CHAPTER 2

THEORECTICAL BACKGROUND: COCHLEAR IMPLANT PROGRAMMES

2.1   INTRODUCTION

"Communication is one of the major characteristics that separates man from other living entities on the planet," says Allum (1996:XV). Cochlear implantation has a direct impact on communication skills. Due to the heterogeneous nature of cochlear implant users, no single approach is better than another, and it is not possible to devise an approach or technique that will be successfully used in all cochlear implant users. What we learn in the end is that rehabilitation is an art, as well as a method that requires the skills of motivated, informed and competent teams of health care professionals (Allum, 1996:XVi). Most cochlear implant programmes follow a similar approach, i.e. pre-operative selection, evaluation of performance, device programming, and post-operative evaluation and monitoring of progress. For successful cochlear implantation to occur, holistic assessment and intervention programmes are warranted. Outcome measures provide support to the intervention goals, motivates families and helps to provide evidence on the effectiveness of cochlear implants. Cochlear implant programmes from Nottingham, Montepellier, St. Louis and Moscow make use of evaluation tools which can be adapted for use at other cochlear implant programmes, and aspects that can be helpful for intervention goal setting and expectations are described (Allum, 1996:XV).

The purpose of this chapter is to provide a theoretical framework for this study through a critical evaluation and interpretation of relevant literature. This will be achieved by discussing various existing cochlear implant centres and the outcome measures used at each cochlear implant programme will be highlighted.

2.2   COCHLEAR IMPLANT PROGRAMMES

Professionals working in cochlear implant programmes are still determining the best methods for documenting changes in communication abilities after cochlear implantation. "Language and speech outcomes that are evidenced-based and have been collected in a systematic way, can assist professionals from different professional backgrounds, to contribute to the ongoing

debates in the field of cochlear implantation" (Dyar, 2003:2). Common issues regarding cochlear implantation usually include those of candidacy trends (lower and upper age limits), bilateral cochlear implantation, the role of sign language before and after cochlear implantation and ways of involving school-aged cochlear implant users in the decision making process (Dyar, 2003).

To ensure that holistic assessments of the paediatric cochlear implant recipients occur, a multidisciplinary team is essential in all cochlear implant programmes. Professional experience reveals an increasing awareness of the complexities involved in cochlear implantation in children. Some of these complexities include the following:

- The inconsistency in outcomes is greater in implanted children compared to the adult hearing impaired population.
- The challenges present in the pre-implant assessment and prediction of benefit is greater.
- The larger number of factors that influence cochlear implant outcomes: age of onset, aetiology, and length of deafness, parental influence and educational management.
- The greater length of time taken to show benefit in children compared the adult hearing impaired population.
- The long-term commitment needed to be given by the cochlear implant programme professionals.
- The parental responsibility in making informed decisions and the commitment to a long-term relationship with the cochlear implant programme.
- The different professionals involved are often based in various geographical areas and are required to work together as a team.
- The time-consuming characteristic of paediatric implantation.

Any paediatric implant team should consider the above-mentioned issues and the way in which they will meet the particular needs of the child, family and professionals involved with the child. A paediatric cochlear implant team generally consists of the child and his/her family, a team co-ordinator, an Ear-Nose-and-Throat-Surgeon, an Audiologist, a Speech-Language Therapist, a Psychologist, a teacher and cochlear implant and hearing aid technicians (Archbold, 1994:28).

Historically paediatric cochlear implant recipients have been assessed post-operatively through audiometric testing, which is conducted in a soundproof booth by trained audiologists. Assessment of functional outcomes after cochlear implantation must also consider a number of other factors including speech perception, speech intelligibility, and mode of communication, educational placement, as well as the social and psychological factors that affect one's ability to function in the mainstream environment. No uniform tool for assessing effective functional outcomes in the daily lives of cochlear implant recipients has been developed due to the heterogeneity of the hearing-impaired population and the variable populations served by existing cochlear implant programmes (Stern, Sie, Kenney, Yuen & Norton; 2004:157).

The Nottingham Paediatric Cochlear Implant Programme was formed in 1989 and remains extraordinary in many respects, because it focuses on young children mainly below the age of five years, it covers a large geographical area and conducts rehabilitation primarily via an outreach programme, in which skills sharing takes place between families and a large range of support professionals. Limited emphasis is placed on direct individual training of auditory and speech skills. The preference is to enable the implanted child to acquire and develop spoken language in their natural everyday contexts. The programme also engages in research, including the development of a computer database devised specifically to monitor the functioning of the device and to monitor the progress of communication skills in these young children (Lutman et.al, 1996:31).

