Adult cochlear implant recipients and meningitis in New Zealand: are patients receiving the recommended immunisations?

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ABSTRACT

AIM: To investigate if adult cochlear implant (CI) recipients have received the recommended immunisations as compared to current guidelines and to report instances of meningitis within this population. **METHODS:** Telephone interview of CI recipient's general practitioner (GP) surgeries for details regarding immunisations received. Subsequent reporting of immunisation rates of adult patients, under the care of the Northern Cochlear Implant Programme (NCIP) in New Zealand, when compared to the recommended guidelines from the Immunisation Advisory Centre (IMAC) and rates of meningitis of CI recipients are presented. **RESULTS:** It is recommended to immunise against the most common organisms causing meningitis, Streptococcus pneumoniae and Haemophilus influenzae type b (HiB), as well as influenza. Data for 135 CI recipients over the last five years was complete. 14.8% of patients had received a full pneumococcal immunisation schedule. 11.9% had received a HiB immunisation and 62.2% an influenza vaccination. No patient had developed meningitis following CI insertion. **CONCLUSION:** This paper highlights clear issues with the immunisation of adult CI recipients.

A cochlear implant (CI) consists of two parts: an external part, the processor, worn behind the ear like a hearing aid which communicates through the scalp via a magnetic coil with the implant proper, the receiver/stimulator, which includes an active electrode array which traverses through the mastoid, middle ear and enters the scala tympani of the inner ear through the round window or a drilled cochleostomy near to the round window.[1] In response to auditory stimuli, this electrode array provides direct electrical stimulation of neurons in the auditory nerve. This gives the recipient a perception of sound which aids speech recognition. Bacteria may directly migrate from the middle ear into the cochlea and labyrinth in a similar manner as reported by Friedmann and Arnold when describing meningitis caused by spreading infection in acute or chronic otitis media.[2] Here organisms infiltrate the cochlear turns along the electrode, enter Schuknecht's bony channels and follow perineural or perivascular pathways into the internal auditory canal.[2,3] Direct haematological spread of infection to the cochlea resulting in micro-abscess formation and onward spread to the internal auditory meatus has also been theorised.[3] Whatever the mechanism, it is well documented that there is a greater incidence of meningitis in both adult and paediatric CI recipients when compared to the general population as a whole.[4–8] Additional risk factors of meningitis have been documented, including inner ear malformations with or without cerebrospinal fluid (CSF) leak, persistent CSF leak after CI surgery, history of a ventriculoperitoneal

Table 1: Immunisation schedule for adult cochlear implant patients adapted from the New Zealand Immunisation Advisory Centre.[9]

Pneumococcus		**Haemophilus influenza B (HiB)**		**Influenza**	
Age	**Vaccine**	**Age**	**Vaccine**	**Age**	**Vaccine**
>18 years ↓	One dose of PCV 13 (PREVENAR 13)* *Followed by:* 23PPV (PNEUMOVAX 23) One dose, at least eight weeks AFTER previous Prevenar 13	2 months to under 65 years	HIBERIX One dose either pre- or post-CI	9 years to <65 years >65 years	INFLUVAC TETRA One dose—yearly vaccination INFLUVAC TETRA Annual vaccination
Minimum of five years after last Pneumovax 23 vaccination ↓	PNEUMOVAX 23 One further dose				
>65 years of age	PNEUMOVAX 23 One further dose once over age 65				

*If 23PPV has already been given (prior to any doses of PCV13) to adults aged 18 years and older, wait at least one year before administering PCV13.

shunt and the use of cochlear implants with positioner devices (which were withdrawn in 2002).[10] As a result of this increased risk, most developed countries including the US,[11,12] the UK,[13] Canada[14] and Australia[15] recommend vaccination against the most common causative organisms. The recommendations from the New Zealand Immunisation Advisory Centre include vaccination against pneumococcus, Haemophilus influenzae and influenza.[9] A summary of the schedule can be seen in Table 1.

Aims

We aim to report the rate of adult cochlear implant patients, under the care of the Northern Cochlear Implant Programme, who received their immunisations as per the schedule recommended by the Immunisation Advisory Centre (IMAC) in New Zealand. We also aim to report any recorded occurrences of post-implantation bacterial meningitis within this patient population.

