NETAJI SUBHAS OPEN UNIVERSITY

STUDY MATERIAL

M. Ed. Special Education (Hearing Impairment / Intellectual Disability) - ODL

B 11 (H.I.)

ASSISTIVE DEVICES & SERVICES FOR INDIVIDUALS WITH HEARING IMPAIRMENT

M. Ed. Spl. Ed. (H.I. / I.D)
ODL Programme

AREA - B

B 11 (H.I.): ASSISTIVE DEVICES & SERVICES FOR INDIVIDUALS WITH HEARING IMPAIRMENT

A COLLABORATIVE PROGRAMME OF
NETAJI SUBHAS OPEN UNIVERSITY
AND
REHABILITATION COUNCIL OF INDIA

AREA - B
COURSE CODE - B 11 (H.I.)
ASSISTIVE DEVICES & SERVICES FOR INDIVIDUALS WITH HEARING IMPAIRMENT

Chairman	**Prof. Subha Sankar Sarkar,** Vice Chancellor, Netaji Subhas Open University, Kolkata
Convenor	**Prof. Atindranath Dey,** Director, School of Education, Netaji Subhas Open University, Kolkata

RCI Expert Committee

Dr. Jayanthi Narayan	Former Deputy Director, NIMH, Secunderabad.
Dr. Varsha Gathoo	Head and Reader, Department of Education, AYJNISHD (D), Mumbai.
Dr. Sanjay Kumar	Assistant Professor, DSMNRU, Lucknow,
Shri Ashok Chakraborty	Ex- Chairperson, ZCC, RCI & Secretary, SHELTER.
Dr. Hemant Singh Keshwal	Assistant Prof. of Special Education and Centre In- Charge, NIEPID- RC, Kolkata.
Shri Suman Kumar	Assistant Professor of Speech & Hearing, AYJNISHD- RC, Kolkata.
Professor A. N. Dey	Director, School of Education, NSOU.
Smt. Antara Choudhury	Assistant Professor of Special Education, School of Education, NSOU.

NSOU Expert Committee [Board of Studies (BoS)]

Professor A. N. Dey	Director, School of Education, NSOU.
Professor Dulal Mukhopadhyay	Professor of Education (Retd), NSOU.
Shri Ashok Chakraborty	Ex- Chairperson, ZCC, RCI & Secretary, SHELTER.
Professor Debasri Banerjee	Professor of Education, Department of Education, University of Calcutta
Dr. Hemant Singh Keshwal	Assistant Prof. of Spl. Education and Centre In- Charge, NIEPID-RC, Kolkata.
Shri Suman Kumar	Assistant Professor of Speech & Hearing, AYJNISHD- RC, Kolkata.
Professor Swapan Kr. Sarkar	Head, SoE, NSOU
Prof. Sanat Kumar Ghosh	Professor of Education, SoE, NSOU.
Professor Sumanta Chattaraj	Professor of Education, SoE, NSOU.
Smt. Swapna Deb	Consultant, SoE, NSOU.
Smt. Antara Choudhury	Assistant Professor of Special Education, School of Education, NSOU.
Dr. Abhedananda Panigrahi	Coordinator, B. Ed., SoE, NSOU.
Shri Prabir Naskar	Assistant Professor of Special Education, SoE, NSOU.

Title : Assistive Devices & Services for Individuals with Hearing Impairment

Unit	**Name of the Unit Writer**	**Name of the Editor**
Unit-1	Dr. Raju Arakh, Lecturer, Dept of Education, AYJNISHD(D), Mumbai	Dr. Varsha Gathoo, Head and Reader, Department of Education, AYJNISHD (D), Mumbai
Unit-2	Ms. Piyali Kundu, ASLP, AYJNISHD (D), RC, Kolkata	
Unit-3	Mr. Indranil Chatterjee, Lecturer, Speech & Hearing, AYJNISHD, RC, Kolkata.	
Unit-4	Ms. Krithika Iyengar Saha, Audiologist, Peerless Hospital, Kolkata	
Unit-5	Dr Prithi Venkatesh, Reader, Dept of Spl Education, AIISH, Mysore.	
General and Format Editing		Smt. Swapna Deb, Consultant, SoE, NSOU. and Smt. Baby Dutta Choudhury, Academic Consultant, SoE, NSOU.
Programme Coordinator		Smt. Antara Choudhury, Asst. Professor of Special Education, School of Education, NSOU.

The Self Instructional Material (SIM) is prepared keeping conformity with the M.Ed.Spl. Edn.(HI/ID) Programme as prepared and circulated by the Rehabilitation Council of India, New Delhi and adopted by NSOU on and from the 2020-2022 academic session.

Mohan Kumar Chattopadhyay
Registrar

Prologue

I am delighted to write this foreword for the Self Learning Materials (SLM) of M Ed in Special Education (ODL). The M Ed in Special Education in ODL mode is a new academic program to be introduced at this University as per NOC issued by the Rehabilitation Council of India, New Delhi and subject to approval of the program by the DEB-UGC.

I must admire the emulation taken by the colleagues from School of Education (SoE) of NSOU for developing the Course Structure, Unit wise details of contents, identifying the Content Writers, distribution of job of content writing, editing of the contents by the senior subject experts, making DTP work and also developing E-SLMs of all the 16 Papers of the M.Ed Spl.Ed (H.I/I.D)–ODL program. I also extend my sincere thanks to each of the Content Writers and Editors for making it possible to prepare all the SLMs as necessary for the program. All of them helped the University enormously. My colleagues in SoE fulfilled a tremendous task of doing all the activities related to preparation of M.Ed in Spl Edn SLMs in war footing within the given time line.

The conceptual gamut of Education and Special Education has been extended to a broad spectrum. Helen Keller has rightly discerned that *"Have you ever been at sea in a dense fog, when it seemed as if a tangible white darkness shut you in and the great ship, tense and anxious, groped her way toward the shore with plummet and sounding-line, and you waited with beating heart for something to happen? I was like that ship before my education began, only I was without compass or sounding line, and no way of knowing how near the harbour was. "Light! Give me light!" was the wordless cry of my soul, and the light of love shone on me in that very hour."* So education is the only tool to empower people to encounter his/her challenges and come over being champion. Thus the professional Teacher Education program in Special Education can only groom the personnel as required to run such academic institutions which cater to the needs of the discipline.

I am hopeful that the SLMs as developed by the eminent subject experts, from the national as well as local pools, will be of much help to the learners. Hope that the learners of the M.Ed Spl Edn program will take advantage of using the SLMs and make most out of it to fulfil their academic goal. However, any suggestion for further improvement of the SLMs is most welcome.

Professor (Dr.) Subha Sankar Sarkar
Vice-Chancellor, NSOU

First Edition : December, 2019

Printed in accordance with the regulations of the Distance Education Bureau,
University Grants Commission, Government of India

AREA - B

B 11 : ASSISTIVE DEVICES & SERVICES FOR INDIVIDUALS WITH HEARING IMPAIRMENT

Unit 1 : Schemes & Services For Individuals With Hearing Impairment

1.1 Schemes for persons with disabilities of various ministries/departments of central and state government in early intervention, rehabilitation, education and employment;

1.2 Schemes for availing aids and appliances: ADIP and other schemes

1.3 Services for individuals with hearing impairment: Types, availability, coverage and quality

1.4 Delivery of services; Role of various stakeholders, planning, implementing, collaboration, challenges and issues

1.5 Appraisal of services: Methods of measuring outcomes and suggesting plan of action

Unit 2: Listening and Assistive Devices in Audiological Management

2.1 Hearing aids: Overview to hearing aids; Overview to electro-acoustic characteristics and need to study same; Importance of ear moulds and its modifications

2.2 Cochlear Implant: Overview to cochlear implants; Need and importance for regular mapping

2.3 FM system: Components, Functioning, Types, Advantages and disadvantages

2.4 Induction loop systems & Hardwire systems: Components, Functioning, Types, Advantages and disadvantages

2.5 Criteria for recommendation of one device over the other; Role of special educators in measuring outcome of listening devices

Unit 3: Assistive Devices in Management of Language & Communication

3.1 Meta level understanding of use of technology for language development

3.2 Access to whole language: Challenges of communication options and use of technology for ways to overcome

3.3 Use and availability of social media for sign language users: Communicative, educational and social purposes

3.4 Orientation to web based Curriculum Based Measurement (CBM) tools

3.5 Tele captioning of popular media and its role in literacy development

Unit 4: Technology & Methods in Management of Speech

4.1 Parameters measured in phonation and supra-segmental aspects of speech using advanced technology and their application

4.2 Need and methods to analyse and to correct articulation of speech

4.3 Selecting management techniques for phonation and supra-segmental aspects of speech

4.4 Selecting management methods for facilitating articulation in CWHI

4.5 Methods to improve speech intelligibility; Measurement of outcome

Unit 5 : Assistive Devices in Educational Management

5.1 Impact of Technology on education: Present & Future

5.2 Assistive technologies for personal and educational purposes: Devices & Processes and their application

5.3 Mainstream Technologies: Universal Designs; its Concept, Principles & product design

5.4 Research & Developments in Educational technology: national & international

5.5 Evidence Based Practices

Netaji Subhas Open University

AREA - B

B 11 (H.I.): ASSISTIVE DEVICES & SERVICES FOR INDIVIDUALS WITH HEARING IMPAIRMENT

B 11 ◻ ASSISTIVE DEVICES & SERVICES FOR INDIVIDUALS WITH HEARING IMPAIRMENT

UNIT ◻ 1	SCHEMES & SERVICES FOR INDIVIDUALS WITH HEARING IMPAIRMENT	9 - 41
UNIT ◻ 2	LISTENING AND ASSISTIVE DEVICES IN AUDIOLOGICAL MANAGEMENT	42 - 117
UNIT ◻ 3	ASSISTIVE DEVICES IN MANAGEMENT OF LANGUAGE & COMMUNICATION	118 - 138
UNIT ◻ 4	TECHNOLOGY & METHODS IN MANAGEMENT OF SPEECH	139 - 173
UNIT ◻ 5	ASSISTIVE DEVICES IN EDUCATIONAL MANAGEMENT	174 - 191

Unit 1 ❑ Schemes & Services For Individuals With Hearing Impairment

Structure

1.1 Introduction

1.2 Objectivesa

1.3 Schemes For Persons with Disabilities of Various Ministries/Departments of Central And State Government In Early Intervention, Rehabilitation, Education And Employment

1.4 Schemes For Availing Aids And Appliances: ADIP And Other Schemesa) Assistance To Disabled Persons For Purchase/Fitting Of Aids/Appliances (Adip)

1.5 Services for Individuals With Hearing Impairment : Types, Availability, Coverage And Quality

1.6 Delivery Of Services; Role Of Various Stakeholders, Planning, Implementing, Collaboration, Challenges And Issues

1.7 Appraisal of Services: Methods of Measuring Outcomes and Suggesting Plan of Action

1.8 Let us Sum up

1.9 Unit end exercises

1.10 References

1.1 Introduction

According to Census 2011, there were about 2.68 crore persons with disabilities in India, constituting 2.21% of the total population in country. Article 41 of constitution of India makes it mandatory to provide the education to all, freedom, justice and dignity of all individuals. Accordingly Central, State and Local Govt. bodies are responsible to ensure the fundamental rights of the citizens of India. In light of the article 14 and 41 the Government of India enacted laws, framed policies, schemes etc. for the welfare and empowerment of persons with disabilities.

1.2 Objectives

a. To know the State and Central Government schemes for the welfare of Persons with Disabilities in India.

b. To know about ADIP and other schemes for availing Aids and Appliances for the Persons with Disabilities.

c. To know about the availability of rehabilitation services its coverage and quality.

d. To know the role of various stakeholders in delivery of services its planning and implementation and understanding the challenges and issues comes in the way of delivery of services.

e. To know the methods of measuring outcome of services and plan of action.

1.3 Schemes For Persons with Disabilities of Various Ministries/ Departments of Central And State Government In Early Intervention, Rehabilitation, Education And Employment

There are many schemes being provided by the central Government and State Government for the rehabilitation and welfare of persons with disabilities in India. They are as follows.

1.3.1 Deendayal Disabled Rehabilitation Scheme (Ddrs)

Department of Empowerment of Persons with Disabilities, Ministry of social Justice & empowerment Government of India ,New Delhi has initiated and implemented the revise scheme of Deendayal Disabled Rehabilitation Scheme (DDRC) with the main objectives of to create and enable environment to ensure equal opportunities, equity, social justice and empowerment of persons with disabilities and encourage voluntary action for ensuring effective implementation of the Rights of Persons with Disability Act, 2016. The scheme has been revised to be implemented w.e.f. 1st April, 2018 as given. The scheme includes model projects as given below.

I. Pre-Schools and Early Intervention and Training

II. Special Schools for Persons with Disabilities for

a. Mental Retardation

b. Hearing & Speech Impaired

c. Visually Challenged

III. b. Cerebral Palsied Children

IV. Rehabilitation of Leprosy Cured Person

V. Half Way Home for Psycho-Social Rehabilitation of Treated and Controlled Mentally III persons

VI. Home-Based Rehabilitation and Home Management.

VII. Community Based Rehabilitation Programme (CBR)

VIII. Low Vision Centres

IX. Human Resource DevelopmentThe organisation has to apply for Grant-in-Aid on the online portal of the Ministry (e-Anudaan) and forward the complete proposal to District Social Welfare Officer. Upon inspection and submission of online inspection report, the District Social Welfare Officer would forward the proposal to respective State Government/UT administration and to Government of India. If the State Government/UT administration does not decide on the proposal within 60 days, Government of India can decide on the proposal on the basis of inspection report submitted by the inspecting officer for NGOs receiving Grant-in-Aid under the scheme.

1.4 Schemes For Availing Aids And Appliances: ADIP And Other Schemesa) Assistance To Disabled Persons For Purchase/Fitting Of Aids/Appliances (Adip)

The main objective of the Scheme is to assist the needy disabled persons in procuring durable, sophisticated and scientifically manufactured, modern, standard aids and appliances to promote physical, social, psychological rehabilitation of Persons with Disabilities by reducing the effects of disabilities and at the same time enhance their economic potential. Assistive devices are given to PwDs with an aim to improve their independent functioning, and to arrest the extent of disability and occurrence of secondary disability.The Scheme is implemented through the various Implementing Agencies. The following agencies are eligible to implement the Scheme on behalf of Department, subject to fulfillment of following terms and conditions:

- Societies and their branches, if any, registered separately under the Societies Registration Act, 1860.
- Registered Charitable Trusts.
- Indian Red Cross Societies and other Autonomous Bodies headed by District Collector/ Chief Executive Officer/District Development Officer.
- National/Apex Institutes, CRCs, RCs, DDRCs, National Trust, ALIMCO functioning under administrative control of the Ministry of Social Justice and Empowerment/Ministry of Health and Family Welfare.
- National/State Handicapped Development Corporation and Section 25 Companies in the Private Sector.
- Local Bodies – ZillaParishad, Municipalities, District Autonomous Development Councils and Panchayats etc.
- Hospitals registered as separate entity, as recommended by State/UT/Central Govt.
- Nehru YuvaKendras.
- Any other organization as considered fit by Department of Empowerment of Persons with Disability (Divyangjan), Ministry of SJ&E.

The Implementing Agencies are given financial assistance for purchase, fabrication and distribution of such standard aids and appliances that are in conformity with objectives of the Scheme. The Scheme shall also include essential medical/surgical correction and intervention, prior to fitment of aids and appliances.The Department for financial assistance has notifies Disability-wise list of contemporary aids and assistive devices for Persons with Disabilities(PwDs) under this scheme.Disability wise list of contemporary aids and assistive devices for Persons with Disabilities(PwDs)

SR. NO.	**Types of Disability**	**Contemporary aids and assistive devices**
1.	Persons with Visually Impairment	List of 51 assistive devices Kit-1: For Primary SchoolChildren studying in Class 1 to 5, Kit-2. For studying in Class 9 and 10, Kit 4: For students studying in Class 11 and 12 which has 2 sub-parts viz. Kit-4 (A) for Blind students and Kit-4(B) for

		low vision students, Kit 5: For Collage students which has 2 sub-parts i.e. Kit-5(A) for Blind Students and Kit-5 (B) for low vision students and Kit-6: ADL Kit for Adults, It also contains COMPENDIUM OF SCHEMES - 2018 11 list of common Low Vision Devices and list of High- end & Other Common Devices meant Smart Cane:
2.	Leprosy Affected:	(i) a common Assistive Daily Living (ADL) Kit to be procured and distributed by ALIMCO and (ii) List of 34 individual optional devices as per requirement for distribution by NIRTAR, IPH, NIOH and NGO partners
3.	Intellectual and Developmental Disabilities:	(a) 4 Kit for Mentally Retarded including viz (i) Kit-1 (A): Age group 0-3 years: Early intervention group (Code: EI) and Kit-1(B): TLM Kit for Multiple Disabled in the Age group 0-3 years (ii) Kit2: Age group (Code: PP), (iii) Kit-3 Age group 7-11 years: Primary group (Code: PR) and (iv) Kit-4: Age group 12-15 & 16-18 years: Secondary & Pre-Vocational (Code: SEC/ PV). To begin with these Kits to be provided in Special Schools across the Country, (b) 3 TLM Kits for children with Multiple Disabilities viz (i) Kit-1 Age group3-6 years (ii) Kit-2 Age group 6-10 years and (iii) Kit 3: Age group 10 years and above and (c) ALIMCO Model Sensory Kit: Multi Sensory Inclusive Education Development (MSIED) Kit for persons with Intellectual and Developmental Disabilities.
4.	Hearing Impaired	Assistive devices like Body Level Hearing Aids, Analog/Non Programmable- Behind the ear (BTE), In the ear (ITE), In the canal (ITC), Completely in the Canal (CIC); Digital/ Programmable- Behind the ear (BTE), In the ear (ITE), In the canal (ITC), Completely in the Canal (CIC); Personal FM Hearing Aids,

		Bluetooth neck loop for hearing aids, Vibratory Alarm, Baby-crying Alerting Wireless device, Door Bell Signaler, Fire Smoke Alarm, Telephone Signaler, Amplified Telephone, Telephone amplifier, Audio induction loop, Infrared system, Hearing aids with bone vibrator, Educational Kit (Children from 2 to 5 years, Pre-school going children) containing Language (Vocabulary) Book, Articulation drill book, Story book, Other materials (Family Hand Puppets, 5 puzzles, Montessori equipments/toys, Shape sorter clock, One set of noise makers, Block sorter boxes, Set of verb cards and 5 soft toys). **Cochlear implant:** Revised ADIP Scheme contains a provision to provide Cochlear implant to 500 children per year, with a ceiling of Rs.6.00 lakh per unit to be borne by the Government. Income ceiling for the beneficiaries will be same as for other aids/appliances. Ali Yavar Jung National Institute for the Hearing Handicapped (AYJNIHH), Mumbai, is the nodal agency for Cochlear Implant Surgery. The Institute invites application by issuing advertisements in news papers (all India editions) and also through their website: www.ayinihh.nic.in. Cochlear Implants are procured by Artificial Limbs Manufacturing Corporation of India (ALIMCO), Kanpur and provided at the nominated hospitals. Surgery is done at identified Government/State Government approved hospitals. For conducting cochlear implant surgery, the Ministry has approved empanelment of Government and Private Hospitals.
5.	Persons with Orthopaedic Handicapped	Motorized tricycles and wheelchairs for severely disabled and for Quadriplegic (SCI), Muscular Dystrophy, Stroke, Cerebral Palsy, Hemipeligia and any

		other person with similar conditions, where either three/ four limbs or one half of the body are severely impaired. Extent of subsidy would be Rs.25,000/-. This will be provided to the persons of age of 16 years and above, once in ten years. However, severely disabled persons of 16 years and above age having mental impairment shall not be eligible for Motorized tricycles and wheelchairs since it puts them at a risk of serious accident/physical harm.
6.	Any disabled specified in RPWD Act 2016	Any suitable Aids and Appliances as may be specified for new disabilities added in Rights of Persons with Disabilities (RPwD) Act,2016.

Quantum of Assistance : Aids / appliance which do not cost more than Rs. 10,000/ - are covered under the Scheme for single disability. However, in the case of SwDs, students beyond Intellectual Disability (ID) class, the limit would be raised uptoRs. 12,000/-. In the case of SwDs, students beyond ID class, the limit would be raised to Rs. 12,000/-. In the case of multiple disabilities, the limit will apply to individual items separately in case more than one aid / appliance is required.

Income Limits :

Total Family Income	Amount of Assistance
i) Up to Rs. 15000/- per month	i) Full cost of aid/appliance
(ii) Rs. 15,001/- to Rs. 20,000/- per month	(ii) 50% of the cost of aid // appliance

The extent of financial support would be limited to Rs. 10,000/- for each disability and Rs. 12,000/- for students with disabilities in respect of devices costing up to Rs. 20,000/-. For all expensive assistive devices costing above Rs. 20,000/-, Government shall bear 50% of cost of these items and the remainder shall be contributed by either the State Govt. or the NGO or any other agency or by the beneficiary concerned, subject to prior approval of Ministry on case to case basis, limited to 20% of the Budget under the Scheme.

Travelling cost: Travelling cost would be admissible separately to the PwD and one escort limited to bus fare or railway, subject to a limit of Rs. 250/- each person, irrespective of number of visits to the centre.

Boarding and lodging expenses: Boarding and lodging expenses at the rate of Rs. 100/- per day for maximum duration of 15 days would be admissible, only for those patients whose total income is upto Rs.15,000/- per month and the same will be allowed to attendant/escort.

b) SCHEME FOR IMPLEMENTATION OF PERSONS WITH DISABILITIES ACT, 1995 (SIPDA)

As per the provisions of Persons with Disabilities (Equal Opportunities, Protection of Rights and Full Participation) Act, 1995 (PwD Act), the Ministry has been Implementing the Scheme for Implementation of Persons with Disabilities Act, 1995 (SIPDA) for providing financial assistance to undertake various activities outlined in the Act. The Ministry has been releasing funds under the Scheme since 1999.The activities/projects under the Scheme are implemented and executed by the following

- States Governments/Union Territories.
- Autonomous Organizations set up by Central/State Governments including Central/State Universities.
- National Institutes/ CRCs/DDRCs/RCs/Outreach Centres under MSJ&E.
- Statutory Organizations of Central/State Govts/UTs.
- Organizations/Institutions set up by Central and State Governments.
- Central/State recognized Sports bodies & Federations.
- Non-Governmental Organizations empanelled by the Department for Skill Training Programme under National Action Plan.

Activities/ components covered in SIPDA scheme

- To provide barrier free environment for the persons with disabilities which include access to built environment in schools, colleges, academic and training institutions, offices and public buildings, recreational areas, health centres/hospitals etc. This would include provision for ramps, rails, lifts, adaptation of toilets for wheelchair users, brail signages and Department of Empowerment of Persons with Disabilities

(Divyangjan) 16 auditory signals, tactile flooring, causing curb cuts and slopes to be made in pavement for the easy access of wheelchair users, engraving on the surface of zebra crossing for the blind or for persons with low vision, engraving on the edges of railway platforms for the blind or for low vision and devising appropriate symbols of disability, etc.

- To make Government websites at the Centre/State and District levels accessible to PwDs.
- Skill Development Programme for PwDs.
- To enhance the accessibility of built environment, transport system and information and communication eco-system through "Accessible India Campaign (Sugamya Bharat Abhiyan)"
- To support and set up new Composite Rehabilitation Centres (CRCs)/ Regional Centres/Outreach Centres and District Disability Rehabilitation Centres (DDRCs)
- To assist State Government to organize camps of issuance of disability certificates.
- To create awareness campaign and sensitization programmes for various stake holders and other Information Education Communication.
- To set up/support resource centres facilitating dissemination of information on disability issues, counseling and providing support services.
- To promote accessibility of libraries, both physical and digital and other knowledge centres.
- Supporting activities relating topre-schooltraining for childrenwithdisabilities, counselling for the parents, training for care givers, teachers training programme and activities relating to early detection camps for children of age 0-5 years and early intervention.
- To establish early diagnostic and intervention centres at District Headquarters/ other places
- Construction of special recreation centres for PwDs
- Support for sporting events at National/State level
- Identification and Survey/Universal ID of PwDs
- Research on Disability Related Technology, Product and Issues.

- Incentive to employers in the private sector for providing employment to persons with disabilities.

c) DISTRICT DISABILITY REHABILITATION CENTRES (DDRCs)

In order to facilitate creation of infrastructure and capacity building at district level for awareness generation, rehabilitation, training and guidance of rehabilitation professionals, the Department is supporting setting up District Disability Rehabilitation Centres in all the unserved districts of the country for providing comprehensive services to the persons with disabilities.The broad objectives of the DDRCs are as follows:

- Survey and identification of Persons with Disabilities through camp approach
- Awareness generation for encouraging and enhancing prevention of disabilities
- Early intervention
- Assessment of need of assistive devices, provision/fitment of assistive devices and follow up/repair of assistive devices
- Therapeutic Services e.g. Physio-therapy, Occupation Therapy, Speech Therapy etc.
- Facilitation ofissue of DisabilityCertificates, bus passes and other concessions and facilities for Persons with Disabilities
- Referral and arrangements for surgical correction through Government and Charitable Institutes
- Arrangement of loans for self-employment from banks and other financial institutions including State Channelizing Agencies (SCAs) of NHFDC
- Counseling of PwDs, their parents and family members
- Promotion of barrier free environmen
- Provision of supportive and complementary services for promoting education, vocational training and employment of Persons with Disabilities through: Imparting orientation training to teachers, community and families; Training to Persons with Disabilities for early motivation and early stimulation for education, vocational training and employment; o Identifying suitable vocations for Persons with Disabilities, keeping in view local resources and designing and providing vocational training and identifying suitable jobs, so as to make them economically

independent and o Providing referral services for existing educational, training and vocational institutions.

d) OTHER SCHEMES

- **SCHOLARSHIP/EMPLOYMENT SCHEMES**
- **Pre-matric scholarship and post-matric scholarship for students with disabilities**

Objectives and brief of the scheme:

- The objectives of the schemes are to provide financial assistance to the students with disabilities for studying in the pre-matric level (class IX and X) and post-matric level (Classes XI, XII and upto post graduate degree/diploma level).
- The financial assistance includes scholarship, book grant, escort/reader allowance, etc.
- Number of scholarships to be granted during 2017-18 is 20,000 for pre-matric level and 17,000 for post-matric level.
- Selection of the beneficiaries under these two scholarship schemes is done on the basis of merit after the recommendation of the State Governments/Union Territory Administration.
- These schemes are being implemented on-line, through a web-portal "National e-Scholarship Portal" (www.scholarships.gov.in) so that the students can apply on-line and the benefits reach the beneficiaries through Direct Benefit Transfer (DBT).

(i) Scholarship and other grant

Items	Day Scholar	Hostellers
Rate of Scholarship (in Rs. Per month) payable for 10 months in an academic year.	350	600
	1,000	1,000
Book and adhoc grant (Rs. Per annum)		

(ii) Allowances:

Allowances	Amount (in Rs.)
Monthly Reader Allowance for Blind students	160
Monthly Transport Allowance, if such students do not reside in the hostel which is within the premises of the Educational Institution.	160
Monthly Escort Allowance for Severely Disabled (i.e. with 80% or higher disability) Day Scholars/Students With low extremity disability	160
Monthly Helper Allowance admissible to any employee of the hostel willing to extend help to a severely orthopaedically handicapped student residing in the hostel of an Educational Institution who may need the assistance of a helper	160
Monthly Coaching Allowance to Mentally Retarded and Mentally ill Students	240

Post-Matric Scholarship:

The value of Post-matric scholarship includes the following for complete duration of the course:-

(i) Maintenance allowance,

(ii) Additional allowance for students with disabilities, for the complete duration of the course,and

(iii) Reimbursement of compulsory non-refundable fees,

(iv) Book allowanceThe details are as follows:

- Maintenance allowance

Groups	**Rate of Maintenance allowance (in Rupees per month)**	
	Hostellers	Day Scholars
Group I All PG Degree / Diploma Courses recognised by UGC in any discipline. All Bachelor's Degree courses in Medicine (Allopathic, Indian and other recognized systems of medicines), Engineering, Technology, Planning, Architecture, Design, Fashion Technology, Agriculture, Veterinary & Allied Sciences, Management, Business Finance/ Administration, Computer Science/ Applications.	**1200**	**550**
Group II Professional Courses leading to Degree, Diploma, Certificate in areaslike Pharmacy (B Pharma), LLB, BFS, other para-medical brancheslike Rehabilitation, Diagnostics etc., Mass Communication, Hotel Management & Catering, Travel/Tourism/ Hospitality Management,Interior Decoration, Nutrition & Dietetics, Commercial Art,Financial Services (e.g. Banking, Insurance, Taxation etc.) for which entrance qualification is minimum Sr. Secondary (10+2).	**820**	**530**
Group III All other courses leading to a graduate degree not covered under Group I & II eg. BA/B Sc/B Com etc.	**700**	**500**

Group IV All post-matriculation level non-degree courses for which entrancequalification is High School (Class X), e.g. senior secondary certificate (class XI and XII); both general and vocational stream, ITI courses, 3 year diploma courses in Polytechnics, etc.	**650**	**400**

In addition, the scheme also provides for books allowance, typing and printing charges, Reader allowance, Escort allowance, coaching allowance and special allowance etc.Scholars will be paid enrolment/registration, tuition, games, Union, Library, Magazine, Medical Examination and such other fees compulsorily payable by the scholar to the institution or University/Board maximum up to the ceiling of Rs.1.50 lakh per annum subject to actual.Refundable deposits like caution money, security deposit will, however, be excluded.

- **Scholarship for top class education for students with disabilities**
- The Scheme aims at recognizing and promoting quality education amongst Students withDisabilities by providing financial support.
- The scheme will cover Students with Disabilities (SwDs) for pursuing studies at the level ofPost Graduate Degree or Diploma in any discipline.
- The scheme is operating in institutions notified by the Department of Empowerment ofPersons with Disabilities, Ministry of Social Justice & Empowerment as institutions ofexcellence.
- The financial assistance includes scholarship, book grant, escort/reader allowance, etc.
- Number of scholarships to be granted during 2017-18 is 110 Scholarship for Top Class Education. 50% of the scholarships are reserved for girls.
- Parental income ceiling is Rs.6.00 lakhs per annum for Top Class Education.
- Selection of the beneficiaries under these three scholarship schemes is done on the basis ofmerit after the recommendation of the Governments of State or Union Territories.

The scholarship will include the following :-

Sl No.	Components of Scholarship	Rate per awardees1.
1.	Reimbursement of tuition fees and nonrefundable charges paid/ payable to the Institution annum	Up to Rs. 2.00 lakh – per (subject to actual amount).
2.	Maintenance Allowance	Rs. 3,000/- per month for hostellers, Rs. 1,500/- per month for day-scholars
3.	Special Allowances (related to types of disabilities like reader allowance, escortallowance, helper allowance etc.)	Rs.2000/- per month
4.	Books & Stationery	Rs. 5,000/- per annum.
5.	Reimbursement of expenses for purchase of acomputer with accessories.	Rs. 30,000/- per awardee as a one-time grant for entire course.
6.	Reimbursement of expenses for purchase of Aids and Assistive Devices including necessary software related to the particular disability of the selected candidate.	Rs. 30,000/- per awardee as a one-time grant for entire course

The Department of Empowerment of Persons with Disabilities announce the details of the scheme and invite applications by issuing an advertisement in the leading newspapers and through the websites and other media outfits. Applications are called for through the National Scholarship Portal, an on-line scholarship management program being developed by Department of Electronics & Information Technology for this purpose.

- **National Overseas Scholarship for students with disabilities:**

Major Activities under different Schemes & Programmes of the National Trust:-

- **DISHA (Early Intervention and School Readiness Scheme):-**

  This is an early intervention and school readiness scheme for children in the age group of 0-10 years with the four disabilities covered under the National Trust Act and aims at setting up Disha Centres for early intervention for Persons with

Disabilities (PwDs) through therapies, trainings and providing support to family members. RO should provide day-care facilities to PwDs for at least 4 hours in a day (between 8 am to 6 pm) along with age specific activities. There should be a Special Educator or Early Intervention Therapist, Physiotherapist or Occupational Therapist and Counsellor for PwDs along with Caregiver and Ayas in the centre. The revised Early Intervention Scheme will have provision to cover 0 to 10 year age group of children in place of 0 to 6 age group as envisaged in the earlier scheme. The set up cost has been increased from Rs. 50,000 to Rs. 1.55 lakh.

ii) VIKAAS (Day Care):- This is a Day cares cheme, primarily to expand the range of opportunities available to persons with disabilities for enhancing interpersonal and vocational skills as they are on a transition to higher age groups. The centre will also offer care giving support to Persons with Disabilities (PwDs) during the time the PwDs are in the Vikaas centre. In addition it also helps in supporting family members of the Persons with disabilities covered under the National Trust Act to get some time during the day to fulfil other responsibilities. RO should provide day-care facilities to PwDs for at least 6 hours in a day (between 8 am to 6 pm) along with age specific activities. Day care should be open for at least 21 days in a month

- **SAMARTH (Respite Care):-**

  The objective of Samarth scheme is to provide respite home for orphans or abandoned, families in crisis and also for Persons with Disabilities (PwDs) from BPL & LIG families including destitute with at least one of the four disabilities covered under the National Trust Act. It also aims at creating opportunities for family members to get respite time in order to fulfil other responsibilities. This scheme aims at setting up Samarth Centres for providing group home facility for all age groups with adequate and quality care service with acceptable living standards including provision of basic medical care from professional doctors. The revised Samarth Scheme will have provision of Work Center. The per beneficiary monthly recurring cost has been revised from 1600 P.M. to 7,000 P.M. The Scheme will have full time support in place of tapering grant.

- **GHARAUNDA (Group Home for Adults):-**

  The objective of Gharaunda scheme is to provide an assured home and minimum quality of care services throughout the life of the persons with Autism, Cerebral Palsy, Mental Retardation and Multiple Disabilities with adequate and quality care service with acceptable living standards including provision of basic medical care from professional doctors. Gharaunda Centre should provide vocational activities, pre-vocational activities and assistance for further training. The revised GHARAUNDA Scheme will have 1:1 ratio for LIG (including BPL) and above LIG PwDs, (which will be paid seats for Registered Organisations) in place of 5:1. There will be monthly recurring fund of Rs. 10,000 per PwD in place of one time payment of Rs. 8 lakh per PwD. In addition, there will be one time set up fund of Rs. 2.50 lakh, crisis fund of Rs. 10 lakh and fund for setting work center ranging from Rs. 25, 000 to 1, 00,000.

- **v) 'NIRAMAYA' Health Insurance Scheme-**

  The scheme is to provide affordable Health Insurance to persons with Autism, Cerebral Palsy, Mental Retardation and Multiple Disabilities. The enrolled beneficiaries get a health insurance cover upto Rs.1.0 lakh, by paying a nominal fee.

- **SAHYOGI (Caregiver training scheme):-**

  This scheme aims at setting up Caregiver Cells (CGCs) to provide training and create a skilled workforce of caregivers to provide adequate and nurturing care for Persons with Disabilities (Divyangjan) and their families who require it. It also seeks to provide parents an opportunity to get trained in care giving, if they so desire. This scheme will provide a choice of training through two levels of courses primary and advanced to allow it to create caregivers suited to work both with Persons with Disabilities (Divyangjan) families and other institutions catering to the needs of the Divyangjan (NGOs, work centres etc.). There is a provision of training cost of Rs.4,200 per trainee, for primary course and Rs.8,000 for advanced course. Also, stipend for trainee @ Rs.5,000 for primary and Rs.10,000 for advanced course has been introduced in the scheme. This scheme aims at setting up Caregiver Cells (CGCs) to provide training and create a skilled workforce of caregivers to provide adequate and nurturing care for Persons with Disabilities (Divyangjan) and their families who require it. It also seeks to provide parents an opportunity to get trained in care giving, if they so desire. This scheme will provide a choice of training through two levels of courses primary and advanced to allow it to create caregivers suited to work both with Persons with Disabilities (Divyangjan) families and other institutions catering to the needs of the Divyangjan

(NGOs, work centres etc.). There is a provision of training cost of Rs.4,200 per trainee, for primary course and Rs.8,000 for advanced course. Also, stipend for trainee @ Rs.5,000 for primary and Rs.10,000 for advanced course has been introduced in the scheme.

- **GYAN PRABHA (Educational support):-**

  Gyan Prabha scheme aims to encourage people with Autism, Cerebral Palsy, Mental Retardation and Multiple Disabilities for pursuing educational courses like graduation courses, professional courses and vocational training leading to employment or self-employment. The National Trust is providing a specific amount per course to a Divyangjan which covers fees, transportation, books, out of pocket expenses (OPEs) etc.

- **PRERNA (Marketing Assistance):-**

  Prerna is the marketing assistance scheme of the National Trust with an objective to create viable and widespread channels for sale of products and services produced by Persons with disabilities (PwDs) covered under the National Trust Act. This scheme aims at providing funds to participate in events such as exhibitions, melas, fairs, etc. to sell the products made by PwDs. The scheme also provides an incentive to the Registered Organisations (ROs) based on the sales turnover of the products made by PwDs. The National Trust shall fund RO participation in national, regional, state and district level events such as fairs, exhibitions, melas etc. for marketing and selling products and services prepared by PwDs. However, at least 51% of employees of these work centres should be Persons with Disabilities covered under the National Trust Act.

- **BADHTE KADAM (Awareness and Community Interaction):-**

  This scheme shall support Registered Organisations (ROs) of The National Trust to carry out activities that focus on increasing the awareness of The National Trust disabilities. Aim of scheme is to create community awareness, sensitisation, social integration and mainstreaming of Persons with Disabilities. The National Trust shall sponsor a maximum of 4 events for each RO per year. Each RO should conduct at least 1 event (either for community, educational institutes or medical institutes) in a year. Bathe Kadam was earlier an initiative of the National Trust which is now converted into a scheme.

Ministry of Human Resource and Development(MHRD)

Scheme for Integrating Persons With Disabilities In The Mainstream of Technical And Vocational Education: The Scheme was introduced in the year 1999-2000 with the objective of upgrading some of the selected polytechnics to integrate persons with disabilities in the mainstream of technical and vocational education. The scheme envisages each polytechnic to train upto 25 disabled students through formal courses consisting of regular three-year diploma programmes and upto I 00 disabled persons each year through non-formal courses consisting of vocational/skill development programmes. The disabled students are encouraged through provisions like scholarship, supply of books/educational materials, uniforms, free boarding and lodgi ng etc. At present the scheme covers about 50 polytechnics throughout the country.

Sarva Shiksha Abhiyan (SSA): SSA is a programme for Universal Elementary Education. SSA has been operational since 2000-2001 to provide for a variety of interventions for universal access and retention, bridging of gender and social category gaps in elementary education and improving the quality of learning.

Aims:

1. To provide useful and elementary education for all children in the 6-14 age group by 2010.
2. To bridge social, regional and gender gaps with the active participation of community in the management of schools.
3. To allow children to learn about and master their natural environment in order to develop their potential both spiritually and materially.
4. To inculcate value-based learning this allows children an opportunity to work for each other's well being rather than to permit mere selfish pursuits.
5. To realize the importance of Early Childhood Care and education and looks at the 0-14 age as a continuum.

- SSA interventions include inter alia, opening of new schools and alternate schooling facilities, construction of schools and additional classrooms, toilets and drinking water, provisioning for teachers, regular teacher in service training and academic resource support, free textbooks& uniforms and support for improving learning achievement levels / outcome. With the passage of the RTE Act, changes have been incorporated into the SSA approach, strategies and norms.

- The changes encompass the vision and approach to elementary education, guided by the following principles :
- Holistic view of education, as interpreted in the National Curriculum Framework 2005, with implications for a systemic revamp of the entire content and process of education with significant implications for curriculum, teacher education, educational planning and management.
- **Equity,** to mean not only equal opportunity, but also creation of conditions in which the disadvantaged sections of the society – children of SC, ST, Muslim minority, landless agricultural workers and children with special needs, etc. – can avail of the opportunity.
- **Access,** not to be confined to ensuring that a school becomes accessible to all children within specified distance but implies an understanding of the educational needs and predicament of the traditionally excluded categories – the SC, ST and others sections of the most disadvantaged groups, the Muslim minority, girls in general, and children with special needs.
- **Gender concern,** implying not only an effort to enable girls to keep pace with boys but to view education in the perspective spelt out in the National Policy on Education 1986 /92; i.e. a decisive intervention to bring about a basic change in the status of women.
- Centrality of teacher, to motivate them to innovate and create a culture in the classroom, and beyond the classroom, that might produce an inclusive environment for children, especially for girls from oppressed and marginalised backgrounds.
- Moral compulsion is imposed through the RTE Act on parents, teachers, educational administrators and other stakeholders, rather than shifting emphasis on punitive processes.Convergent and integrated system of educational management is pre-requisite for implementation of the RTE law. All states must move in that direction as speedily as feasible

Scheme of Integrated Education of Disabled Children (IEDC) – 1974

Integrated Education of Disabled Children (IEDC), was initiated by the Ministry of Welfare, Government of India, in 1974 to promote the integration of students with mild to moderate disabilities into regular schools. The scheme was later transferred to the

Department of Education in 1982-83. The Scheme was last revised in 1992. The program was also designed to promote the retention of children with disabilities in the regular school system. Children were to be provided with financial support for books, stationery, school uniforms, transportation, special equipment and aids.