Outcome measures which provide information on the functioning of the device, as well as the performance of the cochlear implant user, provide vital input for the intervention programme. Deviations from the expected pattern of development (based on the current experience of the Nottingham Cochlear Implant Programme), would usually result in re-programming of the device or adjustments to the intervention goals. Furthermore, collection of outcome measures across children of similar ages over time provides a general baseline against which future cochlear implant users can be compared. (Lutman, 1996:39).

Although current cochlear implant devices are reliable, failures do occur. Total or sudden failures are relatively easy to detect, even in young children. However, some failures may be partial and intermittent, and can therefore be extremely difficult to detect, especially in children with little or no verbal language. Professionals agree that consistent use of the

cochlear implant is vital for the child to adapt to the device, and it is especially important for young children who require the auditory input for spoken language development. Behavioural audiometric tests are used for the evaluation of device performance. When behavioural checks suggest a problem, further objective tests are conducted to establish device performance. Electrophysiological measures such as Auditory Brainstem Responses (ABR) and Electrical ABR's are mostly used. Checks of conventional contralateral hearing aids and cochlear implants should occur daily at home or at school. As a parent or teacher is unable to listen to the output of a cochlear implant, a practical means of measuring the quality of the cochlear implant device is needed. One way in which this can be achieved is to use Ling's Five Sounds (oo, ah, ee, sh, ss) to assess the ability of the child to respond to, and discriminate between, the phonemes across the most important frequency range (Ling, 1976:157; Lutman et.al, 1996:39).

The primary outcome of cochlear implantation in young hearing impaired children is verbal language development. Dyar (2003) classifies language development and examines language skills at five interconnected levels: communication, receptive language, expressive language, voice and speech production. These five levels result in an overall classification of preverbal, transitional and functional linguistic development. One of the main long-term goals of paediatric cochlear implantation is functional language development. Classification into one of the above-mentioned categories also confirms the results obtained from traditional speech and language assessments. Skills of bilingual children using sign language and minimal verbal language can also be categorised into one of the three language development categories. Furthermore, the classification system can identify potential non-sensory complications which may result in verbal language deterioration. Therefore, the classification system can monitor language development on a broader level, after which specific assessments can identify exact problem areas in order to adjust intervention goals accordingly (Lutman et.al, 1996:41).

Threshold determination in a sound-proof booth using warble tones is the most common audiometric measure of sound detection. In general, if children are able to participate in the mapping process, they will be able to successfully participate in pure tone audiometry. This is because similar tasks are used to determine the upper and lower limits of the dynamic range during mapping. The thresholds obtained during mapping are simply a reflection of the sensitivity of the microphone and the input circuitry of the speech processor. On the other

hand, pure tone thresholds provide information on the functioning of the device, as well as the softest sound the child responds to voluntarily, which assists in setting realistic expectations for parents and teachers. Furthermore, a baseline is provided in order to perform quick checks of the device functioning on a daily basis (Lutman et.al, 1996:42).

One of the challenges in assessing young cochlear implant users is that the children are often unable to participate in speech discrimination evaluations until they have acquired sufficient spoken language, which may only occur 2-3 years following implantation. Nonetheless, speech discrimination is one of the primary goals of cochlear implantation and is vital for spoken language development. Therefore, it is necessary to perform speech discrimination on an appropriate level for children with little or no spoken language. The Automated McCormick Toy Discrimination Test (Ousey, Sheppard, Twomey & Palmer, 1989:245) presents digitally stored target words at precisely calibrated levels in order to determine the speech discrimination thresholds using a standard adaptive algorithm. No verbal response is expected as the child simply points to the corresponding toy. The threshold obtained gives a measure of auditory sensitivity, as well as information regarding the child's ability to organise the auditory information into a meaningful word (Lutman et.al, 1996:43).

Some children are unfortunately unable to perform speech discrimination or speech detection tasks in the first 18-months after implantation. Observation of listening skills can be useful when speech discrimination thresholds cannot be obtained. The Listening Progress (LiP) is a profile of initial listening development which includes listening to environmental and speech sounds. The child is expected to respond to and identify sounds in play situations. Responses to environmental, instrumental and speech sounds are documented by encouraging the child to discriminate between two sounds and sounds in isolation. Discrimination of Ling's five sounds is also included in the profile. The LiP is especially useful in children with minimal verbal language, or in children who are unable to report what they hear. Furthermore, the LiP has proven to identify problems in the functioning of the device, the need for mapping and the appropriateness of the auditory learning environment (Archbold, 1994:55).

Video analysis is another observational tool often used at the Nottingham Cochlear Implant Programme. Behaviours such as turn-taking and eye contact, which are precursors of language development, can be observed in young children before they are able to understand or use spoken language (Wetherby, 1991:250). Video analysis also verifies and quantifies

observations of a child with a cochlear implant. The Nottingham Cochlear Implant Programme has adapted the video recording procedure to suit their population of cochlear implant users. Video recordings of the child interacting with someone known to them are made at regular intervals in the first five years after implantation. Results of the video recording analysis provides the earliest formal indication of benefit from the implant (Lutman et.al, 1996:44).

