

Contents

Foreword .....	.....	xix	
Preface .....	.....	xx	
Acknowledgments .....	.....	xxi	
Contributors .....	.....	xxii	
1 Diagnostic Audiology .....	.....	1	
<i>Samuel R. Atcherson and Patricia Gaffney</i>			
1.1 Introduction	1	1.6 The Effectiveness of Diagnostic Audiological Tests	3
1.2 Scope of Practice in Audiology and Licensure	2	1.6.1 Clinical Decision-Making	4
		1.6.2 Evidence-Based Practice	4
1.3 Screening versus Diagnostic Tests	2	1.7 Audiology and Public Health	6
1.4 Diagnostic Tests in Audiology	2	1.8 Audiology through Telepractice	6
1.4.1 Vestibular Testing: A Growing Specialty	3	1.9 Communication of Diagnostic Results	6
1.5 Patient-Reported Outcome Measures as Diagnostic Tools	3	References	7
2 Acoustic Stimuli Used in Diagnostic Audiology .....	.....	9	
<i>Samuel R. Atcherson, M. Bryson Howard, and Jason W. Johnson</i>			
2.1 Introduction	9	2.2.3 Speech Stimuli	14
2.1.1 Listening Conditions for Acoustic Stimuli	9	2.2.4 Transient Stimuli Used in Audiology	18
2.1.2 Visualizing the Properties of Acoustic Stimuli	11	2.3 Other Stimuli Used in Diagnostic Audiology	20
2.2 Types of Stimuli Used in Audiology	12	2.4 Conclusion	21
2.2.1 Tonal Stimuli	12	References	21
2.2.2 Noise	13		
3 Basic Instrumentation and Calibration .....	.....	23	
<i>Ahmad A. Alanazi</i>			
3.1 Introduction	23	3.3.1 Electroacoustic Calibration vs. Biologic Calibration	25
3.2 Instrumentation Standards	23	3.4 Auditory Instrumentation	25
3.2.1 American National Standards Institute (ANSI) ..	23	3.4.1 Tuning Forks	25
3.2.2 International Organization for Standardization (ISO)	23	3.4.2 Otoscope	26
3.3 Calibration	25	3.4.3 Audiology Sound Booth	26
3.4.4 Transducers		3.4.4 Transducers	26

Contents

3.4.5	Audiometer	27	3.5.1	Electronystagmography/ Videonystagmography	30
3.4.6	Acoustic Immittance	28	3.5.2	Vestibular Evoked Myogenic Potential	30
3.4.7	Otoacoustic Emissions	29	3.5.3	Computerized Dynamic Posturography	30
3.4.8	Electrophysiology.....	29	3.5.4	Rotary Chair	31
3.5	Vestibular Instrumentation.....	30		References.....	31
4	Disorders of the Auditory and Vestibular Systems	33			
	<i>Samuel R. Atcherson, Nannette Nicholson, Chad Ruffin, and Dawn M. O'Brien-Taylor</i>				
4.1	Introduction.....	33	4.5	Disorders of the Inner Ear and Internal Auditory Canal	39
4.2	Otologic Examination.....	33	4.5.1	Sensorineural Hearing Loss	39
4.2.1	History	33	4.5.2	Sudden Sensorineural Hearing Loss	39
4.2.2	Physical and Visual Examination of the Pinna and Ear Canal	33	4.5.3	Noise-Induced Hearing Loss.....	39
4.2.3	Otalgia	33	4.5.4	Age-Related Hearing Loss	40
4.2.4	Otorrhea.....	34	4.5.5	Ototoxicity	40
4.2.5	Hearing Loss	34	4.5.6	Vestibular Neuronitis.....	41
4.2.6	Tinnitus	34	4.5.7	Benign Paroxysmal Positional Vertigo	41
4.2.7	Dizziness and Vertigo.....	34	4.5.8	Perilymph Fistula.....	41
4.2.8	Trauma.....	35	4.5.9	Ménière's Disease/Otologic Migraine	41
			4.5.10	Large Vestibular Aqueduct Syndrome.....	41
			4.5.11	Labyrinthitis	42
			4.5.12	Autoimmune Inner Ear Disease	42
			4.5.13	Superior Semicircular Canal Dehiscence	43
4.3.1	Ear Itch, Dermatitis, Chronic Otitis Externa	35	4.5.14	Tumors of the Internal Auditory Canal and Cerebellopontine Angle.....	43
4.3.2	Acute Otitis Externa.....	35	4.5.15	Vascular Compression Syndrome/Vascular Loop	43
4.3.3	Otomycosis (Fungal Otitis Externa)	36	4.5.16	Vertebrobasilar Insufficiency	43
4.3.4	Malignant Otitis Externa	36			
4.3.5	Osteomas and Exostoses	36	4.6	Other Complex Disorders Involving Auditory and/or Vestibular Challenges.....	44
4.3.6	Keratosis Obturans	36	4.6.1	Hidden Hearing Loss	44
4.3.7	Cholesteatoma of the Ear Canal	36	4.6.2	Auditory Processing Disorder.....	44
4.3.8	Referred Otalgia	36	4.6.3	Hyperacusis	44
4.3.9	Perichondritis	37	4.6.4	Motion Sickness and Mal de Débarquement	44
4.3.10	Myringitis	37	4.7	Congenital Disorders	45
4.4	Disorders of the Tympanic Membrane, Middle Ear, and Mastoid Process	37	4.7.1	Congenital Aural Atresia and Anotia/Microtia...	45
4.4.1	Myringosclerosis and Tympanosclerosis.....	37	4.7.2	Ossicular Chain Abnormalities.....	45
4.4.2	Tympanic Membrane Perforations.....	37	4.7.3	Cochlear Anomalies	45
4.4.3	Eustachian Tube Dysfunction	37	4.7.4	Cochlear Nerve Anomalies (Deficiency).....	46
4.4.4	Otitis Media.....	37			
4.4.5	Cholesteatoma.....	38	4.8	Conclusion.....	46
4.4.6	Otosclerosis	38			
4.4.7	Ossicular Chain Discontinuity.....	39			
4.4.8	Neoplasms of the Middle Ear	39		References.....	47
5	Genetics of Hearing Loss	49			
	<i>Tiffany Lepard and G. Bradley Schaefer</i>				
5.1	Genetic Etiology of Hearing Loss.....	49	5.2.1	Nomenclature.....	49
			5.2.2	Autosomal Recessive	50
5.2	Nonsyndromic Hearing Loss	49	5.2.3	Autosomal Dominant	51

