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Kertas Asli/*Original Articles*

A Scoping Review of Assessment Tools and Factors Influencing Spoken Language Development Among Pediatric Cochlear Implant Users

(Kajian Skop mengenai Alat dan Faktor Penilaian yang Mempengaruhi Perkembangan Bahasa Pertuturan dalam Kalangan Pengguna Implan Koklea Pediatrik)

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ABSTRACT

The spoken language development strongly depends on the normally functioning auditory system. For children with severe or profound hearing loss, cochlear implant has become the best solution in improving and promoting spoken language, quality of life, self-esteem and social well-being. Standardized self-report questionnaires are considered as the most widely used and low-cost approach to measure spoken language development among children. We aimed to provide an overview of the questionnaires available for assessing the spoken language development among children with cochlear implant. In addition, factors that may influence the development of good spoken language were also reviewed. A literature search from January 2010 to December 2020 making use of the Science Direct and PubMed databases was conducted. Medical Subject Headings (MeSH) and other key words for the search were (communication OR language) AND cochlear implant AND (children OR pediatric) AND (questionnaire OR survey). Research articles that were identified in the database using the keywords were refined by year. Only original articles were selected. Articles that quoted all the selected key words in the title and abstract; and written in English with full text were included in the review. Twelve instruments were utilized in the methodology of the 10 articles. Only one instrument was specific for spoken language assessment of children with cochlear implant. The age at which a child received an implant, good rehabilitation program and active involvement of parents was found to influence development of good spoken language skills among the cochlear implanted children. Cochlear implants provide deaf children with the opportunity to develop spoken language skills. Longer use of a cochlear implant dramatically affects the amount of spoken language. Rather, it was cochlear implantation at a younger age that served to assists spoken language competence.

Keywords: Cochlear implant; communication; factors; spoken language; questionnaire; children

ABSTRAK

Perkembangan bahasa pertuturan sangat bergantung pada sistem pendengaran yang berfungsi secara normal. Bagi kanak-kanak yang mengalami kehilangan pendengaran yang teruk atau mendalam, implan koklea telah menjadi penyelesaian terbaik dalam meningkatkan dan menggalakkan bahasa pertuturan, kualiti hidup dan kesejahteraan sosial. Soal selidik laporan kendiri piawai dianggap sebagai pendekatan yang paling banyak digunakan dan dengan kos rendah untuk mengukur perkembangan bahasa pertuturan dalam kalangan kanak-kanak. Kajian ini berhasrat untuk memberikan gambaran keseluruhan soal selidik yang tersedia untuk menilai perkembangan bahasa pertuturan di kalangan kanak-kanak dengan implan koklea. Selain itu, faktor-faktor yang boleh mempengaruhi perkembangan bahasa pertuturan yang baik turut dikaji. Sumber Data: Carian literatur dari Januari 2010 hingga Disember 2020 menggunakan pangkalan data Science Direct dan PubMed telah dijalankan. Tajuk Subjek Perubatan (MeSH) dan kata kunci lain untuk carian adalah (communication OR language) AND cochlear implant AND (children OR pediatric) AND (questionnaire OR survey). Artikel penyelidikan yang dikenal pasti dalam pangkalan data menggunakan kata kunci telah diperhalusi mengikut tahun. Hanya artikel asal telah dipilih. Artikel yang memetik semua kata kunci yang dipilih dalam tajuk dan abstrak; dan ditulis dalam bahasa Inggeris dengan teks penuh disertakan dalam ulasan. 12 instrumen telah digunakan dalam metodologi 10 artikel. Hanya satu instrumen khusus digunakan untuk penilaian bahasa pertuturan kanak-kanak dengan implan koklea. Umur kanak-kanak menerima implan, program pemulihan yang baik dan penglibatan aktif ibu bapa didapati mempengaruhi perkembangan kemahiran bahasa pertuturan yang baik dalam kalangan kanak-kanak implan koklea. Implan koklea memberi peluang kepada kanak-kanak pekak untuk

mengembangkan kemahiran bahasa pertuturan. Penggunaan implan koklea yang lebih lama secara mendadak mempengaruhi jumlah bahasa pertuturan. Sebaiknya, implantasi koklea pada usia yang lebih muda membantu kecekapan bahasa pertuturan.