Formal evaluations are mostly not appropriate for young cochlear implant users. As a result observational measures are commonly used. Many profiles have proved to be useful during observation. The Profile of Actual Speech Skills (PASS) has been adapted by the Nottingham Cochlear Implant Programme from a video analysis procedure used by the by the Indianapolis Cochlear Implant Programme (Osberger, Robbins, Berry, Todd, Hesketh & Sedey, 1991:151). The PASS documents the quality, quantity and variety of speech production in children with cochlear implants. The utterances are categorised as actual phonemes or speech sounds, speech-like sounds, non-speech vocalisations and silent speech posture. After the initial profile is determined, any three procedures can be used to investigate consonants and vowels, place of articulation, as well as place, manner and voice features. Valuable information is obtained on the ever-changing status of speech and voice skills following implantation; especially in children who do not have established spoken language. As the PASS is an observational tool, it can be applied in a natural, relaxing setting at specific assessment intervals (Lutman et.al, 1996:46).

The Speech Intelligibility Rating (SIR) is a practical assessment tool used to document emerging speech and voice skills in children with cochlear implants. The scale consists of a set of six categories. At the Nottingham Cochlear Implant Programme, the scale is completed based on video recordings and live assessments. Based on the results achieved during application of the SIR, it has been found that children implanted at a preschool stage, will produce intelligible speech within five years after implantation. This data is useful for setting appropriate expectations for those professionals involved in cochlear implant rehabilitation (Lutman et.al, 1996:47).

To complement the observational methods described above, alternative measures of the child's performance and benefit from the implant are obtained through formal questionnaires. The questionnaires are completed by parents and teachers. The Meaningful Auditory

Integration Scale (MAIS) was developed in Indianapolis by Robbins (1990). All parents and teachers complete the MAIS at the Nottingham Cochlear Implant Programme, with the aim of monitoring the child's use and reliance on the implant. Focus is also placed on reliance on audition and increasing ability to attach meaning to sound (Lutman et.al, 1996:48).

Awareness of environmental sounds is one of the major aims of implantation to ensure the safety of the child. Parents are asked to comment on their child's responses to a range of fifty common environmental sounds and the increasing ability to identify these sounds. Completing the questionnaires enables parents to document listening progress when their child may be unable to co-operate with more formal tests (Lutman et.al, 1996:48).

Questionnaires often limit parental responses. Therefore, structured interviews are commonly used in order to allow parents to elaborate more on certain topics. The Nottingham Cochlear Implant Programme makes use of parental interviews prior to implantation, and annually after implantation. The interview investigates information regarding the child's communication skills, spoken language, listening skills for speech and environmental sounds and general behaviour (Lutman et.al, 1996:48).

The Nottingham Cochlear Implant Programme functions according to the principle that the management of paediatric cochlear implant users is an extension of management provided to hearing aid users. Monitoring progress over a period of at least five years after implantation is viewed as a vital part of the programme. Adequate device functioning, identification of problems, and appropriate expectations are set for parents and professionals. A wide range of assessments are used as children are being implanted at a younger age and their linguistic performance varies from preverbal to functional language development. Measures of sound perception, word discrimination, speech production and vocalisations are included in the assessment tools.   Many of the assessments used, were specifically developed by the Nottingham Cochlear Implant team due to the heterogeneous population they serve. Results from the Nottingham Cochlear Implant Programme indicate that children implanted below the age of five years, whether congenitally deaf or deafened after a period of normal hearing, will develop spoken language to communicate effectively within a hearing world. In general, this level of spoken language development is reached after approximately five years following implantation (Lutman et.al, 1996:49).

The Children's Hospital of Eastern Ontario in Canada assesses the functioning of cochlear-implanted children by using parent reports and standardised tests. The areas of speech perception, language, general development and psychosocial functioning are assessed. Assessment of language includes articulation (Goldman Fristoe Test of Articulation – second edition), vocabulary (Peabody Picture Vocabulary Test – third edition) and expressive and receptive language (Preschool Language Scale – fourth edition). The parental developmental report is obtained through the Child Development Inventory (CDI). The Eastern Ontario cochlear implant programme therefore focuses on the development of the children from an interdisciplinary perspective, including speech and language, motor skills, cognition and psychosocial functioning (Olds, Fitzpatrick, Durieux-Smith & Schramm, 2004:350).

At the Hospital for Sick Children in Toronto, Canada, audiological and speech and language assessments occur at six and twelve months post-implant, and annually thereafter. Combinations of formal and informal assessments are used in combination with auditory-verbal rehabilitation (Sick Kids, 2004:11-18).