5.2.4	X-linked	51	5.5.2	Chromosomal Microarray (CMA).....	55
5.2.5	Mitochondrial	52	5.5.3	Single Gene Sequencing.....	55
5.2.6	Multifactorial.....	52	5.5.4	Next-Generation Sequencing	56
			5.5.5	Multigene Panels	56
5.3	Syndromic Hearing Loss	52	5.5.6	Whole Exome Sequencing.....	56
			5.5.7	Whole Genome Sequencing	56
5.4	Interpreting Family Histories.....	53	5.5.8	Mitochondrial Testing	57
			5.5.9	Metabolic Testing	57
5.4.1	Autosomal Dominant	53	5.6	Benefits and Limitations of Testing	57
5.4.2	Autosomal Recessive.....	54	5.6.1	Determining Etiology.....	57
5.4.3	X-linked	54	5.6.2	Familial Implications	57
5.4.4	Mitochondrial	55	5.6.3	Attitudes and Opinions of Testing	57
5.4.5	Multiple or Unknown Inheritance Patterns.....	55	5.6.4	Psychosocial Impact	58
5.4.6	Multifactorial.....	55		References	58
5.5	Genetic Testing Methods	55			
5.5.1	Chromosome Analysis	55			
6	Radiology and Imaging of Auditory and Vestibular Disorders				61
	<i>Razan Al Fakir (Alfakir)</i>				
6.1	Introduction.....	61	6.4.5	Interpretation of the MRI	68
6.2	Radiology and Imaging of Auditory and Vestibular Disorders	62	6.4.6	MRI Approaches	68
			6.4.7	Other MRI Approaches.....	70
6.2.1	Temporal Bone Overview: Key Structures.....	62	6.5	Strengths and Limitations of HRCT and MRI	71
6.3	Computed Tomography Imaging.....	64	6.6	Auditory and Vestibular Lesions	71
6.3.1	HRCT: The Basics	65	6.6.1	Lesions Involving the Membranous and Bony Labyrinth	73
6.3.2	Temporal Bone Landmarks on HRCT Scan.....	65	6.6.2	Bony Labyrinth Lesions	76
6.3.3	Interpretation of the HRCT scan	67	6.6.3	Lesions Involving the ICA.....	76
6.4	Magnetic Resonance Imaging (MRI)	67	6.6.4	Lesions Involving the CPA	77
			6.6.5	Lesions Involving Central Auditory and Vestibular Pathways.....	77
6.4.1	MRI: The Basics	67		References	78
6.4.2	MRI Technique.....	67			
6.4.3	MRI Protocols.....	67			
6.4.4	Temporal Bone Landmarks on MRI	68			
7	Pharmaceuticals and Nutraceuticals in Audiology				81
	<i>Robert M. DiSogra</i>				
7.1	Introduction to Pharmaceuticals	81	7.2	Nutraceuticals in Audiology	84
7.1.1	The Evolution of the U.S. Food and Drug Administration (FDA)	81	7.2.1	Nutraceuticals and Dietary Supplements for Hearing Loss, Tinnitus, or Vertigo	84
7.1.2	The Premarket Approval Regulation.....	81	7.2.2	Good Manufacturing Practice (GMP) for Supplements	85
7.1.3	Clinical Trials	82	7.2.3	Who's Minding the Store on OTC Tinnitus Products?	85
7.1.4	Clinical Research Access.....	82	7.2.4	Side Effects of Nutraceuticals—Reporting to the FDA	85
7.1.5	Reporting Adverse Drug Reactions.....	82	7.2.5	Advertising Dietary Supplements	85
7.1.6	Pharmacological Terms	82	7.2.6	Over-the-Counter (OTC) Tinnitus Relief Products	85
7.1.7	Pharmaceutical Categories That Cause Hearing Loss	83	7.2.7	"At-Risk" Groups Who Should Avoid Dietary Supplements for Tinnitus	86
7.1.8	Routes of Drug Administration	83			
7.1.9	Research Status	84			
7.1.10	Audiometric Testing Protocols	84			