Kata kunci: Implan koklea; komunikasi; faktor; bahasa pertuturan; soal selidik; kanak-kanak

INTRODUCTION

Hearing contributes to receiving, development, and maintenance of language properties (Svirsky et al. 2000). The first four years of a individual's life is the most important period for language development, which includes the essential grammar and basic vocabulary of their native language. This development continues throughout the life span whereby grammatical structures are added, while the vocabulary expands (Ramos-Macías et al. 2014). According to the World Health Organization, 360 million people (5.3% of the world's population) worldwide were reported to present with hearing loss, where 32 million (9%) of these are children (WHO 2017). Hearing loss among children has been widely quoted in many publications as a considerable health problem (Mencher & Madriz 2000; Olusanya et al. 2000; Rao et al. 2002).

Children with hearing loss were reported to have difficulties in spoken language skills, academic performance, psychosocial behavior, and emotional development. This is due to the poor quality input through a degraded auditory system resulting from hearing loss (Stelmachowicz et al. 2004). This further affects educational achievement, which can impact the outcome of a child's life (Sarafraz & Ahmadi 2009). In addition, children with a disability tend to have fewer friends and fewer opportunities for socializing than the general population (Koller et al. 2018). Although children with severe and profound hearing loss are often the focus of education concerns, past studies reported that even slight and mild hearing loss can negatively impact academic performance, speech recognition in noise, and psychosocial development (Dodd-Murphy & Mamlin 2002; McCormick Richburg & Goldberg 2005; Sarafraz & Ahmadi 2009). Therefore, it is crucial to identify children with hearing loss at an earlier stage to ensure they receive early intervention assistance consistent with their priorities, resources, individual needs and the concerns of their families.

Early identification of hearing loss among children is the first and most important step for obtaining successful outcomes, because it increases the chance of developing good language skills (Ozcebe et al. 2005). Hearing aids and cochlear implants are two different interventions that could improve the ability of a child with hearing loss to access auditory stimuli (Robbins et al. 2004; Walker et al. 2013). While hearing aids can be beneficial for most children with a lesser degree of hearing loss, those with severe and profound hearing loss are less likely to get enough benefit from hearing aids (Walker et al. 2013). In such cases, cochlear implants can be favorable. Implantees report a variety of improvements in their quality of life after implantation. With a cochlear implant, children learn to understand speech sounds due to improvements in the hearing aided thresholds. This further promotes and improves spoken language, influencing the patient's quality of life positively and having important effects on the children's confidence, social life and daily activities (Loeffler et al. 2010).

There has been an increase in studies related to cochlear implantation among children and the assessment of spoken language development; however, no in-depth literatures on this issue have been published. As an essential principle of evidence-based studies, the investigated concern in this study was: 'What are the instruments used to evaluate the spoken language development among children using cochlear implants?' Therefore, this article aimed to provides important information on the available questionnaires in assessing the spoken language development among cochlear implanted children and factors that may influence the development of well-spoken language among these children. Compilation of questionnaire may be helpful for investigators and clinicians in their search for the appropriate instrument based on their research and management objectives, so that investigation is done carefully and comprehensively.

METHODS

DATA SOURCES

A literature search ranging from January 2010 to December 2020 making use of Science Direct and PubMed databases was carried out. Medical Subject Headings and other key words for the search were (*communication OR language) AND cochlear implant AND (children OR pediatric) AND (questionnaire OR survey).* These data were analyzed focusing on evaluating the child's spoken language; hence, questionnaires and surveys will be termed as 'instruments.