IEDC Scheme –Aims :

- The IEDC scheme had the following three main broad aims.
- To facilitate admission to as many children with disabilities as in need in the integrated set up so that the infrastructure and resources already in existence would be made available to these children too.
- To adopt suitable and appropriate teaching methods for effective teaching learning experiences and thereby reduce the drop out rate.
- To establish a linkage between the special schools and the integrated schools in the area for continuing education and "functional" education in the mainstream.

Inclusive Education for Disabled at Secondary Stage (IEDSS):

- The Scheme of Inclusive Education for Disabled at Secondary Stage (IEDSS) was launched during 2009-10 and replaces the earlier scheme of Integrated Education for Disabled Children (IEDC).
- The aim of this scheme is to enable all students with disabilities to pursue four years of secondary education in an inclusive and enabling environment, after completing eight years of elementary schooling.
- The scheme covers all children studying in classes IX to XII in Government, local body and Government-aided schools, with one or more disabilities as defined under the Persons with Disabilities Act (1995) and the National Trust Act (1999).
- The type of disabilities range from blindness, low vision, leprosy cured, hearing impairment, locomotor disability, mental retardation, mental illness, autism and cerebral leprosy, speech impairment, learning disabilities etc.
- Girls with disabilities are provided with special attention to help them gain access to secondary education, information and guidance for their developing potential. Moreover, the scheme envisages to set up model inclusive schools in every state.

1.5 Services for Individuals With Hearing Impairment: Types, Availability, Coverage And Quality

There are many rehabilitative services being provided for the persons with disabilities in India. They are as follows.

Types of Services:

1. Diagnostic / early identification and fitment services
2. Disability Help line
3. Early intervention services
4. Therapeutic services
5. Educational Services
6. Counselling Services
7. Skill development

Diagnostic / early identification and fitment services for the persons with hearing impairment:

The professionals who are trained in the diagnosis and rehabilitation of hearing and speech problems.

Carry out the hearing assessment

Diagnose the type of hearing problem

Do hearing aid testing and fitting

Tell you how to use the hearing aid

Help you with a program geared at helping the child learn to make use of his hearing and develop speech and language

Remedial of speech problems. i.e. provide speech therapy

Presently Ali Yavar Jung National Institute of Speech and Hearing institute and its regional centers carry out the diagnostic services. Composite Regional Centers spread all over India, District Disability Rehabilitation Centers(DDRCs), non -governmental organisations , private establishmentsalso involved in providing the diagnostic services for the persons with hearing impairment. AYJNISHD Mumbai is a nodal agency to implement the cochlear implant services. It has doctors/ surgeons panel spread all over India to take up this work. In diagnostic testing audiologist and speech language pathologist generally do the following tests to detect the hearing and speech problesm.

Air conduction testing

Bone conduction testing.

Speech testing.

Distortion product otoacoustic emissions (DPOAE) testing.

Auditory brainstem response (ABR) testing.

Tympanometry or acoustic emittance testing.

Disability Help line :

The Disability Line launched by AYJNISHD, Mumbai in 2005 was envisaged to bridge this gap to some extent by enabling the public to have easy access to information regarding disabilities, the services available in their neighbour -hood as well as the schemes and concessions offered by the Government. Specifically, the Disability Line provides information about :

- Different types of disabilities.
- Diagnosis and intervention strategies.
- Diagnostic and therapy centres.
- Educational opportunities and Special schools.
- Vocational training and job opportunities.
- Special Employment Exchanges.
- Government Schemes and facilities.
- Organizations working for PWDs.
- Prevention and management of disabilities. 103
- DRS/NHFDC forms by fax.

Disability Help Line has presently been implemented in Maharashtra, Goa and Delhi Telecom Circles and can be accessed by dialing the following telephone numbers:- Maharashtra/Goa : 022-26404019/24/43 or 155206 Delhi : 011-29825094/95

Early Interventional services :

A collaborative project by AYJNISHD, Mumbai and Balavidyalaya, Chennai on 'Early Identification and Early Intervention towards Inclusive Education of Children with Hearing Impairment (0 to 5 years)' was initiated in 2002. Since its commencement in the year 2002, nearly 100 rehabilitation professionals have been trained through orientation programs to equip them to handle the 0 to 2.5 year age group. Nearly 150 children with hearing impairment under the age of 2.5 years have received intervention at the seven centers under the project. AYJNIHH plans to increase the number of intervention centers by training more professionals and also by providing technical as well as financial assistance to the extent possible.

NCED India, Maharashtra Chapter has taken initiatives in the year 2016-17 and conducted short term training programs for the teachers on early intervention programs zonal wise throughout the state of Maharashtra.

As part of manpower development RCI has included subject contents in its certificate, diploma, degree and post degree syllabus to train the teachers on early intervention cervices.

AYJNISHD, Mumbai has AVT program for pre and post auditory therapy after CI. It has also PIP parent infant program at head office and at its regional centers.

Many other NGOs are also involved successfully in providing early intervention to the children with hearing impairment.

Therapeutic services :

AYJNISHD is the major institute to provides various therapeutic services to the persons with hearing impairment such as speech therapy, post cochlear implant therapy, auditory training, auditory verbal therapy. Private clinics run by the registered professionals and CRCs also provides similar kind of services to the persons with hearing impairment.

Educational Services :

There are many facilities available for education of children with hearing impairment in India. More than 387 registered special schools for children with hearing impairment are available in India (AYJNISHD, Website). You may get an idea of education facilities from the following. Majorly education for the children with hearing impaired is provided through special schools and inclusive schools through its different programs such as

Early intervention

PIP

Pre schooling

Primary schooling

Secondary schooling

Collage education Education through NIOS

Indian Sign Language training

Commonly oral, bilingual and total communication modes are used for instruction and communication of the children with hearing impairment. AYJNISHD and its regional centres have diploma programs in Indian Sign Language which is for persons with hearing impairment and normal hearing person as well. ISLRTC is a national institute located in Noida has main objective to disseminate information and create the manpower in Indian Sign Language.

Counselling Services:

Government and private major institutions provide the counselling services through its psychologist and vocational counsellors.

Skill Development Services :

The Department of Empowerment of Persons with Disabilities (Divyangjan), Ministry of Social Justice and Empowerment , Govt. of India being the nodal agency implement the skill development program for persons with disabilities under the SIPADA scheme. Persons with disabilities in India face many challenges when looking to develop employable skills and gaining meaningful employment.

The vocational training is provided by network of skill training providers led by NGOs, private training institutions and public sector government training institutions. The training partners are provided outcome based financial support DEPwD and Ministry of Skill Development and Entrepreneurship.

The training under this scheme is provided to the person who is having Indian citizenship and 40% disability not less that 15 years of age and not more that 59 years of ageand also the applicant should not have gone through any other training program.

Quality and coverage of services Now a days there is lot of awareness among the people about disabled people since last decade is observed. Public and private efforts are key to disseminate the information. In India almost every state and district is covered by DDRCs, CRCs, private organisation that work for providing services. As per report by Program Evaluation Organization (PEO) which was entrusted in 2007-08 and 2009 -10 conducted an evaluation study of the ADIP scheme with the objective of assessing the coverage, targets achieved, implementation process, timeliness and availability of funds, quality of aids/appliances, capability of implementing agencies in providing aids, explore bottlenecks and give recommendations if any for improvement and necessary rectification in future. The details of quality and coverage is discussed in sub topic appraisal of services in this chapter.As per SSA study report in 2010 the enrollment of children in primary education has significantly increased how ever it fail to maintain the quality in education and later the rate of dropout has increased at the secondary level. There are many studies have conducted to see the loopholes in education and other services. And many reports have provided recommendation to the government to improve situation and quality such as making available of teachers, special educators on full time basis in inclusive schools, creating barrier free environment etc.

1.6 Delivery Of Services; Role Of Various Stakeholders, Planning, Implemention, Collaboration, Challenges And Issues

First of all let us know who all are stakeholders in providing the rehabilitation service for divyangjan person.

- Persons with disabilities
- Parents and families of Persons with disabilities
- Organisations of divyangjan people
- Organisation for divyangjan people
- Service provider Agencies (professional)

Role of Persons with disabilities:

In India many facilities and services are available for divyangjan person however a person with disability must know to receive all these available facilities, he must be aware of schemes and govt. policies, legislations like RPWD Act 2016. He must know his legal rights and how to get his own right, it may for his education, employment, equal participation, social rights etc. He should also know how to get the services and raise voice in case of violation of rights.

Role of Parents and families of Persons with disabilities:

Parent of any child play very crucial role in overall development of child. In case of divyangjan child parents role become more critical. The parents first of all are expected to accept the child and his/her disability and start looking in his/her capabilities. Parent has very important role in availing rehabilitative services like getting done diagnosis of disability, getting information about the disabilities and information of service provides, counselling, availability of all kind of services those are most important for child's overall development.

Role of Organisations of divyangjan people:

Disabled people's organizations believe that people with disabilities are their own best spokespersons. Disabled people believe that they best know the needs and aspirations of disabled people. They will represent themselves to governments, service providers. The organisation of divyangjan can involved in many welfare activities like identification of grass-root needs of disabled people ,representing the government service providers, democratic representations, holding open forums to discuss issues of concern to disabled persons, evaluating and monitoring the services,self -development of disabled people and can act as service provider.

Role of Organisation for divyangjan people:

There is great role to play by the organisation for the persons with disabilities like creating awareness, providing intervention, clinical diagnosis, therapies, education, aids and appliances distributors etc.

Planning and Implementation - Resource persons from Department of Empowerment of Persons with Disabilities (Divyangjan), Ministry of Social Justice and Empowerment including personnel from implementing agencies like ALIMCO and National Institutes State and District level Implementing Agencies would be doing planning through workshops and by inviting open suggestions form stakeholders and guideline is prepared for implementation of welfare scheme. Non-governmental organizations are involved in delivery system of services. The concerned Ministry provides the funding to implement the schemes State government involves as well in the program. The National Institutions and CRCs having major role in planning and implementation. The effectiveness of schemes are assessed through conducting research, survey and the strengths and weakness of the schemes are noticed like extreme poverty, illiteracy, non - availability of services at unreached rural areas, cost effectiveness of services, lack of quality of services, lack of sufficient and timely funding to the non – governmental, complicated and lengthy procedure etc. are the major issues in implementation of delivery service.

1.7 Appraisal of Services: Methods of Measuring Outcomes and Suggesting Plan of Action

Methods of Measuring Outcomes:Outcomes of rehab services can be measured through direct and/or indirect method which can be included various ways such as field survey, beneficiaries interviews, data from implementing agencies etc.Government is the major agency to implement the welfare schemes for the persons with disabilities like ADIP scheme, Scholarship schemes,skill development scheme etc. Outcomes are measured under the parameters of

- Benefits to the disabled person in reducing disabilities
- Convenience
- Enhancing the economic potential of the disabled person
- Durability and quality of aids and appliances
- Modern standard aids
- Coverage of the beneficiaries
- Capability of implementing agencies in providing aids
- Exploring bottlenecks

The Government of India launched the scheme of Assistance to Disabled persons for Purchase/fitting of Aids/Appliances (ADIP) with effect from April, 2005. The Ministry of Social Justice and Empowerment implements the ADIP by providing grant-in-aid to the NGOs and other executive agencies of the Centre/State Governments with the aim of reducing the effects of disabilities, and, enhancing the economic potential of the disabled persons by bringing suitable, durable, scientifically manufactured, modern, standard aids and appliances within their reach.

The Ministry of Social Justice and Empowerment, the **Development Evaluation Advisory Committee (DEAC)** entrusted Programme Evaluation Organisation (PEO) to conducted an evaluation study of the ADIP scheme with the objective of assessing the coverage, targets achieved, implementation process, timeliness and availability of funds, quality of aids/appliances, capability of implementing agencies in providing aids, explore bottlenecks and give recommendations if any for improvement and necessary rectification in future.

The study reference period is from 2007-08 to 2009-10 (3 years). The total coverage was 124 In-depth Interviews and 4329 semi-structured interviews spread across 53 districts and 18 States.

There have been mixed response from the beneficiaries on the quality of appliance provided. Field teamfound that the appliances which most of the beneficiaries were using currently are of BIS Standards andmostly purchased by Artificial Limb Manufacturing Corporation . But they were found in damaged conditionand beneficiaries are some how managing with such appliances. This is due to the fact that theimplementing agencies are not providing the maintenance of appliances, hence some of them becomeredundant. As the appliances are given to persons who are below poverty line, these beneficiaries do noteven have enough money to maintain these appliances. It is also found that shops for repair andmaintenance of aids and appliances are also not available within their reach. Thus, costly aids andappliances with very minor problems are abandoned by the beneficiaries and they go back to theirprevious condition of disability. Many of the beneficiaries have reported that they had to throw (in case ofhearing aid) or have sold (in case of tricycle) the appliances received by them because they were notworking properly.

The major problems of the appliances as was reported include:

- Punctured tyres, in some cases even torn off
- Broken tricycle handles
- Crutches without rubber bushes
- Arm rest of crutches torn off
- Hearing aids not functioning properly
- There is no doubt that the scheme has helped in changing lives of a large number of persons. The overallimpact observed during field survey based on detailed

interaction with the beneficiaries, district offices andimplementing agencies are as follows:

- Increased mobility, now the Differently Abled in the "locomotor" category are able to move freely withoutconstant support from others.
- It was observed that these people now move freely in their villages and interact with other people ratherthan sitting at home, which was the case before.
- Many have been able to find some livelihood as they can now reach workplace easily.
- There is a feeling among the beneficiaries that the government gives a thought for their condition andattempts are being made to improve them.

Issues:

Though the ADIP scheme has succeeded in its objectives, there are some constraints which hinder effective implementation of the scheme. Some of these are as listed below.

- Weak institutional coordination, State level line departments are involved in approving and forwardingthe application of the implementing agencies. However, once the fund gets approved by the CentralGovernment, implementing agencies are directly receiving funds from Central Government and Statesare not intimated about fund disbursal. Thus, State Government is not been able to monitor and assessthe process and quality of implementation. Because of this reason some implementing agencies are notadhering to the implementation guidelines.
- Poor and untimely release of fund has been observed, as only 60% of the allocated fund was actuallyreleased during the reference period. Implementing agencies reported that delay in release of fund is abig challenge which is directly affecting the planning of scheme implementation.
- Lack of proper and updated database of the Differently Abled people- There is no proper records of thedistribution of Differently Abled person either with the district office of Social Justice and Empowermentor the implementing agencies.
- The district offices and implementing agencies are relying on the census done by the Central
- Government which is done once in ten years. For providing effective aid to the Differently Abled it isnecessary to have proper details which will help in planning

the location of organising camps and thenumber of Differently Abled who need to be attended.

- Lack of mechanism to ensure that all tehsils and villages of the district are benefited from the scheme-
- The Centre allocates funds for a specific district. There is no mechanism to ensure that all tehsils andtheir respective villages are benefited from the received fund. The implementing agencies have theliberty to select location of organising camps as per their ease.
- There are other self managed NGO's who are working in the district. Some of these also organize camps and distribute appliances to Differently Abled persons.
- Also it is difficult to ensure that the beneficiary will not sell the appliance given to him/her to some otherpeople or for scrap, which has been pointed out by the implementing agencies. There have beenincidents where many Differently Abled people have sold the appliance given to them for some moneyas they do not have any other livelihood.
- Many beneficiaries cannot afford the Maintenance cost of the appliances given to them. As a result asthe appliance breaks down after some months, they become non functional. This is affecting theeffectiveness of the scheme. Also, under this scheme a person will be provided the aid next time onlyafter three years, while in many a cases the issued appliance becomes non functional within six monthsor a year.
- There is serious lack of system to evaluate the work done by the implementing agencies.
- It was pointed out by the IA's that persons living in distant villages do not come to take the appliances inthe camps organised, as bulky appliances such as tricycles would need a jeep to carry them to theirvillages and they cannot bear that cost.
- The awareness among the beneficiaries (56.91%) about the scheme seems low. Only a handful of thebeneficiaries said that they have heard about the scheme.
- Before conducting camps, organisations advertise and inform people about when and where camp isgoing to be organised. In the case of Artificial Limb Manufacturing Corporation, implementing agencieslike Narayan SewaSansthan, Bhagwan Mahaveer, Viklang Sahayatha Samiti are based outside thedistrict and have no institutional setup in most of the States. Therefore, information about the

camp isnot able to reach to the beneficiaries properly specially in the remote areas. Hence, a large chunk ofpopulation remains un-served.

- It was observed that before getting benefit, the beneficiaries and their care takers were not aware of thescheme.
- Caretakers are also not able to take up livelihood options because of the beneficiary.
- In some cases the quality of the aids provided was poor in quality. This is happening especially withhearing aids. Beneficiaries using artificial limbs have complained that the durability of the limbs is verylow. Once it gets damaged they have no option, other than discarding it or approaching to DistrictDisability Rehabilitation Centre for getting it repaired.
- There is lack of capacity in local level agencies/NGOs to implement the scheme

1.8 Let us Sum up

Many schemes and facilities are being provided by the Department of Empowerment of Persons with Disabilities, Ministry of Social Justice and Empowerment,Government of India ,Ministry of Human Resource Development and Labour Ministry for the welfare of persons with disabilities. The schemes such as ADIP,SIPDA, IEDSS, SSA, Scholarships etc. Along with government non governmental organisations having great contribution in providing special education, inclusive education ,therapeutic services, dissemination of information, screening ,fitment and distribution of aids and appliances. Stakeholders like disabled persons, parents, organisations, institutions play the key role in utilizing of available services and helping for reaching to the needy population. There is no doubt that the services have helped in changing lives of a large number of persons, howeverstill there are many challenges and issues being encountered in delivery system of rehabilitation services.Quality issues, lack of state and central coordination, illiteracy, funding, unavailability of services, lacking trained professionals,quality and cost effectiveness of aids and appliances are the major issues observed.

1.9 Unit end exercises

Q.1. List out the governmental schemes and facilities available for the welfare of the persons with hearing impairment.

Q.2. Write on the different types and availability of rehabilitation services for the persons with disabilities in India.

Q.3. Discuss on the role of various stakeholders in service delivery system. What all are the challenges and issues in service delivery in rehabilitation services?

Q.4. Discuss on appraisal of services. Suggest plan of action for improvement in service delivery system.

1.10 References

Department of Empowerment of Persons with Disabilities. Ministry of Social Justice and Empowerment. Govt. of India. Compendium of schemes (2018). Retrieved on December 29, 2019, from http:// disabilityaffairs.gov.in/content/page/compendium-of-scheme. php

Department of Empowerment of Persons with Disabilities. Ministry of Social Justice and Empowerment. Govt. of India. Compendium of schemes (2018).Skill development of persons with disabilities. Retrieved on January 5, 2020, from http:// disabilityaffairs. gov.in/upload/ uploadfiles/ files/ Revised% 20SIPDA% 20Scheme(2).pdf

Henry Enns (n.d.).The role of organization of disabled people. A disabled peoples' international discussion paper. Retrieved on December 30, 2019, from https://www. Independent living. org/ docs5/ RoleofOrgDisPeople.html

Rehabilitation Council of India (n.d.). Establishment of early intervention centers and training of personals. Retrieved from http://www.rehabcouncil.nic.in/writereaddata/ hi.pdf

Unit 2 ❑ Listening and Assistive Devices in Audiological Management

Structure

2.1 Introduction

2.2 Objective

2.3 Hearing Aids

2.4 Cochlear Implant

2.5 Classroom Amplification System

2.6 Loop Induction System

2.7 Criteria for recommendation of one device over the otherAdvantages of ITEs compared to BTEs

2.8 Let us sum up

2.9 Unit end exercises

2.10 References

2.1 Introduction

Assistive technology can be a key factor that enables individuals with disabilities to participate in daily life and be included in society (Schneidert, Hurst, Miller, & Üstün, 2003). However, this technology has a double-edged nature in that it is both a tool for achieving independence and a visible sign of disability (Scherer, 2002). Assistive technology that is seen as a tool or as one way of achieving desired activity is more likely to be assimilated into the user's life. Alternatively, technology seen as a visible sign of a disability can reinforce the stigma associated with the disability. Because individuals with the latter view of technology may avoid or resist using this technology, they may avoid meaningful activities and suffer both social and physical isolation (Polgar, 2010). Hearing technologies for deaf and hard-of-hearing (DHH) individuals include personal amplifiers (e.g., hearing aids [HA] and cochlear implants [CI]), which are typically worn on the head or on the body and assistive listening devices that are not used on the head or body, such as classroom sound field amplification systems (Dillon, 2001). Specialized hearing technologies may reduce the impact of barriers that DHH students experience in schools, such as classroom noise, rapid rate of discussion, rapid change of topics, and large numbers of people engaged in conversation, all of which can prevent DHH students from participating in teacher–student and student–student communication (Luckner & Muir, 2001; Stinson & Antia, 1999). Although DHH students and their teachers report that the use of hearing technology is essential for ensuring effective inclusion (Eriks-Brophy et al., 2006; Luckner & Muir, 2001), the equipment is sometimes used irregularly because of the stigma associated with assistive technologies.

2.2 Objective

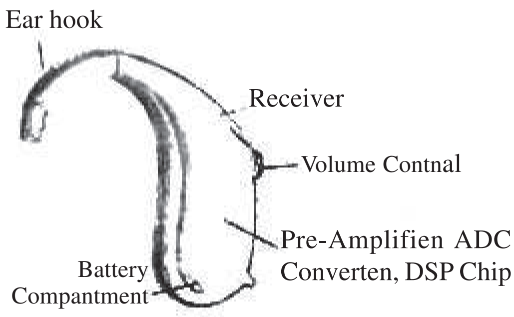
1. Understanding Assistive Technologies
2. What are the options available for the Hearing Impaired individuals with reference to Assistive Listening Devices?
3. Technological Considerations of Assistive listening devices

2.3 Hearing Aids

Hearing aids used today can be broadly classiûed into two styles: Those that ût behind-the-ear (BTE) or more speciûcally are worn over the pinna (commonly called BTE hearing aids) and those that ût in-the-ear (ITE) or in the concha and ear canal (commonly called ITE hearing aids). A BTE hearing aid is coupled to the ear with tubing and either an earmould made custom for the hearing aid user's ear or with an ear dome, also commonly called an ear tip. Within these two broad categories are many different speciûc styles and sizes of hearing aids. When considering what style of hearing aid is appropriate for a patient, many factors are taken into account including the ability of the patient to manipulate the controls on the hearing aids and change the battery and the features contained within the hearing aid. Generally, the smaller the hearing aid, the harder it is to manipulate the controls and change the battery. Choosing a style of hearing aid is also related to an individual's cosmetic preference. For the most part, the signal processing can be implemented in any style of hearing aid with the exception of a few features such as telecoils (a feature for phone communication and looping and directionality). If a telecoil is a desired feature, a hearing aid style with a telecoil built inside must be selected. Directionality, a feature that helps hearing aid users to hear better in noise, cannot be implemented in the smallest ITE devices. The largest percentage (about 71%) of hearing aids sold in the United States is BTE hearing aids (Hearing Industries Association (HIA), 2012).

Behind-the-Ear

BTE hearing aids can be further broken down into those with the receiver located within the case of the hearing aid (traditional BTEs) and those with the receiver removed from the case and instead located at the end of the tubing and placed inside the ear canal (receiver-in-the-ear (RIE)). RIE aids have also been termed receiver-in-the-canal (RIC) but for the purposes of this chapter the term RIE will be used. The traditional BTE aid is shown with tubing and an earmold attached to the aid. The RIE is also shown with tubing which includes the receiver and an ear dome for placement into the ear.



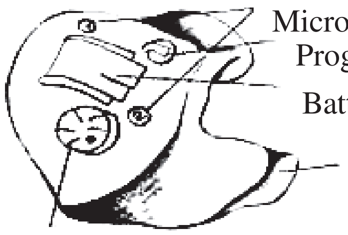
Behind the ear (BTE) Hearing Aid

TRADITIONAL BTES

Traditional BTE hearing aids come in different sizes and are primarily deûned by the hearing aid battery that they use and how they are coupled to the ear. The one on the left would be ût to the patient with a length of plastic tube attached to a custom made earmold, whereas the other two are conûgured to use thin tubing and would be ût to the ear with either a non-custom plastic tip or custom-made earmold. These BTE aids use battery sizes 312, 13, and 675, respectively. As a general rule, the larger the battery used, the more gain the hearing aid is capable of producing. However, the battery size mainly determines how long the patient can use the hearing aid before having to change the battery, with the larger batteries lasting longer. Today, the only hearing aids that use the largest batteries (size 675) are for ûtting patients with severe-to-profound hearing losses. As stated earlier, BTE hearing aids are coupled to the ear with a tube running from the aid to the ear with either a custom

RECEIVER-IN-THE-EAR

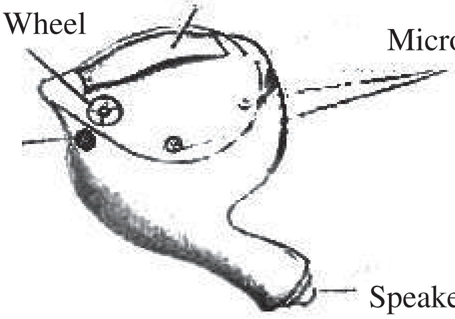
RIE hearing aid style makes up over 45% of the hearing aids sold in the United States (HIA, 2012). This may be different in other countries. RIE hearing aids use a thin tube and couple to the ear with an ear tip or an earmold called a micro mold. An RIE is like a BTE device in that part of the instrument ûts behind the ear, but the receiver is located at the end of the tube within the ear canal. A small wire cable running through a thin tube connects the device behind the ear to the receiver (see Figure 38.3). RIE devices have become popular in the last few years because of their cosmetics and thin-tube options; however, there are thin-tube options in traditional BTE devices as well. To determine if there are beneûts to the RIE style over the traditional BTE, Hallenbeck and Groth (2008) studied the gain (amount of ampliûcation provided to the hearing aid user) before feedback (squealing in hearing aids) in the two styles as this was thought to be one of the reasons that RIE aids had become so popular. Their study concluded that similar gain could be achieved in the two styles and should not be used as a reason to select an RIE product over a traditional BTE. The study did point out that RIE hearing aids potentially offer a smoother, wider frequency response and that there are no moisture problems associated with the tube because of the design. The drawback of RIE hearing aids is that the receiver being located in the ear might cause it to malfunction more often and the receiver is signiûcantly more expensive to replace than a thin tube.



In-The-Ear (ITE)

In-the-Ear

ITE hearing aids come in many speciûc styles and make up approximately 29% of the hearing aids sold in the United States (HIA, 2012). Like BTE hearing aids, this may be



In-The-Canal (ITC)

slightly different in other countries. ITE hearing aids are for the most part custom devices made speciûcally to ût an individual's ear. There are, however, a few styles that ût into the ear that come in standard, noncustom sizes.

NONCUSTOM ITE STYLES:

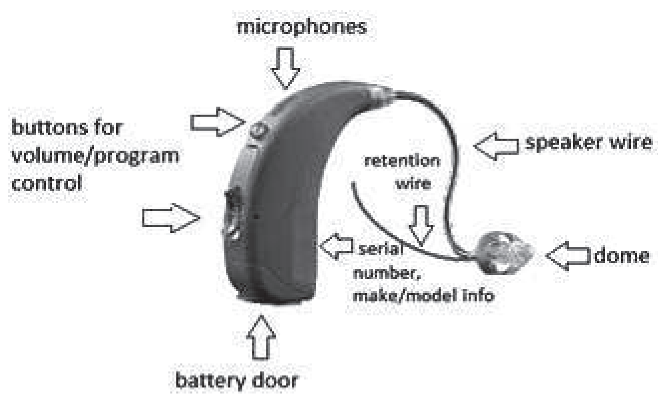
There are some ITE styles that are not custom-made products but do ût in the ear. Figure 38.7 shows examples of three of these types of products. These products are placed in the ear but are not made individually for a patient. Generally these hearing aids do not cost as much as custom-made or BTE devices and they do not have as many features as the other styles overall. Some of these devices are being sold over the counter. If the manufacturer of such devices has not attained Food and Drug Administration (FDA) approval for them as medical devices, they are termed personal sound ampliûcation products (PSAPs) rather than "hearing aids." PSAP is a category of devices deûned by the FDA that is "not intended to compensate for impaired hearing, but rather is intended for non-hearing-impaired consumers to amplify sounds in the environment for a number of reasons, such as recreational activities" (FDA, 2009). They are often compared to reading glasses for the ear and typically marketed for part-time use.

HOW A HEARING AID WORKS

This involves a complex interaction between the device and the individual who uses it. Hearing aids of excellent quality meeting all technical speciûcations may not always be judged to "work" by the user. The many factors which contribute to the ultimate effect of wearing ampliûcation

Components

Hearing aids are wearable electronic ampliûers of sound in the environment that are used to assist with communication for a hard-of-hearing person. At a minimum, hearing aids require a microphone to pick up the sound and convert it to an electrical signal, electronic circuitry to amplify and treat the signal, a



speaker—called a “receiver”—to convert the signal back to sound waves, and a battery to power the device. An example of how these components may be assembled in a BTE device.

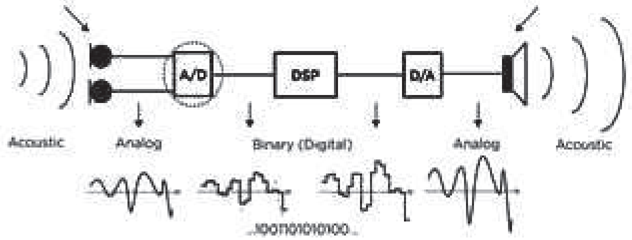
MICROPHONE

The microphone is one of the hearing aid’s transducers. A transducer converts one form of energy to another. The microphone contains a diaphragm that is set into vibration by the pressure variation of sound waves that enter the opening of the microphone, often called a port. The motion of the diaphragm transduces the acoustical energy (sound) to electrical energy. Although various microphone technologies have historically been used in hearing aids, virtually all devices now have either electret or, increasingly, microelectrical-mechanical system (MEMS) microphones. These microphone technologies offer high-quality technical performance, can be very small, and are well suited to mass

production. Hearing aid microphones can faithfully transduce sounds over a broad range of frequencies as well as a large span dynamic range and contribute very little noise to the processed sound that exits the hearing aid. Compared to other hearing aid components, microphones impose the fewest limitations on overall hearing aid electroacoustic design and performance.

DIGITAL SIGNAL PROCESSOR :

The circuitry which manipulates the signal in a hearing aid has traditionally been referred to as the ampliûer. The ampliûer has traditionally been thought of in terms of how it increased the level of the signal at different frequencies. Although the goal of hearing aids is still to amplify sound for compensation of hearing loss, the circuitry in modern hearing aids treats the signal in many other ways to accomplish.



RECEIVER

Like the microphone, the receiver is also a transducer. It converts the processed electrical signal back to acoustic sound waves. The principle is similar to that of the microphone insofar as a diaphragm is set into vibration. The movement of the diaphragm in this case creates the sound waves that are produced by the hearing aid, and the sound waves travel through tubing that connects the receiver to the outside of the hearing aid. Physical properties of the receiver components and the tubing, as well as magnetic forces that drive the vibration of the diaphragm are deciding factors for the output and frequency response of the receiver. The hearing aid receiver most often also incorporates the function of digital-to-analog conversion.

BATTERY

The battery provides the electrical energy to hearing aids. The most common type of hearing aid battery is the zinc– air. It has small holes that allow oxygen to enter the cell when activates the battery.

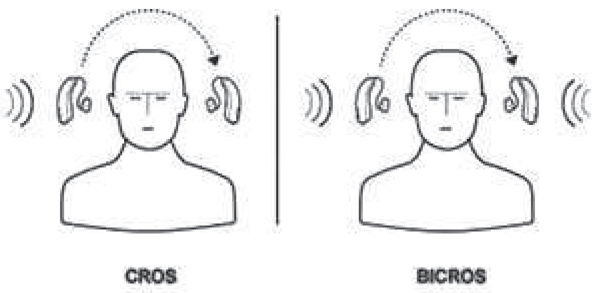
The amount of energy that is stored in the battery is called the capacity and is given in milli-Ampere hours (mAh). Larger batteries can store more energy and thus provide more hours of use than smaller batteries. The combination of how much electrical current in milli-Amperes (mA) is drawn by the hearing aid and the capacity of the battery allows an estimation of battery lifetime. For example, a hearing aid battery may have a capacity of 90 mAh. If the hearing aid draws 1 mA of current, then the estimated hours of use per battery is 90 mAh/1 mA = 90 hours. In reallife use, current consumption by the hearing aid is variable, which means that actual battery lifetime is virtually always shorter than estimated in this way

Rechargeable battery technology is available in virtually every consumer small electronic product, so one might expect hearing aids also to make use of rechargeability.

OTHER STYLES OF HEARING AIDS

CROS/BICROS

Contralateral routing of signal (CROS) and bilateral contralateral routing of signal (BICROS) hearing aids are a special type of hearing aid used when an individual does not have any hearing in one ear that can beneût from a hearing aid. These hearing aids are designed so a microphone is worn on the ear that cannot beneût from a hearing aid and the sound picked up at this microphone is sent wirelessly or via a wire in some cases to the other ear. A CROS hearing aid is worn when one ear cannot beneût from a hearing aid and the other ear has normal hearing. In this case, the sound picked up at the "dead" ear is sent to the aid on the opposite ear with this sound sent to the eardrum. In the case of the BICROS hearing aid, the user has one ear that cannot beneût from a hearing aid and other ear that has some degree of aidable hearing loss. The sound picked up at the "dead" ear is sent to a hearing aid on the other ear where the signal is ampliûed and delivered to the ear.



Bone-Anchored Hearing Aids

BAHAs are surgically implanted aids that directly stimulate the cochlea through bone conduction. These aids consist of a titanium implant, an external abutment, and a sound processor. These aids are meant to bypass the external and middle ears. The titanium implant is surgically placed into

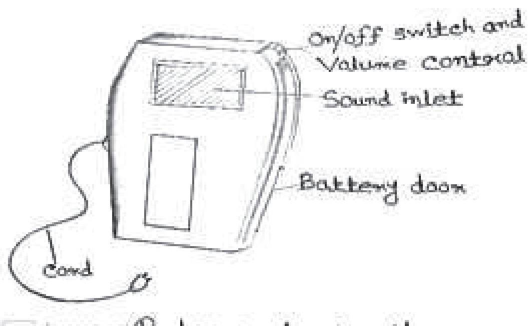
the skull behind the pinna percutaneously (directly coupled to the bone). The sound processor sits behind the ear. This type of aid works by picking up sound at the microphone of the sound processor which is then transmitted to the implant. The implant vibrates within the skull and stimulates the nerve ûbers of the inner ear by bone conduction. Recently, a new BAHA-type device was announced that is transcutaneous; part of the device is implanted but the other part is kept outside the skin similar to a cochlear implant. BAHA-type devices are for unilateral deafness, chronic external and/ or middle ear conditions, and congenital ear malformations.

Bone Conduction Bone conduction hearing aids are a special kind of hearing aid used when the outer ear cannot wear hearing aids. Reasons for this might include an atresic ear, a draining ear, or any a number of problems with the ear where a hearing aid cannot be worn. In this type of device sound is sent directly to the cochlea via bone vibration, thereby bypassing the part of the ear that is diseased. Bone conduction hearing aids traditionally have used a similar type of vibrator known from bone conduction audiometry and attached to the skull with a metal or elastic band.

Some manufacturers are also making use of the bone conduction principle in innovative ways, such as encasing the vibrator in a dental appliance and wearing it in the mouth or encasing it in an earmold and wearing it in an ear canal. In these cases, the microphone and sound processor might be worn on a deaf ear, thus serving the same function as a CROS hearing aid.

Extended Wear

An extended wear hearing aid is one that is placed deep in the ear canal near the tympanic member by an audiologist or otolaryngologist and can be worn for several months. These hearing aids were introduced to the market in 2008. The primary advantages of this type of hearing aid are cosmetic and convenience. The technology inside the device is analog rather than digital, but it is digitally programmed for a patient's hearing loss. The only nonsurgical extended wear hearing aid on the market today, the Lyric, is disposable. Once the battery wears out the aid is thrown away and a new hearing aid must be inserted in the ear canal.

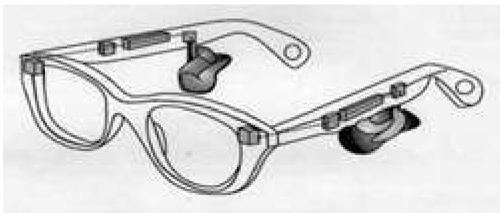


Body-worn hearing aid

Candidates for extended wear hearing aids must have ear canals that can accommodate the device which limits the candidacy as some individual's ear canal size is not suited for this device. Extended wear hearing aids can cost signiûcantly more than other types.

Body Worn Body-worn hearing aids are the largest hearing aids. These aids are composed of a hearing aid worn on the body (usually around the neck) which is connected with cables and earmolds to the ears. Body aids can provide a wide range of gain and output. Body-worn hearing aids were the only hearing aid style available until the 1950s when BTE hearing aids were introduced.

Eyeglass



Eyeglass hearing aids are a combination of eyeglasses and hearing aids. The hearing aids can be located in the frame of the glasses or can be coupled to the frame using an adapter. Tubing then extends from the frames to couple the aids to the earmolds and ear. These types of hearing aids are not very commonly seen today.

ELECTRO ACOUSTICS CHARACTERISTICS

INTRODUCTION

The performance characteristics of a hearing aid, that is the changes affected in a signal as it is transduced from acoustic to electric to acoustic energy are known as the electro acoustic characteristics.

Purpose of EAC:-

- ✓ Studying the performance of the hearing aid and to check if a hearing aid confirms to standard specifications
- ✓ Serves as a quality control
- ✓ Helps in comparing and classifying hearing aids
- ✓ Assists in hearing aid selection
- ✓ To study the effects of electronic and/or acoustic modifications of hearing aid
- ✓ Monitors the hearing aid performance at the time of purchase and during use

- ✓ In order to work effectively with hearing aids, it is necessary to understand how they work and how their performance is measured.
- ✓ The accurate electro acoustic characterization of hearing aid is important for the design, assessment and fitting of the hearing aid.

HOW TO MEASURE-

- ✓ The performance of hearing aid is most conveniently measured when the hearing aid is connected to a coupler.
- ✓ A coupler is a small cavity that connects the hearing aid sound outlet to a measurement microphone.