Contents

7.2.8	Costs	86	7.3.1	Drug Schedules.....	86
7.2.9	Published Nutraceutical Research—Does It Exist?	86	7.3.2	Role of the Audiologist	87
7.2.10	What If.....	86		References.....	87
7.3	New Directions for Audiology—Prescriptive Rights	86			
8	Outer Ear Examination				89
	<i>Bopanna Ballachanda and Robert M. DiSogra</i>				
8.1	Introduction.....	89	8.4	Pathologies and Other Abnormal Findings of the Outer Ear	93
8.2	Instrumentation.....	89	8.4.1	Congenital Abnormalities.....	93
8.2.1	Headlight.....	89	8.4.2	Acquired Infections	93
8.2.2	Otoscope	89	8.4.3	Neoplasms.....	97
8.2.3	Video Otoscope.....	89			
8.2.4	Surgical Loupe.....	90	8.5	Cerumen Management	97
8.2.5	Operating Microscope	90			
8.2.6	Aural Specula.....	91	8.6	Conclusion.....	97
8.3	Ear Canal Examination	91		References.....	97
9	Pure Tone Tests				99
	<i>Clifford A. Franklin and Thomas C. Franklin</i>				
9.1	Introduction.....	99	9.7.2	Conductive Hearing Loss.....	107
9.2	Physical Description of Pure Tones	99	9.7.3	Sensorineural Hearing Loss	108
			9.7.4	Mixed Hearing Loss	108
9.2.1	Frequency	99	9.8	Degree of Hearing Loss	109
9.2.2	Intensity.....	101			
9.3	Frequency and Intensity Function of the Human Ear	101	9.9	Pure Tone Air and Bone Conduction Procedures	109
			9.9.1	Pure Tone Air Conduction.....	109
9.4	Pure Tone Test Equipment: The Audiometer	101	9.9.2	Case History	109
			9.9.3	Test Environment.....	110
9.4.1	Audiometer Types.....	102	9.9.4	Infection Control	110
9.5	Audiometer Components	103	9.9.5	Listener Position.....	111
			9.9.6	Instructions to the Patient	111
			9.9.7	Examination of the Ear	111
9.5.1	Power (On–Off) Switch	103	9.9.8	Ear Selection.....	111
9.5.2	Frequency Selector Dial (Oscillator).....	104	9.9.9	Test Frequencies.....	112
9.5.3	Tone Interrupter (Tone Reverse) Switch	104	9.9.10	Stimulus Type.....	112
9.5.4	Amplifier	104	9.9.11	Presentation Order.....	112
9.5.5	Attenuator (Hearing Level Dial)	104	9.9.12	Masking.....	112
9.5.6	Signal Router Switch.....	104	9.9.13	Earphone Placement	112
9.5.7	Masking Level Controller.....	105	9.9.14	Response Strategy	112
9.5.8	Transducers (Earphones, Bone Oscillators, and Loudspeakers).....	105	9.9.15	Threshold Procedure.....	113
9.5.9	Signal Selector Switch	105	9.9.16	False Negative and False Positive Responses	114
9.5.10	Calibration of Audiometers.....	105	9.10	Pure Tone Bone Conduction (B/C) Audiometry.....	115
9.6	The Audiogram and Audiometric Symbols ..	106	9.10.1	Modes of Bone Conduction.....	115
9.7	Types of Hearing Loss	106	9.10.2	Tuning Fork Tests	115
			9.10.3	Placement of the Bone Conduction Vibrator/ Oscillator.....	116
9.7.1	Normal Findings	107			