We also examined reference lists of the articles that were spotted in the database. Articles that met the following inclusion criteria were included: (1) They had to be articles published in the year 2010 to 2020, (2) The search was restricted to articles written in the English language, (3) The selected keywords had to be mentioned in the title or abstract and (4) They had to be available as full articles. Published proceedings and abstracts were excluded. We also excluded studies involving special groups of children with cochlear implants and other disorders such as auditory neuropathy, auditory nerve hypoplasia, cerebral paralysis, and other complications. Those articles that were adapted or translated into different versions (except those in original form) were also excluded.

ARTICLE SELECTION

Only one author reviewed the articles chosen to go through the selection process. All the articles were merged into one large database, thus, easier to identify duplications of articles. For article selection, titles and abstracts were first screened. If they were appropriate, an in-depth evaluation of the full article was conducted. The following steps as shown in Figure 1 were carried out. (1) Phase 1: Total number of research articles identified in the database using the keywords; (2) Phase 2: Refined the articles by year published. In this review, all of the original research was selected. (3) Phase 3: Number of articles that quoted all the selected key words in the title and abstract; (4) Phase 4: Number of articles written in English and in full text were selected. Instruments that were in English and the original versions were selected for the review purpose.

RESULTS

During the analysis and research of the articles, a total of 1,562 articles were identified in the databases with 982