COUPLER-

- ✓ The basis for this measurement is the ISI standard with HA-2 coupler.
- ✓ An acoustic coupler is a simple cavity of specified shape and volume which is used for the calibration of an earphone.
- ✓ It contains a calibrated microphone to measure the sound pressure developed within the cavity & hence to a SLM, without sound leaking out to other place.
- ✓ A coupler gives only a rough approximation to the acoustic properties of the human ear but has the advantage of simple design and construction.
- ✓ The standard coupler used for the hearing aids has been around for over 50 years and has a volume of 2 cubic cm. This volume was chosen because it was an approximation of the average adult ear canal volume. when a hearing aid is worn.
- ✓ The SPL generated in any cavity by a hearing aid depends directly on the impedance of the cavity. This in turn depends on the volume of the cavity, and on the nature of anything connected to the cavity.
- ✓ In the average adult ear, the residual ear canal has a physical volume of about 0.5cc. This volume acts as an acoustic spring. Or more formally, an acoustic compliance.
- ✓ The ear canal, of course, terminates in the eardrum, on the other side of which is the middle ear cavity. The compliance of the middle ear cavity and eardrum together act as if they have a volume of about 0.8cc

- ✓ The combined 1.3cc volume determines the impedance for low frequency sounds. As frequency rises, the mass of the eardrum and ossicles cause their impedance to rise, while the impedance of the residual ear canal volume falls.
- ✓ An ear simulator mimics this variation of impedance with frequency. As well as the main cavity, with a volume of 0.6cc, the simulator shown has four side cavities, each with volumes from 0.10 to 0.22cc, connected to the main cavity by small tubes, three of which also contain dampers (ANSI s3.25, 1979).
- ✓ As frequency rises, the impedance of these tubes rise and they effective total volume to gradually fall from 1.3cc to 0.6 cc.
- ✓ One ear simulator with four cavities is known as the Knowles DB100 ear simulator. Another ear simulator in common use is the Bruel &Kjaer 4138 ear simulator. It operates on the same principles, except that it has two simulators have a very similar variation of impedance with frequency.
- ✓ But unfortunately, the standard 2-cc coupler is larger than the average adult ear canal with a hearing aid in place, so the hearing aid generates lower SPL in the coupler than in the average ear.
- ✓ This difference is called Real ear to coupler difference.(RECD)
- ✓ So a more complex measurement device, which better stimulates the acoustic of the human ear, is called an ear simulator.
- ✓ An ear simulator or artificial ear is a far more sophisticated device for the calibration of an ear phone. Like the acoustic coupler, it contains a calibrated microphone for the measurement of the sound pressure developed within a cavity.
- ✓ Several standards published by the ANSI & International electro acoustical commission (IEC) specify how hearing aids should be tested.
- ✓ ANSI S3.22 specifies that hearing aids be measured in a 2-cc coupler; whereas IEC 118-0 specifies that hearing aids be measured in an ear simulator.
- ✓ The ITE and ITC hearing aids usually connected directly to a coupler or ear simulator. BTE and body aids, however, connect to the real ear via an ear mould, so an ear mould simulator is added between the coupler or the ear simulator and the hearing aid. In addition BTE hearing aids use tubing when connecting to the real ear, so they also require tubing when connecting to the coupler or simulator.

- ✓ ANSI S3.3 describes a 2-cc coupler as being used in several different applications, the most important of which are…..
- ✓ HA-1 coupler has no ear mould simulator and is used for ITE & ITC aids, which are connected to the coupler via putty.
- ✓ The HA-2 coupler includes an ear mould simulator, which is connected to the BTE hearing aid via tubing, or into which a receiver for a body aid snaps.
- ✓ HA-3 coupler – The HA-3 coupler is a special form of the HA1 coupler, using a rigid or flexible sealing construction. It is intended for the testing the module portion of the modular ITE hg aid and /insert type receiver that does not have a nub. The tube diameter is 1.93mm and the length is 10mm. The length starts at the end of the receiver tubing protruding from the module or receiver.
- ✓ HA-4 coupler- The HA-4 coupler is a variation of the HA-2 coupler and is intended for testing BTE or Eye Glass Hg.Aids its simulates a fitting in which the bore through the ear mould from the end of the ear hook of the BTE aid or from the end of the sound outlet on the eyeglass aid is assumed to have a uniform diameter of 1.93mm and a length of 43mm.

Instrumentation-

- ✓ The sound box has sound – absorbent walls in order to maintain free field conditions.
- ✓ An audio frequency sine wave generator drives a loudspeaker, which is located in the sound box.
- ✓ Any non linearity in the loudspeaker frequency response in the sound box causes errors in the measurement of frequency response of the hearing aid. Therefore the frequency response of the loudspeaker must be flat between 100 Hz and 10 KHz.
- ✓ As no loudspeaker can offer such an accurate frequency response, the non linearity in the loudspeakers frequency response is compensated electronically.
- ✓ The text box provides a convenient way to get sound into the hearing aid in a controlled manner. These sounds can be pure tones that sweep in frequency, or can be complex, broad band sounds are necessary to perform meaningful measurements or many non linear hearing aids.

- ✓ The text box generates sounds of required SPL at the hearing aid microphone.
- ✓ A test box includes a tone and or noise generator, an amplifier, a loud speaker and a control microphone.
- ✓ The control microphone or reference microphone is placed next to the hearing aid microphone.
- ✓ As we know the frequency response of the loudspeaker should be flat between 100 Hz and 10 KHz, so no loudspeaker can offer such an accurate frequency response, the non linearity in the loudspeakers frequency response is compensated electronically. This can be accomplished in two ways.

1) The first method is called comparison method.
2) There is a 2nd method is called as substitution method.

Comparison method-

- ✓ A control microphone (a second microphone) is installed in the sound box symmetrically opposite the test point.
- ✓ The control microphone measures the sound pressure. Whenever the sound pressure deviates from the references value, the electrical input to the loudspeaker amplifier is rapidly adjusted so that the sound pressure at the control microphone again matches the reference value automatically turn the volume of the sound coming from the test box speaker down or up, respectively, until the required level is obtained.

Substitution method-

- ✓ Only one microphone is required for substitution method.
- ✓ It differs from the comparison method in that the electrical input to the loudspeaker amplifier needed to achieve the desired sound pressure is determined in advance.
- ✓ The control microphone is placed in the test position prior to the actual measurement.
- ✓ Prior to measuring any hearing instruments, the loudspeaker frequency response is determined with the measuring microphone at the test point. This curve is stored and the microphone is removed.

- ✓ During subsequent measurements of hearing instruments, the electrical input to the loudspeaker amplifier is manipulated so as to “flatten out” the stored curve
- ✓ If the stored curve has 5 dB notches at 10 KHz, then the electrical input to the loudspeaker amplifier is increased as to give a 5 dB more intense signal at this frequency
- ✓ In this way, a linear frequency response is achieved

COMMON ELECTROACOUSTIC CHARACTERISTICS-

GAIN –

- ✓ The amount, in decibels, by which the sound pressure level developed by the hearing aid in the coupler exceeds the sound pressure level in the sound field at the hearing aid microphone is the gain.
- ✓ Simply, gain equals output minus input.

FREQUENCY RESPONSE –

The frequency range of a hearing aid refers to the useful range of the frequency response.It is expressed by two numbers.

- ✓ Low frequency limit of the amplification.
- ✓ High frequency limit of amplification.

The relation between frequency and gain constitutes one area of interest in specifying electro acoustic behavior of hearing aid.

SATURATION SOUND PRESSURE LEVEL –

The saturation sound pressure level (SSPL) value represents the maximum root mean square (rms) sound pressure level obtainable in the coupler as generated by the receiver of the hearing aid.

HARMONIC DISTORTION –

Usually the result of overloading either the hearing aid amplifier or receiver. It is best indicated when the instantaneous sound pressure of the hearing aid receiver is not directly proportional to the instantaneous sound pressure at the microphone. The distortion results mainly from peak clipping. When clipping occurs, the maxima and minima of the signal are clipped, and hence changing the wave form of the signal.

Measurement of OSPL frequency response:-

The purpose of this test is to determine the sound pressure level obtained in the HA-2 coupler while giving an input 90 dB SPL and the hearing aid gain control in the full on position as a function of frequency.

It is important to know at what level a hearing aid limits its output when it receives a high level input signal. The maximum possible level should not exceed the threshold of discomfort for a user.

Test procedure:-

- ✓ Turn the gain control 'full on' and set other controls to the required positions.
- ✓ Adjust the input sound pressure level to 90 dB SPL at 200 Hz by setting by sine wave generator and input SLM octave filter at 200 Hz.
- ✓ Vary the frequency of the sound source over the recommended frequency range from 200 Hz to 5000 Hz keeping the input sound pressure level constant at 90 dB SPL. Record the respective sound pressure level at all these frequencies from the output SLM by changing the frequency of the sine wave generator and octave filter is set at the input and output SLMs to their respective settings.
- ✓ Both IEC and ANSI standards specify that hearing aid maximum output should be measured using a 90dB SPL input signal, and both standards now use the term OSPL90 to describe the measurement. This level is high enough to cause many hearing aids to reach their highest possible output level at each frequency.
- ✓ Note down the peak SSPL 90 and the corresponding frequency
- ✓ Find HFA SSPL 90 by taking the average of SSPL 90 at frequencies of 1000 Hz, 1600 Hz and 2500 Hz.
- ✓ Plot the SSPL 90 as a function of frequency.
- ✓ The resultant value is referred to as the high frequency average SSPL90 (HFA-SSPL90).
- ✓ This particular term was chosen to delineate between the existing value and the value calculated in accordance with the earlier standards.
- ✓ The tolerance applied to the HFASSPL90 is such that the value shall be within ±4 dB of the manufacturer's specified value for that model of hearing aid.

Measuring on full on acoustic gain frequency response:-

Acoustic gain is defined as the output SPL in an earphone coupler and the input SPL. It is a measure of how much the input signal is amplified. Acoustic gain is a function of frequency and the user gain control setting as well as other factors. When the gain control is set to its maximum position, i.e. full on, and the input SPL is adjusted to a suitable value that will not overload the hearing aid, the full-on gain may be measured and recorded as a function of frequency.

The purpose of this test is to determine the full on acoustic gain obtainable with the hearing instrument. The output sound pressure level in the HA^2 coupler is measured at full on gain control setting with an input below the hearing instrument's saturation sound pressure level (Normally 60 dBSPL)

Test procedure:-

- ✓ Turn the gain control full of the hearing aid on and set other controls to the required positions
- ✓ At a 200 Hz frequency, set the input sound pressure level to 60 dBSPL, where the relationship between the level of the input and out is essentially linear such conditions are considered to exist it at all frequencies within the range of 200 Hz to 5000 Hz, change of the input sound pressure level of 10 dB causes a change of recorded output level of 10 $\pm$1 dB, the input sound pressure level must be reported
- ✓ The frequency response with full on gain is measured by a varying the frequency of the sine wave generator over the recommended frequency. Range of 200 Hz to 8000 Hz keeping the input sound pressure level constant at 60 dB.
- ✓ The full on acoustic gain is plotted as a function of frequency
- ✓ The minimum gain is noted and also the HFA full on gain is calculated by taking the average of gain obtained at the frequencies of 1 KHz, 1.6 KHz and 2.5 KHz.

Measurement of basic frequency response :-

The purpose of this test is to measure the frequency response of a hearing aid without acoustic (feedback) or mechanical (vibration problems) If one compares the shape of the full on acoustic gain frequency response the basic frequency response, then acoustic or mechanical problems can be identified. The more similar the shapes of the curves are, the more stable is the hearing aid.

Test procedure:-

- ✓ Adjust the gain control to the reference test gain position i.e. with an input sound pressure level of 60 dBSPL. The gain should be adjusted so that the output sound pressure level at 1.6 KHz is about 15 $\pm$ 1 dB lower than the OSPL 90 value at 1.6 KHz
- ✓ The other controls should be set to positions that give the broadest frequency range.
- ✓ Vary the frequency of the sound source over the recommended frequency range of 200 Hz to 8000 Hz keeping the input sound pressure level at 60 dBSPL.
- ✓ Plot the output sound pressure level as a function of frequency.
- ✓ Find out the HF average and note down value.
- ✓ Draw a horizontal line 20 d B below this value. Draw vertical lines at the points at which this line touches the curve. These points on the frequency axis give f_1 and f_2.

FREQUENCY RANGE :-

To provide a general idea of the range of frequencies over which a hearing aid might be considered effective, a standardized method of determination has been adopted. The method is based on the frequency response curve. A horizontal line is drawn at a specific location. The frequency range is defined by the intersections (f1 & f2) of the response curve and the horizontal line. The location of the horizontal line is 20 dB downward from the average value of points R1, R2 and R3 at 1000, 1600 and 2500 Hz, respectively.

Non linear distortions:-

The purpose at this test is to determine the degree of the amplitude nonlinearity in the sound output under specified conditions.

The ability of a hearing aid to deliver a clean signal at the required output level is indicated by measuring its nonlinear distortion characteristics.

The total harmonic distortion is a measure of nonlinearity.

The amplitude nonlinearity can be described in terms of

a) **Harmonic distortion :-** When the input is a sine wave, the distortion products occur at frequencies that are harmonics (i.e integer multiples) of the input frequency. Consequently the process is called harmonic distortion.

b) **Inter modulation distortion: -** When a more complex signal is peak clipped, the distortion products occur at frequencies that are harmonics of all the frequencies in the input signal, and at frequencies that are combination of all the harmonics. If two tones, with frequencies f1 &f2 are input, for e.g. distortion component will occur at 2f1, 3f1, 4f1, 2f2, 3f2, 4f2, f2-f1, 2f2-f1, 2f1-f2, 3f1-f2, to name but a few frequencies. Although the mechanism causing the distortion is exactly the same as for harmonic distortion (peak clipping is the most common cause), the result is called **intermodulation distortion.**

Total Harmonic distortion: - (The power of all the distortion products is summed and expressed relative to the power of the wanted output signal component; This ratio is reffered to as total harmonic distortion.)

The gain control is adjusted to the reference test position and the input sound pressure level increased to 70 dBSPL. The total harmonic distortion is measured an input level of 70dB at 500, 800 and 65dB at 1600 Hz. In the event the specified frequency response curves rises 12 dB or more between any distortions test frequency and its second harmonic, distortion tests at that frequency may be omitted.

Percentage of total harmonic distortion (%THD) may be determined using either of the following methods.

Method 1:- The amount of total harmonic distortion is measured in the output coupler by filtering out the fundamental and measuring the RMS sum of the harmonics that remain.

Method 2:- An alternative, and perhaps preferred method the fundamental and each harmonic sound pressure individually. This method has the advantage of reducing the effects of ambient noise.

The methods gives virtually identical results up to 20 % THD.

Percentage of THD values in typically hearing aids are usually in the range of 3 to 10 %. For THD value higher than 20 % , method 2 should be used.

Total harmonic distortion at 500 Hz <2%

Total harmonic distortion at 800 Hz <2%

Total harmonic distortion at 1600 Hz < 1%

EQUIVALENT INPUT NOISE LEVEL: - The quantity is not too important because the internal noise levels of normally operating modern hearing aid electronics are low compared to ambient noise levels typically encountered. The test space must be extremely quiet to avoid false readings due to ambient noise when making the test for this quantity.

Measurement of Battery current:-

The purpose of this test is to determine the current consumption of the H/A in operation.

Test procedure:- With the gain control in the reference test gain position, measure the battery current at the reference test frequency with an input sound pressure level of 60 dB SPL and at the reference test frequency.

- A 1000-Hz tone is introduced in to the free field at an intensity of 65dB SPLand battery current drain is measured.
- When other than a standard hearing aid battery is used as a power source, the internal impedance of the power source is to be stated. The tolerance for battery current drain is such that it shall not exceed the value specified by the manufacturer for that model of hearing aid.

Coupler SPL with Induction coil :-The sensitivity of a telecoil is measured with the aid set to the 'T' mode and oriented to produce the greatest coupler SPL. The aid is placed in a strong magnetic field created with a" Telecoil Magnetic field simulator" and the gain control set to the reference test position. A frequency response (sound pressure level for an inductive telephone simulator or SPLITS) curve can be made between 200 and 5000 Hz. A high frequency average of the SPLITS curve (HFA-SPLITS) or a special purpose average (SPA-SPLITS) can be calculated as described for acoustic gain. Also available are simulated telephone sensitivity (STS) HFA-SPLITS (HFA-SPLITS-Reference test gain + 60 dB0, which is a figure of merit for how much the volume control will have to be rotated when switching from microphone position to telephone position, or STS SPA-SPLITS (SPA-SPLITS-reference test gain + 60dB)

I/O CHARACTERISTICS – AGC Aids :- It is important to know how output SPL varies with as a function of input SPL from 50 to 90 dB in 5 dB steps, measured at one of the following frequencies; 250, 500, 1000, 2000, or 4000 Hz. The curves are drawn on a grid with output SPL as the ordinate and input SPL as the abscissa.

DYNAMIC AGC CHARACTERISTICS: - The AGC function takes time. The "Dynamic AGC characteristics" is a method to determine the attack and release times for the AGC function. With the aids gain control set to the reference-test position, a 2000Hz input tone is abruptly alternated between 55 and 90 dB SPL.

The attack time is defined as the time between the abrupt increase and the point where the output level has stabilized to ±3 dB of the steady-state value for the 90 dB input.

The release time is defined as the time between the abrupt drop and the point where the hearing aid output stabilized to ±4dB of the steady state 55-dB input SPL. Times are stated in milliseconds.

ELECTRO ACOUSTIC MEASUREMENTS OF DIGITAL HEARING AIDS

Introduction

Digital hearing aids are still hearing aids. While they may have many benefits, they are not perfect. At least three possible sources of error exist when fitting hearing instruments and testing can ensure that these errors are minimized. Some digital instruments are noise reduction programs that can make them more difficult to test. Methods are outlined to enable with pure tone and composite signals.

All hearing instruments have some elements in common. All include an input microphone; an output receiver and a battery with its connectors and some way to control the electronic circuit. In an analog hearing instrument, this hardware is all there. In a digital hearing instrument, the additional element of software is added, and this determines how the hearing instrument operates. With most digital hearing instruments, a programmer is also needed to adjust the operational parameters. It may take the form of a small box with a cable and connects to the hearing aid, or it may be a personal computer operating under control of a programming module.

When preparing a digital hearing instrument for the customer, it is usually programmed. In this process, the programming device often displays the predicted response of the hearing instrument as a graph or family of curves. It should be remembered that this display is a prediction, not an actual measurement. The programmer may make a display that, because of a software bug or other hearing instrument defect, does not show the real operating state of the hearing instrument. The instrument may have a frequency response that does not agree with that displayed on the screen. Its AGC action may be disabled, or its knee-points may be set to unknown levels.

It is up to the hearing care professional to determine if the hearing instruments is really doing what it is supposed to do. The professional must be willing to test a digital hearing instrument to be sure that it is operating correctly, and should verify that the hardware, software and programming are all working correctly determine that something has gone wrong and things are not behaving as was expected.

Tests:

The following are the test descriptions:

- ✓ **50 / 60 / 90 dB response: -** Device is stimulated with 84 discrete sinusoids at 50, 60, 90dB. For the 50dB sweep, output response at microphone is measured and compared with average value of 100 typical devices. Each point on the curve is compared to the corresponding, previous and next point on the ideal template. If any point passes this comparison, the point passes. The template is moved up or down to center the response between the upper and lower template boundaries. The tolerance is 4dB from 400Hz to 1900Hz. The tolerance is 6dB from 2000 Hz to 4000Hz. Points outside of the 400 to 4000 ranges are not considered. If all points pass. If any points fail, the 50 dB response test fails. The 90db sweep generates several parameters. The 60dB sweep has no pass/fails parameters.
- ✓ Total Harmonic Distortion: - Total harmonic distortion is measured at 500, 800, and 1600 Hz at 70dB. Device is stimulated at a given frequency and amplitude. Device response at sideband frequencies is measured.
- ✓ [Max THD at 1-2 KHz, 85dB. Aid is swept at 85db. The maximum distortion from 1 to 2KHz is measured.
- ✓ Battery current:- The current consumed by the device is measured while being stimulated by a specified frequency and amplitude sine. Two standards are used: (a) ANSI and (b) JIS / IEC (2.1 mA).
- ✓ Attack and Release time: - At a specified frequency and amplitude, the time between the stimulating signal and the response is measure. There are of two types:
  - o Enhanced attack and release time
  - o Adaptive attack and release time.

#Enhanced attack and release time

The procedure displays numerical and graphical results of attack and release tests using ary of 18 different pure-tone frequencies, or the speech weighted composite signal. These tests are important for testing the performance of frequency specific signal processing circuits.

A choice of test frequencies lets you exercise the attack and release phases of the hearing aid in the specific frequency region for which a particular signal processing circuit was designed to work. Example: 'ASP-type' circuits are usually designed to reduce low frequency background noise. So you would use a low frequency to test the circuit.

The speech weighted composite signal lets you see how the circuit reacts to the broadband speech like signal.

The numerical display gives you the attack and release time for the chosen test signal. Attack time is particularly critical for low frequency active circuits such as 'ASP' since a fast attack time will reach to speech, whereas a slow attack time will react only to ongoing noise.

The graphical display of 'output versus time' lets you see how the device performs over the attack and release phases. Erratic performance during these critical phases could results in effects that are audible to a hearing impaired listener. These effects could be annoying or even could obscure parts of a conversation.

 # Adaptive attack and release time

The adaptive attack and release time test makes it possible to evaluate the performance of special compression circuits that changes their release time, depending on the length of the input signal. This type of processing is designed to distinguish between ongoing speeches and load, abrupt noises that can often cause normal compression circuits to obscure parts of conversation. (Example: Telex's adaptive compression).

It performs a 2KHz attack test following by a special two signal release test consisting of a short signal 1 sec and a long signal 2 sec. we can select whether the signal level varies between 55 and 75, 80, 90 or 95dB SPL (80 is standard). The results will be displayed numerically and graphically on the screen.

Digital signal processing

New technology in hearing aids had added a great deal of capability such as increased clarity and flexible programming. However, the same technology can also have its pitfalls. This test will tell you the digital processing or group delay and the signal phase of the hearing aid.

Digital processing delay

Its measurement will help you in determining whether or not a hearing aid is suitable for a monaural fitting.

One of the properties of digital technology is that it always takes time to process digital data. Imagine the aid or a miniature computer; it takes an analog sound wave, turns it into digital information, performs some kind of algorithm to amplify signal and turns it back into an analog sound wave, for the ear to hear. All of this calculating takes precious time; it's never instantaneous.

The processing delay for some hearing aids is so slight that it is imperceptible to the human ear. The processing delay for other aids can extend to several msec-longer than the calculating time of an analog hearing aid.

How delay will cause problems?

When you fit a client monaurally with an aid with a significant digital processing delay, that person might experience some confusion because his unaided ear will be hearing sounds slightly faster than his aided ear; which creates an echo effect. Problems can also be predicted for patients with open canal fittings. It can be eliminated by fitting patient with an occluded binaural set, than both ears will be listing with the delay, and the confusion will be alleviated.

Measurement Procedure

Done by sending a short impulse from the sound chamber speaker to hearing aid. Hearing aid analyzer mic collects information from the hearing aid for 20 msec from the time the impulse is delivered. This information is a series of number of varying amplitudes. Hearing aid analyzer finds the maximum peak amplitude of the resulting information. Since the impulse response of a hearing aid is not always simple, the analyzer also checks for any peak occurring before the max peak. If a smaller peak exists, and it has amplitude of at least 50% of the max peak, the time of the smaller peak will be considered the processing delay point otherwise, the time of the max peak will be considered the processing delay point. The hearing aid analyzer system delay is subtracted from this delay point in order to form the actual processing delay time. The data collected in the digital processing delay measurements is displayed in graphical format as amplitude v/s time. A dotted vertical line is placed at the calculated delay point. The numerical value is also displayed.

Signal phase

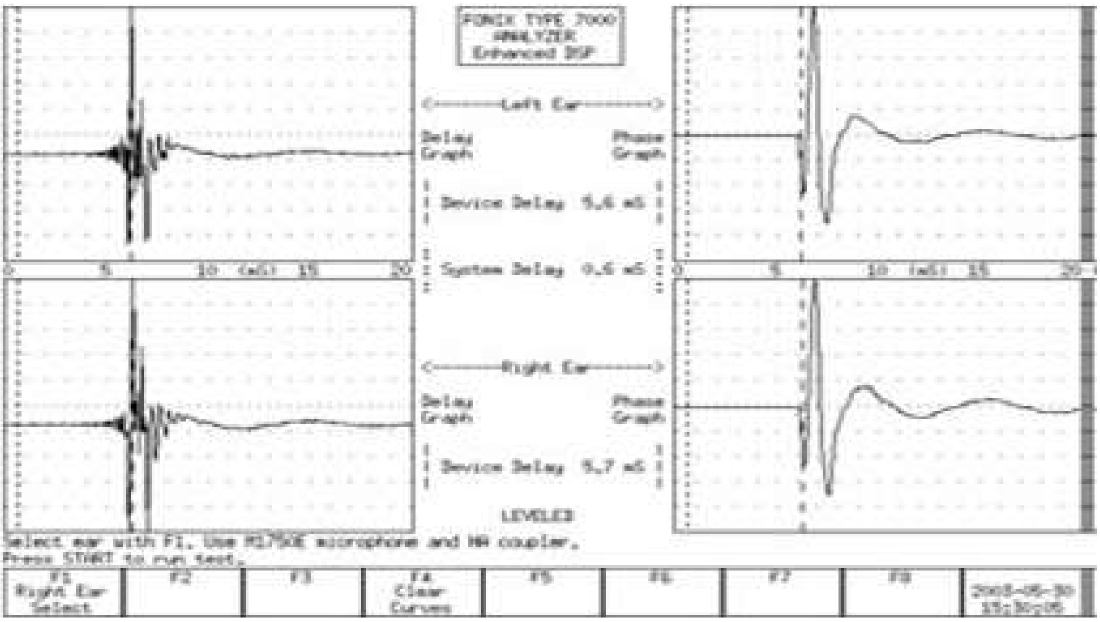
Helps you to determine whether custom binaural hearing aids are working properly together as a team.

This measurement is a test of the 'pushing' and 'pulling' of the amplified sound of the aid. Sound is created by vibrations in the air. These vibrations can be thought of as air pushing pulling against the ear. If sound goes through a hearing aid, the hearing aid might cause a phase shift, turning a 'push' of the sound wave into a 'pull'.

The components of a custom hearing aid are usually wired by hand. The receiver is typically wired into the amplifier in such a way that it may or may not cause a phase shift of the signal. If care is not taken, it is entirely possible to wire one hearing aid of custom binaural set one way, and wire the other aid in the opposite way. This could cause one of the hearing aids to be pulling while the other aid is pushing, resulting in strange sound quality for the hearing and wearer. So it is very important to check the signal phase of the hearing aid while fitting a client with binaural set in order to ensure that the aids are working together as a team.

Measurement procedure

Signal phase measure works by generating a 1 KHz cosine wave, turning it into a test signal, and delivering it to the aid. The cosine wave signal is affect at the time of generation so that it starts at the baseline (0 point). It continuous through a complete cycle and terminates when it reaches the baseline again. This signal, although consisting of only a simple pulse, contains very few frequencies above 1 KHz and is few msec wide at base. The data collected from this measurement is displayed in a graphical formant 20msec wide. The system delays as well as the digital processing delay are noted for reference on the phase graph in the form of vertical lines.



When measuring a set of binaural hearing aids, both the phase and the delay graphs should match fairly closely.

Digital speech signal

- The ANSI 87 and 96 standards were written and published in the days before noise reducing digital hearing aids.

- They have made no provision for testing digital hearing aids.
- However, one can still perform accurate frequency response measurements using the digital speech signal.
- The digital speech signal was developed in order to test noise-reducing digital hearing aids without fear of them going into noise suppression mode.
- It does this by taking the standard composite signal and interrupting it randomly.
- The digital hearing aid responds to this modulated signal as it would respond to normal speech.
- The advantage of digital speech is that the analyzer treats it just as another signal source.
- Then we don't have to test the digital hearing aid any differently than how we test a normal analog hearing aid.

Testing digital noise suppression

- We can use combination of the continuous composite signal and the digital speech signal to see how much the aid lowers the its gain when subjected to a noisy signal.
- This will give an idea of how much advantage the user will be getting in a noisy environment.

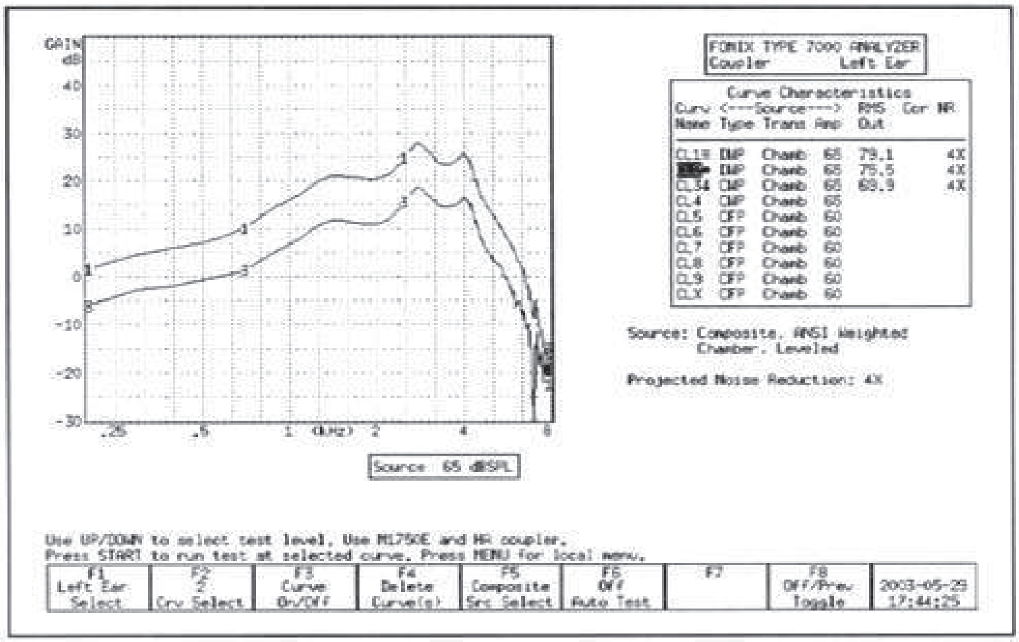


Figure 3.5.4—Digital Noise Suppression test. CRV 1 was measured with Digital Speech. CRV 2 was measured with the Composite signal.

- ✓ We can see the difference between the two curves
- ✓ The composite curve should show lower gain than the digital speech curve.
- ✓ If the two curves fall on top of each other, it's a good indication that the noise suppression feature on the hearing aid either is not working correctly or is not enabled.

Measuring directionality

- ✓ Although directional hearing aids can have different types of polar maps and two or even three microphones, the basic concept is fairly simple: speech sound from in front of the hearing aid wearer is louder than noise from behind him.
- ✓ The hearing aid test system cannot give you a polar plot of the directional hearing aid response, but it can provide you with the basic information of how much directional benefit the hearing aid wearer is receiving and at which frequencies.
- ✓ The directional test takes advantage of the speaker placement in the large sound chamber and the flat testing surface that makes it easy to position the hearing aid for testing.
- ✓ There are two measurements: one where the hearing aid is positioned so that it is facing towards the sound chamber speaker, and one where the hearing aid is positioned so that it is facing away from the sound chamber speaker.
- ✓ You should use the same input signal for both measurements.
- ✓ The source amplitude used for this measurement should be greater than the noise floor of the testing environment but less than the compression knee point of the hearing aid, if possible.
- ✓ 50 dB SPL is usually a good choice.

Speaker Placement

- ✓ The speaker in the sound chamber is positioned on the right side of the chamber at a 45º angle.
- ✓ It is important to keep this in mind when positioning the directional hearing aid for measurements.

Forward measurement

- ✓ The first step in doing a directional test is to position the hearing aid in the sound chamber so that the front of the hearing aid is pointing towards the right side of the chamber.
- ✓ Close the sound chamber lid and perform the following steps:

1. Enter the Coupler Multi curve screen by pressing [F1] from the Opening screen.
2. Use [F5] to set the source type to Digital Speech.
3. Use [(“, ‘“] to set the source amplitude to 50 dB SPL.
4. Press [START].

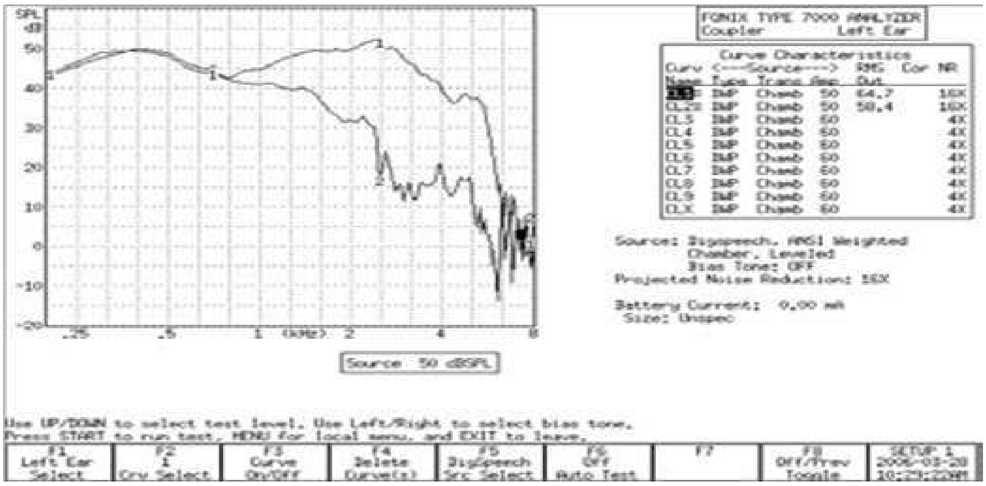
- ✓ After the measurement has stabilized, press [STOP]. The measured curve is the “forward” measurement of the directional test.

Reverse measurement

- ✓ Open the sound chamber and position the hearing aid so that the front of the hearing aid is pointing towards the left side of the chamber.
- ✓ Different hearing aids have different null points so you will want to adjust the positioning so that the sound chamber speaker is pointing towards what should be the null point of the directional aid.
- ✓ Close the sound chamber lid when finished and perform the following steps:

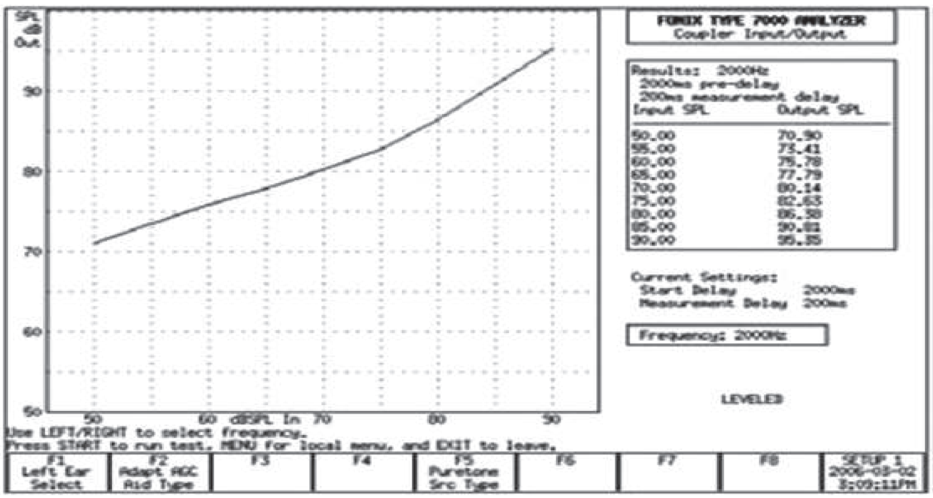
1. Use [F2] to select the next curve.
2. Use [F5] to set the source type to Digital Speech.
3. Use [(“, ‘“] to set the source amplitude to 50 dB SPL.
4. Press [START].

- ✓ When the measurement has stabilized, press [STOP].
- ✓ The measured curve is the “reverse” measurement of the directional test.
- ✓ If the directional microphones of the hearing aid are working properly, this curve should have less output or gain than the forward measurement.
- ✓ The difference in the RMS Out of the two curves will give you the average overall advantage provided by the directional microphones. In this example, the hearing aid has an 8 dB average directional advantage.



Coupler I/O

- ✓ The Coupler I/O Test measures the input/output of the hearing aid from 50 dB SPL to 90 dB SPL in 5 dB steps
- ✓ Test results are shown in both graphical format and numerical format and can be displayed in either Gain or SPL (Output).
- ✓ By default, this test is done with a puretone stimulus at 2000 Hz.
- ✓ The frequency of this stimulus can be changed by using [<, >].
- ✓ You can also toggle the source type between Pure tone and Composite by using [F5].
- ✓ (The frequency selection is only available when the source type is set to Pure tone.)



Hearing aid measurement standards:-

There are several national and international standards that define measurement on hearing aids. These standards describe a series of electro acoustic tests of hearing aids. This chapter essentially deals with the ANSI specification of hearing aids. These standards describe a series of electro acoustic tests of hearing aids. This chapter essentially deals with the ANSI specification of hearing aid characteristics ANSI S3.22-1996; the Indian standard institute specification of hearing aid standards and the international electro technical commission (IEC) standards. (IEC) 118-1994. People who work with hearing aids can use these standards to compare the performance characteristics of individual instruments to the nominal performance characteristics specified by the manufacturers.

SSUMMARY OF SPECIFICATIONS AND TOLERANCES

ASA STD 7-1976

(ANSI S3.22-1976)

SPECIFICATIONS	TOLERANCE
1) SSPL 90 CURVE	Maximum value of SSPL 90 shall not exceed specified value.
2) HF-AV. SSPL 90	Must be within ±4 dB of specified value.
3) Full- on gain curve	**No tolerances.**
4) HF-AV, Full on gain	Must be within ±5 dB of specified value.
5) Frequency response curve (text 1)	See text 2
6) Harmonic distortion (text 1)	Must not exceed specified values at 500, 800, 1600 Hz
7) Equivalent input noise level (text 1)	Must not exceed specified maximum value.
8) Battery current (text 1)	Must not exceed specified maximum value.
9) Induction coil 1000Hz sensitivity.	Must be within ±6dB of specified value.
10) AGC Input-output characteristic	Match measured and specified curves at 70 dB input.Measured value @50 and 90 dB must be within ±4dB of specified values.
11)AGC attack and release times	Must be within ±5ms. Or ±50 % (Whichever is large of specified values)

TEXT 1:-reference test gain control position is used in items 5, 6, 7 and 8. Gain control must be set 17 dB (±1 dB) below HF –average SSPL 90 for each individual instrument.

TEXT 2:- FREQUENCY RESPONSE CURVE.

a) From the manufactures specified frequency response curve determine the average of the 1000, 1600, and 2500 Hz response levels.

b) Subtract 20 dB.

c) Draw a line parallel to the abscissa at the reduced level.

d) Note the lowest frequency, f1, at which the response curve intersects the straight line.

e) Note the highest frequency, f2, at which the frequency response curve intersects the straight line.

FREQUENCY RANGE: - For information purpose, but not for tolerance purpose, the frequency range of the hearing aid shall be considered as being between f1 &f2.

FREQUENCY RESPONSE TOLERANCE: - The tolerances in two bands shall be as follows.

	Freq. limit	Tolerance
Low Band	(1.25f1 to 2000Hz)	(±4 dB)
High Band	2000 to 4000Hz or 0.8f2 Whichever is lower.	(±6dB)

Basic setting of controls on the hearing aid

All trimmers have to be set to give the widest possible frequency response range, the maximum gain and the maximum output. If it is not possible to achieve both the maximum output and the maximum gain set the hearing aid for the maximum output. An exception is an AGC instrument having compression controls. Set the controls as indicated by the manufacturer.

Leveling the test equipment:-

Leveling must account for all items present in the test chamber at the time of testing. The complete hearing/coupler/microphone apparatus (or equivalent) must be in place during leveling with a single microphone system, 'the equivalent substitution method is used and leveling must be redone when even a change is made that could affect the acoustics of the measuring system.

Standard parameters

- Output sound pressure level (OSPL-90) with the gain control of the hearing instrument full and an input sound pressure of 90 dBSPL, the output sound pressure is determined. Frequency of the source is varied from 100 to 10000 Hz.

The maximum OSPL 90 reading has to be no more than 3 dB higher than the manufacturer's specification.

- HF average OSPL 90:-

The maximum output sound pressure level with full on gain at 3 frequencies 100 Hz, 1600 Hz and 2500 Hz are added and the sum is divided by 3. The sound pressure so obtained is called the HFA OSPL 90. the reading can be derived from the OSPL 90 curve. The HFA OSPL90 has to be within $\pm$ 4 dB of the manufacturer's specification

- Full on gain:-

With the gain control of the hearing instrument set at full on and an input sound pressure of 60 dBSPL, full on gain is recorded as a function of frequency if a 60 dB input SPL would overload the hearing instrument, then 50 dBSPL is used.

- HFA full on gain:-

The average of the full on gain at the frequencies 1000, 1600 and 2500 Hz. These three frequencies are chosen by ANSI becoz most hearing aids produce usable output at those frequencies. An HFA reading gives a single number that represents the over all performance, of an instrument for the test condition in question. The HFA full on gain has to be within $\pm$ 5dB of the manufacturer's specification.

- Reference test position:-

With an input sound pressure of 60 dBSPL, the amplification control is adjusted so that the output sound pressure level is 17 dB lower than the HF average OSPL 90. A tolerance of $\pm$ 1 dB is allowed for setting gain control to the reference test position.