Methods

Following approval from the northern cochlear implant programme, a retrospective study investigating adult patients who had received unilateral or bilateral cochlear implantation between September 2013 and September 2018 was undertaken searching the database of the Northern Cochlear Implant Programme. Demographic data including the date of implantation were identified. Telephone interviews were completed with general practitioner (GP) surgeries, obtaining patient information on type and date of any immunisations received, contraindication to immunisations and any hospital admissions for suspected or confirmed meningitis. Simple statistical analysis was completed using Microsoft Excel software.

Results

A total of 189 adult CI recipients were identified within the Northern Cochlear

Table 2: Vaccination rates and timing of vaccination in relation to cochlear implantation.

Received vaccination?	PCV 13 (Prevnar 13)	PPV 23 (Pneumovax 23)	HiB (Hiberix)	Influenza (Influvac Tetra)
NO	95 (70.4%)	81 (60%)	119 (88.1%)	51 (37.8%)
YES	40 (29.6%)	54 (40%)	16 (11.9%)	84 (62.2%)
Timing of vaccination?				
Vaccinated before CI	18 (13.3%)	28 (20.7%)	6 (4.4%)	Yearly prior to CI—38 (28.1%) One dose prior to CI—6 (4.4%)
Vaccinated after CI	22 (16.3%)	26 (19.3%)	10 (7.4%)	Yearly after CI—10 (7.4%) One dose after CI—13 (9.6%)
Unknown timing				No date recorded but confirmed had vaccination—17 (12.6%)

Implant database over the five-year period. Complete data was collected for 135 (71.4%) patients, which were included in the analysis.

Fifty-four patients in total were excluded as they had no known GP (42 patients), GP practice uncontactable despite multiple attempts (10 patients), patient had changed GP with unknown new GP (one patient) or had deceased following implantation from cause unrelated to surgery or bacterial meningitis (one patient).

The average patient age was 61 years (median 65.3, range 20.4–93.7 years) with 51% male and 49% female. No patient had any relative or absolute contraindications to receiving vaccinations.

The results for percentages of patients having received vaccination can be seen in Table 2.

With regards to pneumococcal vaccination, 29% had received the PCV 13 vaccine and 40% the 23 PPV. Only 14.8% (15 patients) had received both of these vaccinations, as per the Immunisation Advisory Centre recommendations.

Overall, 4.4% (six patients) were fully immunised in accordance with the New Zealand Immunisation Advisory Centre guidelines.

In terms of timing of vaccination of patients who received their vaccinations, 45% (18/40) PCV 13, 52% (28/54) PPV 23, 38% (6/16) HiB and 52% (44/84) influenza, received the vaccinations before their implantation surgery.

No cases of meningitis were reported in our patients.

Discussion

Overall, meningitis is a rare complication of cochlear implantation and the rates of meningitis are low. CI recipients are, however, at an increased risk of meningitis.[4–8] A recent review of 18 studies combining 5,324 CI patients identified nine cases of meningitis with an incidence in this population of 0.2%.[8] It should be noted that meningitis caused by various serogroups of the more common organism, Neisseria meningitides bacteria, are not implicated in CI associated infections and that meningitis in CI recipients is more in keeping with an invasive pneumococcal infection. The reported 'all-age' rate of pneumococcal meningitis in New Zealand in 2016 was 0.9 per 100,000 population,[16] which is clearly lower than the most recent 2017 notification rate for meningococcal disease of 2.3 cases per 100,000 population.[17] During implantation, surgeons aim to limit the risk of meningitis by minimising insertion trauma, packing the insertion site, choice of device, providing prophylactic antibiotics around the insertion period, promptly treating any post-implantation acute ear infections and vaccinating the recipient.[18] There is debate about the direct effectiveness of vaccination in preventing meningitis, specifically in cochlear implant recipients,[18] but there is clear evidence that vaccination decreases pneumococcal meningitis incidence, morbidity and mortality. An example of this is a recent study in Brazil, highlighting a 50% reduction in pneumococcal meningitis incidence and 69% reduction in mortality after introduction of a PCV10 vaccination programme.[19] There is also

sufficient evidence from population-based studies, including studies from New Zealand, that vaccination is effective in reducing 'invasive pneumococcal disease', which includes meningitis.[12,20–22] In a recent large double-blind placebo controlled study, vaccination was shown to prevent adult community-acquired pneumonia and reduce the presence of S. pneumoniae sub-types from sampled 'sterile' sites within the study population.[23] There have also been population-based studies with evidence to suggest a sustained additive effect of pneumococcal and influenza vaccination in preventing all-cause mortality and hospitalisation in the elderly population.[24–26] This suggests that combined vaccination can be potentially more effective than single vaccination alone.