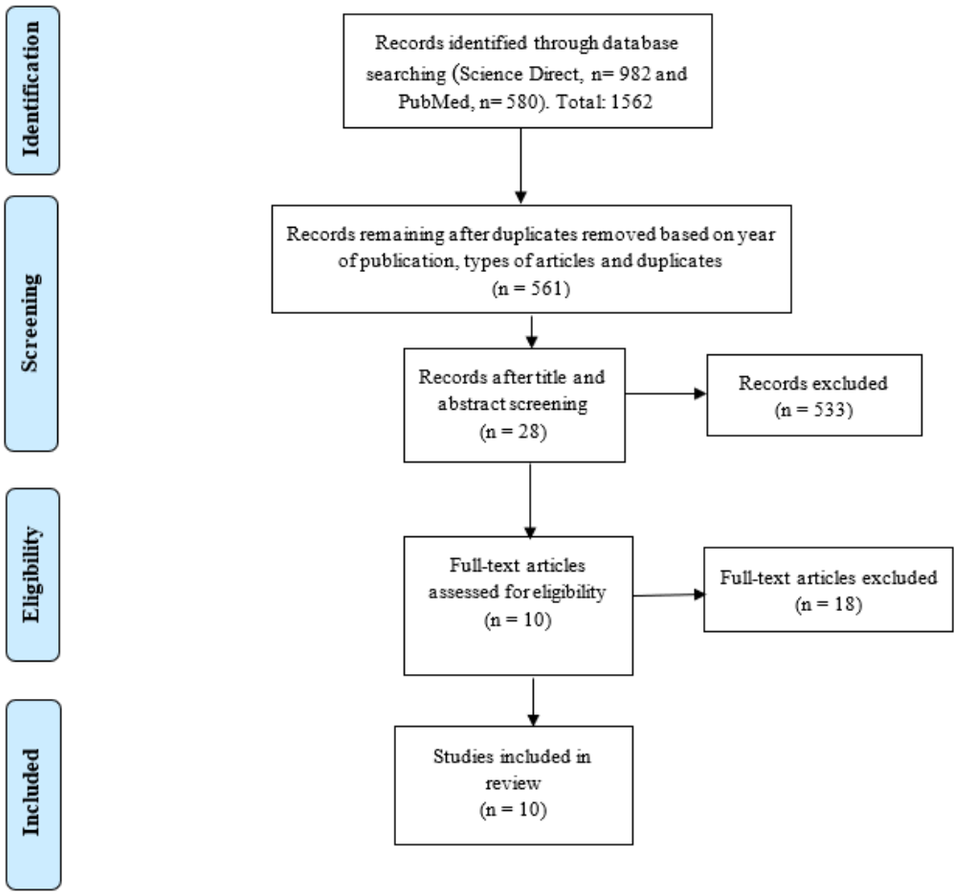

Figure 1 Phases of article selection based on PRISMA flowchart

articles from Science Direct and 580 articles from PubMed databases (Phase 1). In pre-selection of these articles, based on the year of publication, types of articles and duplicates (21 articles) from all the articles found in the electronic search, we took 1001 articles off the list, leaving 561 articles (Phase 2). Out of the 561 articles, 28 articles were selected based on reading the title and abstract (Phase 3). Finally, we took off 18 articles from the list that were in languages other than English and were adapted/ translated into different versions (Phase 4). The last manual search was carried out in electronic databases in December of 2020.

As a result, 10 articles that met the inclusion criteria were analyzed, of which 10% were from 2011 (Clark et al. 2011), 2012 (Nittrouer et al. 2012), 2015 (Meister et al. 2015) and 2017 (Zhong et al. 2017). 20% were from 2010

Table 1 Summary chart of the instruments included in the review.

No.	Instruments	Author	Purpose	Assessment	Appropriate age group	Duration
1.	APCEI-scale	Gérard et al. 2010	Communication skills	Five components of the language: cochlear implant acceptance, perceptive language performance, comprehension of the oral orders, expressive language and speech intelligibility	Children	No time limit
2.	Bus Story subtest of the Renfrew Language Scales	Boons et al. 2013a; Boons et al. 2013b	Narratives	Evaluate narrative skills	6 months to 7 years	10 minutes
3.	Clinical Evaluation of Language Fundamental Word Structure (CELF-WS)	Boons et al. 2013b	Morphology	Four aspects of language (morphology and syntax, semantics, pragmatics, and phonological awareness)	5-21 years	30-60 minutes
4.	Clinical Evaluation of Language Fundamental Formulating Sentences (CELF-FS)	Boons et al. 2013b	Syntax			
5.	Comprehensive assessment of spoken language (CASL)	Tobey et al. 2013	Oral language development	Language comprehension, expression, and retrieval across the following four categories of oral language: lexical/ semantic, syntactic, supralinguistic, and pragmatic	3 through 21 years	30–45 minutes
6.	Expressive One Word Picture Vocabulary Test (EOWPVT)	Boons et al. 2013b, Nittrouer et al. 2012	Vocabulary	Evaluates the ability to name objects, actions, and concepts presented with color illustrations	24 months and 18 years	20 minutes
7.	Functioning Inventory after Pediatric Cochlear Implantation (FAPCI) instrument	Clark et al. 2011, Meister et al. 2015	Verbal communicative performance	Evaluation of the auditory communicative performance	2-5 years	5-10 minutes

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8.	Language Development Survey (LDS)	Nittrouer et al. 2012	Lexical development	Vocabulary and word combinations	18-35 months	10 minutes
9.	Meaningful Use of Speech Scale (MUSS)	Swami et al. 2013, Zhong et al. 2017	Verbal communicative ability	Evaluate voice control, using speech without gestures or signs; and using communi¬cation strategies in daily situations	Children	No time limit
10.	Minnesota Child Development Inventory parent questionnaire (MCDI)	Wie 2010	Expressive Language	Adaptive behavior (motor, speech and language, comprehension, self-help and social skills)	1-6 years old	No time limit
11.	Mullen Scale of Early Learning (MSEL)	Wie 2010	Cognitive and motor ability	Gross motor, visual reception, fine motor, expressive language, and receptive language	Birth to 68 months	15 minutes (1 year); 25-35 minutes (3 years); 40-60 minutes (5 years)
12.	Reynell Developmental Language Scales Receptive (RDLS)	Swami et al. 2013	Expressive and receptive language development	Involves object manipulation and description based on questions that vary in length and grammatical complexity	2 to 7 years	35-60 minutes