The Alexander Graham Bell Association for the Deaf and Hard of Hearing together with the Cochlear Implant Association, Inc (CIAI) situated in Washington, DC made it possible for cochlear implant programmes to exist in many of the states in America. Therefore, similar approaches are followed at the various cochlear implant programmes in America (Alexander Graham Bell Association for the Deaf and Hard of Hearing; 2005:1).

The primary goal of the cochlear implant programme at the University of Iowa Hospitals in America is to provide clinical services to profoundly hearing-impaired individuals and to conduct research related to cochlear implant efficacy. As many of the cochlear implant recipients do not live in Iowa City, the rehabilitation services provided, were designed for use in the child's home, school or community. The team members, therefore serve as consultants for parents and teachers. The rehabilitation has two main focuses, namely parent-centred intervention and child-centred intervention. Assessment and training occurs for both the parents and the child (Tye-Murray, Spencer, Witt & Bedia, 1996:65).

In the assessment component of the parent intervention programme, the primary caregiver's communication skills and conversation styles are assessed with both a unstructured play session and a sign language test battery, which includes a sixty one sentence expressive test

and an open set adaptation of the Carolina Picture Vocabulary Test (Layton & Holmes, 1985). Video recordings are made and transcribed according to the criteria of Fey's Coding System (1986:72). The parent-child interaction video samples are analysed according to the following aspects: mode of communication used, assertive-responsive utterance profile and grammatical measures. Grammatical measures are defined as the total number of words used, the total number of unique words used, the percentage of errors made in sign, type/token ratio, the mean length of utterance in morphemes, bound morphemes, and whether utterances are signed, voiced, or signed and voiced. The results obtained from the analysis provide information about the parent and the child and what adjustments need to be made to the intervention goals (Tye-Murray et.al, 1996:68).

The key to developing a successful intervention plan begins with assessment. Assessment occurs in three key areas during child-centred intervention, i.e. speech production, speech perception and language expression and comprehension (Tye-Murray et.al, 1996:71). Evaluation tools therefore include standardised assessments that evaluate speech perception, expressive and receptive language, vocabulary, basic concepts and communication modality. Informal evaluation methods include language sampling and analysis, probing of functional auditory skills, stimulability of sounds, and the observation of communication repair strategies as well as the documentation of communication preferences. Assessment of speech perception evaluates a child's speech reading skills and recognition of the auditory signal. According to the Iowa Cochlear Implant Programme, three tests are generally included in the speech perception test battery. The Audiovisual Speech Feature Test (Tyler, Fryauf-Bertschy & Kelsay, 1991) assesses how well a child can utilise five consonantal features of articulation (i.e. nasality, voicing, frication, place of articulation and duration) for speech recognition. The Word Intelligibility Picture Identification Test (WIPI) (Ross & Lerman, 1971) assesses a closed set recognition. The Repeated Frame Sentence Test (Tye-Murray, 1993:87-143) assesses the sentence level speech recognition skills. Speech production assessment includes tasks that measure the accuracy of phoneme production, and intelligibility of words, phonemes and narratives. Supra-segmental aspects of speech are also assessed. A phonetic transcription of elicited and spontaneous speech is done. The analyses are then categorised by traditional error analysis, which provides an inventory of the sounds produced, and phonological pattern error analysis, which identifies phonological processes (Tye-Murray et.al, 1996:71).

The Fundamental Speech Skills Test (FSST) (Levitt, Youdelman & Head, 1990) is used to assess breath stream capacity, elementary articulation, pitch control, syllabification, stress and intonation contour. Group data from the Iowa University implanted children, provides a basis for comparison between individual children. The average performance of the children whose implants were done at Iowa University serve as a guide for suggesting therapy goals. The language test battery provides a comprehensive assessment of receptive and expressive semantic and syntactic skills. Spontaneous language sampling analysis is used. A language sample is elicited during a play activity. The sample is video recorded and transcribed using the Systematic Analysis of language Transcripts (SALT) (Miller & Chapman, 1991). A measure of total utterances produced by the child, their type/token ratio, the mean length of utterance (MLU), and how they use questions, negatives, conjunctions, model auxiliary forms and pronouns is also obtained. Information regarding incomplete, unintelligible and non-verbal utterances, number and length of pauses, as well as the rate of speaking, lists and frequencies of word roots and morphemes is obtained from the SALT. Language goals are encouraged through stimulation of language in naturalistic settings during story-telling or during play activities (Tye-Murray et.al, 1996:70). Ongoing assessment is an important part of daily therapy. Continual attention helps to ensure that the quality of services serves as a means by which to measure progress (Boys Town National Research Hospital, 2005:1). Assessment results and suggestions for therapy goals are provided to the school personnel and local speech language therapist. Discussions regarding the children with cochlear implants are often held over the telephone, in order to ensure that everyone involved is informed about the progress or adjustments to the intervention programme (Tye-Murray et.al, 1996:74).