9.10.4	Bone Vibrator Types and Force on Mastoid Surface Area.....	117	9.12	Hearing Screening	119
9.10.5	Bone Conduction Testing Procedures.....	117	9.13	Conclusion	120
9.10.6	Limitations of Bone Conduction Testing	118		References	120
9.10.7	Bone Conduction and Pseudo-Sensorineural Hearing Loss.....	118			
9.11	Describing Pure Tone Findings	118			
10	Clinical Audiometric Masking	123			
	<i>Jackie L. Clark and Ross J. Roeser</i>				
10.1	Introduction	123	10.9.3	Speech Recognition Threshold Testing	133
10.2	What is Masking?	123	10.9.4	Word Recognition Testing.....	134
10.2.1	Masking versus Effective Masking	124	10.10	How Much Masking is Needed?	134
10.2.2	Clinical Masking	124	10.10.1	General Principles.....	134
10.3	Central Masking	125	10.10.2	Undermasking.....	134
10.4	The Need for Masking	125	10.10.3	The Plateau	134
10.5	Considerations in Clinical Masking	126	10.10.4	Overmasking.....	135
10.5.1	Interaural Attenuation	126	10.11	Specific Procedures	135
10.5.2	Air-Conduction Interaural Attenuation	126	10.11.1	Establishing the Starting Level	135
10.5.3	Bone-Conduction Interaural Attenuation	127	10.11.2	Determining Masking Levels for Pure-Tone Air-Conduction Testing	136
10.5.4	The Occlusion Effect	127	10.11.3	Determining Masking Levels for Pure-Tone Bone-Conduction Threshold Testing	137
10.6	Types of Clinical Masking Noises	128	10.11.4	Determining Masking Levels for Speech Recognition Threshold Testing	139
10.6.1	Broadband or White (Thermal) Noise	128	10.11.5	Determining Masking Levels for Word Recognition Testing	141
10.6.2	Narrowband Noise	128	10.11.6	The Masking Dilemma.....	142
10.6.3	Speech Noise	129	10.11.7	Masking with Special Populations.....	143
10.7	Calibrating Masking Signals	129	10.12	Case Studies	143
10.7.1	Biological Method of Calibrating Effective Masking Levels.....	130	10.12.1	Case Study No. 1.....	143
10.8	The Application of Clinical Masking	131	10.12.2	Case Study No. 2.....	145
10.9	When is Masking Needed?	131	10.12.3	Case Study No. 3.....	145
10.9.1	Pure-Tone Air-Conduction Testing	132	10.13	Summary	148
10.9.2	Pure-Tone Bone-Conduction Testing	132		References	148
11	Speech Audiometry	149			
	<i>Lisa Lucks Mendel</i>				
11.1	Introduction	149	11.3.1	Communication Handicap.....	150
11.1.1	What is Speech Audiometry?	149	11.3.2	Differential Diagnosis.....	151
11.1.2	Historical Background	149	11.3.3	Audiologic Rehabilitation and Amplification ...	153
11.2	Terminology	150	11.4	Appropriate and Currently Calibrated Instrumentation	153
11.3	Purposes for Conducting Speech Audiometry	150	11.5	Traditional Measurements in Speech Audiometry	153

Contents

11.5.1	Speech Thresholds	153	11.10.1	Response Format	162
11.5.2	Suprathreshold Word Recognition.....	155	11.10.2	Scoring Methods	163
11.6	Speech Audiometry Test Materials.....	155	11.10.3	Alternative Forms of a Test.....	164
11.10.4	Test Administration Time	164			
11.6.1	Meaningful Monosyllabic Word Tests.....	155	11.11	Methodologic Variability in the Assessment of Speech Perception	164
11.6.2	Phoneme Recognition Tests	156	11.11.1	Stimulus Familiarity and Lexical Considerations.	164
11.6.3	Nonsense Syllable Tests.....	157	11.11.2	Phonetic/Phonemic Balancing	165
11.6.4	Sentence Tests.....	157	11.11.3	Use of a Carrier Phrase	165
			11.11.4	Presentation Format of Test Materials	165
11.7	Speech-in-Noise Testing.....	158	11.11.5	Presentation Levels	166
11.7.1	Noise, Hearing Loss, and Understanding Speech	158	11.11.6	Partial- versus Full-List Test Presentation	166
11.7.2	Speech-in-Noise Tests	158	11.11.7	Number of Test Items	166
11.8	Clinical Application of SNR Loss.....	160	11.12	A Final Word about Methodologic Variability and Test Sensitivity.....	167
11.9	Speech Audiometry in Children.....	161		References.....	168
11.10	Test Administration Variables	162			
12	Audiologic Evaluation of Special Populations	171			
	<i>Angela Shoup and Ross J. Roeser</i>				
12.1	Considerations in Evaluating Special Populations	171	12.3	Older Adults	178
12.1.1	Cognitive Status	171	12.3.1	Considerations in Diagnostic Testing	178
12.1.2	Cross-Check Principle	171	12.4	Children with Intellectual/Physical Challenges.....	179
12.1.3	Patients from Diverse Cultural Backgrounds: A Growing Need.....	171	12.4.1	Developmental Disabilities.....	179
12.1.4	Interprofessional Practice and Audiology	172	12.4.2	Patients with Major and Mild Neurocognitive Disorder.....	182
12.2	Infants and Young Children (0–5 Years)	172	12.4.3	Visual Impairment.....	183
12.2.1	Test Environment.....	172	12.5	Pseudohypoacusis.....	183
12.2.2	Test Stimuli	174	12.5.1	Diagnostic Testing	184
12.2.3	0 to 6 Months Developmental Age.....	174	12.6	Conclusion.....	186
12.2.4	6 to 24 Months Developmental Age.....	175		References.....	186
12.2.5	2 to 5 Years Developmental Age.....	176			
12.2.6	Speech Thresholds and Word Intelligibility	177			
12.2.7	Physiological Tests	177			
12.2.8	Auditory Neuropathy Spectrum Disorders (ANSD)	178			
13	Assessment of Tinnitus and Hyperacusis	189			
	<i>Ali A. Danesh, Hashir Aazh, and James W. Hall III</i>				
13.1	Definitions of Tinnitus and Hyperacusis	189	13.3	Hyperacusis.....	195
13.1.1	Tinnitus	189	13.3.1	Hyperacusis Assessment.....	195
13.1.2	Hyperacusis.....	189	13.3.2	History Taking	197
			13.3.3	Self-Report Questionnaires.....	197
13.2	Audiological Assessment of Tinnitus	189	13.3.4	Loudness Discomfort Levels (LDLs).....	198
13.2.1	Targeted Patient History	190	13.3.5	LDL Test Procedure	198
13.2.2	Diagnostic Audiological Assessment	190	13.3.6	Stimulus	198
			13.3.7	Instructions.....	198