(Gérard et al. 2010; Wie 2010) and 40% were from 2013 (Boons et al. 2013a; Boons et al. 2013b; Tobey et al. 2013; Swami et al. 2013). All of the articles had the pediatric cochlear implant users as the target population and 33.3% of these articles focused on cochlear implanted children alone. Of the 10 studies that examined pediatric cochlear implant users, 58.3% (n=6) studies also included normal-hearing children and pediatric hearing-aid users as participants whereas one study (8.3%) included children with additional disability. The sample size varied from 10 to 300 children, with a well-balanced number of boys and girls. Only one article compared between girls and boys. The age range of the children during the assessment was from 5 months to 6 years of hearing age and from 2 to 8 years of chronological age. Of the selected articles, 58.3% were longitudinal studies and 41.7% used cross-sectional design.

Twelve instruments were identified in the methodology section of the 10 articles analyzed and due to the variability of the instruments, we decided to report them in categories according to the purpose of the instruments as shown in Table 1. The 4 most used instruments were Functioning Inventory After Pediatric Cochlear Implantation (FAPCI) instrument, Expressive One-Word Picture Vocabulary Test (EOWPVT), Clinical Evaluation of Language Fundamental (CELF), and Bus Story Subtest of the Renfrew Language Scales.

Functioning Inventory After Pediatric Cochlear Implantation (FAPCI) instrument was created in 2007, is currently available in different versions and translated in different languages, and is defined as an assessment tool for spoken language performance. Expressive One-Word Picture Vocabulary Test (EOWPVT), which was developed in 2000, evaluates the ability to name actions, concepts, and objects presented with color illustrations. The Clinical Evaluation of Language Fundamental (CELF) was developed in 1992 and evaluates receptive and expressive language. It is available in different translations. Finally, Bus Story Subtest of the Renfrew Language Scales, which is a standardized narrative task, was developed in 1998.

DISCUSSION

The impact of cochlear implant on children with hearing loss can be measured using various parameters such as the improvement in hearing ability, progress in spoken language development as well as other aspects of the child's life such as social well-being. Considering the importance of spoken language development among pediatric CI users, this review was conducted to investigate the instruments that can be used to measure the spoken language skills among this population. In addition, the outcome of the measurements was also discussed briefly aiming at factors that may influence a well-spoken language.

Concerning the general data of the selected articles, the results showed variabilities among the studies which include the age upon evaluation, inclusion of a comparison group, and the instrument used to assess the spoken language development. The data indicated that children of different ages were studied and the number of studies exploring a comparison group (control) was high. In addition, the control group was well matched for age in all the selected studies. The qualitative analysis of the instrument used revealed that the main aspects of spoken language addressed in the studies selected for this review were expressive and receptive language development, verbal communicative performance, vocabulary, morphology, and syntax. In addition, none of the instruments were noted to be designed specifically for this population except for the 'Functioning inventory after pediatric cochlear implantation (FAPCI) instrument'.

The FAPCI was designed to examine the communicative performance of 2 to 5 years pediatric CI users based on the conceptual framework of the World Health Organization's International Classification of Functioning (Lin et al. 2007). It is a reliable (Cronbach's $\alpha \geq 0.86$) and validated scale consisting of 23 items with each item having five-levels of response scale. The purpose of the scale is to measure the day-to-day expressive and receptive communicative behavior of young children, reported by their parents or primary caregivers (Lin et al. 2007). The FAPCI instrument has been translated into Portuguese (Vassoler & Cordeiro 2015), German (Grugel et al. 2009) and Korean (Lee et al. 2009). In addition, as the FAPCI instrument contains items looking into the basic elements of verbal communication of children and the availability of normative data, it is suitable for assessing children using amplification (Meister et al. 2015).