At the Children's Hospital of Philadelphia, in the United States of America, bi-weekly auditory therapy is recommended for each child. Therapy may take place either by team therapists or by other professionals in the school or community. Annual evaluations with the Audiologist, Speech-Language Pathologist and Social Worker document the child's progress and allow for various concerns that become apparent to these professionals, to be addressed (The Children's Hospital of Philadelphia, 1996-2005:1).

The Rainbow Babies and Children's Hospital in Cleveland, USA has an extraordinary paediatric cochlear implant programme. Parents can be sure that their child is receiving the best possible care and most advanced treatment. The paediatric programme includes comprehensive evaluations, individual aural habilitation, education, family support services

and surgical collaboration with the specialist doctors post-implant. A "team approach" to care is an important part of the programme (Rainbow Babies and Children's Hospital, 2005:1).

The cochlear implant programme at the University of Virginia in America focuses holistically on the child and his/her family. Long-term support services are provided. Post-operative evaluations include the assessment of speech, language, auditory and cognitive development. The auditory-verbal approach to therapy is applied in rehabilitation (Virginia Health System, 2005:4).

The University of Texas in Dallas in the USA, also has a cochlear implant programme. This university has a team of specialised professionals who provide comprehensive cochlear implant services.   An educational and rehabilitation programme that emphasises the development of auditory skills is followed (UT Dallas/Callier Advanced Hearing Research Centre, 2005:1).   Evaluation and monitoring of progress occurs on an ongoing basis.   In addition to the expertise offered by the professional staff, the child and his/her family play a critical role in optimizing benefit: they do so by maintaining an auditory learning environment at home, fulfilling the home programme goals and updating the staff on the children's performance in the manner in which they engage in daily living activities.   Although individual performance outcomes vary widely form child to child, satisfaction with the device is generally high due to the extensive assessment and family counselling programme.   The team maintains one philosophical goal, namely maximal use of sound for verbal communication and environmental monitoring (Daniel, 2004:1).

The cochlear implant programme in Arizona, also in the USA functions in a similar way to most of the above-mentioned programmes underway elsewhere in America. A large focus is placed on the rehabilitation post-implant (Mayo Clinic, 2001-2005:2).

The "whole child" philosophy defines the Beth Israel/New York Eye and Ear Cochlear Implant Centre as a model of its type. Ongoing support services enable children with cochlear implants to develop normal speech and language skills and to succeed in complex acoustic environments.   Services include diagnosis and therapies including auditory-verbal/auditory-oral therapy for auditory processing disorders and educational consultation. Speech-Language Pathologists evaluate speech, language and hearing skills for infants and children and they provide speech, language and hearing therapy to children both pre- and

post-implant. The centre also offers the only comprehensive, hospital-based bilingual programme (Spanish or English services are provided) for communication disorders in the New York metropolitan area (The Beth Israel/New York Eye and Ear Cochlear Implant Centre, 2005:1).

The University of Michigan Cochlear Implant Programme aims to provide extensive support services post-implant to the children and their families. Audiological monitoring occurs to ensure optimal device use. Evaluation of speech perception abilities are completed in conjunction with speech and language assessments to ensure proper device functioning and to monitor a child's performance. Progress is measured annually through interval evaluations with the Speech-Language Pathologist and Audiologist. During these evaluations, a child's speech recognition abilities, speech intelligibility and language abilities are formally re-assessed through the administration of various speech perception and speech-language measures. The re-assessment of a child's skills occurs after the first six months post-implant and annually thereafter. The purpose of these evaluations is to monitor a child's performance over time and to provide the family and educational staff with recommendations. Monitoring is also essential in order to ensure device functioning and to provide the Audiologist with feedback regarding possible audiological needs. Additionally, the auditory-verbal approach to therapy is followed (University of Michigan Health System, 2005:2-7).

The Montepellier Paediatric Cochlear Implant Programme in France began in 1989. Their main emphasis is on selecting children below the age of five years for implantation. Assessments take place every three months for the first year, at six-month intervals for the next two years, and annually thereafter. The assessment results, form a picture showing the child's progress and is used to adapt the rehabilitation approach (Sillon, Vieu, Piron, Rougier, Broche, Artieres-Reuillard, Mondain & Uziel, 1996:83). Video analysis is an important part of monitoring the progress of children implanted at a young age (Tait, 1994:234).

