Do interventions based on the viability of the electrode-neural interface improve cochlear implant outcomes? A systematic review

Jason Tzu-Hsien Lien*[1], Ben Williges[1], Jameel Muzaffar[2], and Deborah Vickers[1]

[1]Sound Lab, Cambridge Hearing Group, Department of Clinical Neurosciences, University of Cambridge – United Kingdom

[2]Sense Lab, Cambridge Hearing Group, University of Cambridge Emmeline Cochlear Implant Programme, Cambridge University Hospitals – United Kingdom

Abstract

Background: The viability of the electrode-neural interface is known to affect performance with cochlear implants. It is influenced by factors affecting current spread, channel interaction, and neural survival. However, uncertainty remains about the appropriate interventions for overcoming the issues. Today, the electrode-neural approach, enhancing the transmitted utilisable information between the acoustic signals and the auditory nerve system via changes in the map settings, of improving speech perception is examined in this review.
Objective: This systematic review was constructed around the PICOS (Population, Intervention, Comparison, Outcome, Study) question: "Do training or programming interventions informed by measures of the viability of the electrode-neural interface improve speech perception, compared with the standard clinical map, in adult cochlear implant users?" Further, the rationale behind each intervention is categorised and discussed regarding the underlying physiological mechanism. An overview of improvements achieved in each approach is provided and the possible further advancement is proposed.

Method: The review follows the RPISMA 2020 statement and is registered with PROSPERO, CRD42021292483. The following inclusion criteria were applied: Participants: adult cochlear implant users; Interventions: changes in cochlear implant settings or training regimes (a clearly-stated rationale for the intervention is necessary); Outcome measurements: Speech perception tasks or associated tasks (E.g., spectral-ripple test); Study design: primary human study reported in English. MEDLINE, EMBASE, and CINAHL databases were searched. Eligible studies contained "cochlear implant" and one of the "approach/intervention" keywords and one of the "outcome" keywords. Examples of keywords are current steering, tripolar stimulation, re-mapping, electrode deactivation, channel interaction, current spread, electrode-neural interface, spectral resolution, image-guided, Modulation discrimination, electrode discrimination, transimpedance matrix.

Results: The merged search result showed 927 studies excluding duplicates. After screening the titles and abstracts, 36 studies remained. Currently, the process for quality assessment is ongoing by the four reviewers. Randomised controlled trials are assessed with the critical appraisal tools developed by Centre for Evidence-Based Medicine, Oxford. Randomised trials

*Speaker

are assessed with ROB 2 by Cochrane. Non-randomised studies are assessed with ROBINS-I by Cochrane. Each study is ranked as good, average, or poor based on the percentile of its score compared with studies having the same design. For instance, studies score below the 25th percentile are ranked as poor; meanwhile, studies with scores above the 75th percentile are ranked as good. In terms of meta-analysis, studies are grouped by the underlying physiological mechanism. In each group, the outcomes of studies are weighted and synthesised based on the study design, study quality, and sample size. The improvement in speech perception tasks of each group is reported respectively.