Key points

- The UK National Institute for Health and Care Excellence has estimated a 70% increase in demand resulting from the 2019 modification to cochlear implant criteria
- We modelled the projected increase using our large database of pure tone audiometry results, and adjusted for frailty as a marker of risk of general anaesthesia
- Our results suggest an overall 79% increase in demand, with most of this for adult implantation, and in particular for those over the age of 65
- Our findings are important for those planning delivery of cochlear implant services

Introduction

Under UK National Institute for Health and Care Excellence (NICE) guidelines,[1] eligibility for cochlear implantation is determined by audiological performance on pure tone and (for adults) speech audiometry. Candidacy will also be determined by non-audiological factors such as suitability for general anaesthesia, and cognitive and psychological status. In March 2019 NICE released updated criteria for cochlear implant referral[1] which were more permissive than previous guidelines,[2] and allowed implantation where hearing thresholds in both ears lie at or greater than 80 dBHL (decibels Hearing Loss) at two or more frequencies (at 500 Hz, 1kHz, 2kHz, 3kHz or 4kHz). The previous guidance specified thresholds of 90dBHL at 2kHz and 4 kHz. Candidacy on speech audiometry remained at 50% word recognition at 70dBHL (aided), but now using the Arthur Boothroyd (AB) word test, rather than the Bamford-Kowal-Bench (BKB) test specified in the previous guidelines.

NICE estimated that the change in criteria for implantation would lead to a 70% increase in demand for implants in England, from 1,260 people per year to 2,150[3]. The data or methods underlying that estimate have not been published or made available. A previous study using audiological data from East Kent suggested a much larger increase in eligibility of 163%,[4] but that study did not adjust for other determinants of candidacy (such as performance on speech audiometry or risk of general anaesthesia), and did not report age-specific variation (which are relevant data for national planning of cochlear implant services).

The audiology unit at our hospital is a tertiary centre which sees a large number of adults and children in the region who have sought medical care for hearing loss, and the overwhelming majority of those with severe to profound hearing loss. Here we extracted data from all patients in our database satisfying the 2009 and 2019 criteria on PTA, and used these, together with modelled parameters on risk of general anaesthesia, to estimate the change in potential candidacy for cochlear implantation resulting from the 2019 change in NICE guidelines.

Methods

We searched the Brighton and Sussex University Hospitals (BSUH) NHS Trust audiology database for all service users born after 1st January 1920. For each service user we extracted the last recorded air conduction audiometric thresholds on PTA for each ear and at frequencies of 500 Hz, 1kHz, 2kHz, 3kHz and 4 kHz. Data were exported into Excel (Microsoft Corp, Redmond) using the reporting capability of the Practice Navigator Patient Management System (Auditdata). We extracted the number of service users with bilateral hearing loss who met either the 2009 NICE criteria, or the 2019 NICE criteria for cochlear implant eligibility based upon PTA audiometry. We called these our raw data (R), for both the 2009 criteria (R_{2009}) and 2019 criteria (R_{2019}), and separated results by age range.

The surgical procedure for cochlear implantation almost invariably requires general anaesthesia, and so we adjusted our raw data to account for this. We did not have specific data in our cohort on those at high risk from general anaesthesia, so we used predicted age-specific frailty as a proxy[6]. We decreased all figures for our raw data (R_{2009} and R_{2019}) according to the prevalence of frailty identified in a review by Collard et al.[6], namely 3% for those aged 65-69, 7% for those aged 70-74, 10% for those aged 75-79, 16% for those aged 80-85, and 26% for those aged over 85. We call these adjusted figures A_{2009} and A_{2019}.

Results

We sourced data on 60,563 adult and 11,547 paediatric service users. Figure 1 shows raw data on cochlear implant candidacy (R_{2009} and R_{2019}) by age. Raw and adjusted data are summarised in Table 1, which shows that our overall estimate for the increase in number of service users who are candidates for cochlear implants under the new NICE criteria is 79% (2176/1217).

In terms of age:

- The relative projected increase among children is 46% (133/91), and this represents 4% (42/959) of the total of additional service users qualifying for implants.
- The relative projected increase among young adults aged 18-65 is 43% (605/424), and this represents 19% (181/959) of the total additional service users qualifying for implants.
- The relative projected increase among older adults aged over 65 is 105% (1438/702), and this represents 77% (736/959) of the total additional service users qualifying for implants.

Discussion

Our modelling, using adjusted data from our audiology database, suggests an overall 79% increase in eligibility for cochlear implantation amongst service users in our region seeking care for their hearing loss. This figure is higher than but broadly in line with the 70% estimate provided by NICE.[3] It is much lower than the 163% increase suggested by Grounds et al using unadjusted audiological data from East Kent.[4]

There were assumptions and limitations to our modelling that could limit the accuracy of our estimate. We used only data from service users who have attended our unit, so did not necessarily capture all those in our region with severe or profound hearing loss, and we made no adjustments for migration into and out of our region. We used frailty as a proxy for risk of general anaesthesia, but this may be inaccurate. We made no adjustments for aided speech audiometry, although de facto people with better hearing thresholds on PTA will, as a rule, perform better on speech audiometry[8] (albeit unpredictable on a case by case basis). This suggests our modelled increase in eligibility may be an over-estimate (a greater proportion of those meeting the 2019 criteria on PTA will be predicted to have adequate aided speech performance and therefore be ineligible for cochlear implantation).We also made no adjustment for cognitive, psychological, or service user choice as impediments to cochlear implant uptake, on the assumption that those who had already sought care for audiological rehabilitation in our department (represented in our database) would also be happy to proceed with cochlear implantation (which may be untrue, particularly for elderly service users[5]). Our data are for the population of Sussex, which currently has a marginally older demographic than the average for England and Wales.[10] Beyond these methodological limitations, our estimate could also be affected by changes in health seeking behaviour, as only a small proportion of those potentially eligible for cochlear implantation are thought to access such services.[4]