The Montepellier children's test battery assesses two main areas, namely speech perception and speech production. The following tests are used to assess speech perception: Perception of nonsense syllables (closed set) using high and low frequency syllables; discrimination of duration (closed set); discrimination of pitch and onomatopoeic words (closed set) using three different animal sounds; syllable rhythm identification (closed set); identification of words (closed set); identification of sentences (closed set); integration of visual and auditory input

test or lip reading (closed set) using phonetic discrimination between two monosyllabic words; recognition of short sentences in everyday life (open set); recognition of monosyllable words test (open set); speech tracking (open set) using short stories from picture books and environmental sounds (open set). Tests of speech production include onomatopoeic imitation using everyday life sounds, repetition of words using mono-, bi- or tri-syllabic words and repetition of short sentences. General data is obtained from a questionnaire given to the caregivers to complete. It contains valuable information about the child's use of the implant, their reaction to sound and their general behaviour since the implant. Results from the above-mentioned test battery together with the questionnaire completed by the caregivers and analysis of the video recordings are used at each assessment interval at the Montepellier Cochlear Implant Programme. The psychological impact shown by cochlear implant recipients is believed to be an important aspect of the assessments. The psychological data is collected in an informal way through contact with the family, the child's teachers and the observation of the children themselves. At Montepellier, working in close collaboration with a team is of the utmost importance. The team consists of two otologic surgeons, three speech therapists and audiologists, an electrophysiologist and a psychologist. Radiologists are involved to rule out any morphologic abnormalities during the selection process. Local teachers and rehabilitation members are all seen as valuable members of the Montepellier Cochlear Implant Programme (Sillon, et.al, 1996: 83-100).

The cochlear implant programme at Avicenne's Hospital in Bobigny in France emphasises the importance of evaluation protocols for device adjustments and to adapt the training from observed results. Comparing pre- and post-operative results also provides valuable information about the effectiveness of the rehabilitation programme, and more importantly, this includes the comparison of scores with normal-hearing children of the same age. The assessment protocol assesses four main areas (for children under 6 years): comprehension, auditory perception, expressive abilities and behaviour (Fugain, Ouayoun, Monneron & Chouard, 1996:300).

The evaluation of language reception consists of the following categories: knowledge of body parts, colour recognition, space notion (where?), quantity notion (how much?), property notion (whom?), tactile notion (soft or rough), word identification using objects and pictures, recognition of simple commands (from pictures) and complex sentence recognition (using pictures as clues). Furthermore, visual cues such as lip reading are permitted during the

evaluation of comprehension abilities (Borel-Maisonny, 1967; Lege & Dague, 1978; Fugain et.al, 1996:307).

Visual cues such as lip reading are not permitted during the evaluation of auditory perception. The test material includes an alerting function, i.e. reaction to sound, sound localisation, noise/no noise, voice/no voice and familiar sounds (rings, voice, engine, etc.); intensity differentiation (tape-recorded familiar sounds and synthesiser-produced sounds); prosodic identification (live-voice and synthesiser-produced); pitch reproduction (live-voice); intonation differentiation (live-voice and tape-recorded materials); and phonetic differentiation using simple and complex sentences, vowels and consonants (Fugain et.al, 1996:307).

Language expression is evaluated by comparing the child with a cochlear implant with children that have normal hearing and are in a similar age group (Fugain, et.al, 1996:308). The scores obtained are variable and range between one and five months for early language skills, to four years, where functional language abilities are present (Chouard & McLeod, 1973:12-58; Lafon, 1966:57-61).

The quality of cochlear implant effectiveness is evident in behavioural and interpersonal relationships, and therefore psychosocial issues are seen as an important aspect in the rehabilitation programme. Questionnaires, interviews and subjective observations are used to elicit information from all the team members involved. Aspects such as communication attitude (pleasure or disinterest in communication), mode of communication (oral, sign or mixed) and parent-child interaction are considered. The quality of the communication is also considered, whereby adjustments are made to the intervention goals if necessary (Fugain et.al, 1996:307).

The main aim of the cochlear implant programme at Avicenne's Hospital in Bobigny is to "provide speech communication that is as close as possible to the communication of normal-hearing individuals" (Fugain et.al, 1996:309). It is also vital to establish close relationships with the child and parents to ensure follow-up contact and progress monitoring (Fugain et.al, 1996:309).

In Sweden, the Cochlear Implant Programme in Stockholm uses a battery of assessments for pre- and post-operative evaluation. The speech perception assessments used include the three-digit test, consonant confusions, vowel confusions, everyday sentences, spondee words and speech tracking. The Raven's Progressive Matrices (Raven, J.C., Court & Raven, J., 1986) is used to obtain an idea of the patient's intellectual resources. The Westrin Intelligence Test III (Westrin, 1966) is used to measure verbal capability. A personality questionnaire is completed to determine the cochlear implant candidate's likelihood to benefit from the training programme. The training programme consists of three days intensive training and home training programmes are provided. One-day training done on a monthly basis is provided, if necessary. Assessments occur at six months, one year and two years post-implant (Cook, 1991:242).