13.3.8	Presentation Levels	199	13.3.12	Special Cases of Hyperacusis.....	200
13.3.9	Diagnosis of Hyperacusis Based on LDLs and Hyperacusis Questionnaire	199		References	201
13.3.10	Severe Hyperacusis.....	200		Appendix 13.A.	205
13.3.11	In-Depth Interview.....	200			

14 Diagnosing (Central) Auditory Processing Disorders in Children..... 207

Kelli McGuire and Robert W. Keith

14.1	Introduction.....	207	14.10	The Test Battery Approach to Central Auditory Testing.....	216
14.1.1	Some Important Definitions	207	14.11	Suggested Central Auditory Tests.....	217
14.1.2	(Central) Auditory Processing Disorder	208	14.11.1	Temporal Processes	217
14.2	Further Definition of (Central) Auditory Processing Disorder.....	209	14.11.2	Pattern Recognition Testing	218
14.3	A Note on the Development of Specific Subgroups of Central Auditory Disorders ...	210	14.11.3	Localization and Lateralization.....	218
14.4	Use of Standard Scores in Determining Subject Profiles	210	14.11.4	Low-Redundancy Monaural Speech	218
14.5	Auditory Neuropathy Spectrum Disorder (Auditory Dys-synchrony)	211	14.11.5	Dichotic Stimuli	219
14.6	Referral Guidelines.....	213	14.11.6	Electrophysiologic Assessment of Central Auditory Function.....	221
14.7	Questionnaires	213	14.12	Language Testing: What the Audiologist Needs to Know	221
14.7.1	A Checklist of Attention and Hyperactivity.....	213	14.12.1	Discrimination	221
14.7.2	The University of Cincinnati Auditory Processing Inventory (UCAPI).....	214	14.12.2	Phonology	221
14.8	Case History.....	214	14.12.3	Receptive Language	221
14.9	Assessment: Prior to Central Auditory Testing.....	214	14.12.4	Expressive Language	222
14.9.1	Testing for Peripheral Hearing Loss, Including Conductive and Sensorineural Impairment.....	214	14.12.5	Prosody	222
14.9.2	Other Factors to Consider When Diagnosing (Central) Auditory Processing Disorders	215	14.12.6	Pragmatics.....	222
14.9.3	Background Information on Sensitized Speech Tests	215	14.13	Language Testing.....	222
			14.14	Interpreting Test Results	222
			14.14.1	Controversies Surrounding (C)APD Diagnosis ..	223
			14.14.2	DSM-5: Comorbidity of Disorders	223
			14.14.3	Professional Organization Perspectives.....	223
			14.14.4	Multidisciplinary Approach	223
			14.15	Acknowledgments.....	223
				References	223

15 Diagnosing Central Auditory Processing Disorders in Adults: A New Perspective on Hearing Difficulties..... 227

Gail M. Whitelaw and Christina M. Roup

15.1	Introduction.....	227	15.4.1	Considerations Prior to APD Testing	230
15.2	History of APD and APD Testing.....	227	15.4.2	Detailed Case History.....	230
15.3	Prevalence of Functional Hearing Difficulties: A Growing Population.....	229	15.4.3	Authentic Subjective Assessment Using Patient-Reported Outcome Measures	231
15.4	Behavioral Protocol for Measuring Deficits in Auditory Processing	229	15.4.4	Audiologic Assessment	232
			15.4.5	Behavioral Suprathreshold Auditory Processing Test Battery	233
			15.5	APD and Peripheral Hearing Loss in the Aging Population	237