The optimal timing of vaccination for cochlear implant recipients is unclear,[12] but in most cochlear implant programmes it is preferred that candidates receive the vaccination prior to implantation.[11–15]

There are few articles on vaccination against Streptococcus pneumoniae in cochlear implant patients specifically.[27] Vaccination rates published from the US seem to range from 49% to 99%,[28,29] but a recent Polish study of 740 patients showed a vaccination rate of 49.2% in children and 5.5% in adults. Overall, our results compare unfavourably with the rates reported in the literature. In our review no patient contracted meningitis so far, but this potential risk needs to be managed by improving vaccination rates. Poor rates of general vaccination uptake are a worldwide public health problem[30] and comments upon the potential barriers to vaccination must be made. In New Zealand, prior to the latest guidelines from 2017, only the pneumococcal vaccine was recommended outside of the routine childhood vaccination schedule, but this was not publicly funded and therefore a cost to the patient. Hence, socioeconomic considerations may have contributed to the low vaccination rate in our population.

After 1 July 2017, CI recipients were added to the special group schedule, with full funding for vaccination available.[9] In general, health practitioners may not have been aware of this change in guidelines. In a recent study from the US, it was reported that "cochlear implant providers have a high awareness of vaccination guidelines, but less detailed knowledge of age-specific recommendations". Most had the primary care provider give the recommended vaccinations.[31] The current practice of the NCIP is similar, in that general practitioners are sent a copy of the vaccination eligibility on discharge following implantation. It is therefore surprising that there is low rate of vaccination. Other barriers to vaccination may have played a part. These have been defined and discussed in the literature and include lack of physician recommendations, mistaken patient assumptions such as "healthy people do not need immunisation", concerns about side effects, fear of autism, fear of needles or objections based on moral or religious grounds,[31,32] but the degree to which these may have impacted upon our patient population and our results is difficult to estimate.

Strategies to improve vaccination uptake have been investigated for other vaccination programmes. A recent systematic review, based principally on papers from the US, reviewed potential interventions to increase influenza vaccination rates in high-risk children including: multi-component strategies, letter reminders, telephone recall, letters plus telephone calls, educational tools and year-round scheduling, among others. There was good evidence for the effectiveness of reminder letters, but weak evidence for the effectiveness of other strategies.[33] Further studies from the US have investigated the effects of using an 'immunisation verification protocol' to increase the recording and uptake of vaccines. This identified that those patients who were required to document immunisation status before surgery had the highest rates of compliance.[34] Unfortunately, to the authors' awareness, there were no other specific studies investigating methods for increasing vaccination uptake within this specific group of patients or how effective these methods might be. Practically, within New Zealand, the adoption of reminder letters to both patients and vaccination providers is potentially both attainable and manageable following implantation. This may increase awareness among medical professionals and patients. Similarly, disseminating relevant research or updates among relevant media platforms, such as publication in

journals, may also highlight a need for changes in practice. Having vaccinations before implantation or as a prerequisite to implantation is not likely to be feasible for various reasons, including the point that patients typically may fall into the 'specially funded' criteria only after implantation. Equally, central funding for implants is fluctuant and delaying any patient's implantation to wait for immunisations is not necessarily beneficial. This is in-line with international practice; such as that in the UK where "immunisation should not delay implantation".[13]

Limitations and future work

The retrospective nature of this work leads to potential issues regarding documentation of interventions. It is possible that individuals received vaccination, but this was not documented. Given the number of patients involved, it is clear that patients lost to follow up may have influenced the results of this work.

The Northern Cochlear Implant Programme have taken measures to address the low vaccination rate in our patient cohort. General practitioners will be contacted regarding the availability and requirement of these vaccinations. There will be systematic improvements to our services to ensure vaccination rates are monitored for the adult and paediatric population of cochlear implant recipients.

A review of the vaccination rate, specifically in the paediatric CI population, is underway.

Summary

The vaccination rate of CI patients implanted by the Northern Cochlear Implant Programme in New Zealand is low, but fortunately no CI recipient has been identified as having had a CI-related meningitis infection as yet. Systematic approaches with an initial focus on dissemination of new guidelines are required to increase the vaccination rates in our CI users.

Competing interests:
Dr Neeff is the chairperson of the Northern Cochlear Implant Programme Advisory Group. The Northern Cochlear Implant Programme (NCIP) is a publicly funded programme for profoundly deaf children and adults in the northern region of New Zealand.

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