Research at the Stockholm Cochlear Implant Programme indicates that a formal training programme, individually tailored to each child's needs and abilities, in combination with monitored practical usage helps implanted children increase their self-confidence, adapt to their new artificial hearing and more rapidly obtain the maximum possible benefit from their implants (Cook, 1991:240). Other cochlear implant programmes in Sweden focus on bilingualism (sign language and oral/aural approach) and sees sign language as an important part of the rehabilitation process (Bredberg & Martony, 1996:289).

The cochlear implant programme at the Hospital of Basal in Zurich, Switzerland approaches rehabilitation with an emphasis on educational and audiological issues. "The ultimate goal is to provide a service that help the cochlear implant user become integrated into a hearing community" (Muller, Allum, D.J. & Allum, H.J., 1996:102). The centre strives to improve continual support systems or services that must take place outside the programme. A part of the in-service care is the assessment of how the child uses the information sent through the implants. Post-operative evaluations of a variety of commonly assessed auditory skills for children are conducted (Boothroyd, 1991:67-72; Reid & Lehnhardt, 1993:241-247; Archbold, 1994:197-213; Allum, 1995:23-24). In terms of the network service, selected educators are trained in the method of assessment administration and they are able to co-ordinate with the testing done in hospital. The final interpretation of the data takes place within the cochlear implant programme at the hospital in conjunction with the rehabilitation counsellor (Muller, et.al, 1996:102).

The Melbourne post-operative programme for children with cochlear implants targets children under five years and encourages the oral/aural communication option for young cochlear-implanted children. The aims of a rehabilitation programme become more complex for a child receiving a cochlear implant. The device needs to provide speech perception abilities to facilitate the development of the entire linguistic system, to develop a range of speech sounds, to enable speech monitoring via auditory feedback and to access the shared knowledge available in the world. The rehabilitation programme is divided into five components. Medicals take place monthly for the first six months and then at least every six months thereafter. Programming of the speech processor occurs on a weekly basis for the first month, monthly for the next six months and every six months thereafter. The habilitation component consists of learning language through listening, developing speech sounds and self-monitoring, guidance to parents to optimise listening and consultation with the other professionals involved. The assessment component consists of sound detection/sound imitation performed on a daily basis, video analysis of parent-child interaction performed monthly and speech perception testing and speech and language analysis done every six or twelve months. Technical support is also provided to complete minor repairs, provide spare parts, and to guide parents in checking and maintaining the speech processor and headset on a daily basis (Dettman, Barker, Rance, Dowell, Galvin, Sarant, Cowan, Skok, Hollow, Larrat & Clark, 1996:149).

The rehabilitation cochlear implant programme at the III ENT Clinic of Rome University in Italy focuses on speech-language therapy sessions for speech, language and listening development. Monthly video-recorded sessions are made in order to provide parent guidance and to monitor the child's progress (Tait, 1993:378). The rehabilitation process, even though based on well-defined procedures, must be flexible enough to adjust to the various needs of the individual, and should also consider the social and cultural environment in which the individual interacts (Bosco, Ballantyne & Argir, 1996:195).

The Cochlear Implant Centre in Hannover, Germany follows a twelve-week rehabilitation programme that involves the child who has undergone a cochlear implant and his/her parents. The programme can be completed within two years, depending on the scheduling. The programme involves special hearing training and the development of spoken language and communication skills. The child's cognitive, emotional and social development is also incorporated in the programme. Additionally, the children also receive rhythm and movement

training. The Cochlear Implant Centre serves as a link between the local teachers and therapists, and the parents as the teachers/therapists are expected to attend discussions and training sessions to ensure ongoing auditory rehabilitation of the children with cochlear implants. No emphasis is placed on the role of assessment and monitoring of progress, and the centre does not seem to use a standard assessment protocol to assess the children with cochlear implants post-operatively on an annual basis. However, ongoing assessment of the achievement of short-term goals occurs during the training sessions, to ensure that the long-term goal of functional spoken language and development of articulation skills is achieved. The ongoing assessment results bring immediate changes to the rehabilitation programme. The mission of the Cochlear Implant Centre is to provide holistic treatment and real-world experiences for each implanted child. The programme strives to provide special support for the children, parents, teachers and other individuals involved. Cochlear implantation is only the initial step to a new world of sound. The centre has an ongoing programme that continues to provide information and services to cochlear implant users and their families, and ensures that a life-time of support is available (Bertram, 1996:58).

The Vienna cochlear implant programme in Austria offers post-operative rehabilitation once or twice weekly for auditory, speech reading and communication training. According to the literature that pertains to the Vienna cochlear implant programme, no emphasis is placed on assessments for the monitoring of progress. This could lead to a problem on providing feedback to parents and professionals. (Eisenwort, Baumgartner, Willinger & Gstöttner, 1996:245).