Contents

15.6	Billing and Coding Considerations	238	15.9	Case Studies	239
15.7	Listening Effort and Fatigue due to APD and/or Functional Hearing Difficulties	238	15.9.1	Case 1: Acquired APD	239
			15.9.2	Case 2: Developmental APD.....	240
15.8	Management of APD and/or Functional Hearing Difficulties	238		References	241
16	Middle Ear Measures				245
	<i>Naveen K. Nagaraj, Ajith Kumar Uppunda, and Sandeep Maruthy</i>				
16.1	Introduction	245	16.9.1	Absorbance at Tympanometry Peak Pressure and Ambient Pressure.....	252
16.2	Basic Principles of Immittance Test	245	16.9.2	Average Absorbance Tympanogram	252
16.2.1	Calculating the Total Impedance of the Middle Ear.....	245	16.9.3	Normative Values and Clinical Case Examples...	253
			16.9.4	Middle Ear Disorders.....	253
16.3	Admittance in Clinical Tympanometry	246	16.10 Acoustic Reflex Testing	255	
16.4	Tympanogram and Its Derivatives	246	16.10.1	Acoustic Reflex Pathway.....	255
16.5	Clinical Classification of Tympanograms	248	16.10.2	Acoustic Reflex Threshold.....	257
16.6	Signature Tympanograms	249	16.10.3	Clinical Applications of Acoustic Reflexes	258
16.7	Eustachian Tube Function Test	249	16.11 Case Studies	259	
16.8	Multifrequency and Multicomponent Tympanometry	249	16.11.1	Case 1.....	260
16.8.1	Measuring Resonance Frequency.....	251	16.11.2	Case 2.....	261
16.9	Wideband Immittance Measurement	252	16.11.3	Case 3.....	261
			16.11.4	Case 4.....	261
				References	263
17	Otoacoustic Emissions				265
	<i>Laura Dreisbach, Gayla L. Poling, and David K. Brown</i>				
17.1	Introduction	265	17.5	Expected Outcomes for Various Pathologies	280
17.2	Brief History of Otoacoustic Emissions	265	17.5.1	Acoustic Neuroma	280
17.3	Detection, Measurement, Interpretation, and Applications of Otoacoustic Emissions	265	17.5.2	Sudden Sensorineural Hearing Loss	281
17.3.1	Characteristics of Otoacoustic Emissions	266	17.5.3	Auditory Neuropathy Spectrum Disorder	281
17.3.2	Transient Evoked Otoacoustic Emissions	267	17.5.4	False/Exaggerated Hearing Loss.....	281
17.3.3	Distortion Product Otoacoustic Emissions	271	17.6 Conclusion	281	
17.3.4	Stimulus Frequency Otoacoustic Emissions	277	References	282	
17.3.5	Spontaneous Otoacoustic Emissions	277			
17.4	Calibration	279			
18	Electrocochleography				287
	<i>John A. Ferraro</i>				
18.1	Introduction	287	18.2	Salient Features of the Cochlear Microphonic, Cochlear Summating Potential, and Action Potential	287

18.2.1	Cochlear Microphonic.....	288	18.3.4	Interpreting an Electrococleogram	295
18.2.2	Cochlear Summating Potential	288	18.4	Clinical Applications of the Electrococleogram	297
18.2.3	Action Potential.....	289	18.4.1	Ménière's Disease/Endolymphatic Hydrops....	297
18.3	Administering Electrococleography	289	18.4.2	Enhancement of Wave I.....	300
18.3.1	Recording Techniques: Transtympanic versus Extratympanic	289		References	304
18.3.2	Recording Parameters.....	291			
18.3.3	Preparing for Electrococleography.....	294			
19	Auditory Brainstem Responses	307			
<i>David K. Brown, Gayla L. Poling, and Laura Dreisbach</i>					
19.1	General Description of the Auditory Brainstem Response	307	19.3.3	Neurodiagnostic Auditory Brainstem Response	317
19.1.1	The Auditory Brainstem Response Waveform...	307	19.4	Patient Factors Affecting the Auditory Brainstem Response	319
19.1.2	Origins of the Auditory Brainstem Response....	308	19.4.1	Patient's Age	319
19.2	Auditory Brainstem Response Principles....	308	19.4.2	Gender	320
19.2.1	Stimulus Parameters.....	308	19.4.3	Pharmacological Agents.....	320
19.2.2	Recording Techniques.....	311	19.4.4	Body Temperature	320
19.2.3	Response Analyses	313	19.5	Establishing Clinical Normative Values	320
19.3	Auditory Brainstem Response Applications	313	19.6	Conclusion	321
19.3.1	Screening Auditory Brainstem Response.....	313		References	321
19.3.2	Threshold Auditory Brainstem Response.....	314			
20	Middle Late Responses and Cortical Auditory Evoked Potentials.....	325			
<i>Mayur Bhat, Hari Prakash P, and Samuel R. Atcherson</i>					
20.1	Introduction.....	325	20.4	Late Latency Response	329
20.2	Recording Auditory Evoked Potentials.....	325	20.4.1	Stimulus Parameters	330
			20.4.2	Applications of LLR.....	331
20.2.1	Electrodes.....	325	20.5	P300 Event-Related Potential	334
20.2.2	Electrode Montage	325	20.5.1	Source.....	334
20.2.3	Extracting the AEP	326	20.5.2	Waveform and Recording	334
20.2.4	Monitoring Eyeblink Artifacts	327	20.5.3	Clinical Application	335
20.2.5	Repetition Rate and Interstimulus Interval.....	327	20.6	Other Late Responses	336
20.2.6	Prestimulus Recording	327	20.6.1	Mismatch Negativity	336
20.2.7	Patient State and Attention	327	20.6.2	N400.....	339
20.3	Middle Latency Response	327		References	340
20.3.1	Recording Procedure for MLR	328			
20.3.2	Common Clinical Uses	328			
20.3.3	Factors Affecting MLR.....	329			
21	Clinical Applications of the Auditory Steady-State Response in Audiology Today	347			
<i>James W. Hall III, Samantha Kleindienst Robler, and Lisa Duong Taniguchi</i>					
21.1	Introduction.....	347	21.1.1	Historical Overview	347