- Frequency response curve:-

A frequency response curve is obtained with the gain control in the reference test position and the average SPL of the frequencies 1000, 1600 and 2500 Hz is determined. A horizontal line is drawn on the graph 20 dB below this average value. The point at which the line intersects the frequency response curve indicates the ASA frequent range. The lower band position of the frequency response curve (< 2 KHz) must fall within $\pm$ 4 dB of the specified curve. The high band portion of the frequency response (>2 KHz) must fall within $\pm$ 6dB of the specified curve.

- Introduction coil sensitivity:-

The hearing instrument is set to the 'T' (telephone input) mode and placed in a sinusoidal alternating magnetic field having an rms magnetic field strength of 10 mA/m at 1000 Hz. The gain control is set to full on and the hearing instrument is oriented to produce the greatest coupler sound pressure level.

- Battery current drain:-

The battery current is determined with the hearing instrument adjusted to the reference test position. The battery current is measured a this position with an input sound pressure level of 65 dB SPL of 1000 Hz. The hearing aid manufacturer is required to state the battery type used for all the published S3.22 tests of an instrument. The battery current drain may not be more than 20% higher than the highest value specified by the manufacturer.

- Equivalent input noise level (EIN)

The equivalent noise level Ln is measured in very quiet ambient conditions with the gain control in the reference test position. It is calculated as follows.

Lav = Average dBSPL output at frequencies 1000, 1600 and 2500 Hz

L2 = Noise level of the unit in the reference test position

Ln = L_2 (Lav -60) dBSPL

The EIN level has to be less than or equal to the highest value specified by the manufacturer plus 3 dB.

A

Some highlights

- ✓ When you set up an AGC aid for an ANSI test sequence, you will start with its compression controls set to minimum (with the compression knee point set as high as possible) Just before the input/output and attach and release measurements, the test sequence will pause to allow you to set the compression controls of the aid to maximum (with the compression knee point see as low as possible.)
- ✓ When you adjust the gain control of the H/A midway through the automated test sequence, the measured reference test gain value will now only have to be within 1.5 dB of the target value instead of within 1 dB.
- ✓ The EIN formula uses a 50 dBSPL input instead of a 60 dBSPL input. With ANSI 96, any aid with a compression knee point below 60 dBSPL showed artificially high EIN results. This means that ANSI 2003 EIN test results should be better (lower) for AGC aids.

Indian Standards Institutions (ISI) standards

The Indian standard was adopted by the Indian standard institution in February 1984. This standard is designed to be a basic document specifying a wide range of measurement standard from which those applicable to particular needs can be selected. The standards include numerous hearing aid performance parameters that are felt to be significant in predicting the suitability of a H/A for various applications.

Classification of hearing aids

The performance of H/S shall be classified on the basis of the following parameters

a) The maximum saturation sound pressure level

b) The average OSPL 90

c) Full on acoustic gain and

d) HF average full on gain

H/A are classified into the following 3 classes mild, moderate and strong class H/A

General requirements

This standard is based on the free field technique in which the H/A is placed in a plane progressive wave, with the earphone coupled to a standardized coupler, and the sound pressure generated by the H/A in the cavity of the coupler being measured by a condenser microphone. The measurement specified are based on the substitution method in which the reference point of the H/A is made to coincide with the test point chosen on the axis of the sound source.

Test equipment and environment

Sound source substitution method:

± 1 dB over the range 200 to 5000 Hz ± 1.5 dB over the range 5000 to 8000 Hz

Comparison method:

± 1.5 dB over the range 200 to 3000 Hz

± 2 dB over the range 3000 to 8000 Hz

Frequency accuracy

Accurate within ± 2% of the indicated value. Total harmonic distortion of the sound source not to exceed 1% 70 to an input SPL of 70 dB 2% of an input SPL greater than 70 dB and up to 90 dB

Total harmonic distortion in measuring equipment less than 1% for SPL up to 130 dB in the range 200 to 5000 Hz less than 3% for SPL above 130 dB and up to 145 dB

Coupler microphone

Flat within ± 1dB over the range 200 to 3000 Hz, within ± 2 dB in the range 3000 Hz to 8000 Hz relative to the pressure sensitivity level at 1000 Hz

Battery or supply voltage:- accurate with ± 2% reference test frequency: 1600 Hz frequency range: at least 200 to 8000 Hz temperature: 15 to 35 ^{0} C

Relative humidity: Less than 80% Air pressure 86 to 106 Kpa reference sound pressure 20 u pa. Test environment free field conditions where in the sound pressure variations do not exceed ± 1 dB .

Controls on the hearing aid

The tone control setting that gives the widest frequency range, shall be selected in preference to setting in which the low and high frequencies are attenuated. All other control settings should be chosen to give the highest OSPL 90 and the highest acoustic gain.

Standard parameters:-

- Sound pressure level curve for an input SPL of 90 dB (OSPL 90) with the gain control of the hearing instrument on and an input sound pressure of 90 dBSPL, the output sound pressure is determined. The recommended frequency range over which the frequency of the source is varied from 200 to 8000 Hz.
- HF average full on gain:- The average of the full on gain at the frequencies 1000, 1600 and 2500 Hz.
- Full on acoustic gain frequency response: The output SPL in the coupler is measured at fuli on gain control setting with an input SPL of 60 dB. If this does not produce essentially linear input output conditions it can be set to 50 dBSPL. Linear input output conditions are considered to exist at all frequencies within the range 200 to 8000 Hz a change of the input SPL of 10 dB causes a change at the output level of 10 $\pm$ 1 dB
- Comprehensive frequency response and basic frequency response:- With the gain control at the reference test gain position, the frequency of the sound source in the range of 200 to 8000 Hz keeping the SPL constant at 50, 60, 70, 80 dB and 90 dB the frequency response shall be obtained. The basic frequency response is the curve obtained an input level of 60 dB
- Frequency range:- A frequency response curve is obtained with the gain control in the reference test position and the average SPL of the frequencies 1000, 1600 and 2500 Hz is determined. A horizontal line is drawn on the graph 20 dB below this average value. The point at which the line intersects the frequency response curve indicates the frequency range.
- Effects of tone control position on the basic frequency response:- The tone control setting that gives the widest frequency range, shall be selected in preference to setting in which the low or high frequencies are attenuated. The frequency of the sound source is varied over the range 200 to 8000 Hz, keeping the input SPL constant at 60 dB.
- Effect of gain control position on frequency response:- The gain control from a full on position is varied downward in approximately 10 dB steps at the reference frequency. At each setting the gain control shall be varied over the frequency range from 200 to 8000 Hz keeping the input SPL constant.

- Effect on the full on acoustic gain of variation of battery or supply voltage. With the gain control full on. The Input SPL is set to a sufficiently low value at the reference frequency and the gain is determined. This shall be repeated for two values of the supply voltage (i.e. at 1.5 volts and 1.0 volts) within the specified voltage range for normal operation of the battery.
- Effect on OSPL 90 of variation of battery or supply voltage:- with the gain control full on, the input SPL is set to 90 dB at the reference frequency and the OSPL 90 is determined. This shall be repeated for various values at the supply voltage within the specified voltage range for normal operation of the battery.
- Battery current:- With the gain control in the reference test gain position measure the battery current at the reference test frequency and at an input SPL of 60 dB. The direct current measuring system shall have the following characteristics.

a) An accuracy of $\pm$ 5% at the value of the current measures

b) A direct current resistance not exceeding 50/1, when I is the current being measured in mill amperes and

c) An alternating current impedance not exceeding 1 ohm over the frequency range 200 to 8000 Hz

- Harmonic distortion:- The gain control is an adjusted to the reference test position and the input sound pressure level to set to 70 dB SPL, the frequency of the sound source is varied over the frequency range 200 Hz to 8000 Hz and analysis of output signal to be done for levels at the harmonic frequencies. In the event the specified frequency response curves rises 12 dB or more between any distortion test frequency response curves rises 12 db or more between any distortion test frequency and its 2^{nd} harmonic, distortion tests at the frequency may be obtained and its 2^{nd} harmonic distortion tests at the frequency, may be omitted. The total harmonic distortion is given by the formula.

And harmonic distortion of the n^{th} order by the formula

Where P1 is the sound pressure of the fundamental frequency of the signal in the coupler and P_2, P_3, P_4 —— P_n are the sound pressure of the harmonic components of the second, third fourth —— nth order. In ISI specification the harmonic distortion measures at 1.5 volts and 1.0 volts.

Intermediation distortion:-

With the gain control of the H/A in the reference test gain position, set the frequencies f1 and f2 (within 350 to 5000 Hz) such as f2-f1=250 Hz having amplitude within 1.5 dB, f2 being higher in frequency then f1. The sound pressure level of the two test tones shall be at 64 dB. Frequency differences other than 250 Hz may be appropriate and when used the frequency difference should be stated. If the signal to noise ration is too low at 250 Hz a higher frequency difference may be used.

Internal noise generation in the H/A,the internally generated noise is expressed as an equivalent input noise level the equivalent noise level LN is measured in very quiet ambient conditions with the gain control in the reference test position. The reference test frequency is 1600 Hz, but for certain H/A s a higher frequency may be chosen. The equivalent input noise level LN can be calculated as follows.

$LN = L_2 - (L_8 – L_1)$ dBSPL

Where L2 = The sound pressure level in the coupler

L_8 =The sound pressure level in the coupler

L_1= The input sound pressure level at the RTF (60 dB)

<u>Comparison of main test standard and condition</u>

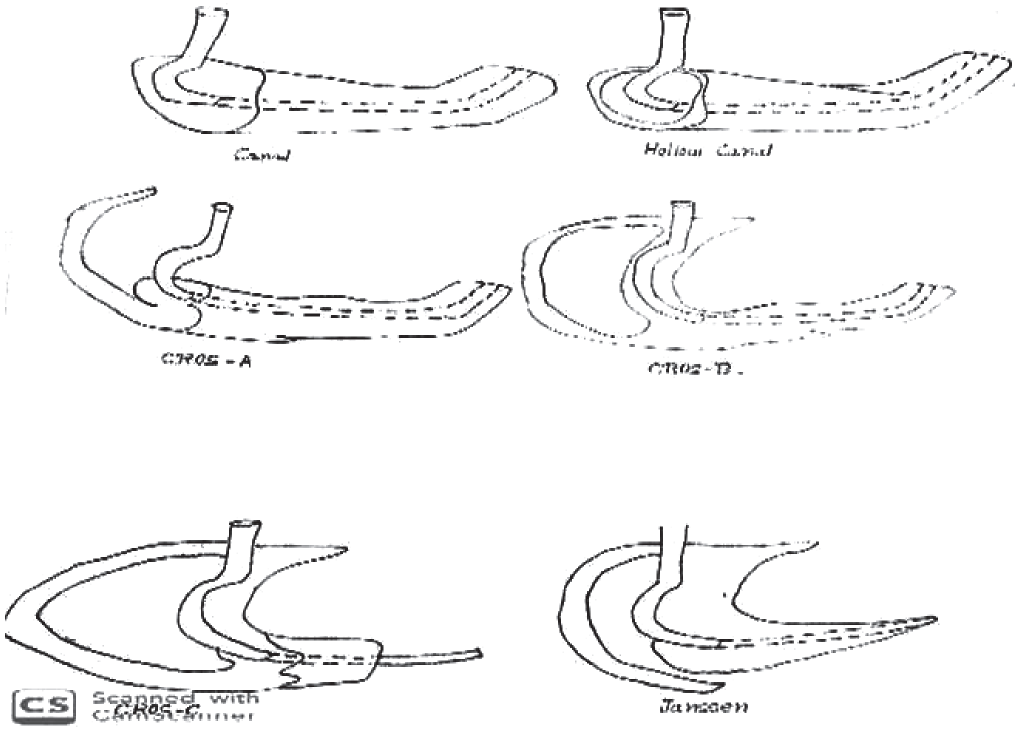
Subject	**IEC**	**ANSI**	**ISI**
RTGCP	Single frequency 15 dB gain control set back	HFA (SPA) 17 dB gain control set back	Single frequency 15 + 1 dB control set back
Battery current Input full on gain	60 dBSPL input 50 dBSPL if OSPL 90 SPL 60 is <5 dB	65 dBSPL input 50 dBSPL if OSPL 90 SPL 60 is < dB	60 dBSPL input 60 dBSPL linear I/o connect to 50 dBSPL
Full on gain at 1.5 volt	Yes	Yes	Yes
Full on gain at 1 Volt	No	No	Yes
Distortion at 1.5 volt	1 frequency	3 frequency	3 frequency
Distortion at 1 volt	No	No	3 frequency
Frequency range	No	Yes	Yes
Tolerance	No	Yes	No

Subject	**IEC**	**ANSI**	**ISI**
AGC measurements	No	Yes	Yes
Directional microphone	No	Yes	No
Ambient conditions	Temperature 23^0 C + 5^0C	Temperature 23^0 C + 5^0C	Temperature 15^0 C + 35^0C
	Relative humidity 40-80%	Relative humidity 0%-80%	<80%
	Air pressure 101.3 Kpa (+5, -20)	Air pressure 101.3 Kpa (+5, -10)	Air pressure 86 to 106 Kpa

EAR MOULD

Development of Ear mould technology and modification :-

The ear mould is an integral part of an individual amplification system. It is a bridge between the hearing aid and the user. An ear mould is a plastic or silicon insert that couples the hearing aid receiver or tube to the ear canal so that amplified sound is conducted from the hearing aid receiver to the ear canal.

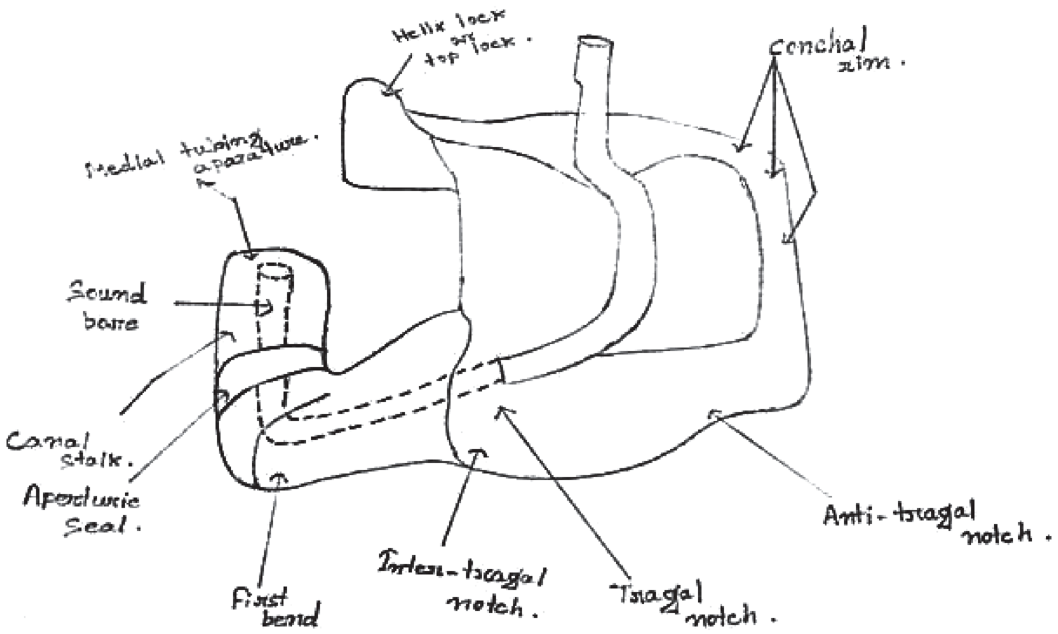


Functions of Ear Mould:-

(a) The basic purpose of an ear mould is to keep the hearing aid /the receiver in place. It serves as a comfortable and effective anchor for the hearing aid in the ear.

(b) It provides a channel of transmission for the amplified sound from the receiver to the eardrum.

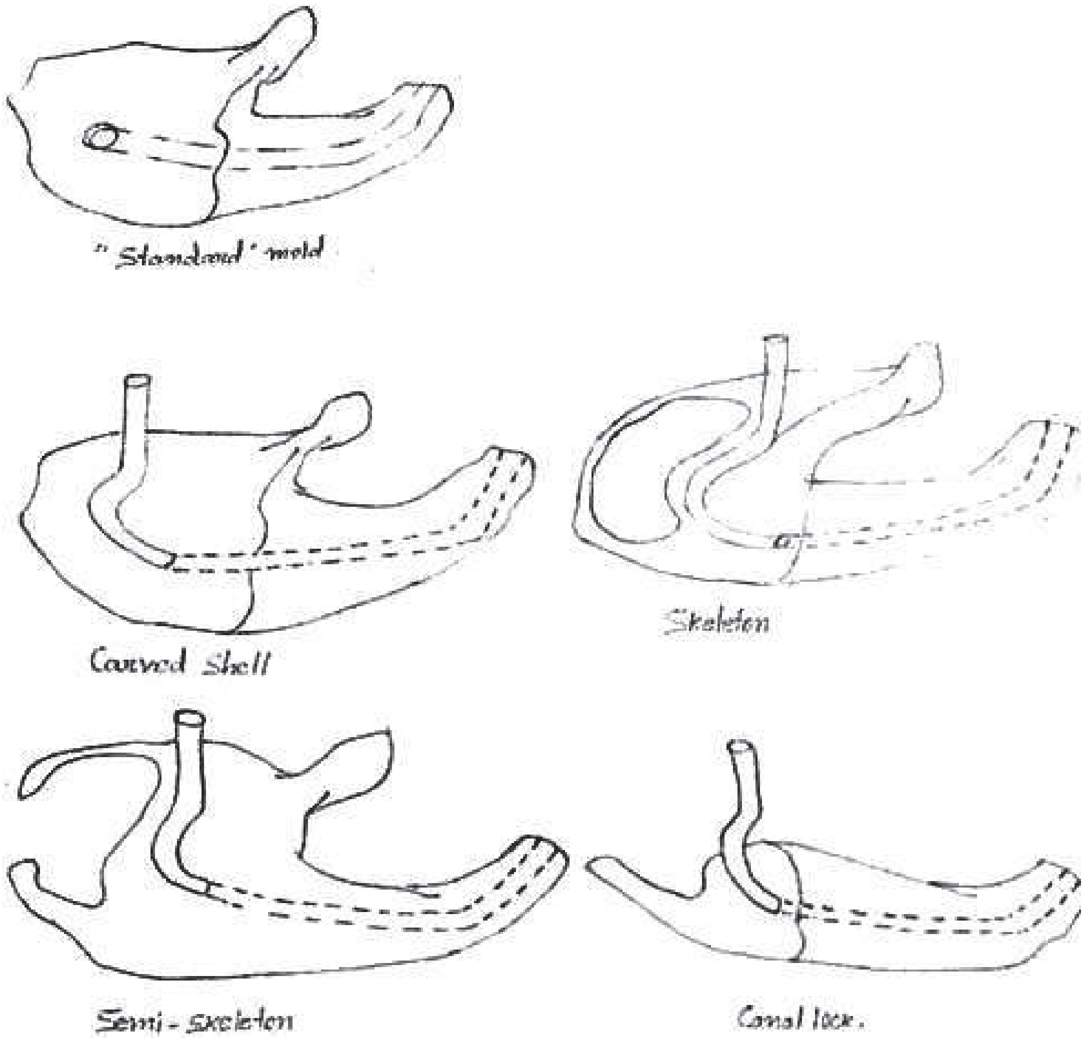
(c) The ear mould prevents acoustic feedback from occurring. Acoustic feedback is a squealing sound that emanates from the hearing aid if the ear mould is ill fitting. The amplified sound escapes from the ear canal if the mould is ill fitting and is again fed into the microphone causing the squealing sound.



Earmold.

The ear mould also acoustically shapes the amplified signal by contributing to the spectrum of the sound reaching the ear. It can enhance or reduce the amplification in certain frequency ranges and can also contribute to the quality of the sound reaching the ear.

The ear mould provides several basic functions. First, it couples the hearing aid with the user's ear. It channels the sound from the hearing aid, through the ear canal, to the eardrum. The ear mould also helps to secure the hearing aid in place. The challenge is to provide the user with a secure fit. Yet the tighter the fit, the more uncomfortable the device is to wear. A well fitted ear mould directs sound from the hearing aid to the ear without feedback, thus allowing the user to hear comfortably (Lachapelle, 1999). Ear moulds are required for all hearing aids, and since the anatomical structure of the ear varies from person to person, the majority (80%) of all ear moulds are custom made.



An ear mould is also used to protect hearing in environments with loud noise. For example, the ear mould can be used in recreational settings such as car racing, hunting, and for fans of sports or music during games and concerts. It also provides hearing protection for industrial workers such as carpenters, factory workers, machinists, and others (Ear mould Design, 2000).

The use of ear moulds for Assistive Listening Devices (ALD) is less common; however, in those situations where ear moulds are appropriate, the general characteristics do not vary from those of a hearing aid. Only 5% of the people who experience hearing loss use ALDs (National Center for Health Statistics, 1997).

Statement of the Problem

The ear mould is an important link in fitting a hearing aid system and must meet multiple requirements. The ear mould must:

- Provide a satisfactory acoustic seal.
- Acoustically couple the hearing aid to the ear.
- Retain the hearing aid on the pinna (auricle).
- The ear mould must be better integrated into the overall design and performance of the hearing aid.
- Be comfortable to wear for an extended period.
- Be aesthetically acceptable to the user.
- Be of a style that the user can physically handle.

Failure to meet any of these requirements will increase the likelihood of product abandonment by the user. Therefore, Stakeholders desire improvements in the fitting, production, comfort and performance of ear moulds as they are used for hearing aids or as hearing protection devices.

Current Technology

Custom modification of the ear mould aids in the overall fit (comfort & security) and minimizes acoustic feedback. These custom designs are handmade which is time consuming and costly. Yet, the time taken to properly fit the ear canal in the beginning may reduce the need for modification to the ear mould shell later.

There are a number of options in the type of materials used to create the ear mould. Proper selection of the material is critical to improve the overall fit and comfort to the user. Some materials may cause allergic reactions for the user, some provide options in colours, while others are simply more comfortable for the user (individual perception). Material characteristics or properties may change over time and become hard, or may experience shrinkage causing poor fit or discomfort to the user. hearing aid. Three of the most common options include; venting, dampers and horn effects. Each will affect different portions of the hearing aid response curve (Microsonic, 2000a).

Venting is an opening that is drilled into the earmold to release low frequency sound. This reduces the "plugged feeling" experienced by the hearing aid user while speaking, described as "talking inside a barrel." This sensation is called the *occlusion effect.*

Dampers are materials that are used to alter the frequency and decrease unwanted peaks of sound waves. Common materials used include wool, plastic and metal, which fit inside the ear mould tubing.

The *horn effect* is provided when the bore of the ear mould increases as it goes deeper into the ear canal. It increases and extends the high frequency sound waves. A *reverse horn effect* is achieved by adapting the ear mould to gradually narrow towards the inner portion of the ear canal.

Additional adjustments to the ear mould can be made by buffing and shaping the product for a better fit. However, this is a "hit and miss" approach. Another method of securing the ear mould in the ear canal is to wrap the shell with a flexible material that will provide a temporary solution to the problem.

Health care professionals must evaluate each person individually as to the material and style selection of ear moulds to best meet their needs and to ensure the highest success rate with the hearing aid. Issues to consider include:

- whether the user is active or sedentary in their lifestyle,
- user dexterity (for example, the persons ability to handle hearing aid insertion, daily care, and cleaning of the ear mould),
- the anatomy of the individual's ear and the affect it has on the choice of material or style of hearing aids that are to be used (anatomic considerations when choosing a hearing aid include: a deformed outer ear, the depth of the concha, whether ear canal is of sufficient diameter and whether there is a sharp enough bend to hold the hearing aid),

- growth changes, (in particular children),
- changes in morphology of the ear canal as it slowly adapts to the continuous pressure of the device (continuous pressure may cause the area to expand slightly),
- amplification objectives of the fitting,
- toxicity or allergies to plastics,
- appearance — colour selection, hearing aid style and ear mould design options, and
- the number of modifications that may be required after delivery of the device (Microsonic, 2000b).

Each manufacturer offers a variety of materials to be used with ear moulds to meet the specific needs of each client. Choosing the correct material for ear moulds is as important as determining the ear mould style and acoustics. Some of the generic varieties include:

- *Acrylic* is used to create hard custom ear moulds, used with mild to severe hearing losses. Most ear mould styles can be made with acrylic and are available in a range of colour options.
- *Polyethylene* is a semi-rigid material and is hypoallergenic. It is used for mild to severe hearing losses. Polyethylene is not as durable as other materials and should be handled with care. The color selection is limited to white.
- *Silicone* is a flexible inert material that is useful when fitting client's with allergy problems (although the hypoallergenic feature is not available if produced in any color other than beige or clear). There is little to no shrinkage with silicone and can therefore be used when fitting high power hearing aids.
- *Lucite* is a clear synthetic plastic resin that is rigid at all temperatures. It is useful for mild to moderate hearing losses. It does not shrink over time, is easy to grind and buff, but is not recommended for children.
- *Poly Vinyls* (Polymerized vinyl) provide a soft, comfortable fit with a superior acoustic seal. The texture of the material provides a rich mellow sound quality that preserves the harmonic and resonant characteristics of the ear canal.

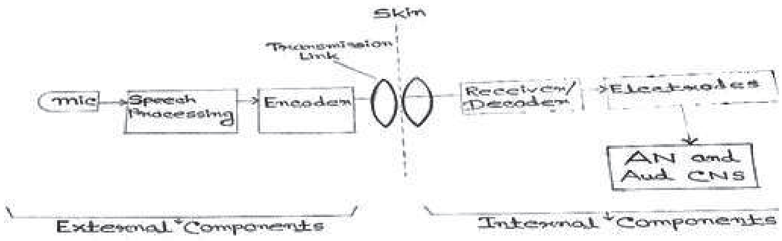
2.4 Cochlear Implant

Introduction

Cochlear Implants (CI) are surgically implanted electronic devices coupled to external components that provide useful hearing and improved communication to adults and children with severe-to-profound hearing losses. A CI consists of a microphone; an external processor, which analyze the incoming signal; an internal processor and an electrode array, which is surgically placed inside the cochlea. A speech processor converts the acoustic sound signal into an electrical signal. The electrical stimulation of the electrode array replaces the transduction process that is performed by the sensory cells of the inner ear in the normal cochlea. In this manner, the CI provides direct input to the central auditory pathway by electrically stimulating the spiral ganglion cells of the auditory nerve.

WORKING OF THE IMPLANT

1. Sound waves are received by the microphone.
2. The signal from the microphone is sent along the cable to the speech processor.
3. The speech processor acts on the signal according to the coding strategies develop to enable optimal hearing with the cochlear implant.
4. The coded signal is sent through the cable to the transmitter.
5. The transmitter transfers the signal together with the energy required by the implanted electronics through the intact skin to the implanted receiver.



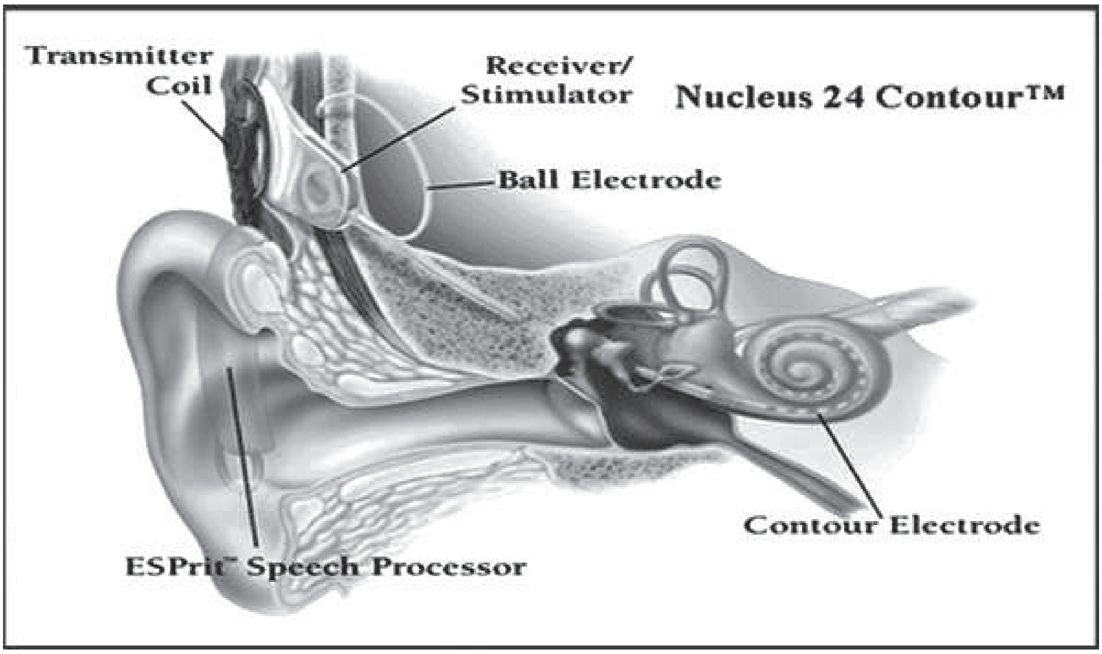
Block Diagram for Typical Cochlear Implant System

6. The implanted receiver and stimulator decodes the signal and sends a pattern of small electrical impulses to the electrode in the cochlea.
7. The small pulses conducted by the contacts stimulate the spiral ganglia at various sites and different parts of the auditory nerve are stimulated according to the pitch

of the sound. In response the auditory nerve carries out its natural function and conducts the nerve impulses to the brain.

8. The brain receives the impulses and interprets them as sound, which the implant user hears.

COMPONENTS OF CI SYSTEMS



CI systems are made up of several components and all require the patient to wear equipment externally as well as having the internal, surgically implanted electrode array. The internal part implanted at the operation consists of a receiver and an active electrode. All materials used in the manufacture of the implant are fully tested for biological compatibility and durability. The electronic components of the receiver are held in sealed housing which is implanted under skin behind the ear. The active electrode connected to the receiver is inserted to the cochlea through cochleastomy into the basal turn. The contacts (platinum-iridium alloy) are enclosed in silicone and the electrode cable made in such a way that it can be inserted about 25mm into the cochlea.

The external components consist of a speech processor and transmitter. The speech processor can be body worn or behind the ear. The speech processor converts incoming signals into the required electrical signals.

External components:

It consist the microphone, the speech processor and a means of transferring the signal to the implanted electrodes.

1) ***Microphone*:** The microphone picks up sound from the environment and converts it into an electrical signal. For most body-worn system the microphone is housed in its own case which is similar in appearance to a small post-aural hearing aid. The signal is transferred from the microphone to the body-worn speech processor via a lead. The Nucleus CI 24M, Medel Combi 40+ and Clarion CII system have the option of BTE processors which have integral microphones.

2) ***Speech processors*:** The speech processor converts the raw signal from the microphone into a form that can be delivered to the implanted electrodes and produces an audible yet comfortable sensation of hearing. The speech processor has programmable electronics that are set individually to suit each patient by an audiologist with the aid of a computer and a device-specific interface. Speech processors have on/off switches and adjustable sensitivity controls. They may also have volume controls and programming selection buttons if the processor can store more than one program. The processor is powered by batteries. Hearing aid batteries are used for the head-level processors, and larger batteries (e.g., two to four AA batteries are used for the body-worn processors. Battery life typically exceeds 12 to 16 hours, allowing patients to use their devices during the waking hours without the need for recharging or replacing the batteries.

Adequate battery life for the head-level processor is made possible trough use of low-power integrated circuit technology, particularly low-power digital signal processing (DSP) chips that have become available. The head-level processors in some cases have reduced capabilities or reduced options for changes in processing strategies or processor parameters to save space and to reduce power consumption. Such tradeoffs may reduce the speech reception performance for users. In those cases, a body worn processor may be preferable to a head-level processor, even though the latter is more cosmetic and convenient. Advanced in battery, integrated circuit, and DSP chip circuit technologies have been driven by huge commercial markets for mobile phones, portable computers, and other hand held or portable instruments. The economic incentives to develop better batteries and power-efficient chips are enormous. Most new-generation processor has warning lights or sounds to indicate faults. Speech processor may be body-worn or post-aural. The Nucleus Esprit and Esprit 22 post-aural processors support the SPEAK strategy only. The Nucleus 3G post-aural processor can support SPEAK and other faster rate speech processing strategies. The Medel Tempo+ post-aural speech processor supports the CIS processing strategy. The Clarion CII post-aural processor supports a range of speech processing options. A processor requires rechargeable batteries that generally need to be changed more than once a day.

PACKAGING:

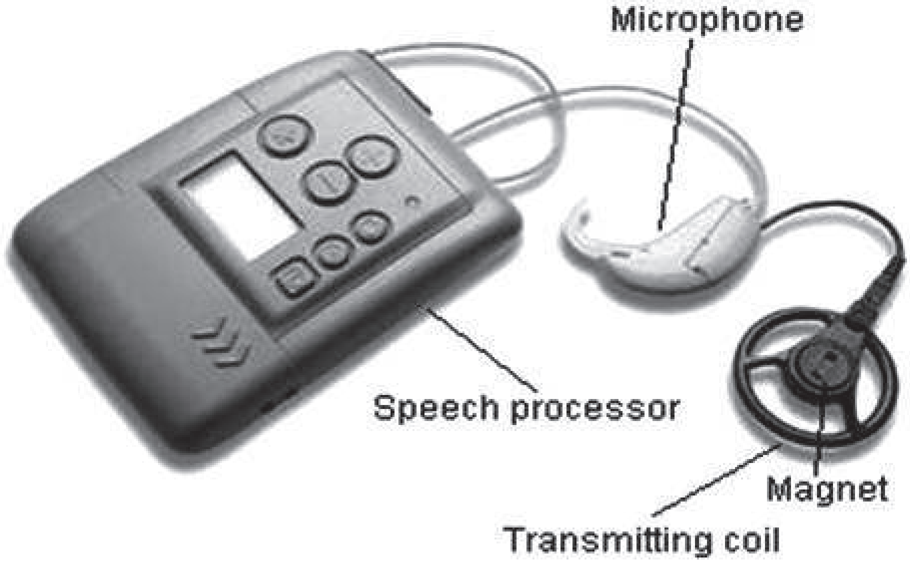
BODY WORN SPEECH PROCESSOR:

Body-worn speech processors allow the presentation of some or all strategies in regular use (SPEAK, CIS, ACE). They may have flexibility for research on alternative strategies. There is a telemetry link sending voltage from implant electrodes back for analysis. It has a liquid crystal display of program settings, signal levels, and diagnostics. There is a control panel disable feature for children. It also had data logging to monitor usage, and compatibility with assistive devices. It could be used with single-or double-battery packs, the weights being 114 and 146g, respectively.

The Clarion S body worn speech processor provided the SAS and CIS strategies and had the dimension of 7x6x2.2cm. The body worn version CIS PRO+, with the dimensions 9x6. 8x2cm, it requires two rechargeable AA batteries for an average of 1 day of operation (Med EI application to the FDA, August 21, 2001).

The MXM Digisonic speech processor operated with two rechargeable batteries that had a life of 12 to 16 hours. There was also a sensitivity control with separate base and treble to improve the contrast of speech in noise.

Behind-the-ear speech processor:



Many patients find a behind-the-ear speech processor desirable, particularly as it is more convenient and cosmetically pleasing to dispense with the leads passing from the microphone to the body-worn device. Miniaturization of the nucleus 24 processor required high-powered since-air batteries and a low power consumption, which is easier to achieve with strategies using low stimulus rates. Its dimensions were 4.6x1.9x0.9cm. In 2002 the ESPrit-3G provided alternative strategies such as ACE and CIS. It gave a choice of sensitivity or loudness control, simple rotary and in-line switches, and compatibility with assistive devices. Triple 675 zinc air batteries gave typically from 16 to 150 hours of usage. The ESPRIT-3G had a built-in telecoil that allowed listeners access to hearing aid compatible telephones and to connect to sound systems is public venues with assistive listening devices like induction loop and infrared or FM system.

The Clarion behind-the-ear speech processor used rechargeable batteries, but this limited their running time. The Med EI Tempt+ speech processor used three zinc-air batteries for approximately 36 hours operation. It dimensions were 6.6x1.3x0.9cm, and came in straight, angled and children's configuration.

Signal transfer to the implanted electrodes**:** A direct hardware connection through the skin via a plug or pedestal fixed surgically to the skull is the simplest method for transferring signal to the internal electrode array, as used in the Inner aid implant. This method of connection is known as percutaneous connection and has the advantage that it is easier to apply new processing strategies without replacing the internal electrode array. However, prone to damage and infection can develop around the pedestal, which in the worst case can necessitate reimplantation. Currently available CI use Transcutaneous links where the skin remains intact. The signal is transmitted across the skin via a FM carrier wave to the internal receiver stimulator; here the signal is converted back to an electrical signal and stimulates the implanted electrodes in most systems the transmitter and the internal receiver stimulator are magnetized to keep the transmitter and receiver correctly aligned and thus maintains good contact across the skin.

Nucleus Freedom Speech Processor

Transmission link

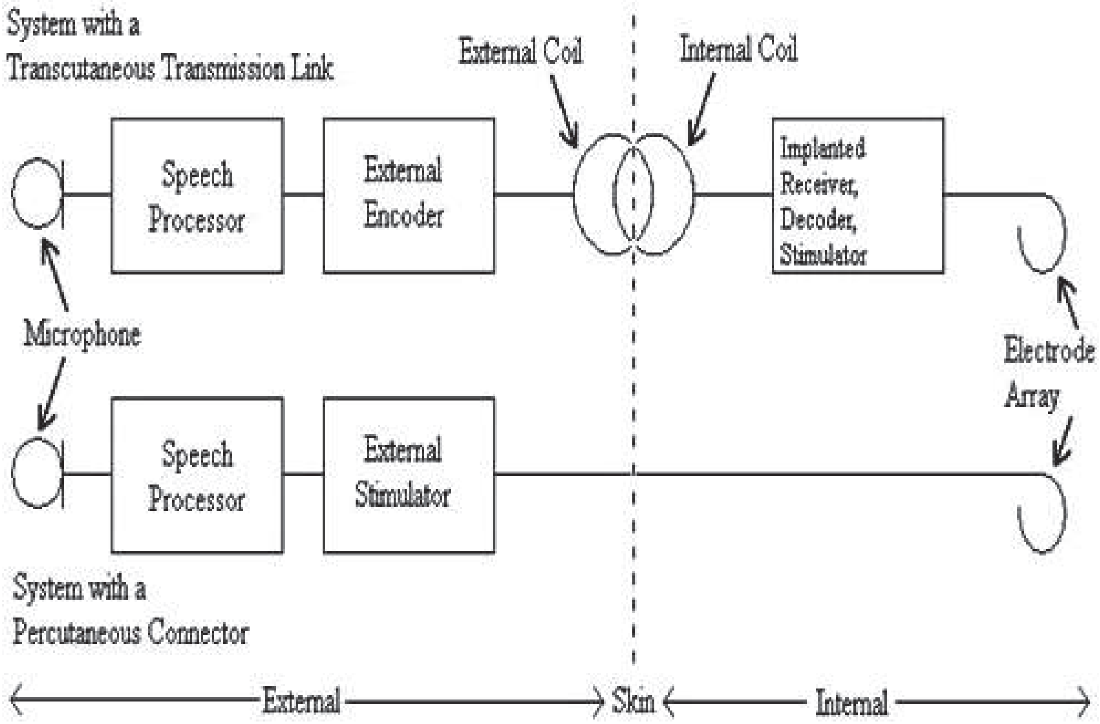
There are two types of transmission link:

1. Transcutaneous transmission link
2. Percutaneous connector

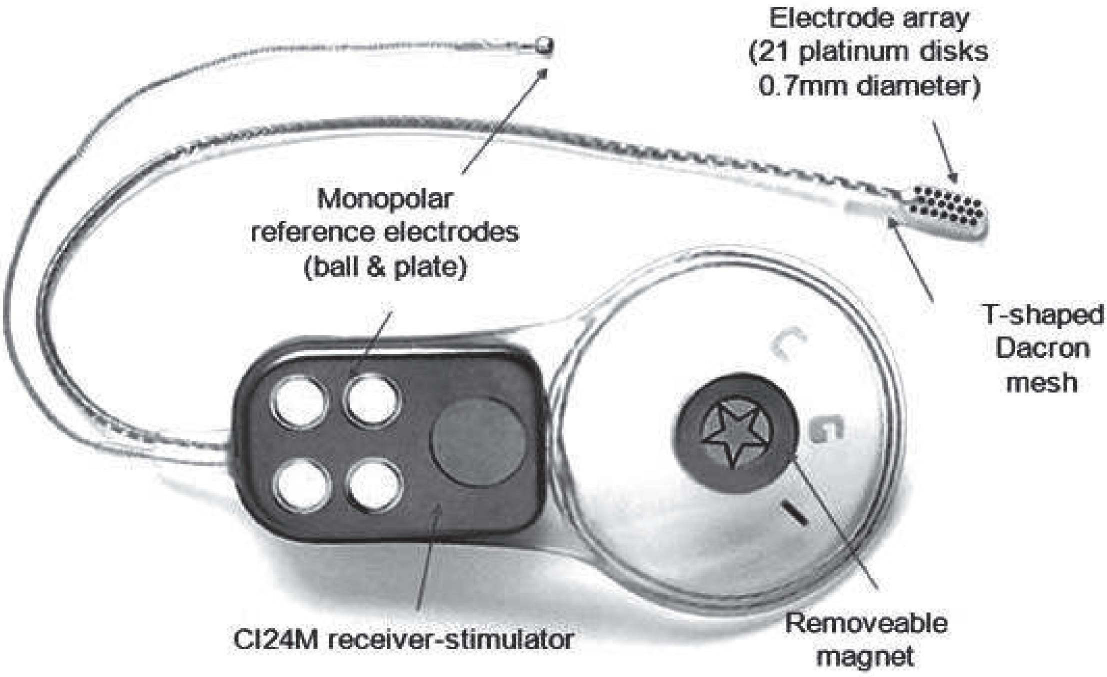
A transcutaneous link consists of an external transmitting coil and an internal, implanted receiving coil. The external transmitting coil encodes the stimulus information and sends a radiofrequency signal across the skin to the internal receiving coil of the receiver/stimulator package. This radiofrequency signal powers the receiver/stimulator package, which decodes the signal and appropriately stimulates the electrode array via a cable connecting the package to the electrodes. The external transmitting coil is held in place over the internal receiver/stimulator package with a pair of external and internal magnets in the centers of the coils. The receiver/stimulator package is implanted posterior to and above the pinna in a flattened or indented part of the skull.

