So an anonymous attendee has said, "Bluetooth enabled devices are great until the patient does not know how to operate their phone and blame the hearing aids as faulty. What advice would you give to remediate this?" That's a really excellent question. Obviously, what you want to do is you want to empower the individual. And I know that in my experience many individuals want to be able to troubleshoot themselves. They often report to me that, "Oh, I'm having this difficulty, and I don't want to bother you. I don't want to come back into the clinic in person to see or to speak to a clinician. I want to be able to be independent and sort this myself."

Now, something that we can do is we can provide patients with information in any form that can help them to achieve or to alleviate some of these difficulties. So provide some kind of quick troubleshooting tips. Now, I'm aware that some hearing aid

manufacturers do this very successfully, and they provide written guidance in, say, a manual. There are also YouTube videos, for instance. And I have been involved with a group in Nottingham, Mel Ferguson who you might be aware of, developing a resource called C2Hear. And I'd be more than willing if that person wants to get in contact with me, I can send you the link to those days.

They're on YouTube and we have our own independent website where there are a whole host of resources for patients and clinicians. And they show kind of video demonstrations. There's quizzes and so forth to kind of help patients get familiar with their devices. Now, although these haven't been developed for people using smartphone connected hearing devices, I'd very much like there to be due to that advances in technology. So that's one potential idea or solution. So we've got another question here from Dixie Armada. Hope I'm pronouncing that correctly. "Given that residents of the UK can receive hearing aids at no cost, why would they try direct to consumer devices?" That's a really good question, as well. So, yeah, as I mentioned, within the publicly funded National Health Service hearing aids are provided free of charge in most areas.

There's only one area in the UK that doesn't provide those for people with mild to moderate hearing losses. And that's another debate that I could bore you with that at another time. But what I would say is that irrespective of the devices that can be provided, I still come up against this stigma related issue. So lots of people come to me and say, "Oh, I don't want to use hearing aids. They're big, they're clunky, they look ugly." So there's still this misconception that these devices, even though technology has advanced, that they're still not ideal. In addition, some people want to be able to manage their hearing loss and other aspects of their health independently without having to see a clinician, even if it is available free of charge.

And I think really what this does is it opens up the door to individuals who might not perceive that they have a difficulty or might perceive that their difficulty isn't bad enough to warrant getting a hearing device. So they might act as kind of gateway products so that people can try them, similar to, say, spectacles that you can buy in the supermarket, for instance. So you kind of can try them. You see, oh, yes, they do provide some kind of benefit. And then, that might act as a gateway to people seeking more formal rehabilitation care. So I think that's a really interesting point. And further work certainly needs to be done in order to kind of understand different patients' perspective.

I can't see any other questions popping through. I don't know whether I've covered the time. We've got a couple of minutes if there are any more questions. If not, it's been lovely to speak to you and engage with you all, and I wish you a very lovely rest of the day.