Contents

21.1.2	Pioneering Investigations of ASSR	347	21.3.3	Development, Age, and Sex Factors in Measurement and Analysis	351
21.1.3	Initial Clinical Application.....	347	21.3.4	Achieving Adequate Test Conditions: Sleep, Sedation, and Anesthesia	352
21.2	ASSR Measurement.....	348	21.4	Clinical Applications.....	353
21.2.1	Introduction	348	21.4.1	Newborn Hearing Screening	353
21.2.2	Basic Principles	348	21.4.2	School-Age Children	353
21.2.3	Anatomy and Physiology.....	348	21.4.3	Diagnosis of Hearing Loss	354
21.2.4	Stimulus Parameters	348	21.4.4	Auditory Central Nervous System and Auditory Processing Disorders.....	357
21.2.5	Detection Methods and Analysis	350	21.4.5	Management of Patients with Hearing Aids and Cochlear Implants	358
21.2.6	Current Clinical Instrumentation.....	350	21.4.6	Clinical Applications in Adults.....	359
21.2.7	Differences between ABR and ASSR.....	351		References.....	361
21.3	Considerations in ASSR Measurement.....	351			
21.3.1	Patient's State	351			
21.3.2	Test Time	351			
22	Neonatal Hearing Screening, Follow-up, and Diagnosis	365			
	<i>Nannette Nicholson and Dawn M. O'Brien-Taylor</i>				
22.1	Newborn Hearing Screening.....	365	22.5	Diagnostic Follow-up.....	381
22.1.1	Brief History of Newborn Hearing Screening ...	365	22.5.1	Etiologies of Hearing Loss.....	381
22.1.2	CDC National EHDI Program	366	22.6	Early Intervention	382
22.1.3	The Early Hearing Detection and Intervention (EHDI) System.....	366	22.6.1	Amplification	382
22.1.4	Role of an Audiologist in the EHDI System	367	22.6.2	Communication	382
			22.6.3	Education	383
22.2	Newborn Hearing Screening Methods.....	368	22.7	Family Support and Partnership	383
22.2.1	Newborn Hearing Screening Equipment and Parameters.....	368	22.7.1	Existing Communities.....	384
22.2.2	Newborn Hearing Screening Protocols	369	22.7.2	Parent-to-Parent Support.....	385
22.2.3	JCIH Risk Factors for Follow-up and Monitoring	369	22.7.3	Information.....	385
22.2.4	Training Protocols for Newborn Hearing Screeners	372	22.7.4	Professional to Parent	385
22.2.5	Loss to Follow-up/Loss to Documentation/Loss to Treatment	373	22.7.5	Adult Deaf or Hard of Hearing Mentors	385
22.2.6	EHDI-PALS	373	22.7.6	Policy	386
22.2.7	NICHQ Action Kit for Audiologists	375	22.8	Organizations that Provide Family Support..	387
			22.8.1	Alexander Graham Bell Association for Deaf and Hard of Hearing	387
22.3	Medical Home and Ongoing Periodic Early Childhood Hearing Screening.....	375	22.8.2	Hands & Voices.....	387
22.3.1	Medical Home.....	375	22.8.3	The CARE Project	387
22.3.2	Ongoing Pediatric Early Childhood Hearing Screening.....	377	22.8.4	Parent to Parent USA	387
22.4	Diagnostic Considerations.....	377	22.9	Data Management	387
				References.....	389
22.4.1	Birth to 3 Months	378		Appendix 22.A	392
22.4.2	3 to 6 Months	379		Appendix 22.B	394
22.4.3	6 Months to 24 Months.....	380		Appendix 22.C	396