A percutaneous connector is a wire that passes through the skin and directly connects the speech processor to the electrode array. (Wilson, 2004) No commercially available cochlear implant systems use a percutaneous connector. This is likely due to the fact that skin is closed over the implant when there is a transcutaneous link, decreasing the risk of infection. Use of a transcutaneous link instead of a percutaneous link, however, limits the amount of information that can be transmitted. Transcutaneous links limit stimulus update rates and restrict the types of stimulus waveforms that can be transmitted. (Wilson, 2004).

In some cases the transmission link may be bidirectional, allowing data to be transmitted from the internal components to the external components. Such data can include impedances of electrodes, voltages at unstimulated electrodes, and intracochlear evoked potentials. Such measurements can be useful in assessing the condition of the auditory nerve and for programming the speech processor. (Wilson, 2004)

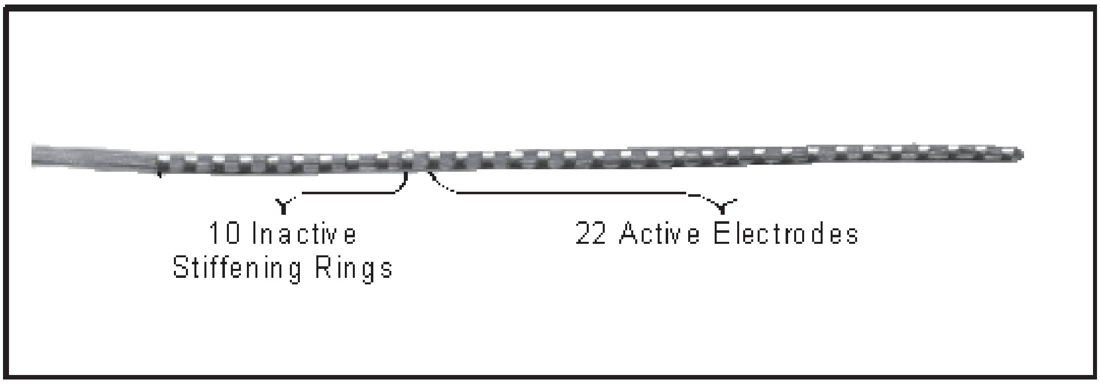


A. **Internal device components:**



It consists of a receiving coil or internal processor and an electrode array.

1. *Receiving coil or internal processor*: It is the largest portion of the internal device and is surgically placed in the mastoid bone. It is composed of magnet and an antenna, which receives the signal from the external coil. Either silastic or ceramic casting houses the receiving coil.
2. *Implanted electrode array*:



It is connected to the internal receiver stimulator. *Extracochlear electrodes* are located outside the cochlea, such as on the plate of the receiving coil or placed under the temporalis muscle.

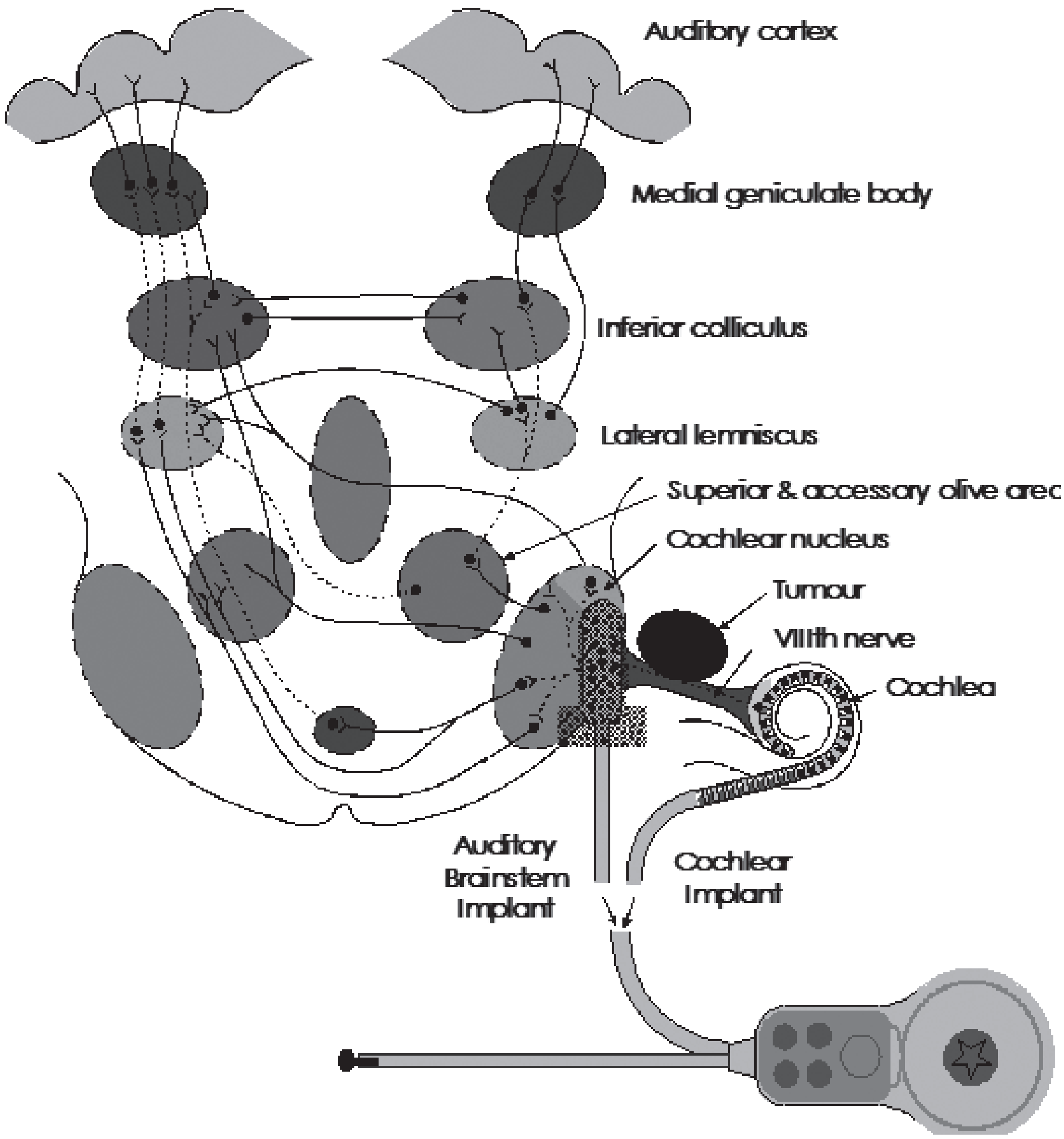
Generally, extracochlear electrodes are used as a ground source for *monopolar* stimulation and usually single-channeled. *Intracochlear electrodes* are housed along a carrier called the *electrode array* and can be programmed to serve as either an active or indifferent component of the electrical charge. Intracochlear electrodes are surgically placed inside the cochlea and may vary in material, shape, size, number and spacing along the electrode array.

Multichannel devices, which use more than one intracochlear electrode, take advantage of the tonotopic organization of the cochlea and provide differently processed information to electrodes positioned at different locations with in the cochlea. The total no. of electrodes available on may be less than the no. of electrode available on the array. For e.g. a particular electrode may be the deactivated because the patient feels discomfort (dizziness) when it is stimulated**.** Several electrodes along the array may be deactivated for a specific speech processing strategy. Lastly, incomplete insertions may limit the no. of electrode that can be stimulated. The Medel Combi 40+ allows the deepest insertion.

Presently, electrode array are either *precoiled* or *flexible.* Precoiled arrays are spiral shaped and are designed to follow the curve of the scala tympani. Flexible array are straight and thin are designed to follow the natural curve of cochlea. The design of the electrode array that 'hug' the modiolus is currently an area of intense research activity.

CI manufacturers may offer a choice of electrode arrays. Medel and MXM have split electrode that may be more suited to ossified cochlea. Different parts of the cochlea are drilled out and then two or more sections of the split array are placed in different regions of the cochlea thus maximizing the use of tonotopic organization of the cochlea.

Design rationale:



Research for the design and development of an electrode array:

- **Electrode placement:** Clarke et al (1975) observed fewer traumas when a free-fitting electrode carrier was inserted along the scala tympani of the basal turn
- **Electrode placement close to auditory nerve in speech frequency range:** The preliminary results to insert the electrodes along the scala tympani of the basal

turn through the round window were not successful. The electrode did not go beyond 15mm. but the electrodes were needed to inserted 20mm and preferably 25mm to lie opposite the auditory nerve fibres conducting the speech frequencies. To overcome this difficulty, drilling with care into the scala tympani at points around the cochlea so that electrode arrays could be threaded along the basal and middle turns of the cochlea (Clark et al., 1975).with this technique, there was a problem of the underlying structures as a result of fenestration. Another technique was retrograde insertion. However, this methods method caused more traumas than the earlier one. Later, it was found preferable to insert a free –fitting electrode array via the round window along the scala tympani of the basal turn of the cochlea. However, problem still remained how to insert it sufficiently to lie close to auditory nerve. A significant limitation to deep insertion was friction between the electrode array and outer wall and with graded stiffness from tip to base. The solution came from an electrode array made from a silastic tube which reduces friction between it and the outer wall and with graded stiffness from tip to base.

- **Current localization:** Black and Clack (1977) developed a computer model, which plotted voltage distributions for different electrode stimulus configurations. The results show that the best current localization could be expected from any array within the scala tympani.
- **Electrode metal:** In developing an electrode array, one of the issues is the metal to be used for the electrodes. Initially, gold electrodes were preferred (Michelson, 1971). Later, platinum was used. The advantage of platinum black is that it increased the surface area, but this was significantly reduced in the presence of protein. In 1975, development of a multiple electrode array by sputtering platinum onto a thin ribbon of Teflon so that a large no. of electrode tracts and electrode pads could be condensed into a small space (Clark and Hallworth, 1976). But this array could not sufficiently bend well to pass around the cochlea without cracks developing in the electrode tracks or pads. Furthermore, when the Teflon strips were inserted into the 'cat's cochlea, their edges cut the basilar membrane (Clark et al., 1987). Later, bared ends of 20 individual electrodes around silastic carrier were developed. This provided a large surface area. However, this electrode caused significant trauma when removed for replacement with another. To avoid this problem, a banded electrode was conceived and used for subsequent patients. Being circumferential it also has the advantage that it could be rotated to facilitate

insertion, and still make good contact with the auditory neurons. Shepherd et al., 1984, evaluated the tissue reaction of the biomaterials in the multi-channel cochlear prosthesis. Silastic MDX-4-4210 was compared with other widely used biomaterials including FEP Teflon, polyurethane (Pellethane) and silastic tubing. The histological response of muscle and the cochlea to silastic were minimal and compared favorably with other three materials assessed. The minimal tissue reaction and near normal appearance of the cochlea, demonstrates the suitability of this material for use in intracochlear implants.

- **Electrode insertion depth and frequency up-shifting:** Electrode arrays are inserted only partially into the cochlea, typically 22-30mm, depending on the state of the cochlea. The fact that the electrode array is not fully inserted into the cochlea creates a frequency mismatch between the analysis frequency and the stimulation frequency. For e.g. an electrode array, consisting of 5 electrodes, inserted 22 mm into the cochlea. The output of the first analysis filter, which is centered at 418 Hz, is directed to the most apical electrode which resides in the 831 Hz place in the cochlea. As a result, the speech signal is up-shifted in frequency and is therefore less intelligible. This is consistent with patient's reports that speech sounds unnatural and "high-pitched" or "Donald-duck like" when their device is first activated.

- **Electrode design:** Some of theissues associatedwith electrode design are:- (1) electrode placement, (2) no. of electrodes and spacing of contacts, (3)orientation of electrodes with respect to the excitable tissue, and (4) electrode configuration.

1. ***Electrode placement:*** The extracochlear and intracochlear electrode placement (*already dealt is previous section*). Gostoettner and Aduunka et al., 2001, studied on the perimodiolar-positioned CI electrodes that have been developed in order to bring the electrode contacts as close as possible to the spiral ganglion cells, which are the target of electrostimulation. This resulted in lower electrical thresholds, higher dynamic ranges and less channel interaction when compared with normal implant electrodes which are usually located peripherally within the scala tympani.

2. ***No.* of electrodes *and spacing between electrodes:*** The no. of electrode as well as the spacing between the electrodes affects the place resolution for coding frequencies. In principle, the larger the no. of electrodes, the finer the place coding

frequencies. Frequency coding is constrained by the no. of surviving auditory neurons that can be stimulated at a particular site in the cochlea and by the spread of excitation associated with electrical stimulation. Unfortunately, there is not much that can be done about the first problem. The spread of excitation varies with the electrode configuration: monopolar and bipolar (*dealt later*).

3. ***Orientation of electrodes:***Current electrode arrays do not include any special provision for positioning the electrodes within the cross section of ST.Presently, electrode array are either *precoiled* or *flexible*.

TYPES OF ELECTRODES

STANDARD ELECTRODE ARRAY

The Standard Electrode Array offers the deepest insertion (approximately 31mm) and widest contact spacing (2.4mm) available today. It features 12 pairs of electrode contacts and is designed to provide stimulation of the complete frequency range.

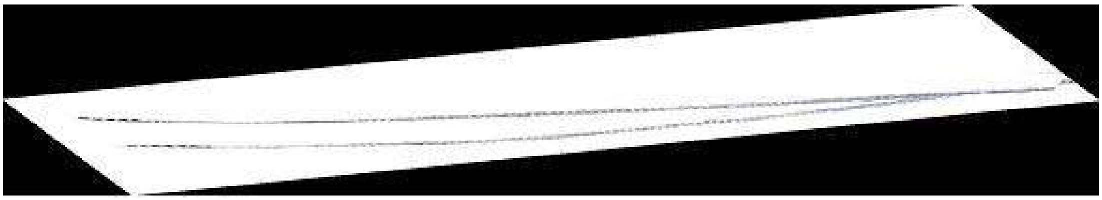
COMPRESSED ELECTRODE ARRAY

Specifically designed for partial ossification or malformation of the cochlea, the Compressed Electrode Array features 12 pairs of contacts equally spaced over a shorter distance to maximize the number of channels available and

Optimize performance.

SPLIT ELECTRODE ARRAY

Specifically designed for severe ossification of the cochlea, the Split Electrode features two separate electrode branches, one with five pairs and one with seven pairs of contacts. The arrays are designed for insertion into different areas of the cochlea to maximize the number of channels available and optimize performance.



MEDIUM ELECTRODE ARRAY

The Medium Electrode Array features 12 electrode pairs with moderate contact spacing for cases where deep insertion is not desired or is not possible due to anatomic restrictions.

FLEXsoft ELECTRODE ARRAY

Similar to the Standard Electrode Array, the FLEX*soft* Electrode Array allows deep insertion into the apical region of the cochlea. The specially designed leading section offers increased mechanical flexibility for reduced insertion force.

FLEXeas ELECTRODE ARRAY

The FLEX*eas* Electrode Array is intended for situations in which insertion no deeper than the basal cochlear turn is desired. The array features a designed leading section with increased mechanical flexibility and reduced insertion force.

Summary:

Based on the above, the CI can be classified as:

- *Based on transmission:*

1. Percutaneous system
2. Transcutaneous system

- *Based on electrode placement:*

1. Intracochlear system
2. Extracochlear system

- *Based on mode of stimulation of electrodes:*

1. Monopolar stimulation system
2. Bipolar stimulation system

- *The most common classification:*

1. Multichannel CI system
2. Single-channel CI system

IMPLANT CHARACTERISTICS

Several types of implant device have been developed over the years. These devices differ in the following characteristics:

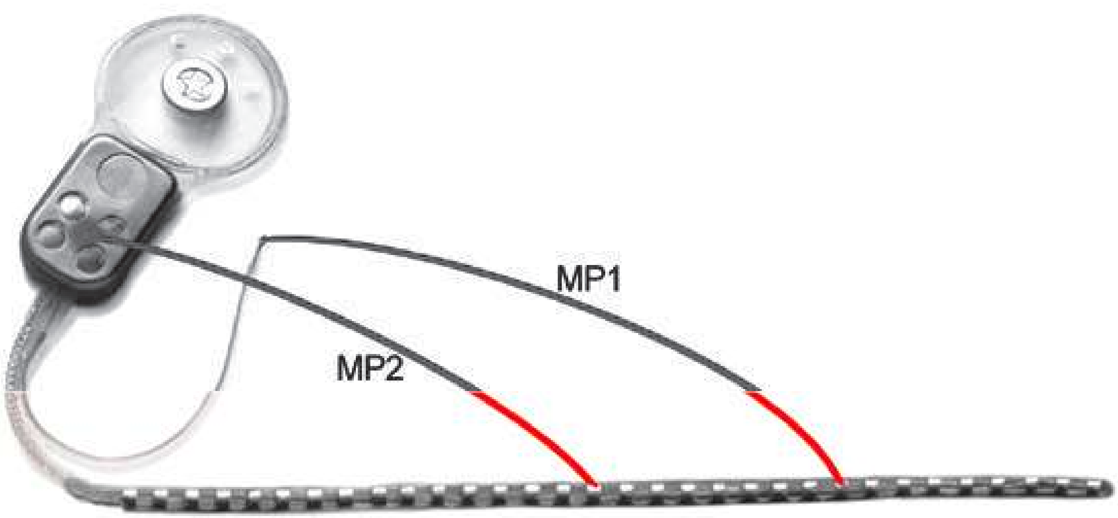
1. Electrode design (already dealt)
2. Type of stimulation: Analog or Pulsatile (dealt later in speech processing strategies)
3. Mode of stimulation: Monopolar, Bipolar, or Common
4. Transmission link: Transcutaneous or Percutaneous (already dealt)
5. Signal processing: Waveform representation or Feature extraction

Stimulation mode:

To induce an electrical field current must flow from an active electrode or positive pole to a reference or ground electrode or negative pole. This current flow can be produced in 3 different ways in CI. They are:

- Monopolar stimulation
- Bipolar stimulation
- Common ground stimulation

For ***monopolar stimulation***, the active and reference electrodes are positioned remotely; the active is inside cochlea and reference is on the receiver stimulator case or embedded in muscle (temporalis) outside the cochlea. Thus, an electric field is created from the stimulated electrode (usually an intracochlear electrode) to the ground (placed extracochlear). Hence, current spread over a wider area for monopolar stimulation. The tonotopicity pitch can be maintained with monopolar stimulation as the current density is greatest around the active intracochlear electrodes. MONO stimulation causes the greatest overlap of electrode fields. Monopolar configurations might excite a larger population of neurons, creating a richer representation of the stimulus and yield better current-level sensitivity.



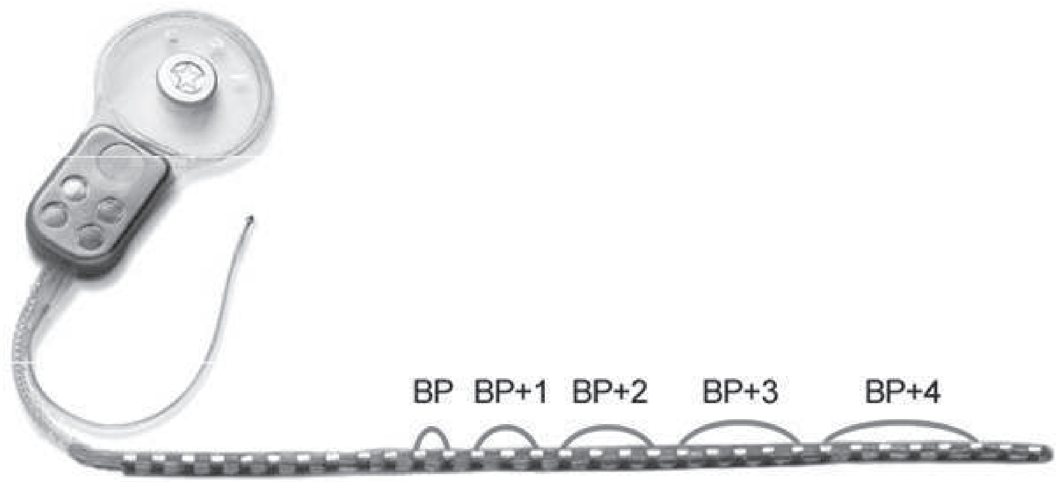
Advantages:

- The wide current spread can produce auditory percepts using much lower current level.
- The information can potentially be presented at a faster rate and that the power consumption of the system can be minimized.
- The tonotopic pitch order of the electrode percepts is maintained with monopolar stimulation as the current density is greatest around the active intracochlear electrode.

Disadvantage:

- Some current flows external to the cochlea, potentially causing stimulation of other structures.

For ***bipolar stimulation***, the active and reference electrodes are adjacent to each other. Bipolar stimulation gives more specific stimulation but because fewer neurons are stimulated, a higher current level is required to produce the same loudness sensation as monopolar stimulation.

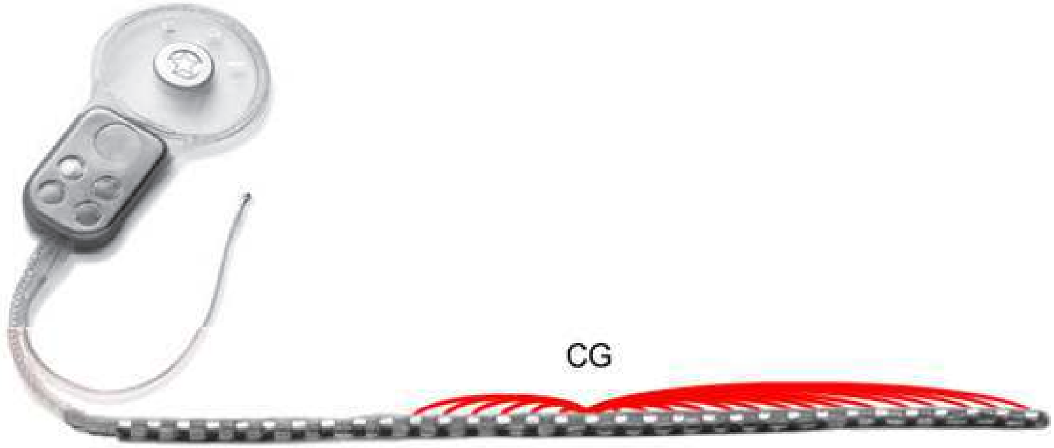


- In a true bipolar mode, often too few ganglion cells stimulated to create a sufficiently loud percept within the output limits of the system which may be inadequate for the patient.
- Power requirements are higher.

Advantages:

- Stimulation of electrodes in close proximity provides more spatially selective stimulation (highly selective fields- pitch specificity)
- The bipolar configuration was an attempt to limit the interelectrode interaction by placing a ground near each electrode such that a smaller field would be created with less interference and more discrete stimulation.

In *common mode stimulation,* when an active electrode has been designated, all of the other electrodes are connected together electronically to constitute a single reference electrode. As a result, current spreads from the active electrode to each of the other in the array. In practice, the common ground mode, in spite of its wider current spread, offers electrode discrimination equivalent to that provided by bipolar modes. This occurs because the concentration of the current or the "charge density" is greatest in the vicinity of the active electrode. The spiral ganglion cells in this region therefore receive to the position of this electrode within the cochlea. As such there appears to be no disadvantage in employing the common ground mode for young implantees with complete electrode insertions.



The spatial specificity of stimulation for selective activation of different populations of cochlear neurons depends on many factors, including:

- Whether neural processes peripheral to the ganglion cells are present or absent
- The number and distribution of surviving ganglion cells
- The proximity of the electrodes to the target neurons
- The electrode coupling configuration.

The factors can interact in ways that produce selective excitation for monopolar or bipolar stimulation and in a way that produce broad excitation fields for either type of stimulation. Eg. Highly selective fields can e produced with bipolar electrodes oriented along the length of surviving neural processes peripheral to the ganglion cells. Highly selective fields also can be produced with close apposition of monopolar electrodes to the target neurons. In addition, broad fields become more likely with increasing distance between electrodes and target neurons for either coupling configuration. Broad fields may be required for adequate stimulation of cochlear with sparse nerve survival.

An important goal of implant design is to maximize the number of largely of largely non overlapping population of neurons that can be addressed with the electrode array. This may be accomplished thorough positioning of electrode contacts immediately adjacent to the inner wall of the ST.

The current electrode array do not include any special provision for positioning the electrode within the cross section of the ST. placement close to the inner wall can increase the spatial specificity of stimulation and produce reductions in threshold and increase in the dynamic range of stimulation (Cohen et al, 1998, Ranck, 1975; Shepherd et al 1993).

Although the close placement next to the inner wall is likely to improve spatial selectivity, it is important to note that the inner wall is not always close to the spiral ganglion (SG) throughout the length of the ST (Ariyasu et al, 1989, Ketten etal, 1997).

The neural tissue likely to be activated by electrical stimulation is located nearest to the electrodes. In the cochlear the current pathway from the electrode to the axonal process is likely to be through the highly conducting fluid of the ST. it is notable that the threshold and comfortable levels of implanted patients are usually lowest with MONO stimulation, highest with BI, and intermediate for CG.

STIMULATION PARAMETERS:

The parameters are manipulated to produce sufficiently loud stimuli in the shortest possible time. This allows the highest possible stimulation rates for signal processing. These considerations have resulted in the "stimulus level" scales used within the programming software, which provides a logarithmic scale of "charge delivered" by varying current and pulse width.

TYPES OF IMPLANT:

Cochlear implants can be categorized in at least two important ways.

- Electrodes may be inserted either within the cochlea (intracochlear) or placed outside the cochlea (Extracochlear);
- The signals may be transmitted through either one channel (single channel) or several independent channels (multichannel);

Extra cochlear electrode: the electrodes may be attached to the round window niche or, in some cases, to the promontory. Single-channel stimulation is more common in this form of implant.

Extracochlear stimulation, in contrast to intracochlear stimulation, has the advantage that the procedure does not invade the cochlea and is reversible. The disadvantages of extracochlear stimulation are narrower dynamic range, higher current density, and, concomitantly a greater potential for stimulating other neural tissue, possible resulting in facial nerve stimulation or vertigo. An additional concern is maintaining long-term contact between the external electrode and the round window or promontory.

Intracochlear electrode: In an intracochlear implant, an electrode or electrode array is inserted into the cochlea. For multichannel operation, the electrode array is usually inserted quite deeply into the cochlea (toward the apex), whereas for single-channel operation, a short single-channel electrode that does not extend beyond the first bend in the cochlea can be used. Multiple electrode arrays have been developed with as many as 24 electrodes that can be stimulated independently.

SINGLE CHANNEL VERSUS MULTI-CHANNEL COCHLEAR IMPLANTS

In cochlear implant systems, the term channel refers to the number of stimulation sites within the inner ear, or cochlea, and is defined by a range of frequencies, or pitches. All sounds, ranging from low pitch (bass) to high pitch(treble) sounds are separated into the number of available channels.

In a *single channel system*, all sound information is delivered to only one channel. Thus, all information is transmitted to a single area of stimulation within the cochlea, regardless of the pitch of the incoming signal. Thus the Single-channel implants provide electrical stimulation at a single site in the cochlea using a single electrode.

Advantages:

- It does not invade the cochlea
- The process is reversible.
- Less risk of insertion trauma

Disadvantages:

- Does not utilize the place coding mechanism as in a normal cochlea.
- Speech perception using single-channel implants

Multi-channel cochlear implant systems divide the incoming signal into various frequency bands that are then transmitted to various sites of stimulation spanning the inner ear. In this way, low pitch sounds are sent to one part of the cochlea and high pitch sounds to another. The goal in multi-channel systems is to more closely mimic the human ear, in which sounds are organized by frequency, like the keys of a piano. Because the system can transmit much more detailed information about the incoming signal, the processing of sound is more complex, and the device fitting is somewhat more involved.

Multi-channel implants provide electrical stimulation at multiple sites in the cochlea using an array of electrodes. An electrode array is used so that different auditory nerve fibers can be stimulated at different places in the cochlear, thereby exploiting the place mechanism for coding frequencies. Different electrodes are stimulated depending on the frequency of the signal. Electrodes near the base of the cochlear are stimulated with high frequency signals, while electrodes near the apex are stimulated with low frequency signals.

Advantages:

- These have a potential for low current density.
- They have a wider DR
- It uses the convenient tonotopic stimulation
- Information is transmitted in a form that is easier for the user to understand.

Disadvantages:

- Usual hazards of the surgery
- insertion trauma
- possibility of mechanical damage to the cochlea
- possible release of toxin corrosion products
- Difficulty of replacing the device.

RISKS AND COMPLICATIONS OF SURGERY

1. Infection of the wound: the device may need to removed
2. facial weakness: for mast cases weakness is transient

3. balance symptoms: usually transient
4. taste disturbance:
5. Device failure: total implant failure may occur, but this is uncommon (less than 4% in Nottingham).
6. risk of meningitis with middle-ear infection: rare occurrence; vaccination is advised.
7. Electrochemical damage to the ear from long-tern electrical stimulation: the effects appear to be minimal based on current knowledge if the stimulation is appropriate.
8. head growth in children
9. Limitation of certain activities like rugby, boxing, squash.
10. electrostatic damage
11. tinnitus: usually transient
12. vertigo: usually transient
13. complication relating to anesthesia: if occurs, may be serious

PROTOCOL FOR POSTOPERATIVE MANAGEMENT:

1. **FOR CHILDREN:**

Postoperative Recuperation

- Recuperation includes 1 to 2 days at the hospital.
- Additional time is required for healing of the incision.
- Recuperation takes about 4 to 6 weeks on average.
- Pre-programming response training can be started or continued during the recuperation period.

Speech Processor programming

- Programming patient contact time is often longer for children than adults as they have shorter attention spans and require more breaks.
- Several days may be required to develop the program for long-term use.

- Regular visits should be scheduled for the first 6 months so that the processing can be refined as the child gains more experience with sound.

Rehabilitation/Habilitation training

- The habilitation/rehabilitation period for children will be long-term and emphasis of initial sessions at the implant centre is on continued training of auditory concepts as the program is refined, along with practice with the processed signal.
- Follow up Visits
- Follow up visits should be scheduled at 6 month interval for 2 years, and then once in a year.
- At follow up sessions, the child's MAP should be assessed and adjusted as necessary.
- Follow up questionnaires are administered. Time set aside for Counselling.

Post operative evaluations

- Annual evaluations are recommended.
- Evaluations should include warble tone thresholds in the sound field, closed or open set speech perception tests, and measurement of speech reading ability.

Recommended postoperative protocol

- Warble tone and speech detection thresholds (in sound field)
- CID Early speech perception test.
- NU-CHIPS
- GASP words
- MAC
- CID sentences.
- PBK words

2. **FOR ADULTS:**

Postoperative Recuperation

- Recuperation includes 1 to 2 days at the hospital.

- Additional time is required for healing of the incision.
- Recuperation takes about 4 to 6 weeks on average.
- Pre programming response training can be started or continued during the recuperation period.

Speech Processor programming

- Approximately 9 hours of patient contact time is required for the initial fitting procedure.
- Three hour test sessions, one each for 3 days, provide the patient with experience with the device (including overnight at home) before the speech processor is programmed for long term use.

Rehabilitation

- The first half of the session is used for testing, evaluating, and reprogramming the speech processor.
- The second half of each session is used for counselling and practice with the speech processed signal.
- Pre-lingual deafened individuals need extensive auditory training to get the most out of their potential with the cochlear implant. It is important for patients and family members to recognize that a long time course is required for the development of auditory skills. Also, consistent use of cochlear implant is important for the development of auditory skills.

Follow up

- Post operative follow up checks are suggested at 6 months, 1 year, and yearly, with additional training available if the patient needs it.
- A minimum of 4 weeks of home experience with the cochlear implant device is suggested before the postoperative evaluation

Recommended Postoperative protocol

- Warble tone and speech detection thresholds (in sound field) with the cochlear implant.
- Four choice spondees.

- Vowel identification.
- Monosyllabic words (NU6)
- CID sentences.
- Iowa sentences.

Equipment

During mapping the headset is connected to the speech processor and placed over the implant. The recipient's system via the processor is connected to the programming system via the programming cable and the programming system is connected to the computer that runs the programming software.

2.5 Classroom Amplification System

In a classroom situation, the children with hearing impairment usually sit some distance away from the teacher. Due to their physical placement, the signal to noise ratio available at the ears of the children is much poorer than what is available in a one to one situation. This leads to reduction in the intelligibility of the speech of the teacher. So various method have been adopted to overcome these difficulties and to increase the distance between the teacher and the students in classroom situation. So classroom amplification system is necessary.

Individual hearing aid:

Children using individual hearing aid experience all the difficulties of an increase in the signal to noise ratio in a classroom situation. When the acoustic environment of the classroom is not satisfactory, then speech intelligibility is affected.

Hardwire Group Hearing Aid System:

The amplification device which is used simultaneously more than two persons at a time is called group hearing aid.

Hardwire system is one of the group hearing aid in which the microphone and headphones separately connected to the amplifier by means of electric cables.

This system consists of teacher's microphone, amplifier, a set of headphones, student's microphone attenuator box and mixers.

Teacher's microphone is connected to amplifier and the set of headphones are also connected with amplifier and amplifier is connected with power supply. For two headphones one microphone is provided and these are connected with the mixer. In mixer there are many switches to control individual or by the students.

When the teacher speaks, the teacher's microphone converts sound energy to electrical energy which is amplified by the amplifier. The amplified electrical energy is again converted into sound energy by earphones and thus the children hear the teacher's volume. Volume control is attached with each earphones of headset separately. Hence, the gain of headphones can be controlled separately. When the child speaks, the student microphone converts sound energy into electrical energy and amplified the input signal. Then the same process occurs as in the case of teacher's microphone. In this way the children are able to hear their own speech or the speech of other children in the classroom.

Advantages:

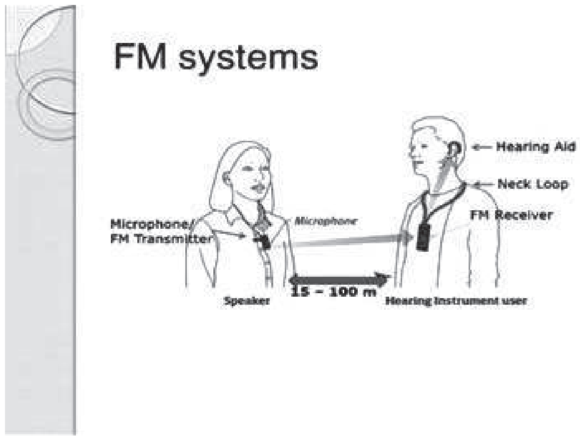
1) This system provides good speech quality because of higher signal to noise ratio and here the distortion is less.
2) The range of frequency response of group hearing aid is wide (from 200 Hz to 6000 Hz) and output deliver by the headphone is also wider as compared to receiver of conventional hearing aid.
3) The distortion of the microphone will be less because of its high powerful microphone.
4) Communication between student vs. teacher, teacher vs. students and student vs. student will be better.
5) Each student irrespective of distance from the teacher can get equal input.

Disadvantages:

1) Mobility of the student is collapsed here. Learning by activities is an important part of education especially in children and this is totally impossible here.
2) The headphone is heavy and cover the larger part of the head, it may create difficulty sometimes in children.
3) The attenuator may be misused regularly by children.

FM System

FM hearing systems are also sometimes called as the wireless hearing systems. This system consists of a microphone, a FM transmitter, amplifier and processor. Each child in the class has FM receiver, processor and amplifier.



Functions:

Microphone picks up the acoustical signal and converts it into electrical signal. Then it is amplified by amplifier. The speech of a teacher is transmitted by means of radio waves. Audio waves are superimposed on radio-waves in FM circuit. Radiowaves act as a carry wave. The transmitter transmitted the radio-waves into the atmosphere.

These radio-waves are detected and received by the FM receiver and it converts into acoustical energy.

Advantages:

1) Mobility of child is present.
2) Here signal to noise ratio is very higher.
3) Sound quality is very good. This is the reason that hearing is better and education is better.
4) There is no question of spill-over.
5) Frequency response is of wide range.
6) Teacher vs. student communication and student vs. student communication are present here. Therefore this is the best amplification for classroom.
7) Electromagnetic interference is generally not a problem here.
4) It cannot be used outside the classroom.

2.6 Loop Induction System

It is one of the method of providing amplification for the children with hearing impairment using the conventional hearing aid. A loop induction system can be used in conjunction with the individual hearing aid. Loop induction system consists of group of components consists of a microphone, an amplifier, an impedance matching transformer, a loop of wire fixed around the inner walls of the room and a hearing aid which have the telephone pick up or telecoil facility. Usually copper wire is used around the room at the 3 feet higher from the floor (in classroom situation).

Functions:

The speech signal from the speaker or teacher is picked up by the microphone, and amplifier of the system amplifies the input signal and fed to the loop. The electrical current passing through the loop produces electromagnetic field within the room. Suppose a child using conventional hearing aid on "T" position (telecoil is on) the telecoil in the hearing aid pick up the signal (electromagnetic waves) and amplify this signal by amplifier and then the receiver converts it to acoustical energy or sound energy.

If hearing aid position is on "M", the microphone cannot pick up electromagnetic wave because it only picks up acoustical energy. When the wearer wishes to hear sounds from the environment, to hear friend's talking for instance then he must be fitted with a switch that allows the microphone to remain operative. This is known as an "MT" switch. Where a hearing aid is not in use, separate induction loop receivers can be used.

Advantages:

1) Mobility of student is not restricted. Here child can move freely, inside the classroom. That is the reason learning through activity is better.
2) Signal to noise ratio is better because the microphone is close to the teacher's mouth.
3) This system is the most in expensive than others, require little maintenance, work relatively well.
4) The children have the advantages of continuing to use their own hearing aids, when the system is in use and the environmental noises are also cut off because of hearing aid is on "T" position.
5) It may also be use in public area such as railway station, own TV room etc.

Disadvantages:

1) Using loop induction system in the spill over effect. The electromagnetic waves generated by the system do not remain confined to the boundaries of the room and infiltrate the other neighboring rooms as well. This is the reason it would create problems of interferences in signals when the system is used in the two adjacent rooms. This is the reason it is used in alternative classrooms.
2) There may be some space in the room where electromagnetic field is not made. From here, telecoil does not pick up electromagnetic waves. This is the reason that sound is not heard. This dead spot is called null- point. This can be avoided by re-designing the room.
3) Some hearing aids has no telecoil/ MT facility. Here student to student communication is very less. For that cordless microphone or suspension microphone should be used.
4) Even with a strong telecoil, the distance and orientation of the hearing aid telecoil from the loop can significantly affect the gain and frequency response of the signal.
5) Any device that produces a magnetic field like TV, radio may interfere with signal reception. This is the reason if a loop system is near by TV, radio station, disturbance may occur. It requires proper earthling.