Cochlear implant programmes in Europe (e.g. Spain, Greece, Denmark, Norway, Poland, Finland, etc.) belong to the European Association for Cochlear Implant users and these countries all follow a similar approach. Literature indicates that very little emphasis is placed on post-implant assessment and progress monitoring using tried-and-tested assessment protocols (EURO-CIU, 1995-2005:1-2).

It is clear that the European Cochlear Implant Programmes follow intense language and auditory training programmes. However, little emphasis is placed on the use of assessment protocols on an annual or bi-annual basis. Ongoing assessments at each training session are used, whereby immediate adjustments can be made in order to reach their long-term goals. Ongoing assessments are often very valuable in young children to determine change in their

behaviour and to identify subtle progress made (Nelson, 1998:235). Therefore, although tried-and-tested assessment protocols are not a focus, monitoring progress remains an important aspect of the rehabilitation programme.

The Iran Cochlear Implant Centre values post-operative evaluations. Regular speech perception and speech-language skills assessments are an important part of the post-operative follow-up, as it allows monitoring of the user's performance and progress over time, which can be compared to pre-operative levels. Specific error patterns obtained in different assessments may identify a need for remapping or replacement of faulty external equipment. Results are used to target specific intervention required for habilitation or educational purposes (Iran Cochlear Implant Centre, 2005:2).

The cochlear implant programme at the Magrabi Eye and Ear Hospital in Dubai offers cochlear implant surgery followed up by a rigorous programme, which includes audiology sessions followed by speech therapy. Rehabilitation is provided in Arabic, English as well as French (Stensgaard, 2003:1).

Research has proven that the success of a cochlear implant not only depends on the device itself, but also on good patient selection, superior surgical skills and well-monitored post-surgical rehabilitation (Tye-Murray, 2004:726). Infrastructure provision is generally less than satisfactory in developing countries (e.g. China, Egypt, Arabic countries, Argentina, Mexico, and Columbia, etc.). A review done of published materials indicates that in the following countries: China, Egypt and Saudi Arabia, patient selection and pre-surgical screening procedures have been standardised for cochlear implants and in many ways these procedures are similar to the standards which have been adopted in many Western countries. However, there are some distinct differences in patient selection criteria. An additional problem is that there is a lack of adequate training for professionals involved in cochlear implant programmes. Therefore, developing countries still receive a large amount of support from established cochlear implant programmes in the United Kingdom and United States of America (Zeng, 1996:5).

It is evident that paediatric cochlear implantation is a complex process that is constantly changing. In order to ensure a comprehensive rehabilitation programme, the cochlear implant programmes must ensure that educational issues are included and managed appropriately.

Chute, Nevins & Parisier (1996:129) believe that "attending to the needs of the whole deaf child, rather than simply the audiological aspects of hearing loss, will result in a comprehensive management plan which emphasizes the importance of monitoring progress and providing educational support by making substantial contributions to the future academic and economic success of these children".

The cochlear implant centres mentioned above follow a multidisciplinary approach, and view the parent involvement as crucial (Allum, 1996:35, 55, 116, 245). Furthermore, the assessment protocols at most of the cochlear implant programmes discussed, include assessments of auditory ability, speech perception, expressive and receptive language, speech production, communication skills and psychosocial issues. A combination of formal and informal assessments, seem to be the trend. It is therefore clear that the general philosophy of holistic treatment and attending to the whole child with a hearing impairment is a key aspect, and the focus on only audiological abilities has shifted in most cochlear implant programmes. As a result, the goals of cochlear implant centres cannot be met without the support of a multifaceted and multi-professional team. It is clear that assessments are an important part of a cochlear implant programme and not one assessment protocol is identical at the different cochlear implant centres mentioned. Assessment protocols need to be specific to the needs of each cochlear implant centre and the population they serve. A universal assessment protocol will not be the answer to monitor progress in young cochlear implanted children.

Ideally cochlear implant centres should be able to select a group of efficient tests to quantify speech perception, recognition and understanding adequately, but in many instances they simply do not exist. This means that the centre will have to select these materials, test children and modify the materials in an evolving process (Müller, et.al, 1996:114). This process serves to validate assessment protocols by making use of a scientific method. Furthermore, the results from the assessment protocols can clearly prove the efficacy of cochlear implantation, and the outcomes and progress can be provided to parents, teachers, medical aids, and other individuals involved.

2.3   SUMMARY

The goal of this chapter was to describe and discuss existing cochlear implant centres, with a focus on post-operative assessments and progress monitoring within the variable cochlear

implant programmes. Research indicates that each cochlear implant programme functions in a unique manner, depending on their circumstances, resources and the hearing impaired population they serve. Not one identical assessment protocol is used at the various cochlear implant centres mentioned. It is clear that a universal assessment protocol will not be the solution to monitoring progress in young children with cochlear implants, but rather that unique assessment protocols should meet the needs of each individual centre.