Our modelled increase in demand is relevant for those planning delivery of cochlear implant services, and the breakdown by age is important. Our data show that the greatest increase for cochlear implant candidacy to be amongst older adults, particularly those aged over 65. In 2018, 18.3% of the UK population was aged over 65, comprising 12.2 million people, but by 2068 this is projected to increase to 20.4 million[10] (through a combination of population growth and improved life expectancy), with coastal areas of the UK continuing to house the highest proportion of people aged over 65.

There are currently 24 cochlear implant centres in the UK[9] and our data, and the projected demographic changes in the UK, are relevant considerations for the planning of additional capacity through the expansion of existing implant centres, or the opening of additional centres to meet future increased demand.

References

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All data accessed from Brighton and Sussex University Hospitals Audiology Practice Navigator system. These data are available upon reasonable request.

Figure 1: Raw yield for cochlear implant candidacy on PTA according to patient age.

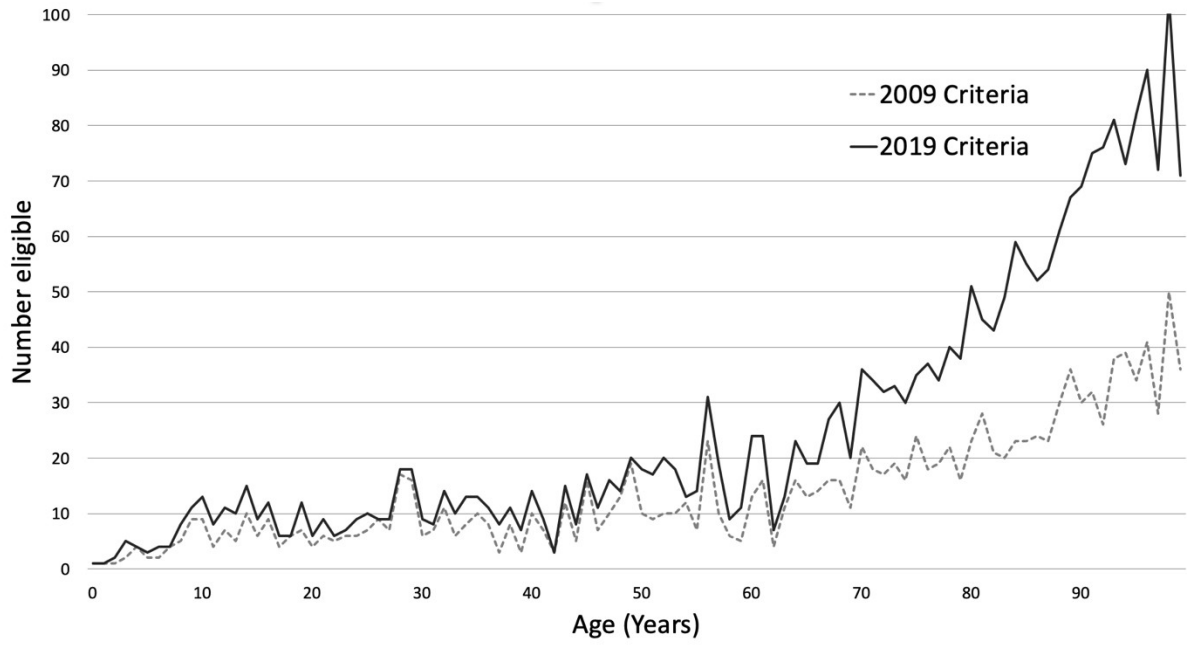

Table 1. Raw and adjusted data on number of service users eligible for cochlear implantation using data from our audiology database. N_{age} = the number of patients falling into each age cohort held within the database. R_{2009} = raw data for eligibility on pure tone audiometry on 2009 NICE criteria, R_{2019} = the same for 2019 NICE criteria. A_{2009} = adjusted estimate for 2009, based upon a reduction of eligibility in older adults on estimates of frailty. A_{2019} = adjusted estimate for 2019.

Decade (Years)	N_{age}	R_{2009}	F_{cf}	A_{2009}	R_{2019}	F_{cf}	A_{2019}	A_{2019}-A_{2009}	% Increase
0-9	4067	31	0	31	43	0	43	12	39%
10-18	7480	60	0	60	90	0	90	30	50%
Total Paediatric	11547	91		91	133		133	42	**46%**
19-39	9154	160	0	160	217	0	217	57	36%
40-59	14792	204	0	204	297	0	297	93	46%
60-64	3768	60	0	60	91	0	91	31	52%
Total Young Adult	27714	424		424	605		605	181	**43%**
65-69	3820	70	3%	68	115	3%	112	44	64%
70-74	4711	92	7%	86	165	7%	153	68	79%
75-79	4104	99	10%	89	184	10%	166	77	86%
80-84	4125	115	16%	97	247	16%	207	111	115%
85-89	4261	136	26%	101	289	26%	214	113	113%
90+	11828	354	26%	262	792	26%	586	324	124%
Total Older Adult	32849	866		702	1792		1438	736	**105%**
Total Adult	**60563**	**1290**		**1126**	**2397**		**2043**	**917**	**81%**