2.7 Criteria for recommendation of one device over the other

Advantages of ITEs compared to BTEs

1) Considered more modern and cosmetically acceptable.
2) Better microphone placement for obtaining high frequency gain.
3) Easier to insert and remove and to adjust volume control.

Advantages of ITCs over ITEs

1) It is more cosmetically appealing than the ITE.
2) Here high frequency amplification is better.
3) Users often experience less difficulty with feedback when using the telephone, compared to the ITE.

4) Users experience less wind noise due to a more deeply seated microphone.

Advantages of ITEs over ITCs

1) More gain and output can be attained.
2) Telecoil and direct audio input are available
3) ITEs are less expensive volume control and battery is larger in size that is the reason for easier manipulation

Advantages of CICs over ITCs

1) Deep microphone placement and reduced residual ear canal volume result in a significantly increased output, and in high frequency amplification.
2) Deep fitting helps to reduce the occlusion effect.
3) It is easy to insert and remove.
4) Feedback problems are reduced, including during phone use.

ROLE OF SPECIAL EDUCATOR IN MEASURING OUTCOME OF LISTENING DEVICES

- The special educator ensures the involvement of parents of students with additional requisites in the educational processes of the children.
- The special educator collaborates closely with teachers, other professionals and administers to foster the teaching and leaning of students with additional requisites.
- Create a program geared to the assessed needs , goals & objectives, functional levels and motivational levels of students.
- Conduct frequent assessments / listening checks which focus on both long and short term needs of the students
- Selection of appropriate texts, learning aids, materials and supplies
- Supervision of students in classroom and school buildings.
- Prepars, adapts and delivers instructional materaials to deaf and head of hearing students.
- Partipation in auditory training and follow up.

2.8 Let us sum up

The hearing technology offered to DHH children in inclusive schools can consist of assistive listening devices, including teacher-worn microphones and student-worn microphones used by hearing classmates. Teachers and students must make daily use of the equipment. Their attitudes toward hearing technologies may affect the degree of usage and, accordingly, the level of participation in school. This article presents DHH children's attitudes toward the different hearing technologies offered and explores predictors that can affect the children's attitudes toward these technologies and their utilization. A comprehensive understanding of the factors affecting the utilization of HA can improve rehabilitation interventions provided by health personnel and itinerant educators both at school and at home.

2.9 Unit end exercises

1. Write an essay on amplification technologies.
2. Enumerate Assistive technologies with suitable illustrations.

2.10 References:

Clark G.M., Cowman, R.C.S., & Dowell,, R.C.(1997). Cochlear implantation for infants and children Advances. San Diego: Singualar publishing group.

Cullington H.E. (2003) Cochlear implants. London: Whurr Publishers.

Earmold Design. (2000). *Hearing & Ear Protection - Introduction,* Retrieved from www.earmolddesign.com/catalog_html/36.htm.

Kochkin, S. (1997a). *Customer Satisfaction & Subjective Benefit with High Performance Hearing Aids.* Knowles Electronics. Retrieved from www.knowlesinc.com .

Kochkin, S. (1997b). *MarkeTrak IV: What is the Viable Market for Hearing Aids?* Knowles Electronics. Retrieved from www.knowlesinc.com.

Lachapelle, R. (1999). *The Earmold.* Retrieved from www.rayshearing.com/earmold.htm .

Laurie S. Eisenberg. (2009). Clinical Management of Children with Cochlear Implants.

Microsonic, Inc. (2000a). *Custom Earmolds -- Acoustic Options.* Retrieved from www.earmolds.com/acoustic_opt.htm.

Microsonic, Inc. (2000b). *Patient Evaluation for Earmold Selection.* Retrieved from www.earmolds.com/patient_eval.htm .

National Center for Health Statistics. (1997). *Advance Data* (292). Washington, DC: Vital

Statistics of the Centers for Disease Control and Prevention.

Smedley, T, & Schow, R. (1998). Problem-Solving and Extending the Life of Your Hearing Aids. In R Carmen (Ed.), *The Consumer Handbook on Hearing Loss and Hearing Aids - A Bridge to Healing* (pp. 130-158). Sedona: Auricle Ink Publishers.

Sweetow, R. (1998). Hearing Aid Technology. In R Carmen (Ed.), *A Consumer Handbook on Hearing Loss & Hearing Aids - A Bridge to Healing* (pp. 111-129). Sedona: Auricle Ink Publishers.

Waltzman S.B. & Roland J.T. (2000). Cochlear implants. Boston: Theme publishersClinical Guidance, 2011, Cochlear

Unit 3 ❑ Assistive Devices in Management of Language & Communication

Structure

3.1 Introduction

3.2 Objectives

3.3 Meta Level Understanding of use of Technology for Language Development

3.4 Access to Whole Language: Challenges of Communication options and use of Technology for ways to Overcome

3.5 Use and Availability of Social Media for Sign Language Users: Communicative, Educational and Social Purposes

3.6 Orientation to Web Based Curriculum Based Measurement (CBM) Tools

3.7 Tele Captioning of Popular Media and its Role in Literacy Development

3.8 Let us sum up

3.9 Unit end exercises

3.10 Reference

3.1 Introduction

The terms *assistive device* or *assistive technology* can refer to any device that helps a person with hearing loss or a voice, speech, or language disorder to communicate. These terms often refer to devices that help a person to hear and understand what is being said more clearly or to express thoughts more easily. With the development of digital and wireless technologies, more and more devices are becoming available to help people with hearing, voice, speech, and language disorders communicate more meaningfully and participate more fully in their daily lives

3.2 Objectives

- Understanding developmental needs of communication

- Components of Assistive Technologies
- Users' aspect of Assistive technology
- Modalities to develop curricular framework of language usage

3.3 Meta Level Understanding of Use of Technology for Langage Development

Language development will start from the birth. During the course of time language development has been enhanced by the effective usage of high tech gadgets like computers, smart phones, tablets etc.

A variety of e-learning technologies are available for use in educational programs. In many parts of the world, education ministries and universities have invested much effort into increasing the use of the web in all its forms (for example, e-books, simulations, text messaging, podcasting. wikis, and blogs) to meet the demands of competitive markets and to bring a variety of learning choices to their learners. It has been reported that the advent of new technology has a positive influence on both learners and teachers. Researchers have demonstrated that technology boosts the development of teaching methods as well as students' knowledge. Technology provides learners with regulation of their own learning process and easy access to information the teacher may not be able to provide. The potentially positive side of incorporating technology has encouraged foreign language educators to apply its advantages to enhance pedagogical practices. However, the integration of technology in the classroom cannot be devoid of problems. This paper aims to discuss both the positive and negative aspects of technology use so as to provide practicing teachers and researchers with some essential background information and useful references. The list is not exhaustive but serves to be a starting point for interested readers. We will begin with the advantages. In addition, technology appears to improve language learners' academic ability. Computer Assisted Language Learning (CALL) can do just this. This improvement is probably achieved by changing students' learning attitudes and boosting their self-confidence. The use of technology enhances learners' language proficiency and their overall academic skills. The advent of technology and development in the field of education has accelerated a shift from teacher-centered to learner-centered approaches in language learning and teaching. To meet the needs of digitally grown-up learners, teachers need to adopt a different role. They need to be facilitators, rather than the traditional bench-bound instructors, and they need to support and guide students' learning. Learning technologies support this important shift for the benefit of the learner.

3.4 Access To Whole Languge : Challenges of Communication Options And Use of Technology for ways To Overcome

Audiological (re)habilitation and aural (re)habilitationrefer to a widerange of modalities employed by the audiologist tomaximize the hearing-impaired patient's ability tolive and communicate in a world of sound. The modalities of audiological intervention include the use of physical instruments such as hearing aids, cochlear implants, tactile aids, and hearing assistance technologies, as well as therapeutic approaches like patient and family counseling, developing effective communication strategies, and auditory-visual training. To this list must be added referrals to and interactions with other professionals who are involved with the patient's management, such as speech-language pathologists, physicians, psychologists, teachers, etc.The primary step in audiological management involves determining the need for amplification, and then providing the patient with it, always staying mindful of the fact that the hearing aid is partof the aural rehabilitationprocess, and not an end unto itself. This concept is by no means limited to hearing aids, but applies equally to cochlear implants, hearing assistance technologies, and tinnitus management. In each case, the overall process involves considerations of the patient's *candidacy* for intervention; the *selection* of the instrument; *verification*of its fit, functioning, and ability to provide the prescribed characteristics; and validationof the patient's performance; as well as counseling, monitoring,and follow-up.

Candidacy for Audiological Intervention

Who is a candidate for audiological interventions, such as amplification? The consensus of current opinion is that any patient complaining of auditory difficulties in communicative situations should be viewed as a potential candidate for audiological intervention, such as hearing aids or other kinds of assistive devices (e.g., Hawkins, Beck, Bratt, et al 1991). Clearly, the patient should have some degree of hearing loss, and the need for amplification unquestionably rises as the degree of hearing loss worsens. Complicating matters is the distinction between the *need for* amplificationdue to the extent and impact of the auditory deficit versus how much benefit thepatient experiencesfrom the hearing aid. When the hearing loss is moderate to severe, unaided speech communication is belabored or impossible (need), and this situation improves appreciably albeit not totally when hearing aids are worn (benefit). What's more, the improvement is readily appreciated by the patient and by others. However, the need for amplification can be ambiguous in cases considered to be marginal because of a mild, high-frequency, or unilateral loss. Here the degree to which the hearing loss affects speech communication is often subtle, inconsistent, and situational, depending on such factors as speaking level, whether there are background or competing noises, and the communicative demandsof the patient's occupational and social interactions. The benefits of amplification can be similarly subtle and inconsistent in patients with marginal impairments, so that a patient may need a hearing psychology aidbut perceive little or no benefit from it. However,little perceived benefit does not mean no benefit. The subtle benefits of amplification often become apparent when the patient forgets to bring his hearing aid to an important meeting or must do without the instrument while it is being repaired. At the opposite extreme, patients with profound losses have the greatest need for hearing aids, but they often receive relatively little benefit in terms of auditory speech reception because their residual auditory capability is often minimal. Again, however, remember thatlimited benefit for the purpose of hearing speech is not the same as no benefit at all. On the contrary, patients with profound losses benefit considerably from their hearing aids in terms of the ability to hear for alerting, warning, and emergency signals, and as an aid to lipreading. Clearly, hearing aid candidacy depends on more than auditory status alone, and is particularly affected by the patient's communicative requirements and theneed to rely on auditory information. Other motivational factors interact with the hearing loss to induce the patient to see an audiologist, and then to follow the recommendation to obtain hearing aids and to use them. Some of the major factors that appear to motivate patients to obtain a hearing aid for the first time include communication problems at home, in noisy listening situations, in social situations, and at work, as well as encouragement by the spouse (Bender &Mueller 1984Acceptance of the hearing impairment itself and of the need for clinical assistance to deal with it alsoweighs heavily in the patient's decision to obtain amplification. A patient in one of the "marginal" categories is often not willing to accept himself as hearing impaired, let alone so much so that amplification is needed. This is particularly true when the loss has developed slowly and insidiously over a long period of time.

Special candidacy issues come into play with pediatric patients, and it is essential for comprehensive intervention including appropriate amplification to be introduced as soon as possible (e.g., PWG 1996; JCIH 2007, 2013; AAA 2013). It is important to be mindful that infants and children are in the process of developing auditory skills, speech, language, and world knowledge. Thus, the hearing-impaired child is faced with a double challenge because

(1) development in these areas relies heavily on auditoryinput, and

(2) she cannot depend on linguistic and world knowledge to make up for missed sounds.

At this point, it important to mention a large-sample prospective study by Ching, Dillon, Marnane, et al(2013) because it overcame many of the limitations ofprior studies that failed to provide cogent support for early intervention for young children with prelingualhearing loss (see, e.g., Puig, Municio, &Medà 2005;Wolff et al 2010). They found that better speech/ language and related performance in prelinguallyhearing-impaired 3-year-olds was significantly associated with (1) cochlear implants that were turned on at an earlier date, (2) less severe hearing losses, (3) no other disabilities, (4) female gender, and (5) higher maternal education.1 The significant impact of cochlear implants highlights the efficacy of early intervention with children with severe and profound losses. In fact, delaying cochlear implantation from 10 months to 24 months was associated with a dramatic decrease in performance scores at age 3. In addition to the considerations already discussed, hearing-impaired infants and children are also candidates for amplification if they have unilateral and/or mild losses, or permanent conductive losses, as well as for a trial period with hearing aids when cochlear implants are being considered and in cases of auditory neuropathy syndrome disorder (see, e.g., GDC 2008; Roush, Frymark, Venediktov, &Wang 2011; AAA 2013).

Research indicates that practices offering aural rehabilitation (AR) tend to have higher rates of hearing aid satisfaction, along with fewer hearing aids returned for credit (Kochkin, 1999). AR is an important aspect of treating a patient with hearing loss; however, it is often overlooked by the hearing health-care provider, as much of the emphasis of treating individuals with hearing loss focuses on the technology of the device rather than rehabilitation. While technology does play a large and important role, aural rehabilitation is still necessary and vital in increasing patient satisfaction. Despite exciting and rapidly advancing developments, technology alone often is not enough to address a patient's hearing needs. The use of AR can be likened to the repair of a broken arm in which surgical treatment is provided to repair the damage. Once the medical and surgical treatment is completed, it is still important to exercise the arm to achieve maximum recovery. It is not so different with hearing aids. Just as we provide hearing aid technology as treatment of hearing loss, the brain still needs to be "exercised" to maximize the benefit received. In addition to demonstrating lower hearing aid returns and better outcomes (Kochkin, 1999), another advantage of AR is that it requires the patient to be an active participant in his or her own care, treatment, and eventual success. Patients are encouraged and guided to learn management strategies that can empower them to advocate for themselves. Aural rehabilitation addresses the patient as a whole, which includes active input and collaboration. Incorporating AR into a hearing aid fitting allows audiologists to offer a customized, patient-centered approach to obtaining amplification. This collaboration can improve the patient's satisfaction with hearing aids. AR also has the potential to emphasize audiology from other hearing service professionals because it positions the audiologist to look at the patient as a whole entity beyond the prism of technology. In a competitive market of "big box" stores and hearing aids delivered over the Internet, the ability to offer AR provides the audiology professional with an opportunity to remain relevant and viable while better serving patients. As sales over the Internet have the potential to grow, so does the potential of dissatisfaction. The Internet is not an ideal forum for hearing aid candidates to discuss issues related to their hearing loss and it lacks personal contact with a knowledgeable professional best able to provide assistance beyond the technology. The training of an audiologist provides the knowledge to address the patient's unique hearing needs along with the psychosocial aspects related to the loss. This holistic view equips and prepares the audiologist to implement recommendations beyond providing hearing aid technology. Aural rehabilitation has become a more streamlined service to offer, with an increasing number of affordable and customizable treatment options with the advancement of the Internet, computers, and tablets. AR is often viewed as financially limiting in the confines of most practices. However, using new AR delivery models can provide a cost-effective opportunity to incorporate AR into your practice. Some clinicians prefer a traditional style of AR that involves direct, in-person patient contact. A cost-effective alternative to this option is a group workshop. This eliminates the time spent on individual programs and it allows this service to be provided in a group environment. A group dynamic also offers the opportunity for patients to provide support to each other and discuss their relevant experiences. Multiple participants will also allow the program to be offered at a lower cost to the individual patient. If you choose to offer individual or group sessions, remember these should be provided on a fee-for-service schedule as appropriate. Consider supplementing formal programs with informal AR exercises as well. Melissa Heche, AuD, from New York Speech and Hearing, Inc., reported that she provides exercises that are tailored to the patient's needs, lifestyle, and experiences. An example of this includes a therapy in which she introduces music (sometimes using specific notes on a piano), infiltrates environmental noises, and asks the patient to perform and actively listen to a variety of phonemic exercises. One of the more popular types of AR that has been increasing in visibility is the LACE (Listening and Communication Enhancement) program. LACE is a computer-based software that allows patients to complete the training at home on their own time. As a way to increase participation, some clinics have chosen to include the LACE program as part of a complete hearing rehabilitation package bundled into the cost of the hearing aids and service. Some clinics will offer the program as an additional option to purchase. The advantage of incorporating the LACE into your program is that it helps reinforce the notion that the rehabilitation process consists of several components. The hearing aid serves as the tool to provide access to sound, and AR is the exercise used with the tool to maximize auditory processing. Offering LACE as part of the program eliminates the need for patients to "choose" to participate, and it simply becomes part of the process. Patients can be registered for LACE at the time of the hearing aid evaluation or at the time of the fitting. Getting registered is the first step toward participation. The actual sessions can then be initiated either at the time of the fitting or several weeks after they have worn their hearing aids. The program should be monitored to ensure follow-through. Audiologists, assistants, or staff can conduct follow-up calls to the patient. Progress can also be tracked online, allowing for continued contact with patients regarding their training at follow-up appointments. This also provides an opportunity to provide reminders to continue or start sessions. Some clinics will offer incentives such as free batteries to complete a set amount of LACE sessions within a certain time period. There are also alternatives to LACE. Some manufacturers have developed programs that can be used in the office or at home. This includes Starkey's Hear Coach app currently available for use on Mac-supported devices, including iPhones/iPads, and is also available on Android-supported technologies. This may be a great option for your more technologically savvy clients and will give them the opportunity to complete their AR on the go. As discussed, the importance of incorporating AR into our daily practice is evident, and there are ways to make it more cost-effective. AR can be used in any clinic environment with delegation and practice, and we should all be making an attempt to incorporate this service to maximize our patient's success. Not every patient may be inclined to participate in AR, but at the very least our patients should be counseled regarding the important role it plays in their success, and it should be provided as an option.

The treatment phasealso addresses several broad areas of redemption:

(1) Psychosocial counselingis provided, dealing with such factors as explaining the nature of the hearing loss, helping the patient and her family understand its ramifications, and dealing with the patient's attitudes regarding aural rehabilitation.

Of course, audiological counseling should not meander into the realm of psychotherapy, the need for which should be handled by appropriate referrals.

(2) Amplification and other instruments are a major component of the intervention process. These instruments include hearing aids, group amplification devices, and other assistive listening and warning devices. The instruments must be selected and fitted, and must also be adjusted over time. Theaudiologist also orients and instructs the patient (and often others as well) regarding the use and care of each device, its use in various situations, coordination with other devices, etc.

(3) Communication traininginvolves learning strategies to improve communicativesituations and listening effectiveness,as well as developing skills through auditory-visualtraining, and other activities.

(4) The overall coordinationphase of the program deals with making useof other professionals and resources that are appropriatein a given case, such as vocational rehabilitation,social work, psychology, medicine, etc.

3.5 Use And Availability of Social Media For Sign Language Users

Sign Languages (SL) are necessary for the intellectual development of Deaf children. They are complete linguistic system used by the Deaf Culture for education, communication, creation and dissemination of knowledge. Arbitrarily forbidden for more than 100 years, the lack of SL artifacts is now a major problem the Deaf: there are few loci where they can interact in their own language (i.e. there are few media in SL). The recent growth in social media (virtual applications that allow the user to create and share their own content) has provided a new vector for the use of SL (whether in real time, or separated in space and time) and value SL as a Language of culture, identity and inclusion. The research surveyed Deaf students of a Bachelors program in Linguistics and shows that social media has become a new Agora for the Deaf Culture. Social

Media and the Deaf Bishop, Taylor and Froy, discussed the potential of computer-mediated communication to reduce the social isolation experienced by the Deaf, and found that the subjects demonstrated that the use of social media could be less stressful. Barak and Sadovsky showed that the use of social media brought extra benefits for the Deaf because it is a means of communication that is primarily based on visual and images, and not on the auditory channels; and that the Deaf were more prone to use social media, and concluded that the use of social media may be seen as an empowering aid. Other studies treated the Deaf as deficient, such as that conducted a study on the implications of communication as social engagement for interactions between Deaf and non-Deaf people. Donovan, examined the online health information seeking practices of the Deaf using existing tools based on the oral language, which mirrors the findings of Zazove et al., that the use of Internet was associated with the English language. Lomick and Blogg found that Deaf people relied more on blogs and vlogs as important communication tools during a social movement activisms at a school for Deaf. As can be seen, most of these studies treat deafness as a disease to be hidden from others. We find in Möbus one of the few studies that are concerned about the use of SL to make digital content accessible. Valentine and Skelton explore how the Deaf are using the Internet to communicate within their community given a new space and boost to their activities. And Blom et al. explores ways in which Deaf people find online friends. This is a clear call for further research on the informational and communication practices of the Deaf using SL in social media. Language and communication with people are paramount to create understanding and appreciation for diverse cultures and perspectives. Traditional social venues such as school, clubs, associations and church, for example, provide opportunities for important human interaction and socialization. In the digital environment, individuals are capable of finding those who share the same linguistic codes, like SL, and thus are exposed to learning, exchange of experiences, diversity of information whereas otherwise they might be isolated (e.g. consider the case of a Deaf individual living in rural areas). The Deaf may also find others who use the written form of the oral language, and try to expand their inclusion into that world, and increase their social life. Most social media studies show that the value of using social media is that it builds relationships through making new friends that participate in social communities. Social media use also allows for members to support one another. As such, the use of social media is related to social capital gains. Putnam, describes Social Capital as the “features of social organizations such as networks, norms, and social trust that facilitate coordination and cooperation for mutual benefit”. Social capital can be expressed when the ties refer to emotionally supportive relations. In other words, social capital is what is acquired through relations among people who trust one another, who are more inclined to share personal experiences and help their peers, count on the collaboration of others, reduce conflicts. Social media interaction can increase self esteem through conflict resolution; and can reduce uncertainty and suspicion of others. For example, the use of social media makes individuals feel happier. Many research has shown that social media is more interactive (than traditional media such as television): they allow for interactions with various people who regardless of political, socio-economic and geographical barriers. Unfortunately, most social media available are designed for non-Deaf people (i.e. heavily relied on text). But social media that provide the ability for the user to post video and to make video calls present a new opportunity for the Deaf. Given that social interaction and communication provide social support and sense of belonging, it is valid to research how the Deaf are using these new social media for their well-being.

The D/deaf and users of British Sign Language (BSL) have a very strong culture which includes attitudes, behaviours, history and norms. Since 2003, BSL has been recognised as a language in its own right and is often, the preferred language of D/deaf people in the UK. The D/deaf do not consider themselves to be disabled, just different from those who can hear. One advantage is that groups are very easy to set up, and it has become a platform to promote activities such as information and learning. Social media also has the ability to connect both local and national groups, and when sites such as Facebook first became popular, it allowed for BSL users to be able to communicate instantly with hearing friends, family and groups online.

There are a large range of D/deaf groups and the Deaf Opinions Group is a particularly popular group, and the brain child of Angel Walford. Angel is a freelance support worker, who set up the group on Facebook to help people obtain easy access to information people often asked her about. It's this type of group that provides the function of a D/deaf club on a very large scale.

The only snag with social media is that users of BSL have experienced difficulties in fully engaging, due to the fact that English is not their first language. Status updates are written in English text and BSL has its own grammatical structure

This has led to BSL users posting their updates in the form of video. Online activity means that deaf organizations such as the British Deaf Association (BDA) have been required to adapt. David Buxton who is the Director of Campaigns and Communications said “The BDA produces a large amount of video in BSL for posting on Facebook. This means D/deaf people do not have to rely on written statements or stories which they sometimes find difficult to follow.”

One concern is that Facebook’s popularity amongst the D/deaf and BSL users could lead to more D/deaf clubs within the community closing, and fewer opportunities for people to physically meet and sign with each other face-to-face. However, most D/deaf people feel the benefits outweigh the negatives.

Communicative Approaches

Several communication approaches and techniques are available for use by the hearing impaired and deaf. Because the means of communication cannot be separated from the overall habilitation and education of this population, the choice of which communication method will be used is a central issue in the education of the hearing impaired and deaf. Audiologists have a responsibility to inform parents about the approaches available for their children. However, we must remember that we share this responsibility with other professionals such as educators of the

deaf and speech-language pathologists, and that the final placement decision rests with the child’s parents. In fact, even though the JCIH (2013) guidelines highlight the importance of *listening and spokenlanguage*, they make it clear that *language* means “all spoken and signed languages” (p. *e*1325); thus, families may choose American Sign Language (ASL) as the preferred communication mode, and services in these cases should be provided by people who are fully competent in ASL.

Manual Systems

American Sign Language (ASL) developed as the manual language of the deaf community. It is not a “translation” of the English language into a set of equivalent signs, but is rather a language unto itself with its own lexicon and grammatical rules. This concept can be difficult for hearing individuals to understand even if they have learned to speak a foreign language like Spanish or German, either of which is a spoken language. In contrast to *spoken*languages, which are suited to transmission via sound (acoustic spectra that change with time), ASL uses *spatial* dimensions (hand shakes, movements, and locations and orientations relative to the signer’s body) over time. Signed English (Bornstein 1974) is similar in many ways to ASL, with modificationsintended for use by younger children, suchas the addition of signed pronouns, helping verbs,and syntactic markers. A variety of other signing systems have been developed over the years that have attempted to represent the spoken language manually; however, these have not received the wide acceptance enjoyed by ASL.

Fingerspelling involves hand positions and motions corresponding to the conventional 26 letters of the alphabet. Words are spelled out with letters in order. Fingerspelling is employed by users of both oral/aural and manual systems.

Cued speech (Cornett 1967) is a visual system used to supplement lipreading. It uses a total of 12 hand postures and positions produced by the talker while speaking to help the speechreader distinguish between homophonous sounds.

Total communication encourages the combined use of both speech and/or sign language in whatever combination fosters the child's best language development (Jordan, Gustason, & Rosen 1979). This approach has replaced oralism as the principal means of communication in most educational institutions for the hearing impaired. The relative advantages of oral versus total communication programs for the speech communication abilities of profoundly hearing-impaired children have always been controversial. Studies comparing the effects of these two types of settings have yielded conflicting results. One reason for the inconsistencies involves comparisons among elementary school children whose communicative skills are still being developed.Geers and Moog (1992) improved our understanding of this issue by comparing two large, well-matched groups of teenagers with profound hearing impairments who were educated in either oral versus total communication programs since they were in preschool. They found that speech perception, speech production, and oral communication skills were significantly better for the subjects who were educated in oral programs.

Todomais a manual system employed by individuals who are both deaf and blind. In the Todoma method, the "listener" feels the talker's face and neck. Reed and colleagues (1985) found that speech reception by Todoma relies principally on the feel of lip and jaw movements, laryngeal vibration, and oral air flow, and secondarily on the feel of muscle tension and nasal air flow.

3.6 Orientation to Web based Curriculum Based Measurement (CBM) Tools.

Curriculum-based measurement, or CBM, is a method of monitoring student educational progress through direct assessment of academic skills. CBM can be used to measure basic skills in reading, mathematics, spelling, and written expression. It can also be used to monitor readiness skills. When using CBM, the instructor gives the student brief, timed samples, or “probes,” made up of academic material taken from the child’s school curriculum.

Curriculum-Based Measurement (CBM) is a method teachers use to find out how students are progressing in basic academic areas such as math, reading, writing, and spelling.

CBM can be helpful to parents because it provides current, week-by-week information on the progress their children are making. When your child’s teacher uses CBM, he or she finds out how well your child is progressing in learning the content for the academic year. CBM also monitors the success of the instruction your child is receiving – if your child’s performance is not meeting expectations, the teacher then changes the way of teaching your child to try to find the type and amount of instruction your child needs to make sufficient progress toward meeting the academic goals.

When CBM is used, each child is tested briefly each week. The tests generally last from 1 to 5 minutes. The teacher counts the number of correct and incorrect responses made in the time allotted to find the child’s score. For example, in reading, the child may be asked to read aloud for one minute. Each child’s scores are recorded on a graph and compared to the expected performance on the content for that year. The graph allows the teacher, and you, to see quickly how the child’s performance compares to expectations. (The figure below is an example of what a CBM graph looks like.)

After the scores are entered on the graphs, the teacher decides whether to continue instruction in the same way, or to change it. A change is called for if the child’s rate of learning progress is lower than is needed to meet the goal for the year.

The teacher can change instruction in any of several ways. For example, he or she might increase instructional time, change a teaching technique or way of presenting the material, or change a grouping arrangement (for example, individual instruction instead of small-group instruction). After the change, you — and the teacher — can see from the weekly scores on the graph whether the change is helping your child. If it is not, then the teacher can try another change in instruction, and its success will be tracked through the weekly measurements.

CBM can also help you work more effectively with the school system on your child’s behalf. CBM graphs make the goals, and your child’s progress, clear to you and to the teacher. In this way, CBM can help parents and teachers communicate more constructively.

In contrast to norm-referenced academic achievement tests, CBM offers distinct advantages. Using CBM, an instructor can quickly determine the average academic performance of a classroom. By comparing a given child's CBM performance in basic skill areas to these classroom, or local, norms, the teacher can then better judge whether that child's school-skills are significantly delayed in relation to those of classmates. CBM has other benefits as well: Good overlap with curriculum Because CBM probes are made up of materials taken from the local curriculum, there is an appropriate overlap between classroom instruction and the testing materials used. In effect, CBM allows the teacher to better test what is being taught. Quick to administer CBM probes are quick to administer. For example, to obtain a single CBM reading fluency measure, the instructor asks the student to read aloud for 3 minutes. CBM measures in math, writing, and spelling are also quite brief. Can be given often CBM probes can be given repeatedly in a short span of time. In fact, CBM probes can be given frequently, even daily if desired. The resulting information can then be graphed to demonstrate student progress. Sensitive to short-term gain in academic skills Unlike many norm-referenced tests, CBM has been found to be sensitive to short-term student gains. In fact, CBM is so useful a measure of student academic progress that teachers employing it can often determine in as short a span as several weeks whether a student is making appropriate gains in school skills. Q: What effect does CBM have on academic progress? A: Instructors are faced with a central problem: they cannot predict with complete assurance that a particular instructional intervention will be effective with a selected student. The truth is that only through careful observation and data gathering can teachers know if a child's educational program is really effective. Much of the power of CBM, therefore, seems to lie in its ability to predict in a short time whether an intervention is working or needs to be altered. By monitoring students on a regular basis using CBM the teacher can quickly shift away from educational programming that is not found to be sufficiently effective in increasing a child's rate of learning. In fact, research has shown that teachers who use CBM to monitor the effectiveness of instructional interventions tend to achieve significantly higher rates of student learning than those instructors who rely on more traditional test measures.

3.7 Tele Captioning of Popular Media And Its Role in Literacy Development

Hearing aids are devices that boost sound levels so the patient canhear them. This process is called **amplification**. Most simply, a hearing aid amplifies sounds justlike a megaphone, except the amplified sound is directed right into the listener's ear. The hearing aid's **microphone**picks up sounds and converts them into an electrical signal. A device that transforms energy from one form to another is called a **transducer**. Thus, the microphone is an acoustic-to-electrical transducer.Once the sound has been changed into an electrical signal it can be manipulated by electronic circuits. Obviously, the principal manipulation is to boost its intensity, that is, to *amplify* it. This is done by the **amplifier**. The amplified electrical signal is then converted back into sound by an electrical-to-acoustic transducer or loudspeaker. The hearing aid's loudspeaker is called the **receiver**. The amplified sound from the receiver is directed into the patient's ear. Two other components of all hearing aids should be mentioned at this time. One is the **battery**, which provides the power to accomplish all of the hearing aid's functions. The other is the **earmould**, which is the object actually inserted into the patient's ear. In fact, the majority of modern hearing aids are completely contained within the earmould itself. Earmouldsare almost always custom-made from an impression taken of the ear. The sounds picked up by the microphone are called the **input** to the hearing aid and the sounds produced by the receiver are called the **output**. The patient hears the output from the hearing aid. The amount of amplification is called **gain**. Any hearing aid has a range of gains that it can generate, and the patient has some degree of control over this gain by using a **volume control**(more technically called a **gain control**), just like the volume control of a radio. The sound level of a hearing aid's output cannot be limitless. The greatest sound magnitude that canbe produced by a hearing aid is quite descriptively called its **maximum power output (MPO)** or **outputsound pressure level (OSPL)**. Itrefers to the output of the hearing aid in dB SPL when the hearing aid is saturated. In fact, OSPL used to be called *saturationsound pressure level (SSPL).*

Two more commonly encountered hearing aidcomponents are worthy of mention. One of theseis the **tone control**. It adds flexibility to the instrumentby adjusting the relative levels of the higherand lower frequencies much like the bass and trebleon a stereo set. The **telecoil**is a circuit that allows the hearing aid to pick up magnetic signals generated by many telephone receivers instead of using the microphone. Telecoils are associated with a switch labeled “M/T”or “M/T/MT,” allowing the patient to select between using the hearing aid’s microphone **(M)** in the normal manner, using the telecoil**(T)** while bypassing the microphone, or in some cases using the microphone and telecoil simultaneously **(MT)**. The telecoilallows the patient to hear the telephone signal withoutinterference from noises in the room, and/or to attend to a telephone conversation that would not be possible using the microphone. The MT position might be selected when the patient desires to hear the phone clearly but also needs to hear what is going on around her, or when she needs her hearing aid to monitor her own voice while speaking on the phone.

TYPES OF HEARING AIDS

Body hearing aidscontain all of their components and controls (except for the receiver and earmold) in a case about the size of a small pocket calculator. A wire leads from the case to the receiver and earmoldat the patient’s ear. The case is usually worn somewhere on the chest. Typical locations are in a chest-level pocket; clipped to a shirt, jacket, or undergarment; or in a specially made harness.

Behind-the-ear (BTE)orpost-auricularinstruments have their components contained in a crescent-shaped plastic case that fits behind the auricle. The amplified sound produced by the receiver, which is located in the case ofthe instrument, is transmitted via a plastic tube to an earmold in the patient’s ear.

Receiver-in-the-canal (RIC) hearing aid is a noteworthy modification of the BTE arrangement in which the receiver is located inside of the patient’s ear canal, and is connected to the body of the instrument by a tiny wire. The more powerful models of BTE instruments rival the amounts of gain that could only be provided by body aids in the past, although many patients with very severe and profound losses still require body instruments.

Eyeglass hearing aids have their components built into the temple piece of the patient’s glasses. Similar to BTEs, the receiver output goes through a plastic tube to an earmold in the patient’s ear. These instruments have various practical problems because they are part of and inseparable from the patient’s eyeglasses, and are rarely used anymore.

In-the-ear (ITE) hearing aids have all of their components built into the earmold. In spite of their small size, the technology has progressed to the point that a majority of patients can now be fitted with ITE-type instruments. In-the-ear hearing aids vary widely in size. The largest ones fill the whole concha and extend into the ear canal. Smaller units take up less and less of the concha, and the smallestones fit completely into the ear canal. The lattergroup constitutes a category of instruments called completely-in-the-canal (CIC)hearing aids. To be considered a CIC instrument, the outermost partof the device must be at least 1 to 2 mm inside of the ear canal entrance. Very tiny CIC instruments are sometimes called invisible in-the-canal (IIC) hearing aids. Most CICs also are deep canal fittings, meaning that the device extends into the bony part of the canal so its receiver end is within ~ 5 mm of the eardrum. (Actually, a deep canal fitting can be achieved with any kind of hearing aid as long as its earmold extends this deep into the external auditorymeatus.)

Telephone Devices

Hearing aid compatibility has been required for most new telephones since 1991. The simplest systems are telephones that provide amplified signals, often with a volume control. The use of special telephone amplifiers is facilitated by the common use of modular telephone connectors, which are available as special replacement handsets or as in-line amplifiers installed between the telephone and the handset. One should be sure to check for electronic compatibility with the telephone when using replacement handsets and in-line amplifiers. Several telephones specially designed for use by the hearing impaired are also available, as are various portable amplifiers. Portable amplifiers and other instruments can pick up either acoustic or magnetic signals from telephones, or are connected by direct audio input.

Telecommunication devices for the deaf (TDDs)or **text telephones (TTs)** as well as personal computers(PCs) provide telephone access for those who cannothear amplified speech from the telephone. The TDD is basically a portable terminal that sends and receives typed messages via the telephone. The TDD and telephone are often connected using an acoustic coupler. Communication between people using voice telephones and TDDs (or computers) is made possible by dual-party relay systems, which telephone companies must provide under Public Law 101-336 (the Americans with Disabilities Act). Communication between TDDs and PCs has been somewhat of a problem because TDDs have traditionally used a system called **Baudot code**, whereas PCs use **ASCIIcode** and also operate at much faster transmission rates. As one might expect, TDDs are now available that can use both formats.

Television and Related Devices

Closed captioning is probably one of the best known assistive approaches in current use. It involves providing subtitles on a television monitor or movie screen giving the gist of what is being said from moment to moment. Although closed captioning previously necessitated the use of a decoder box, Public Law 101-431 (the Television Decoder Circuitry Act of 1990) mandates that closed caption decoders be built into all new television sets with screens 13 inches in size and larger. **Real-time captioning**involves providing the detailed text of what is being said, and is often desirable for lectures and similar situations.

Alerting and Safety Aides

Many hearing-impaired individuals cannot rely upon the auditory channel to know when the doorbell is ringing, when the alarm clock sounds, or when emergency signals like smoke or burglar alarms go off. For this reason, sound signals like bells, tones, buzzers, and sirens are supplemented or replaced with flashing lights and/or vibrators on all kinds of common devices. In addition, special-purpose devices are alsoavailable, such as lights or vibrators that indicatewhen a call is coming in on a telecommunication device, or when the baby is crying. Before leaving this section, we must not forget that **hearing dogs** can serve as portable alerting and assistive aides, as well as valued and loved companions, to their severely hearing-impaired or deaf owners. The right of hearing-impaired persons to have and be accompanied by their hearing dogs is protected by several federal laws, such as the *AirCarrier Access Act of 1986* for airlines, the *Americanswith Disabilities Act of 1990* for public places, and the *Federal Fair Housing Amendments Act of 1988* for housing.

Auditory and Visual Training

One of our principal goals is to maximize the amount and quality of speech information that the hearing impaired patient can obtain. This involves (1) providing an optimum acoustical signal with hearing aids or other devices, and (2) training the patient to derive the most information about the spoken message from what he hears and sees by using the acoustical and visual representations of speech to the fullest, and taking advantage of various forms of contextual and linguistic cues. Even though we will be considering some aspects of speechreading and auditory training separately, the student should know from the outset that combined auditory-visual training is usually the preferred treatment mode. Also, virtually all practice exercises can be done in the auditory, visual, or combined audiovisual mode. In fact, it is not uncommon to present exercises in all three modes to demonstrate to the patient the benefits of using all possiblecommunication channels, and to give him practice indoing so. In addition, most techniques are successfully used in both individual and group therapy.

Continuous-discourse tracking (De Filippo & Scott 1978) is a popular therapy technique that provides practice in the use of repair strategies. The clinician orally presents a passage to the patient, who must in turn repeat it back verbatim on an ongoing basis (based on vision, audition, or a combination of the two). Thus, the patient literally tracks what the clinician is saying: the clinician says a phrase, the patient repeats it word for word, the clinician presents the next phrase, the patient says it back exactly, etc. This continues until the patient makes an error. Then the clinician provides the patient with a variety of clues and prompts to help her get the correct word(s). The prompts might include repeating the misperceived word, paraphrasing it, using fill-ins, or any of a host of other tactics to help the patient get the correct word. Tracking performance is assessed in terms of the number of words per minute that can be repeated by the patient.

Computer-based approaches A growing number of computer-based auditory training programs are becoming available. Let's briefly review several of them.

The Seeing and Hearing Speech (Sensimetrics2002) program provides practice (and assessment) materials for adult patients in four groups: (1) vowels; (2) consonants; (3) stress, intonation, and length; and (4) everyday communication. The material can be presented in the auditory, visual, or combined auditory-visual mode, and a variety of noise backgrounds may be used.

Sound and Beyond includes auditory training materials for adults with severe to profound losses. It includes exercises on pitch discrimination; environmental sound discrimination and identification; discriminating male and female voices; discrimination and identification for vowels and consonants; word discrimination; sentence recognition; and identifying musical instruments and tunes.

Adaptive Listening and Communication Enhancement (**LACE**; Sweetow&Sabes 2006) providesauditory training for adults. It includes speechreception exercises in the presence of babble or acompeting talker, and for compressed speech; auditoryshort-term memory and processing speedexercises; and communication strategies. In LACE, the patient receives feedback on his responses, and the approach is adaptive in the sense that exercises increase and decrease in difficulty based on whether the patient's prior responses were correct.

Conversation Made Easy (Tye-Murray 2002) is a computer-based speechreading program that can be used in the vision-only or combined auditory-visual mode; and has versions for adults and teenagers, as well as for children with higher-level and lower-level language skills. It includes speechreading exercises involving (1) analytic exercises with sounds, words, and phrases; (2) unrelated sentence recognition with repair strategies; and (3) contextually related material with both repair and facilitative strategies.