23	Intraoperative Neurophysiologic Monitoring	399			
<i>Aage R. Møller[†]</i>					
23.1	Introduction.....	399	23.4.1	Monitoring of the Function of the Facial Nerve in Operations for Vestibular Schwannoma	408
23.1.1	History of Intraoperative Neurophysiological Monitoring.....	400	23.4.2	Preserving the Facial Nerve in Operations for Vestibular Schwannoma	408
23.1.2	Creation of Societies and Certifications of IONM	401	23.4.3	Preservation of Other Cranial Nerves in Operations for Skull Base Tumors.....	411
23.1.3	History of Research in the Operating Room	401	23.4.4	Monitoring Many Cranial Nerves in the Same Operation.....	412
23.2	Principles of Intraoperative Neurophysiological Monitoring	401	23.4.5	Recording Electrodes	412
23.2.1	Purpose of Doing Intraoperative Monitoring	401	23.4.6	Monitoring of Lower Cranial Motor Nerves	412
23.2.2	Practical Aspects of Doing Electrophysiologic Recordings in the Operating Room.....	401	23.4.7	Techniques for Monitoring Cranial Motor Nerves	412
			23.4.8	The Effect of Anesthesia.....	413
			23.4.9	Monitoring of Other Cranial Nerves.....	413
			23.4.10	Which Changes Should Be Reported to the Surgeon?	413
23.3	Monitoring Sensory Systems.....	402	23.5	Assessment of the Benefit from the Use of IONM and ION	414
23.3.1	Practical Aspects of Recording Sensory Evoked Potentials in the Operating Room.....	402	23.5.1	Different Surgeons May Benefit from Monitoring?	414
23.3.2	Practical Aspects of Monitoring Auditory Brainstem Responses	402	23.5.2	Determining the Benefits of Intraoperative Monitoring.....	414
23.3.3	Interpretation of the Auditory Brainstem Response.....	404	23.5.3	Which Preoperative and Postoperative Tests Are Important?	414
23.3.4	Recording Directly from the Auditory Nervous System.....	404	23.5.4	Which Operations Should Be Monitored?	415
23.3.5	Interpretation of the CAP Recorded Directly from the Auditory Nerve	405	23.6	Intraoperative Monitoring as an Aid to the Surgeon in Carrying Out Operations	415
23.3.6	Effect of Hearing Loss on the Recorded Auditory Evoked Potentials	405	23.6.1	Vestibular Nerve Section	415
23.3.7	Changes in the Function of Structures in the Cerebellopontine Angle from Surgical Manipulations	405	23.6.2	Hemifacial Spasm	415
23.3.8	Recording the Response from the Cochlear Nucleus.....	406	23.6.3	Implantations of Electrodes for Deep Brain Stimulation	416
23.3.9	Use of Electrocochleography to Monitor Auditory Function.....	407	23.7	Risks Involved in Intraoperative Monitoring	417
23.3.10	Monitoring Some Brainstem Functions by Recording the Auditory Brainstem Response	407		References	417
23.4	Monitoring Cranial Motor Nerves	408			
24	Assessment of Vestibular Function.....	419			
<i>Richard E. Gans and Joseph Sakumura</i>					
24.1	Introduction.....	419	24.6.2	Advantages and Disadvantages of Videonystagmography.....	431
24.2	How Balance Works.....	419	24.7	Vestibular Evoked Myogenic Potentials (VEMPs) – Cervical and Ocular	432
24.3	Patient History	419	24.7.1	Cervical VEMP.....	432
24.4	Neurodiagnostic Test Selection	421	24.7.2	Ocular VEMP	433
24.5	Patient Preparation	421	24.8	Dynamic Visual Acuity Tests	435
24.6	Eye Movement and Vestibular Assessment	421	24.8.1	Advantages and Disadvantages of Dynamic Visual Acuity Tests	435
24.6.1	Videonystagmography (VNG)	423			

Contents

24.9	Video Head Impulse Test	435	24.11.1	Sensory Organization Test	440
24.9.1	Patient Preparation and Administration	435	24.11.2	Motor Control Test	441
24.10	Rotary Chair Testing	436	24.11.3	Interpretation of Computerized Dynamic Platform Posturography	441
24.10.1	Sinusoidal Harmonic Acceleration Test	436	24.11.4	Advantages and Disadvantages of Computerized Dynamic Platform Posturography	442
24.10.2	Step Velocity Test	438	24.12	Report Writing and Interpretation	442
24.10.3	Advantages and Disadvantages of Rotational Chair Testing	439	24.13	Summary	442
24.11	Computerized Dynamic Platform Posturography	439		References	443
25	Public Health in Audiology	445			
	<i>Christopher Spankovich</i>				
25.1	Introduction	445	25.3.1	Planning and Management to Promote Health ..	447
25.2	Public Health: A Brief Historical Perspective	445	25.4	Public Health in Audiology Today	452
25.2.1	History of Public Health and Audiology	446		References	452
25.3	Core Competencies in Public Health	447			
26	Diagnostic Audiology via Telemedicine	455			
	<i>Erica L. Dombrowsky, Rachel Tomasek, Darrin A. Worthington, and Chad Gladden</i>				
26.1	Introduction	455	26.5	Automated Audiometry—Store and Forward Telehealth	456
26.2	Clinical Video Telehealth	455	26.6	Support Staff for Teleaudiology	457
26.3	Store and Forward Telehealth	455	26.7	Televestibular Screening, Diagnosis, and Treatment	458
26.4	Remote Diagnostics—Clinical Video Telehealth	456		References	458
27	Communicating Diagnostic Results to Patients and Families	459			
	<i>John Greer Clark</i>				
27.1	Gaining the Patient's Perspective	460	27.4.3	Audibility Index and the Count the Dots Audiogram	464
27.2	Investing in the Beginning	461	27.4.4	Speech Recognition Scores	464
27.3	Information Retention	461	27.4.5	Speech-in-Noise Test Results	465
27.3.1	Emotional State and Decreased Information Retention	461	27.5	Beyond CPT 92557	466
27.3.2	Increasing Information Retention and Recall ...	462	27.6	Setting the Stage for What Is to Come	466
27.4	The Content of Information Delivery	462	27.7	Clinical Vigilance	467
27.4.1	Degree of Hearing Loss	463		References	468
27.4.2	Percentage Hearing Loss Descriptors	463			
Index	.....				471