A major concern in the field of cochlear implantation has been whether there is some critical period of spoken language development within which hearing loss children should be implanted. Studies have proven that babies start to hear and can respond to sounds even before birth (Kolata 1984; Rajalakshmi 2018). As such, a child who is born with hearing loss is missing out on these important early inputs of sound. Our review supports the idea that age at intervention is important because children who receive cochlear implants at younger ages did show a better, age-appropriate spoken language outcome that may approximate those of their hearing peers of the same age (Calvo & Bialystok 2014).

Spoken language development corresponds to the child's hearing age and/or to how long the child has had access to sound (Wie 2010; Tobey et al. 2013; Swami et al. 2013). This reveals that delays and/or gaps in spoken language development between normal-hearing children and cochlear implanted children increases with age. According to Hart et al. (1995), children need to hear approximately 30,000 words a day by the age of three years, to expand the spoken language skills that are required to succeed in school and everyday life. Thus, early identification of hearing loss and appropriate intervention is crucial. Universal neonatal hearing screening (UNHS) program has been recommended that all babies should be screened for hearing loss by the age of 1 month, completing appropriate audiologic evaluation by the age of 3 months, and introducing the appropriate intervention by the age of 6 months (Holman et al. 2013; Joint Committee on Infant Hearing. 2007; McKinney 2017; Miyamoto 2017).

Another factor that promotes good spoken language skills among the cochlear implanted children is a good rehabilitation program (Swami et al. 2013). Rehabilitation begins as soon as hearing loss is detected, which lasts for several years, depending on the age of implantation. It could be continued further if the child needs more support; even after entering school (Ostojić et al. 2015). Speech and hearing rehabilitation gives meaning to the sound perceived through the cochlear implant (Ling 2002). Therefore, to optimize these children's communication and language development, rehabilitation focusing on their specific weaknesses remains necessary.

At the same time, parents are encouraged to talk to their children. This is one of the best ways to develop spoken language skills. Body language and facial expressions of the parents will help the child to understand better (Kaiser & Hancock 2003; Yoder et al. 2001). Parental involvement based on standardized observations of parent-child interactions reported that these could increase the variable on spoken narrative skills (Boons et al. 2013a). Additionally, parents should be required to be involved in all activities during their child's rehabilitation.

A great concentration of instruments was used for the assessment, with the emphasis on the child's spoken language development. However, all of the instruments were not developed specifically to monitor this population except for the FAPCI instrument. In addition, all of the

current instruments have low usage rates. Hence, the review points to the need to develop and apply a standardized instrument for this population. However, as instruments such as FAPCI are measured by self-reporting and perception in nature, a more objective measure is required to examine the language skills. Past studies have addressed the concern that parents' reporting of their children's functioning was viewed with some skepticism by clinicians (Ireton & Glascoe 1995). Another study stated that measures that required direct observation were found to be more sensitive than those using parental reporting (Nittrouer et al. 2012).

Finally, it is also possible that other variables might be influencing in the outcomes, such as cognitive factors, where short term memory processing may impact the communication and language ability (Hay-McCutcheon et al. 2008) and bilingualism contribute significantly to children's language development (Calvo & Bialystok 2014). Thus, it is important to determine such factors before measurements are recorded, thus providing an adequate level of reliable evidence.

CONCLUSION

The outcome of this review extends our understanding of the types of instruments used to measure the spoken language skills among cochlear implanted children in order to most effectively monitor their spoken language development. It is well documented that cochlear implants have an impact on the ability of deaf children (threshold average of 2000, 3000, and 4000 Hz ≥75 dB HL) to develop spoken language skills. In addition, a better outcome is seen with early diagnosis and intervention. However, the findings also report the factors that affect spoken language development, such as a good rehabilitation program may promote language development most effectively. Thus, spoken language skills of cochlear implanted children increase accordingly with increasing hearing age and the duration of rehabilitation. The study outcome may help clinicians and parents to create the best possible circumstances for children with CIs to acquire language.

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