Computer-based approaches A growing number of computer-based auditory training programs are becoming available. Let's briefly review several of them.

The Seeing and Hearing Speech (Sensimetrics2002) program provides practice (and assessment)materials for adult patients in four groups: (1) vowels; (2) consonants; (3) stress, intonation, and length; and (4) everyday communication. The material can be presented in the auditory, visual, or combined auditory-visual mode, and a variety of noise backgrounds may be used.

Sound and Beyond includes auditory training materials for adults with severe to profound losses. It includes exercises on pitch discrimination; environmental sound discrimination and identification; discriminating male and female voices; discrimination and identification forvowels and consonants; word discrimination; sentence recognition; and identifying musical instruments and tunes.

Adaptive Listening and Communication Enhancement (**LACE**; Sweetow&Sabes 2006) providesauditory training for adults. It includes speechreception exercises in the presence of babble or acompeting talker, and for compressed speech; auditoryshort-term memory and processing speedexercises; and communication strategies. In LACE,the patient receives feedback on his responses, andthe approach is adaptive in the sense that exercisesincrease and decrease in difficulty based on whetherthe patient's prior responses were correct.

Conversation Made Easy (Tye-Murray 2002) is a computer-based speechreading program that can be used in the vision-only or combined auditory-visual mode; and has versions for adults and teenagers, as well as for children with higher-level and lower-level language skills. It includes speechreading exercises involving (1) analytic exercises with sounds, words,and phrases; (2) unrelated sentence recognition with repair strategies; and (3) contextually related material with both repair and facilitative strategies.

3.8 Let us sum up

The terms assistive device or assistive technology can refer to any device that helps a person with hearing loss or a voice, speech, or language disorder to communicate. These terms often refer to devices that help a person to hear and understand what is being said more clearly or to express thoughts more easily. With the development of digital and wireless technologies, more and more devices are becoming available to help people with hearing, voice, speech, and language disorders communicate more meaningfully and participate more fully in their daily lives.

3.9 Unit end Exercises

1. **Write an essay on Assistive technologies.**
2. **How sign language is used as the substitute for spoken language in persons with hearing impairment ?**

3.10 Reference

1. Curriculum-Based Measurement: A Manual for Teachers Jim Wright Syracuse (NY) City Schools
2. Dillon, H. (2001) .Hearing Aids. Boomerang press.
3. Gelfand, S. A. (1997).Essentials of Audiology. Thieme Medical Publisher.
4. Katz, Z.(2009). Hand Book of Clinical Audiology. Library of Congress Cataloging-in-Publication Data.
5. Pollack , M. C.(1988). Amplification for The Hearing-Impaired. Harcourt Brace Jovanovich, publishers.
6. The New Agora: Social Media as a Vector for Sign Language as a Language of Culture, Identity and Inclusion of the Deaf, Proceedings of the 51st Hawaii International Conference on System Sciences

Unit 4 ❑ Technology & Methods in Management of Speech

Structure:

4.1 Introduction

4.2 Objective

4.3 Parameters measured in phonation and suprasegmental aspects of speech using advance technology and their application

4.3.1 Procedures & Software used to assess Phonation and Suprasegments

4.4 Need and methods to analyse and to correct articulation of speech

4.4.1 Need for Assessment

4.4.2 Screening procedures

4.4.3 Assessment battery for Articulation / Phonological Disorders

4.4.4 Formal traditional articulation tests

4.4.5 Combined Articulation and Phonological tests

4.4.6 Phonological tests

4.4.7 Assessment of Stimulability

4.4.8 Assessing Speech Intelligibility

4.5 Selecting management techniques for Phonation and Suprasegmental aspects of Speech

4.5.1 Techniques for management of Phonation

4.5.2 Techniques for managing Suprasegments (Stress, Intonation & Rhythm)

4.6 Selecting management methods for facilitating articulation in CWHI

4.6.1 Need for treatment

4.6.2 Selection of Intervention approach (Phonetic Or Perception)

4.7 Methods to improve Speech Intelligibility; Measurement of Outcome.

4.7.1 General considerations

4.7.2 Approaches for Improving Intelligibility

4.7.3 Measurement of speech intelligibility.

4.8 Let us sum up

4.9 Unit end exercises

3.10 Reference

4.1 Introduction

Phonation:

Sounds produced from the vocal folds are called phonation. It is a physical process by which the sound is produced. The measurement of sound signal as produced by the vocal folds is important in order to identify the underlying physiological deficit of voice. This measurement can be done by 3 ways:

- Perceptual measurement
- Acoustic measurement
- Aerodynamic measurement

However there has been little standardization in measurement across laboratories. Some centers have developed their own equipment configuration for extracting acoustic information from vocal signal. Even when using the same equipment, center often differ in the way in which a portion of the vocal signal is selected for analysis. These methods provide objective data relative to a set of normal values. There is a large number of acoustic measures many which are mathematical derivation of five common features. These measures are:

1. Fundamental frequency-perceptual correlates of pitch
2. Intensity-perceptual correlates of loudness
3. Perturbation measures-cycle to cycle variation in the acoustic signal for either frequency or amplitude of the wave form.
4. SNR-Relative contribution of periodic and a periodic component of the signal.

Suprasegmental aspects:

In linguistics, prosody refers to intonation, rhythm, and vocal stress in speech.

The prosodic features of a unit of speech whether a syllable, word, phrase or clause are called suprasegmental features because they affect all the segments of the unit.

- **Stress**: Stress is the degree of loudness with which a syllable is spoken as to make it prominent. Loudness is a component of prominence. If one syllable is spoken louder than the others, it will be heard as stressed syllable.
- **Pitch**: It is some degree of highness or lowness of tone in each syllable of a word.
- **Intonation**: The pattern of rises and falls in pitch across a stretch of speech such as a sentence is intonation. In other words, the going up and down of pitch over different syllables in an utterance is called as intonation
- **Rhythm**: It is the sense of movement in speech, marked by the stress, timing and quantity of syllables. It shows the recurring alternation of strong and weak elements in the flow of sound and silence in sentences or lines of verse.

4.2 Objectives

- To understand concepts of Phonation , Suprasegments, Articulation/Phonology
- To understand methods of evaluating Phonation &Suprasegments
- To understand how to evaluate Articulation/Phonological errors in Speech
- To understand concepts & management strategies for Phonation/Voice &Suprasegments
- To understand concepts & management strategies for Articulation/phonological errors.

4.3 Parameters measured in phonation and suprasegmental aspects of speech using advance technology and their application

There have been various advanced technologies introduced to assess these suprasegmental aspects and the phonation using digital processing signals system (DSP).

Some of the instruments used for this purpose are as follows:

MDVP, VAGHMI, SSL, CSL, DR.SPEECH, LTAS, PELSA, VISI PITCH, CAFET, PEPPER, PORTA, SALT

1. Dr. Speech:

It is a voice activated software device. It is a game like tool to provide real time reinforcement of a clients' attempts to produce in pitch, loudness, voiced/unvoiced phonation, voicing onset and MPD.

Vocal assessment: it allows the user to record analyzes and display the acoustic and EGG signal in real time. The programme will automatically compute statistical information and plot a voice a profile from a sustained vowel. Capturing the subject's video image and recording progress from one session to another session can be easily obtained. Vocal assessment provides an objective, non invasive, measures from acoustic and EGG signals &comparison can be made with a normative data base. Based on the comparison preliminary vocal function, harshness, regularity of vocal fold vibration and glottal closure time.

2. Multi Dimensional Voice Profile (Mdvp):

This is software from Kay-electronics New Jersey. Voice analysis is best accomplished by an organized protocol of perceptual evaluation, aerodynamic analysis, and electrographic analysis. MDVP is part of the acoustic analysis.

MDVP and CSL can be used effectively for perceptual analysis by storing samples of the patient's voice (usually sustained & read passage) and critically listening to these stored voice samples juxtaposed with past visits to help hear changes in the voice.

MDVP provides a robust multidimensional analysis of voice with graphical and numerical presentation of analysis result.MDVP is the leading programme for voice analysis in use around the world and is commonly cited in the profession literature.

MDVP is delivered with two versions a basic and an advanced. The advanced version is intended for use by skilled users who requires more flexibility and power in their analyzer.

MDVP PARAMETERS

✓ **Amplitude perturbation quotient (APQ)**

- ✓ **Amplitude tremor intensity index (ATRI)**
- ✓ **Degree of sub harmonics (DSH)**
- ✓ **Degree of voice less (DUV)**
- ✓ **Degree of voice breaks (DVB)**
- ✓ **Amplitude tremor frequency(FATR)**
- ✓ **Fo- tremor frequency(FFTR)**
- ✓ **Jitter percent(jitt)**
- ✓ **Noise to harmonic ratio(NHR)**
- ✓ **Number of sub harmonics(NSH)**
- ✓ **Number of un voice segments(NUV)**
- ✓ **Number of voice breaks(NVB)**
- ✓ **Pitch periods(PER)**
- ✓ **Phonation fundamental frequency range (PFR)**
- ✓ **Pitch perturbation quotient (PPQ)**
- ✓ **Highest fundamental frequency (Fhi)**
- ✓ **Lowest fundamental frequency (Flo)**
- ✓ **Average fundamental frequency (Fo)**
- ✓ **Frequency tremor intensity index (FTRI)**
- ✓ **Absolute jitter (jita)**
- ✓ **Relative average perturbation (RAP)**
- ✓ **Smoothed amplitude perturbation quotient (SAPQ)**
- ✓ **Total no. of segments(SEG)**
- ✓ **Shimmer in dB(shdB)**
- ✓ **Shimmer %(shimm)**
- ✓ **Soft phonation index (SPI0):**
- ✓ **Smoothed pitch period perturbation (SPPQ)**

- ✓ **Standard deviation of the Fo (STD)**
- ✓ **Average pitch period (To)**
- ✓ **Tsam:.**
- ✓ **Peak amplitude variation (VAM)**
- ✓ **Fundamental frequency variation (VFo)**
- ✓ **Voice turbulence index(VTI):**

Real analysis: it provides real time visual and auditory feedback of acoustic performance of speakers during speech.

Phonetogram: it displays the dynamic range of the human voice in terms of both Fo and Io.

Speech therapy: it can be used for both assessment and therapy

It provides a real time reinforcement when client attempts to produce change in pitch, loudness, MPD etc

3) **VAGHMI**

This system is used for the diagnostic, therapaeutic and research in the speech and hearing field.It consists of

- **Voice analysis**
  - -Fo and intensity
  - -jitter and shimmer
  - -LTAS
- **Physiologic measurements**
  - -inverse filtering
  - -mark glottal wave
  - -EGG marking
- **Speech analysis**
  - -dis fluency analysis
  - -listen and mark

These measurements can be **ONLINE** **OFFLINE**

ONLINE MEASUREMENTS*:* The subjectsspeaks in the microphone and immediately the results are displayed, it consists of:

MPD, S/Z RATIO, SUBGLOTTAL PRESSURE, NASALANCE AND TONAR, DDK.

OFFLINE MEASUREMENTS: There are four stages in off line measurements:

- preparation of sample file
- Analysis
- calculation for statistical saving
- Recall of saved statistics

Offline measurements include= acoustic analysis and physiologic measurements, nasalance module

It also has a **Therapy module** which is a sophisticated software tool that converts a personal computer to therapy equipment relating to voice and speech disorders, it has two groups,1) articulation therapy,2) voice therapy

- **Articulation therapy**: consist of programme for vocal tract profile indicating articulators positioning, viewing speech signal waveform, spectrum training, production of vowels, nasals, fricatives, plosives, and for dis fluent speech for stutters
- **Voice therapy**: consist of programmes for respiratory laryngeal and nasality controle that determine voice quality.

This software incorporates various games, puzzles, with colour visuals. The performance are scored and reinforcement message appears on the screen.This software is easy to operate and user friendly

3) SSL (Speech Science Lab)

Speech science lab was first introduced in 1992. It is a comprehensive software package especially for speech science research. It consists of a wide range of tools for graphic visualization of signals and spectra, analysis, and synthesis and display and editing the parameters.   Modules of SSL are……

a) **Wave spectrum**

b) **VSS spectrograph**

c) **ACOPHONE I& ACOPHONE II**

d) **ARTACO**

e) **Utilities**

f) **Record and play**

a) **Wave spectrum:** this module provides a programme to study temporal and spectral properties of signals. Iit has signal display and manipulation

Signal display:uses

- to compare wave forms
- spectra and auto correleation function of 2 signals
- to measure duration of segments
- to measure manually the Fo formants and levels
- to measure temporal and spectral properties of speech sounds
- for preparation of stimuli based on signal editing for speech perception experiments
- for segmenting speech sidnal to create the data base
- *signal manipulation :* to scale, to pre emphasis, & to add filters etc

b) **VSS Spectrograph(voice and speech system spectrograph)**

This module provides programme to generate 1 or 2 channel spectrogramme(NB,WB,VERY WIDE BAND). They can be displayed in a variety of option ,this VSS spectrograph can be used to

- compare original and coded synthesized speech utterance
- compare speech segments across different speakers
- rates of speaking and context
- measures formant frequency and Fo
- measures the duration of the segments

- validate analysed formant data and Fo

c) **ACOPHONE I:** acoustic phonetic I provides programmes for analysis editing and synthesis based on the principle of uniform frame rate coding. It can be used to

- acoustic phonetic studies
- research in speech production and perception
- studies on voice sources and intonation
- development of voice mail
- fixed vocabulary voice response system.

There are sub module a. VSLP: voice source excited linear prediction

b. FBAS: formant based analysis synthesis

ACOPHONE II: it provides programme for interactive analysis synthesis and editing. It implements cascaded hybrid and parallel formant filter module. Application are:

- to develop a text to speech synthesis system
- detailed and accurate analysis of microphonetic events
- preparation of stimuli for perception

d) **ARATACO(Articulatory acoustic of vowels):** it provides a program to calculate formant frequency and bandwidth for user defined Articulatory shape or vocal tract function of vowel sounds . This module is useful to steady speech production of vowel quality. Articulatory parameters and vocal tract area function for a given reference vowel can also be determined interactively.

e) **Utilities:** this provides programmed to print and edit speech data file to create and print leader file , to print parameters result file to initialize variables to create batch file etc it prints on screen the sampled values of a signal file and save the sampled values and also to save the contents of binary result

f) **Record and play:** this module provides programme to record and play one signal for vss data acquisition hard ware. This is specific to vssdata acquisition hard ware.

4) **Aniwax computer speech system**

It is a hard ware/soft ware voice input/output packages that enhance speech communication skills and understanding, including pitch rate, intensity, resonance, phonation, articulation, accent removal and auditory training. The module converts voice into real time , animated graphics for user matching and assessments.

5) **CAFET:** it is a cognitive behavioral approach to fluency/stuttering therapy. It integrates the feed back from the phonatory and respiratory function. Visual biofeedback and real-time message on the computer screen measure programmes and print out breathing and voicing errors. The result are recorded on the disk or printing and analysis ,itincludes,internal circuit board, respiratory transducer, respiratory sensor and microphone.

6) **IBM personnel system / 2 speech viewer** : it is a professional clinical tool that addresses a key element in speech therapy the feedback process. Bold animated display and audio play back refine and simplify the process by focusing on the speech signal and by making feed back information that clear and meaningful.

7) **Nasometer:** measures the ratio of acoustic energy from the nasal and oral cavities. As the client speaks micropne collects the data, which is translated into oral/nasal ratio and displayed on the screen. The softwares calculates statistical information for display.it consist of an I/P device (2 directional microphone and a nasal-oral separator . analysis circuit which utilizes, IBM pc and software. The nasometer is useful in evaluating clients and in therapy for providing feedback.

8) **Parrot easy language sample analysis (PELSA):** PELSA is designed for a grammatical analysis of a language sample. The user types and translates a language sample up to 100 utterances. The computer analysis percentage correct of specific demonstration locatives, pronouns, conjunction, articles, preposition, possessives, comparatives, superlatives, past and present tense markers. The use is provided with a list of auxillary, verb infinite, past tense, and present progressive verb forms. There is a table of the percentage correct no. of affirmative, no. of utterance, and MLU. The other feature includes sample editing and print out of result.

9) **PEPPER (programmes to examine phonetic and phonologic evaluation record):** it is a series of speech analysis programmes desiged to examine, phonetic, phonologic, prosodic aspects of normal and disorderd speech. Speech transcripts can be entered using IPA or more narrow phonetic transcription system for single or multiple samples.

10) **SALT (systematic analysis of language transcripts)**

Is an language analysis tool with coding and analysis option to specific need. SALT perform 50 analysis of language samples with coding and analysis option to meet specific needs. The flexible coding and editing including complete and incomplete utterances total root wprds,pauses and morpheme analysis. SALT can be directed to find symbols, words or combination of items before after with any other items.

11) **Port a voice speech system:**

It's a augmentative communication speech system that includes a battery operated computer , speech synthesizer and soft ware. Port a voice is used by locating a words or phrases with in lists, making a vocabulary list and typing words the user wishes to speak.

12) **Computerized speech science lab (CSL):** model 4300 and 4400 is the latest one. This is a CSL hardware/software package for the acquisition, analysis, display, playback and storage of speech signal. Analysis format includes spectrograph, pitch, intensity, and long term average spectrum.

CSL 4300: is highly flexible audio processing package which is designed to provide variety of speech analysis operations. Operations are data acquisitions file, management, graphic numerical display, audio output, signal editing and variety of analysis function.

CSL 4400: this can do a various analysis like pitch extraction, intonation counter, nuclear tone, IPA and these can be done for any part of the sample to be analyzed.

13) **Forensic Voice Analysis**

- It has been used for the purpose of voice identification & elimination since 1960s
- It has been used in a number of criminal cases of murder, rape, extortion, political corruption, money laundering, etc,.
- The basic theory is that every voice is individually characteristic and can be identified through the ***"voiceprint"*** analysis
- **Type of analyses**
- specifically spectrographic analysis
- aural or perceptual comparison

Spectrographic analysis has been paramount in eliminating and identifying voice

Instruments for analysis

- Visual comparison of voice using spectrography
- A spectrogram displays speech signal frequency across time
- Vertical impressions for consonants, horizontal bars indicating formants for vowels and amplitude information through the grayness/darkness

Formants are "vocal tract resonances displayed in spectrograms as broad bands of energy" Important formants in speech analysis are f1 & f2

<u>Visual comparison involves</u>

- General examination of features like time, frequency and amplitude
- Specific features in
  - vowels and consonants in isolation
  - vowels and consonants in combination
- Pitch, bandwidth, mean frequency, vowel formants, nasal resonance plosion, and pauses.

The instrument used for spectrography should be

***a professional one** and

* **should have the facility for wide band and narrow band spectrography**

<u>Aural comparison</u>

- Aural comparison is carried out using special tapes of high quality
- It is used to facilitate visual comparison
- Features included are - **resonance quality, pitch, temporal factors, inflection, dialect & breath pattern**

<u>Procedural considerations</u>

- Only original recordings of voice samples are accepted unless the original is erased and high quality copy is available
- Recordings to be played back on appropriate professional tape recorder, digital recording is not accepted
- Spectrograms to be produced on professional instrument

- When necessary, enhanced tape copies are prepared and separate set of spectrograms are prepared
- Similarly pronounced words are compared between the original and the recorded voice samples, atleast 20 words are needed for comparison
- Words with distorted spectral patterns are not included
- Aural examination is to be made of each voice sample to determine similarities or dissimilarities in pronunciation (disguise, drug/alcohol use, altered psychological state, manipulation)
- An aural comparison is made by repeatedly playing the 2 voice samples on separate recorders and electronically switching back and forth between them
- The examiner has to resolve differences (if any) found between the aural and visual results by repeated comparison
- Results given as "voices similar (identification)" or "voices dissimilar (elimination)"
- Through a comparison of test sample yields decisions like – "correct acceptance", "correct rejection", "false acceptance" and/or "false rejection"

Speech features to be compared

- f0 at selected locations
- amplitude of nasal consonant
- band amplitude of filtered vowels
- mean freq. of f1 & f2 separately

14) **Oral output signal:** the most readily available signal for acoustic analysis is the sound pressure waveform emanating from the mouth. It can be tape recorded of fed into analytical system via a microphone placed in front of the subject mouth. The usefulness of the signal obtained in this manner, however is limited. The acoustic features of the oral output signal are determined not only by the glottal sound but also by transmission characteristic of the vocal tract and lip radiation characteristic. In assessing vocal function, the glottal sound must be examined.

15) Glottal sound wave by inverse filtering based on a physical model

The idea of inverse filtering is to obtain the glottal sound or glottal volume velocity wave form by eliminating the contribution from the vocal tract transmission and lip radiation from the oral output signal. The technique is theoretically based on the vowel production model as a linear physical system. Use of the digital computers has facilitated technical progress. However precise determination of the formant frequencies and band width for each oral output signal is tedious. In addition FM tape recorder is required because any low frequency phase distortion which inherent in regular tape recorders interferes with accurate approximation of glottal sound source.

16) Residue wave derived by the inverse filtering based on linear prediction

This filtering technique is theoretically based on a mathematical model called the linear prediction model of speech production.(Atal and hanaver 1971). The inverse filtering in this case is a equivalent to a combination of the inverse characteristic of the lip radiation, vocal tract and glottal shaping spectra contribution to the oral output signal i.e. speech signal. The residue signal which is obtained by filtering the speech signal with this filter is an estimate of a periodic source signal which is theoretically an impulse train. Since it is a hypothetical input signal it is not directly related to any physically observable signal. It can be, however obtained automatically and more easily than the glottal sound wave form obtained with the physical inverse filtering technique compares the speech , glottal sound and residue signal.

17) Glottal sound wave derived by a reflection less tube (sondhi's tube)

This technique employs long reflection tube which is considered to act as pseudo infinite termination of the vocal tract. When a subject produces a neutral vowel into the tube, a microphone with in the tube picks the glottal source wave form, because the reflection less termination of the tube significantly reduces the resonant characteristic of the vocal tract. This method was originally described by sondhi 1975. Under ideal condition it should be an easy, simple, quick means of obtaining the glottal source wave form. Recordings reported previously, however, were not satisfactory.

18) PM 100 pitch analyzer

This device displays Fo and Io separately on a monitor that is split screen. It is used in practice for analysis a longer speech segments. Mean Fo (and SD), jitter, shimmer, and is also used as a therapy tool.

Advantage: it also input up to 30 min

- used as therapy tool

Dis advantage: Audio output is not available

- absence of spectral analysis

19) IVANS (The interactive voice analysis system)

It is a unique and innovative system for clinical voice analysis. The programme is organized for client record keeping such as entering data about client's medical history, recording voice samples, performing acoustic measurements and maintaining client's progress.

The following parameters can be obtained:

S/Z ratio, jitter, MPD, relative average perturbation, shimmer, amplitude perturbation quotient, glottal noise, normative noise energy, pitch amplitude, spectral flatries ratio, phonation range, dynamic range, tremor measurement, LTAS.

20) VISI pitch IV model 3950

Kay pentax has introduced visi pitch, the latest version of the most widely used clinical instrumentation tool for speech language pathologist, encompassing the many features of previous generations of this acclaimed speech therapy tool. VISI pitch provides the latest state of art high fidelity hard ware for robust data acquisition and play back and an additional software module. Now with 8 standard modules, VISI pitch can be used with virtually every type of communication disorder in both assessment and therapy task. Critical speech and voice parameters are extracted and displayed in true real time to help clients achieve therapy goals with visual feed back protocol driven assessment tasks provide clinician with valuable objective data using parameters that are well documented in the professional literature. In addition to visual feedback and analysis of important speech/voice parameters, VISI pitch IV also provide multiple auditory feed back tools that compliments the visual feedback offered by other module.

Importance of speech biofeedback: VISI pitch IV extracts acoustic parameters during speech/ voice production and present these in real time, providing clients with clear intuitive visual display, using target vocalization provided by a clinician, client attempts can be directly compared both graphically and with auditory play back.

Application ;   voice disorders

Motor speech disorders

Voice typing

Fluency

Selected articulation testing

Hearing impaired speech

Professional voice

Accent reduction

21) Praat

Is a programme for speech analysis and synthesis written by Paul Boersmaoch and David Weenick at the department of phonetics of the University of Amsterdam This programme is constantly being improved and a new build is published almost every week. The latest version was introduced on 22 February 2005.

Praat analyses mono as well as stereo signal can be recorded and saved, opened, and played back in stereo. The modest support for stereo signal that praat does provide is therefore the convenience of colleagues who have their speech material in stereo form. In fact, outside the lab it is almost impossible now a day to produce monotape recording with standard equipment and standard connecting cables.

4.4 Needs and methods to analyze and to correct Articulation of speech

Need for assessment

Assessment and Diagnosis is major stage in Articulation and phonological Diagnosis and management. It includes gathering and synthesizing the information about client'sproblem and assigning an individual to a particular categorywithin a classification system based on attributes, characteristics, or behaviours. The main purpose of initial evaluation is

a) Determine the Reality of the problem

b) (b) determine the etiology(ies), and

c) provide a clinical focus as to potential treatment approaches(Haynes &Pindzola, 2004).

After a thorough differential case history is collected, a carefulassessment should be completed as a basis for diagnosisand for planning appropriate and effectivetreatment. Through observation, the diagnostician obtains significant information about theclient's speech sound system, motivation, approachto a problem, interests, perseverance, cosmeticcharacteristics present when talking, and other importantidiosyncrasies.

Preliminary consideration

Conducting an accurate assessment require knowledge and awareness of the general characteristicsof persons with articulation/phonologicaldeviances and good observation skills. Although there are a great manybehavioural differences, a number of likenesses arepresent among persons with these speech disorders. Furthermore, not all of the characteristics may havebeen clearly implicated,another characteristic common to articulationand phonological problems is that of multiple causes (Haynes &Pindzola, 2004; Powers, 1971;Shriberg, 1982). Sometimes, there may be an obviousreason for the speech disorder and, consequently, the diagnostician fails to consider other possibilities.

Screening Procedure

Screening most often occurs in preschool or school settings. Screening of preschool and school populations typically includes all of the domains of communication, including articulation/phonology, language, voice, fluency, and hearing. Screening instruments are either formal or informal. Informal tools designed by speech language pathologists that includes items such as saying one's name and address, counting, naming, etc. formal screening procedures include published instruments such as Flucharty Preschool Speech and Language screening test (Second edition, 2000) and Slosson Articulation Test and Phonology (SALT-P, 1986).

Assessment battery for Articulation and Phonological Disorders

Accurate assessment of articulation/phonology involves eliciting various types of speech samples including formal articulation/phonological test, assessment of stimulability and intelligibility from spontaneous speech samples.

The assessment includes Case history information, assessment of speech structures and function, auditory sensitivity, benefit from the hearing amplification, and probably assessment of speech sound discrimination skills. The assessment of speech structures often includes diadochokinetic tasks, which are to sample speech rate.

Four steps are involved in speech sound evaluation procedures:

- Obtaining speech samples
- Tape recording the client's responses
- Transcribing the sample
- Scoring and analyzing the sample

The samples should be collected in the form of words, phrases, conversation and spontaneous speech.

Newman &Creaghead (1989) pointed out that the optimal sample should

1. Reflect the child's production in actual communicative situation
2. Reveal both inconsistencies and consistent patterns
3. Contains the full set of phonemes of the language

Ideally the sample should include conversational speech. The primary disadvantage of single-word, phrases and sentences, particularly when elicited by repetition or imitation, is that the sound production may not truely reflect the child's production of these same sounds in spontaneous speech.

Conversational speech can be elicited in various ways, such as by using toys and pictures, talking about the child's interest, retelling stories, and observing the child and parents interacting verbally.

The speech samples need to be transcribed live, such that the diagnostician makes notes about the production and transcribes them as accurately as possible while the child is speaking. Additionally, audio and video tape should also be taken. The examiner should then compare the live transcription with the perception of sound production from the tape recordings. The last step in articulation/phonological testing is to analyse the speech sample.

Articulation and phonological tests:

Assessment of the child's speech production system should include formal articulation/phonological tests. There are three types of articulation tests, most of which are standardized:

- Traditional articulation test

- Combined articulation and phonological tests and
- Phonological test

Formal traditional articulation test:

Generally, formal articulation tests sample speech sound production in isolated words that typically are elicited by pictures without a model from the examiner. Some tests also provide written word lists pr written sentences for individuals who prefer the test items are sequenced in the development order of the phoneme acquisition. The test results provide information about types of misarticulation, and the word position where the error occurs.

Some of the Formal traditional articulation tests are as follows:

- Arizona Articulation Profeciency test (3rd revision)
- Goldman-fristoe test of articulation (G-FTA-2)
- Photo Articulation test (3rd) (PAT-3)
- Templin-Darley tests of Articulation
- Weiss Comprehensive Articulation Test

Combined articulation and phonological tests:

Some tests assess both individual phonemes misarticulations. These tests have advantage of being able to do a phonetic analysis and phonological deviation analysis from the same speech sample. However, it takes more time than in traditional articulation test.

- The BanksonBernthal test of phonology
- The clinical test of articulation and phonology
- The computerized articulation and phonological evaluation system
- The Smit-hand articulation and phonological evaluation
- The structured phonographic articulation test

Phonological tests:

The phonological tests provide a more efficacious intervention programs for selected children by providing a clearer and more precise understanding of the child's underlying phonological system. Phonological test generally provide the following information :

- Types of phonological deviation used
- Frequency of their occurrences
- Percentage of occurrence when considering the number of opportunities
- Phonetic interventory

Some phonological tests are mentioned below:

- Hodson assessment of phonological patterns (HAPP-3) 2004/ Hodson computerized assessment of phonological patterns (HCAPP), 2003
- BanksonBernthal test of phonology
- Clinical assessment of articulation and phonology
- Khan-Lewis phonological analysis

Assessment of stimulability:

The assessment of stimulability provides information about the child's articulation abilities and is used determining prognosis and for planning treatment (Miccio, 2002; Powell &Miccio, 1996).testing stimulability requires the child to imitate the clinician producing the phonemes that were misarticulated during articulation testing. It demonstrate the child's ability to produce a sound in a highly supportive condition (Bain, 1994). A suggested procedure for assessment of stimulability is to elicit three repetitions in isolation and three in words containing each phoneme that are misarticulated.

Speech intelligibility assessment:

The measurement of intelligibility has been approached in number of way (Gordon-brannan, 1994)

- Open-set word identification
- Close-set (multiple choice format) identification
- Rating scales; in which the listeners judge o a predetermined rating scales
- Estimation from articulation/phonological testings
- Some formal assessment instruments are available to measure intelligibility (Weiss, 1982). *The assessment of intelligibility of dysarthric speech, the children's Speech Intelligibility Measures, the Weiss Intelligibility (1982).*

4.5 Selecting management techniques for phonation and suprasegmental aspects of speech

The voice varies according to the context of speech and to the physical and psychological conditions of the human being, and there is always a normal standard for the vocal output. Hearing loss can impair voice production, causing social, educational and speech limitations with specific deviation of the communication related to speech and voice. The deviations of voice can represent such a negative impact on this population that it can interfere on speech intelligibility and crucially compromise the social integration of the individual. Voice problems in individuals with this impairment are directly related to its type and severity, age, gender and type of hearing device used. While individuals with mild and moderate hearing loss can only present problems with resonance, severely impaired individuals may lack intensity and frequency control, among other alterations. The commonly found vocal deviations include strain, breathiness, roughness, monotone, absence of rhythm, unpleasant quality, hoarseness, vocal fatigue, high pitch, reduced volume, and loudness with excessive variation, unbalanced resonance, altered breathing pattern, brusque vocal attack, and imprecise articulation. These characteristics are justified by the incapability of the deaf to control their vocal performance due to the lack of auditory monitoring of their own voice caused by Hearing loss. Some of the therapy techniques that could be used for phonation in CWHI are

Individual who are deaf or hard of hearing, often have difficulty monitoring VP function due to lack of, or decreased **auditory feedback**. Hearing aids and cochlear implants serve to assist the individual's auditory feedback mechanisms, thereby improving self-monitoring skills.

Visual and tactile feedback

Individuals who are profoundly deaf may benefit from **visual and tactile feedback** to normalize hypernasal speech (Nguyen et al., 2008).These feedback techniques may include

- visual monitoring of nasal airflow with a mirror, See-Scape™, or nasometer and
- tactile feedback during chewing exercises associated with vibratory sensations in the nasal and facial bones or during humming.

ChantTalk

Similar to a religious chant, this technique is performed using a soft glottal attack (SGA) along with a recorded voice or the therapist, who gradually introduces normal speech as the patient progresses.

Chewing Technique

Practice the motions of chewing in an exaggerated manner and then gradually, over time, add random sounds, words, phrases, sentences, and conversation while slowly reducing the degree of exaggeration of the mouth movements. This exercise helps to release excess and produce natural tension in the vocal tract and laryngeal area and if done correctly encourages mouth opening and reduction of tensions in the jaw.

Yawn Technique

Practice yawning accompanied by a vocal sigh. This helps to produce a relaxed sound (often referred to as phonation) by creating normal muscular tension in the laryngeal area.

Humming

The humming task helps to produce a gentle airflow through the larynx as the sound (phonation) begins.

To increase phonation duration and breath support

Respiratory exercises to increase breath support including deep inhalation and exhalation should be implemented. To increase phonation duration CWHI should be asked to take deep breath and once the inspiration is complete, child should start phonating /a/ or /E/ from the beginning of inspiration.

For supra segmental aspects

Over the years there has been, a shift away from this atomistic view of language learning towards a more holistic, “top down” approach which has been reflected in both syllabus and material design, as well as in testing and in classroom practice. (Thornbury 1993) The current emphasis on *pronunciation* teaching is on the broader phonological aspects of connected speech, and their link to meaning on discourse level, and has resulted in renewed interest in the place of pronunciation in communicative language teaching. (Evans & Jones 1995).

The supra-segmental features are those which operate over longer stretches of speech, such as, stress, rhythm, intonation, pitch, and voice quality as opposed to the segmental features which are referred to as the individual sounds. In his book, pronunciation, Laroy asserts that :

It is impossible to speak without rhythm and intonation, and these deeply affect the quality of speech sounds. (Laroy 1995:39)

It is commonly agreed upon that it is intonation that has the greatest likelihood of impeding intelligibility in a learner's speech. By giving prominence to a word that conveys an altogether different message than what was intended or by using an inappropriate pitch key when speaking which confuses whether or not the speaker is making a statement or asking a statement are just two examples of problems that could occur. Although the supra-segmental features are sometimes called the 'unteachables', Laroy (1995) suggests that they are not' unlearnable'.

Beginning at the top: By beginning with the overall voice setting or voice quality of English and engaging the learner in activities which raise his or her awareness to the way the language sounds, (perhaps by comparing it with other languages), is in line with a holistic, "top-down" approach. This integrates listening and speaking skills, involves the students' personality and opinions, and raises their awareness of how English and other languages they are familiar with differ, or are somehow similar: In this light O'Connor states the following:

The basis of articulation has already been shown to be important in foreign- language teaching: better results are achieved when the learner gets the basis of articulation right rather than trying for the foreign sound sequences from the basis of his own language (O' Connor, 1973:289 in Thornbury 1993).

The most common supra segmental errors made by CWHI include the following:

1. Difficulty in pronouncing sounds which do not exist in the student's language.
2. Confusion of similar sounds, for example, /i:/ in eat or N in it, or /b/ and /p/.
3. Use of simple vowels instead of diphthongs, for example, use of /i:/ instead of /I/.
4. Difficulty in pronouncing consonant clusters, for example, desks, fifth.
5. Tendency to give all syllables equal stress, and flat intonation.

Stress, rhythm, and intonation are the three important elements of the Supra- segmental system used. When the syllables are produced with more force or intensity than others, it is called stress.

Focusing on selected sounds: The sounds targeted to teach stress, should be part of a meaningful word or phrase or sentence. Children generally pick up the sound system by listening to the model or voices on cassette, etc. However, the presentation of sounds in a carefully selected word or phrase or sentence will help to direct the child's learning process. And this will help to monitor progress. By practicing words and phrases which contain the sounds to be learned, students are able to master the production and use of these sounds.

Following are the steps to teach stress:

- Introduce the sound.
- Focus child's attention on the teaching point.
- Present a sentence or line/text which has the sound.
- Underline the sound in the text.
- Avoid complications of stress, intonations, etc.
- Include examples of the sound in all the positions.

Teaching stress and intonation: The syllable should be well understood by the clinician who should be able to identify the syllables in an utterance. The clinician should be skilled in identifying and counting the syllables in words, phrases, and sentences.

It is to be remembered that most words with two or more syllables have one stressed or strong syllable and one or two unstressed or weak syllables. Stress is not dependent upon fixed place in the sentence. Stress can occur on any syllable. Generally speaking, only nouns, verbs, adjectives, adverbs, demonstratives and interrogatives are stressed.

The goal is to increase the ability of the students to recognize and place stress. To achieve this it is important to give students groups of graded lists of words, such as two syllabic, three syllabic, four syllabic, and five syllabic words. Perhaps each group may consist of five or six words, and students will be asked to listen to the oral model provided and to mark the syllable or syllables which are stressed. The task may be made more complex by asking students to mark not only the stressed but also the unstressed syllable of the words.

Auditory recognition must be followed by oral production. Production of individual words must be followed by the production of phrases and sentences in that order. This means that the length of time between stressed syllables is always about the same, and if there are several unstressed syllables they must be said more quickly.

For example: “He wrote a letter”. “He wrote a long letter”. “He wrote a very long letter”. In each of these sentences, the unstressed syllables (a, a long, a very long) take about the same amount of time to say. So, “a very long” has to be said more quickly

Rhythm :

Rhythm of speech can be corrected clapping or tapping on a desk on each words spoken in the sentence. Clapping or tapping more loudly for the stressed syllables, and less for the unstressed syllables. Write the stressed syllable in heavier letters.

Prator, Jr., and Robinett (1972) suggest tackling the problem of acquiring a good speech rhythm under five parts:

I. Giving proper emphasis to stressed syllables, and making these recur rather regularly within a thought group.

II. Weakening unstressed words and syllables, and obscuring the vowels in most of them.

III. Organizing words properly into thought groups by means of pauses.

IV. Blending the final sound of each word and syllable with the initial sound of the one following within the same thought group.

V. Fitting the entire sentence into a normal intonation pattern.

Intonation: Intonation is speech melody. The way our voice goes up and down during speech. Intonation is very important in expressing meaning, and especially Intonation patterns are quite complex, and it is better for students to acquire them naturally rather than try to learn them consciously. That is, modeling and imitation in an unconscious way is important.

Rising intonation is used in asking yes/no questions, and to express surprise, disbelief, etc. The voice rises sharply on the stressed syllable.

Falling intonation is used for normal statements, commands, and for WH-questions. The voice rises slightly earlier in the sentence, and then falls on the key word being stressed.

The way to practice stress and intonation: The easiest way for students to practice stress and intonation is by repetition. Prepare sets of sentences with contrasting intonations and give them to the students to practice. Identify such sentences, wherever possible, from within the lesson.

- A good model of the sentence should be given.
- Say it at normal speed, making a clear difference between stressed and unstressed syllables, and using natural intonation.
- Indicate the stress and intonation clearly, using gestures.
- Say the sentence in sections, starting with the end of the sentence and gradually working backwards to the beginning. For example, living here/been living here/ have you been living here?, etc.
- Watch carefully whether the child pays attention to stress and intonation when they repeat the sentence.

4.6 Selecting management techniques for facilitating articulation in children with hearing impairment

Need for treatment:

Analyzing the results of articulation assessment is important; but the decision for implementing intervention involves more than looking at the standardized test scores. Beyond the test performance, the need for treatment is related to social, occupational, cultural and ethical aspects of the individual's environment.

The factors determining the needs for treatment of articulation:

- Articulation deficits result in barrier to social and professional opportunities (Bryne&Shervanian, 1977). Hence a probable or desired lifestyle or occupation of a person should be considered when determining need for articulation treatment.
- Another factor in determining the need for treatment of articulation/phonology is the attitude of peers, family and important others in the peer's environment

(Andrews, 1996; Johnson et al., 1967). Attitudes of the speakers range from acknowledge of speech problem to the rejection and insistence that the problem does not exist to intense concern or preoccupation with it.

- A third factor is the nature of the articulation/ phonological deficiency itself; that is, the cause, severity, and effects on communication. Certainly, an important criterion for determining the extent of the problem is the intelligibilityof the speaker. Additionally, the frequency with which articulation errors occur, the type of misarticulation, the phonological deviations used and stimulability. The consistency with which the individual misarticulates the phoneme is also a factor (consistency effect).
- Age is also a critical factor for determining the need of the treatment. The developmental age of the phoneme should be considered while determining the need of the treatment, along with other factors.
- Final factor pertains with etiology of the disorder. One reason for differentiating between functional and organic causes is to acquire some idea about seriousness of the communication problem and its possible prognosis.

Selection of intervention approach

After the diagnosis and determining the need of treatment; the clinician must select the treatment approach and develop the treatment plan individualised for each client. Intervention approach and plan for children with hearing impairment can never be same with that of children with childhood developmental Dysarthria.

Murphy and Dodd (1995) summarized phonological rules used by profoundly hearing impaired children. They reported that the hearing- impaired children use many of the same phonological processes young hearing children do (e.g., voiced/ voiceless confusions, final consonant deletion, and fronting). However, other deviant patterns are also apparent in the speech of hearing-impaired children, such as, glottal replacement, deaffrication, stopping, and a preference for the use of nasal consonants. The production of vowels by the CWHI is commonly characterized by substitutuion, neutrilization, centralization, and omissions (Osberger&McGarr, 1982). Study by Serry and Blamey (1999) reported that the order of acquisition for the CWHI and normally hearing children are closely related. The rate of acquisition is however slower for CWHI.

Acquisition of speech production skills depends on the hearing amplification used, hearing age, and auditory deprivation, speech and language development, benefits from the amplification, associated problems, etc.

When articulation/phonological treatment are implemented, the first decision is to determine whether a phonetic or phonological approach should be implemented. Phonetic approach focus on individual speech sound targets whereas phonological approach focuses on speech sound patterns.

Considerations of phonetic treatment approach:

The following questions need to be addressed:

- How many sounds will be targeted or taught at a time?
- Which sound or sounds will be taught first?
- Will specific auditory training or speech perception training be needed?

Number of sounds to be targeted at a time:

Traditionally, treatment began with working on one or two phonemes if they are cognates of one another; for example, /s/and /z/, or /t/ and /d/. Working on second sound will began while continuing the generalization of the first sound. One possible exception to this recommendation of working with only one sound at a time is, with adults or children who are highly motivated and better able to handle two or three sounds at a time.

Target phoneme selection

There are several criteria to aid in selection of target phonemes. It is advisable to select the misarticulated phoneme(s) that are relatively easy for the client to produce

Selection criteria for phoneme target

- Phoneme that is earliest to develop.
- Later developing phoneme
- Stimulable phoneme
- Nonstimulable phoneme
- Phoneme produced correctly in a key word

- Frequently occuruing phoneme
- Visible phonemes (i.e., labials, dentals, alveolars, some palatals)
- Consistently misarticulated phoneme
- Phoneme that client/others desired to target
- Phoneme for which the client has been criticized or penalized
- Phoneme that is omitted or has an atypical substitution
- Phoneme least affected by physical limitations
- Same phoneme for a group of clients

Speech perception training:

Much study has been done about the relationship between speech perception and articulation skills. Various opinions are held regarding whether or not to include perception training (variously called auditory training, ear training, and speech sound discrimination training) as part of the treatment of articulatory disorders. For example, Van Riper and Erickson (1996) generally recommend auditory training for all "functional" articulation cases; while, Rvachew (1994) recommended it for all clients. For CWHI, auditory training is functional step for the articulation treatment. The rationale for implementing auditory training is that speech is learned by the ear. A person has to hear a sound several times before all its salient features are perceived. On the other hand, the rationale for not using auditory training is that individuals usually can learn to produce sounds correctly without it.

4.7 Methods to improve speech intelligibility; Measurement of outcomes

Understanding oral speech is one of the most important factors, in the evaluation of articulation and phonology. Speech intelligibility has been characterized as the single most practical measurement of oral communication competence (Metz, Samar, Schiavetti, Sitler& Whitehead, 1985).the degree of unintelligibility is perhaps the most important single pragmatic indicator of articulatory/phonological severity. Attaining a valid, reliable and valid intelligibility is problematic because of numerous factors:

- Articulation/ phonological characteristics
- Suprasegmental aspects

- Voice characteristics
- Fluency
- Linguistic factors
- Contextual factors

Following are the methods to deal with these factors:

Slow Down

Children with hearing impairment have speech clarity issues because along with having poor articulatory repertoire; they speaks very fast; substituting most of the speech sounds with vowels. By having them slow down slightly, their tongue, lips, and jaw have a little more time to get where they need to be produce intelligible speech. This can make a significant difference in intelligibility. Hence speech intelligibility can be improved by reducing the rate of speech and children should be asked to speak as slow as one word at a time. And stretch and give stress to each word.

Speak Slightly Louder

Many children with hearing impairment have intelligibility issues due to mumbling. Most of the children have hypernasality with cul-de-sac features of voice. Mumbling occurs because of low volume and minimal movement of the jaw, lips, and tongue while talking.

By increasing the volume slightly, a stronger signal is sent from the brain to the larynx (voice box). However, the way the human body is made means that the stronger signal does not just go to the larynx, but also to the tongue, lips, and jaw. The stronger signal results in exaggerated movement of these articulators.

For example; while playing games the child should be asked to speak loudly (like yelling) with his mouth open wider, and lips move further, and tongue's movement become magnified. A slight increase in volume will likely increase speech clarity because the mouth must make bigger and more forceful movements.

Speech should have Context

Context gives a listener cues about the conversation. If clinician know that the child is trying to tell you about a situation at lunch or at recess, clinician are much more likely to decipher what the child is attempting to say. While this strategy doesn't actually change the child's intelligibility, it can significantly increase how much of his conversation is understood. Clinician can get context by asking questions that begin with "what", "who", "where", and "when". If possible, ask the child to show you what he is talking about.

Get on the Child's Level

While it is not always practical to get eye level with the child every time he talks, it will be helpful at times. Getting eye level with the child will help the clinician and the child focus on each other. Even minor distractions can prove to be significant barriers if the child has difficulty articulating what's on his mind. Second, it shows the child that you are giving your full attention and that you care about what they are saying.

Praise Good Speech Most children are highly motivated by praise and they want to make you happy. By praising good speech behaviors (i.e. going a little slower and slightly louder), you encourage them to repeat those behaviors. Praise can come as words of admiration, high-fives, fist-bumps, etc. If an immediate reinforcement is followed after their good speech with a little bragging to the child's parents later the same day, it can make a significant impression on that child.

Practice Consistently to Become Habit

Spaced repetition develops into habits. For the first week, child should be praised at every possible opportunity. The praise can slowly be faded out as their good speech behaviors become habit. The winning strategy for improving speech clarity over the long term is this: Consistent (daily) reinforcement of good speech will result in long term improvement. A little bit of practice on a daily basis will result in much faster progress than intense practice that happens sporadically.

Don't Stress

Getting anxious and uptight about the child's speech clarity is counterproductive. It's not unusual that one week their speech clarity may seem good, but the next week it is poor again. Their speech clarity is definitely going to fluctuate some, but overall their clarity should be improving. Another reason not to get uptight about the child's speech is that they will likely feed off of caregiver's and clinician's emotions- If you seem anxious it will affect their mood and likely their speech.

Approaches for improving intelligiblity

The Core Vocabulary Approach

1. Choose 50 words that are highly important to the child and to the child's environment. These words should be used a lot.
2. Achieving consistency is paramount. Establish consistent productions at any level and build their consistency up to the word level.
3. As words become clearly spoken, move them off of the list and add some new. The list always stays at 50 words.
4. Stick with the list and use it to take data to see what to keep and what to have become intelligible.

Speech intelligibility of CWHI depends on various factors. Clinician must keep in mind that a child's speech will be perceived unintelligible if the child has ariculatory/ phonological errors. Hence, first target is to treat misarticulation of speech. The management of speech intelligibility should begin at word level, followed by connected speech, phrases, sentence, complex sentence and other higher levels of speech production.

Choosing the stimulus

- At word level- core word, side word
- At phrases level- common phrases including activities of daily living, verbs, etc
- At sentences level- daily activities, story narration, situational descriptions (like- birthday party, a visit to zoo), etc

Measurement of outcome

The measurement of the outcomes associated with speech and language therapy is an essential component of delivering effective and high quality services. Outcome measurement is core to:

- Delivering evidence-based and child-centred services.
- Evaluating clinical effectiveness and supporting quality improvement.
- Demonstrating the impact of the therapy.

To support best-practice in relation to outcome measurement, it is recommended that speech and language therapists are aware of the importance of:

- The routine measurement of the outcomes of therapy, using an appropriate approach and tools.
- The use of validated outcome measurement tools.
- Capturing the service-user's perspective on their outcomes and their experience of care.
- Using outcome data in the context of other data and alongside other available tools, frameworks and resources, to support the delivery of quality services.
- Outcome measurement being embedded within a model of working that emphasizes the need for reflection, and that holds the notion of health benefits and outcomes as an integral part of practice.

Hence, for outcome measurement, the speech language pathologist should use the same test used for assessment of intelligibility before starting the therapy in order to find out the baseline function of the child and do the post therapy evaluation in order to estimate the current baseline of the child after the therapy.

Once, the clinician has the current reports of the child's baseline function; clinician should compare the pre therapy and post therapy functions of the child to see the effectiveness of therapy. Based on the comparison, further decisions regarding the therapy should be made.

4.8 Let us sum up

Sophisticated, computer-based instrumentation has become increasingly available to the voice clinician. Yet substantial questions remain regarding its clinical necessity and usefulness. A theoretical model based on the scientific method is developed as a framework that can be used to guide the clinician in the selection and application of instrumental measures. Using the process of hypothesis testing, instrumentation is presented as an integral component of clinical practice. The uses of instrumental measures, and their relevance to long- and short-term treatment goals, are addressed. Clinical examples are presented to illustrate the incorporation of instrumentation and the scientific method into assessment and treatment.

4.9 Unit End Exercises

1. What is the need of advancement of technologies in the management of Speech Disorders for the hearing Impaired ?

2. Illustrate various instruments for assessment and management of Speech Disorders by a qualified Speech Pathologist?

4.10 References

1. Adamson, L., Romski, M., Deffebach, K., & Sevcik, R. (1992). Symbol vocabulary and the focus of conversations: Augmenting language development for youth with mental retardation. *Journal of Speech and Hearing Research,* 35, 1333-1343.

2. American Speech-Language-Hearing Association. (2018). *Facilitated communication* [Position Statement]. Retrieved from www.asha.org/policy/

3. American Speech-Language-Hearing Association. (2016). *Scope of practice in speech-language pathology* [Scope of Practice]. Available from www.asha.org/policy/.

4. Angelo, D. H., Jones, S. D., & Kokoska, S. M. (1995). Family perspective on augmentative and alternative communication: Families of young children. *Augmentative and Alternative Communication,* 11, 193-201.

5. Assistive Technology Act of 2004, Pub. L. No. 108-364. 118 Stat. 1707 (2004).

6. Autism Spectrum Australia (Aspect) (2013, March). Evaluation of the Language Acquisition Through Motor Planning (LAMP) Program with children with autism spectrum disorders (ASD). *Aspect Research Insights,* 6, 1-4. Retrieved from https://www.liberator.co.uk/media/wysiwyg/Documents/Autism_Spectrum_LAMP_Research_Report.pdf

7. Bailey, R. L., Parette, H. P., Jr., Stoner, J. B., Angell, M. E., & Carroll, K. (2006). Family members' perceptions of augmentative and alternative communication device use. *Language, Speech, and Hearing Services in Schools,* 37, 50-60.

8. Barker, R. M., Saunders, K. J., & Brady, N. C. (2012). Reading instruction for children who use AAC: Considerations in the pursuit of generalizable results. *Augmentative and Alternative Communication,* 28, 160-170.

9. Beukelman, D., McGinnis, J., & Morrow, D. (1991). Vocabulary selection in augmentative and alternative communication. *Augmentative and Alternative Communication,* 7, 171-185.

10. Beukelman, D. R., & Mirenda, P. (2013) *Augmentative and alternative communication: Supporting children and adults with complex communication needs.* Baltimore, MD: Brookes.

11. Binger, C., & Light, J. (2006). Demographics of preschoolers who require AAC. *Language, Speech, and Hearing Services in Schools,* 37, 200-208.

12. Binger, C., & Light, J. (2007). The effect of aided AAC modeling on the expression of multi-symbol messages by preschoolers who use AAC. *Augmentative and Alternative Communication,* 23, 30-43.

13. Blockberger, S., & Johnston, J. (2003). Grammatical morphology acquisition by children with complex communication needs. *Augmentative and Alternative Communication*, 19, 207-221.

14. Blockberger, S., & Sutton, A. (2003). Towards linguistic competence: The language experiences and knowledge of children with extremely limited speech. In J. Light, D. Beukelman, & J. Reichle (Eds.), *Communication competence for individuals who use AAC* (pp. 63-106). Baltimore, MD: Brookes

Unit 5 ❑ Assistive devices in Educational Management

Structure

5.1 Introduction

5.2 Objective

5.3 Impact of technology on Education: Present & Future

5.4 Assistive technologies for personal and educational purposes: Devices & Processes and their application

5.5 Mainstream Technologies: Universal Designs; its Concept, Principles & product design

5.6 Research & Developments in Educational technology: National & International

5.7 Evidence Based Practices

5.8 Let us sum up

5.9 Unit end exercises

5.10 Reference

5.1 Introduction

The world of education is currently undergoing a massive transformation as a result of the digital revolution. Because of this "digital revolution," it is both important and practical to make use of the availability and accessibility of technology in designing educational or training programs. Technology has the potential to contribute to a better quality of life for students with intellectual disabilities, which is more than just a matter of convenience. The use of technology in education is inevitable; it is only a matter of time before schools will fall behind unless they try to catch up. Students spend long hours of their day outside school using technology, so is it reasonable to expect them to come to school and find themselves in the world of no technology and feel attracted to this world. In addition to the factor of attractiveness, there is also the effectiveness of using technology, which has been proven through some studies. For instance, argue that digital textbooks offer a better alternative than traditional textbooks because they can provide instant feedback, interactive representations, and the system of universal design for learning (UDL). Continuing to deliver education and training in the traditional way and using the same tools that have been used for decades is affecting these programs' outcomes and making them fall far behind what the labor mark demands. Thus, updating school programs with current technological tools and devices for both students with and without disabilities has become necessary. It is very important to ensure that students with disabilities are prepared to meet the challenges of postsecondary settings; many technological tools could increase, as much as possible, the possibilities for students with disabilities to overcome these challenges with fewer difficulties. In many cases adapting the right assistive technology for students with disabilities could save time and effort. Ignoring the existence of devices and tools that can help students with disabilities facilitate and maximize their educational and academic gains can also prevent students from having opportunities to reach their maximum performance, or at least to make them more confident while undertaking some tasks that can be done easily using low-tech Assistive technology.

5.2 Objectives

To understand the present and future impact of technology on education

To understand the assistive technologies for personal and educational purposes

To know about universal designs; its concept, principles & product design

To know about the national &international developments in educational technology

5.3 Impact of technology on Education: Present & Future

Technology has played a central role in all aspects of our lives. Technology has helped human beings shape and change the physical world to meet their needs by manipulating materials and tools with updated techniques. The term educational technology refers to the instructional use of computers, television and other kinds of electronic hardware and software. Educational technology is interchangeably used as instructional technology because it draws attention to the instructional use of educational technology. According to the Association for Educational Communications and Technology " Instructional technology is a complex , integrated process involving people, procedures, ideas, devices and organization for analyzing problems, implementing, evaluating and managing solutions to these problems in situations in which learning is purposive and controlled.

Technology and Learning

The primary purpose of employing instructional technology in schools is to enhance student learning. Technology cannot take over a teacher at anytime, but it can support the teacher's teaching. The principal task of the teacher is to transfer knowledge and textbook content to the student's mind. Teacher's instruction is followed by periodic examinations to determine if the transfer has occurred. Instructional technology assists this transfer process by means of accurate and compelling presentations of content.

Computer Assisted Instruction programs were essentially technology based instructions used in classrooms in the form of printed, programmed learning books. The programme encouraged self-paced learning among children. In computer assisted instruction, computer would keep track of students work and provide a record of each student's progress for the teacher. Instructional technology also helps children with learning difficulties provide drill and practice exercises by installing software and hardware in school laboratories.

The above paragraphs discussed the evolution of technology in Education and its growth in the field of technology. In the following paragraphs, we will read about the current role of technology in education. A teacher may use a variety of theories and techniques to teach children, but technology will help her to enhance her teaching and thereby supporting student learning. Although a teacher might have a variety of technological support to select from but she will select only those which will promote their instructional goals. Technology is currently being used to support the four goals namely:

1. Building student capacity for research
2. Making student inquiry more realistic
3. Presentation of information in an appealing form
4. Offering access to learning resource beyond the school.

Let us see these in detail :

Student research: Computer and technology has paved for student research. Students can now collect information not only through school/ college libraries, but they have access to digital versions of these references. They can substantiate their work by gathering /add digital images, video, audio and global positioning satellites. Primary and secondary sources of information could be gathered from internet which includes government documents, photographs and diaries.

Student Inquiry: Education is meaningful when it is real and authentic for the learner. Learning through technology helps students to get a view of the real world activities. Students can not only collect data, but they also have an opportunity to investigate questions or issues that concern them. Technology (especially communication technology) can help individuals to contact experts working in various fields of their interest. Technology has paved ay for interactive learning wherein, it has taken education beyond the four walls of the classroom. For.e.g. If a student who want to learn more about a current event, such as an experiment on an international space station, scientific endeavours or wants to have a peek into an activity happening at the other end of the globe, he/she can do so with the help of going on a virtual trip with the help of internet and web camera.

Constructing new knowledge: James Pellegrino and Janice Altman (1997), believe that the ultimate use of technology occurs when students use technology to move from being knowledge consumers to being knowledge producers. Students have upgraded their work by integrating digital video, audio text, multimedia presentations or web based documents in their project work rather than just projecting it in a traditional paper or research report. The use of technology has helped students to express their knowledge in a more interesting manner.

Access to learning resources: To make the process of learning interesting, the learners should be provided with a varity of technologies (e.g.interactive television, internet video conferencing) so as to make them active participant in the learning process. Access to learning is beneficial for students who may be unable to attend classes in the school building and are home bound, home schooled and for dropouts. Learning resources helps not only the regular learners, but children with special needs are also benefitted with the same.

Impact of technology in Future

The future of education is technology dependent. Literature reveals that technology will play a central role in nearly all aspects of our lives as we as embarking on the fourth Industrial Revolution. World Economic Forum estimates that 65% of children entering primary school will find themselves in occupations that do not exit. It is also estimated that by 2020, there will be 1.5 million new digitized jobs across the globe.

In our complex and rapidly evolving world today, academic models based on interdisciplinary research are necessary to create effective teaching and learning environments. The future of classroom lies in technology driven environment like cloud based technology, customisable learning management platform, distributed cognition (dCoG)-(A concept in which the people, environment and artefacts are regarded as one cognitive system). Through dCoG, educators can view human learning through digitally enhanced learning experiences that facilitates the interaction of people, the environment (classrooms, workplace, learning, informed settings) and tools (hands-on-activities, simulators, games etc).

According to human psychologist, learning has not changed vastly overtime, but external factors like how we comprehend, retain and receive new material. However, to accelerate learning, technology gives us exciting opportunities to shape learning experiences and achieve learning goals.

Thus it could be concluded that, technology based education can create a dynamic, digital and hands-on-learning experience that is tailored, flexible and relevant thereby developing the talent needed to power the digital economy. However, it should be understood that the role of human teacher cannot be replaced by technology. As teachers will have a unique and personal insight into each learner's progress, serving as a role model and local expert therby providing inspiration in a way that both should go hand in hand.

5.4 Assistive technologies for personal and educational purposes: Devices & Processes and their application

Technology can serve two major purposes i.e. helping and teaching (Smith, 1991). Technology that helps an individual to carry out a functional activity is termed assistive technology. Assistive technology can serve a variety of functional needs. It can also be used as part of an educational or rehabilitative process and also for remediation or rehabilitation. Often rehabilitative or educational technology is employed to develop skills for the use of assistive technologies.

Appliances versus tool: An appliance is a device that "provides benefits to the individual independent of the individual's skill level (Vandeheiden,1987,p 705)

Tools, on the other hand require the development of skill for their use. Household appliances such as refrigerators' do not require any skill to operate whereas tools such as a hammer or saw do require skill.This same criterion applies to assistive technologies. The determining factor in distinguishing a tool from an appliance is that the quality of the result obtained using a tool depends on the skill of the uses. For e.g eyeglasses, splints a seating system or a key guard for a computer are all appliances, since the quality of the functional outcome does not depend on the skill of the user. On the other hand, success in maneuverings a powered wheelchair does depend on the skill of the user, therefore the wheelchair is classified as a tool.

Before going to the assistive technologies for personal and educational purposes; it is important to know the principles of assessment and intervention in assistive technology.

The assistive technology intervention begins with an assessment of the consumer. Through this assessment information about the consumer is gathered and analyzed so that appropriate assistive technology (Hard and Soft) can be recommended and a plan for intervention developed. Information is gathered regarding skills and abilities of the individual, what activities she would like to perform and the context in which she will performing these activities. The assessment also yields information regarding the consumer's ability to use assistive technologies. Based on the assessment results a plan for intervention developed and a decision regarding the type of assistive device used could also be made.

Let's us now discuss few assistive technologies for personal and educational purposes.

Planar: It is a technology used to support the body only where it easily comes in contact with the body (Such as bony prominences) used for individuals who require minimal support.

Fig 1.

Fig 2.

The above figures 1 and 2 shows the two types of Planar. This is basically used for growth or postural changes. This technology is used for postural control and deformity management.

There are two types namely

1. Pre-fabricated
2. Custom fabricated

1. **Pre-fabricated:** It is made to fit a wide range of individuals. This type of pre-fabricated planar has adjustable components. This type allows the system to be modified for growth or posturer changes.
2. **Custom fabricated:** Custom fabricated planar systems are made of similar materials and design as pre-fabricated systems but the dimensions of the seating surface and components are customized to fit the individual.

Standard Contoured Modules

Planar systems provide adequate support for many individuals who have relatively good motor control, fair trunk support and spinal curvatures or fixed deformities however for individuals with less control, the planar surface does not provide enough support .Contoured technologies use curved surfaces depending on the specific approach which match closely to the shape of the human body. By contouring the seating surface to the person's body. We increase the amount of contact that the body has which the seating surface. This provides increased support and control.

For a significant number of individuals, there is a need for contouring, as it helps to take the exact shape of the body. One model included in the standard contoured module is called as vacuum consolidation. The vacuum consolidation method of contouring uses a bag filled with small particles (similar to a bean bag chair)) (Fig 3:a, b & c)to make the basic shape for contoured cushion the person to be fitted is seated in the bag and placed in the optimal position. A vacuum pump is used to draw air out of the bag which forces the particles in the bag to compress and closely match the person's shape.

Fig 3a.

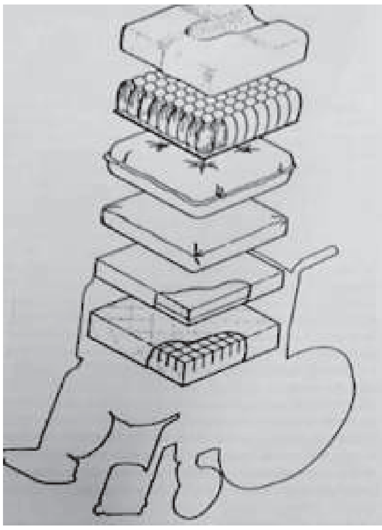


Fig 3b.

Control enhancers: Interface positioning, Arm supports, Mouth sticks, Head pointers and Hand pointers.

Control enhancers include aids and strategies that enhance or extend the physical control (range and resolution). This helps to enhance the persons control to the extent that his range and resolution make it possible for the person to be independent. It also helps to make the task easier and minimize fatigue for an individual. These include mouth sticks, head and hand pointers and arm supports. (Fig 4, a,b,c,&d)

Fig 4a

Fig 4b

(Or)

Fig 4d

Fig 4c

The person and the control interface should both be positioned to maximize function.

Individuals who have weakness in the arm may not have enough strength to access the full range of a keyboard adequately. A mobile arm support which supports in arm movements by eliminating some of the effects of gravity may then allow the individual to access a keyboard.

There are commercially available aids that can be strapped on the hand to assist in pointing [7.4. B] such as the typing aid as shown in Fig 5

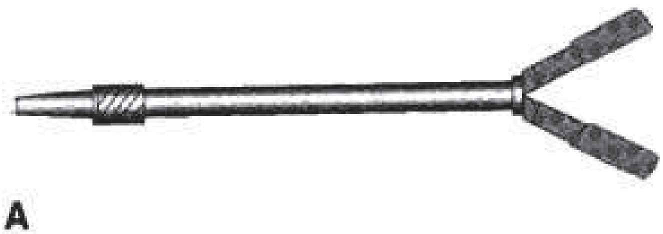


Fig 5

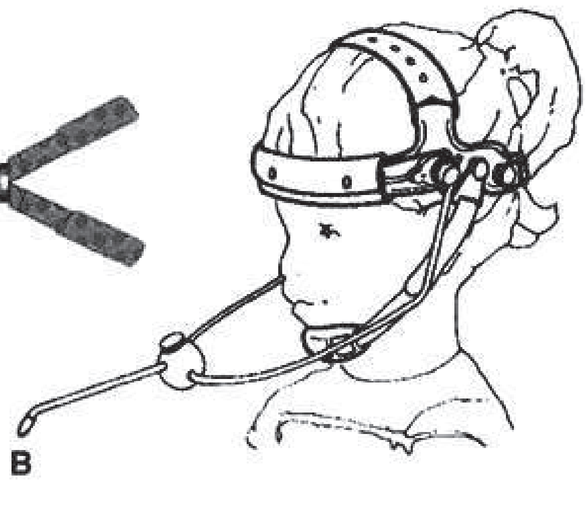


Fig 6

For individuals who lack functional movement in their arms and hands, a mouth stick or head pointers (Fig 6) can be used with head and neck movement to access a keyboard or perform other types of manipulation tasks (e.g dialing a telephone numbers or turning pages in a book).

Mouth sticks are often used by individuals who are quadriplegic as a result of a spinal cord injury. A mouth stick consists of a pointer attached to a mouth piece. The user grips the mouth piece between his teeth and moves his head to manipulate control interfaces on other objects.

Keyboards:

For written communication, a keyboard is typically considered the most efficient means of in putting information. The standard keyboard is the first choice for computer access. The other types of keyboard include [Fig 7:a,b & c]

Fig 7 a

Fig 7 b

Fig 7 b

Thus it could be concluded that educational and personal assistive devices cannot be separated and they are interdependent on each other.

5.5 Mainstream Technologies: Universal Designs; its Concept, Principles & product design

Let us begin with the meaning of Universal Design (UD). Universal design (UD) is the design of prodiucts and environments that can be used by all individuals as much as possible without having to make adaptations. (Connell et al.1997). Universal design then promotes accessibility for as many people as possible across environments. Universal Design stems from efforts to make environments "barrier free" and assistive technology , which creates access to environments, that might not otherwise be possible for individuals with disabilities. Removing barriers allows people with disabilities to participate in events and activities of daily life , but removing those barriers also helps people without disabilities. Universal design can also be applied to education and is called universal design for learning (UDL) (CAST,2004). UDL focuses on the design of curricula and instruction that helps teachers be responsive to the individual differences of their students with disabilities while also being beneficial for students without disabilities. Orlwis and MCLane (1998) describe universal design as how materials and instruction are designed so that all students with a variety of differences in learning, seeing, hearing, moving and understanding English can access and benefit from instruction.

Universal design of curricula and instruction means that adaptations are incorporated into the materials and instruction during development. The intent is that the materials be flexible enough to accommodate the diverse learning needs evident in most classrooms

There are three features of universally designed curricula and instruction. First, there are multiple means of representation, which means that information is presented in various formats to reduce sensory and cognitive barriers. The second feature, the multiple means of expression, refers to the ability of students to respond in a variety of ways. The third feature , multiple means of engagement refers to actively involving students in activities and matching the mode of representation and expression with their needs and interest.

Digital media is an excellent example of how universal design features promotes access for students with different needs such as learning, seeing, hearing, moving and understanding English. Universal design allows the broadest spectrum of learners to access the curriculum, students with varying learning needs, those with disabilities and those with other special needs.

Let us see few products supporting Universal Design for Learning Curb cuts and wheel chair ramps allows people who use wheelchairs to use sidewalks , cross streets , have access to buildings , and be free to move independently as they shop , go to restaurant or go to the movies. However, curb cuts and wheel chair ramps also help parents with strollers and people with shopping carts as they shop and walk through neighborhoods or shopping centers. So the universal design feature of curbs and ramps benefits many individuals in society. For reducing sensory and cognitive barriers, written text can be accompanied by audio for students who are blind and graphics can be used to enhance the content for students who are deaf or have learning problems. Closed captions on video are another example of ways of representing information. For multiple means of voice recognition software, scanning devices and switches help students with physical disabilities access the computer to complete computer based activities. Digital media is also engaging in universal design features which include current technology and partnership with textbook publishers making electronic version of the textbook for the ease of reading. For children with learning disabilities, having difficulty in reading, computer can be used to immediately translate visual access (print) to the curriculum materials to an auditory means (listening to the text) of gaining information. Electronic media also helps persons with severe visual disabilities allowing books to be 'heard' rather than 'read'. Like the students with visual impairment can listen to the social studies text book rather than reading it through Braille print.

5.6 Research & Developments in Educational technology: National & International

Technology has become a part and parcel of our lives. It plays an important role in the learning process. Technology has played a seminal role in the field of education. Just as the modern world is incomplete without technology, similarly education too would fall short of an "enlightening experience" without the use of technology. In order to understand the full impact of technology, it is important to know how it has impacted education.

Some of the developments in Education using technology are given below:

1. **Classroom based learning:** Nowadays technology has supported textbook learning. Information could be gathered from textbook as well as from computers. It has become an integral pat of classroom based teaching and learning. Today

many educational set-ups like schools, colleges and universities in India use projector screens instead of blackboards to teach in the classroom set-up. Powerpoint presentations have helped teachers to support teaching and put across their ideas in the most amazing way. Student experience a different kind of set-up in today's technology based classroom. Gadgets like tablets and laptops are used to take down notes. Animated content are created on various subjects and in different languages so that students can have a better understanding of a complex subject in a simple way.

2. **Online learning management system:** Technology has made the learning process interesting. Many colleges and universities are integrating online learning management system or LMS platform into their web portal. Students can remotely login to access course material and also attend live classes with their teachers. The features of online learning management system include:

a. Pre-recorded lectures

b. Learning through recorded material

c. Revising and reviewing course material at the learner's own pace.

But the difficulty lies in non-availability of computer and broadband in schools and in rural areas. However, Government is providing computers to consumers residing in remote areas and creating content that consumes less data and can be easily accessed on internet.

Learning through mobile apps

India is one of the second largest mobile phone user after China. Mobile phone is used not only for communication but also presents a huge opportunity for delivering e-learning content through mobile apps. Educational mobile apps have paved their way into the educational scenario. Popular platforms like android and iOS are hosting educational mobile apps. Educational app based on particular subjects are being developed. They are simplifying complex concepts with easy to understand illustrations and animations, puzzles, games etc. There are subject wise apps available. Since the affordability of these products have gone up people from rural set-up can also pursue their dreams of higher education.

Thus it could be concluded that for a nation to progress, the younger generation should be educated and updated. This up gradation is possible through a strong technological and educational support.

5.7 Evidence Based Practices

Evidence based practices will provide us with literature which suggest that with the integration of assistive technology, lives of individuals with disabilities will be improved and lead to increased productivity, independence in areas of daily living activities, school work and leisure. It may also provide these individuals with opportunities to compete more equally with peers who are able –bodied. However, in order to allow for this productivity and independence, the assistive technology must match the varied needs of the client.

Studies addressing the benefits of assistive devices, have looked at potential barriers to the use of the device. Research has also shown that research data can help in the area of service delivery. Evidence based research may help the therapists and other professionals to make effective and efficient service delivery in this area. Research and literature provide access to and use of assistive technology. This will increase the individual's access to and independence within the community.

Qualitative research has developed evidence in the area of assistive technology. The data collected not only guides decision but also describes how individuals are effectively using their technology. Studies on interactive framework support collaboration and decision making. Effectiveness regarding the implementation of these models may also be best measured through qualitative methodologies such as case studies and ethnographies. A collection of information regarding the assistive technology is important for decision-making, procurement and implementation in order to prevent abandonment and to meet the varied needs of the clients.

5.8 Let us sum up

Assistive technology is defined as "an item or piece of equipment or product system either acquired commercially, off the shelf, modified, or customized and used to increase, maintain, or improve functional capability for individual with disabilities" (Johnston, Beard, & Carpenter, 2007). Special education teachers, especially in middle and high school, should be exposed to technological tools that can help students to bypass their academic weaknesses. Teachers will help students by training them to use portable and cheap tools that, in most cases, could make students live and behave more independently when they leave high school, which will increase their chances of maximizing their degree of achievement and independence, though it will still be behind their peers without disabilities. For instance, training students to use a calculator can be more practical than beginning to teach middle and high school students' basic math (like adding two numbers). Furthermore, if students can use the calculator but have difficulty saying numbers correctly, they can use more advanced tools, such as a talking calculator, which helps students to say numbers correctly and can be used whenever or wherever they need it.

5.9 Unit end exercises

1. Write a note on Evidence Based Practices in Educational Technology.
2. Explain mainstream technologies with suitable illustrations.
3. Write a brief note on 'impact of technologies in Special education'.

5.10 References

Anderson-Inman, L., Knox-Quinn, & Horney, M. (1996). Computer-based study strategies for students with learning disabilities: individual differences associated with adoption level. Journal of Learning Disabilities, 29, 461-484.

Basham, J. D., Israel, M., Graden, J., Poth, R., & Winston, M. (2010). A comprehensive approach to RTI: Embedding universal design for learning and technology. Learning Disability Quarterly, 33, 243-255.

Basham, J. D., Lowrey, K., & deNoyelles, A. (2010). Computer mediated communication in the universal design for learning framework for preparation of special education teachers. Journal of Special Education Technology, 25, 31-44.

Blackorby, J., & Wagner, M. (1996). Longitudinal postschool outcomes of youth with disabilities: Findings fromthe National Longitudinal Transition Study. Exceptional Children, 62, 399-413.

Bouck, E. C., Doughty, T. T., Flanagan, S. M., Szwed, K., & Bassette, L. (2010). Is the pen mightier? Using pentop computers to improve secondary students' writing. Journal of Special Education Technology, 25, 33-47.

Brown, C. (1987). Computer access in higher education for students with disabilities. Washington, DC: Fund for the Improvement of Postsecondary Education, U.S. Department of Education. Retrieved from http://www.htctu.net/publications/articles/cahe/cahe.htm

Burgstahler, S. (2003).The role of technology in preparing youth with disabilities for postsecondary education and employment. Journal of Special Education Technology, 18, 7-19.

Collins, A., & Halverson, R. (2009). Rethinking education in the age of technology: The digital revolution and the schools. New York, NY: Teachers College Press. Retrieved from http://ocw.mit.edu/courses/media-arts-and-sciences/mas-714j-technologies-for-creative-learning-fall-2009/readings/MITMAS_714JF09_read03_coll.pdf

Collins, T. (1990). The impact of microcomputer word processing on the performance of learning disabled students in a required first year writing course. Computers and Composition, 8, 49-68.

Cullen, J., Richards, S. B., & Frank, C. (2008). Using software to enhance the writing skills of students with special needs. Journal of Special Education Technology, 23, 33-44.

Cutler, E. (1990). Evaluating spell checkers, thesauruses, dictionaries and grammar editors for the community college student with learning disabilities. In H. J. Murphy (Ed.), Proceedings of the Fifth Annual Conference on Technology and Persons with Disabilities, 5, 163-175.

Elbro, C, Rasmussen, I., & Spelling, B. (1996). Teaching reading to disabled readers with language disorders: A controlled evaluation of synthetic speech feedback. Scandinavian Journal of Psychology, 37, 140-155.

Higher Education Opportunity Act, 20 U.S.C. § 1001 et seq. (2008). Retrieved from

http://www.nacua.org/documents/heoa.pdf

Johnston, L., Beard, L. A., & Carpenter, L. B. (2007). Assistive technology: Access for all students. Columbus, OH: Pearson Merrill Prentice Hall.

Lankutis, T. (2004). Special needs technologies: An administrator's guide. Technology & Learning, 25, 30-35.

Ludlow, B. L., & Fosha, J. D. (2007). Critical technology issues for school leaders/the universally designed classroom: Accessible curriculum and digital technologies. Journal of Special Education Technology, 22, 60-62.

McInerney, M., Riley, K., & Osher, D. (1999). Technology to support literacy strategies for students who are deaf. Final report. Washington, DC: American Institutes for Research. Retrieved from http://www.bglad.org/literacystategies.pdf

Mitchem, K., Kight, J., Fitzgerald, G., Koury, K., & Boonseng, T. (2007). Electronic performance support systems: An assistive technology tool for secondary students with mild disabilities. Journal of Special Education Technology, 22, 1-14.

Mull, C. A., & Sitlington, P. L. (2003). The role of technology in the transition to postsecondary education of students with learning disabilities: A review of the literature. Journal of Special Education, 37, 26-32.

Patton, C. M., & Roschelle, J. (2008, May 7). Why the best math curriculum won't be a textbook. Education Week, pp. 24-32.

Raskind, M. H. (1994). Assistive technology for adults with learning disabilities: A rationale for use. In P. J. Gerber & H. B. Reiff (Eds.), Learning disabilities in adulthood: Persisting problems and evolving issues (pp. 152-162). Stoneham, MA: Andover Medical.

Rose, D. H., Hasselbring, T., Stahl, S., & Zabala, J. (2005). Assistive technology and universal design for learning: Two sides of the same coin. In D. Edyburn, K. Higgiris, & R. Boone (Eds.), Handbook of special education technology research and practice (pp. 33-41).

Skylar, A. A. (2008). iPod "teach": Increased access to technological learning supports through the use of the iPod Touch. Journal of Special Education Technology, 23, 45-49.

Stodden, R. A., Conway, M. A., & Chang, K. T. (2003). Findings from the study of transition, technology and post secondary supports for youth with disabilities: Implications for secondary school educators. Journal of Special Education Technology, 18, 29-43.

Trace Center. (1995). Principles of universal design. Madison, WI: University of Wisconsin - Madison, Trace Center.

Wehmeyer, M. L. (2006). Universal design for learning, access to the general education curriculum and students with mild mental retardation. Exceptionality, 14, 225-235.

Wehmeyer, M. L., Palmer, S. B., Smith, S. J., Davies, D. K., & Stock, S. (2008). The efficacy of technology use by people with intellectual disability: A single-subject design meta-analysis. Journal of Special Education Technology, 23, 21-30.

Wehmeyer, M. L., Smith, S. J., Palmer, S. B., Davies, D. K., & Stock, S. E. (2004). Technology use and people with mental retardation. International Review of Research in Mental Retardation, 29, 291-33

মানুষের জ্ঞান ও ভাবকে বইয়ের মধ্যে সঞ্চিত করিবার যে একটা প্রচুর সুবিধা আছে, সে কথা কেহই অস্বীকার করিতে পারে না। কিন্তু সেই সুবিধার দ্বারা মনের স্বাভাবিক শক্তিকে একেবারে আচ্ছন্ন করিয়া ফেলিলে বুদ্ধিকে বাবু করিয়া তোলা হয়।

— *রবীন্দ্রনাথ ঠাকুর*

ভারতের একটা mission আছে, একটা গৌরবময় ভবিষ্যৎ আছে, সেই ভবিষ্যৎ ভারতের উত্তরাধিকারী আমরাই। নূতন ভারতের মুক্তির ইতিহাস আমরাই রচনা করছি এবং করব। এই বিশ্বাস আছে বলেই আমরা সব দুঃখ কষ্ট সহ্য করতে পারি, অন্ধকারময় বর্তমানকে অগ্রাহ্য করতে পারি, বাস্তবের নিষ্ঠুর সত্যগুলি আদর্শের কঠিন আঘাতে ধূলিসাৎ করতে পারি।

— *সুভাষচন্দ্র বসু*

Any system of education which ignores Indian conditions, requirements, history and sociology is too unscientific to commend itself to any rational support.

— *Subhas Chandra Bose*

Published by : Netaji Subhas Open University, DD-26, Sector-I, Salt Lake, Kolkata-700 064 &
Printed at : The Saraswati Printing Works, 2, Guru Prosad Chowdhury Lane, Kolkata 700 006