

CONTENTS

CONTRIBUTORS

xxiii

SECTION 1. ANALYSIS OF ELECTROPHYSIOLOGIC WAVEFORMS

1. ELECTRICITY AND ELECTRONICS FOR CLINICAL NEUROPHYSIOLOGY	3
<i>Terrence D. Lagerlund</i>	
BASIC PRINCIPLES AND DEFINITIONS IN ELECTRICITY	3
CIRCUIT ANALYSIS	5
RESISTIVE-CAPACITIVE AND RESISTIVE-INDUCTIVE CIRCUITS	7
CIRCUITS CONTAINING INDUCTORS AND CAPACITORS	8
FILTER CIRCUITS	12
TRANSISTORS AND AMPLIFIERS	13
2. ELECTRIC SAFETY IN THE LABORATORY AND HOSPITAL	17
<i>Terrence D. Lagerlund</i>	
ELECTRIC POWER DISTRIBUTION SYSTEMS	17
ELECTRIC SHOCK	17
LEAKAGE CURRENT	20
ELECTRIC SAFETY PRINCIPLES AND IMPLEMENTATION	24
3. VOLUME CONDUCTION	28
<i>Terrence D. Lagerlund</i>	
PRINCIPLES	28
ELECTRIC PROPERTIES OF VOLUME CONDUCTORS	30
CALCULATING POTENTIALS IN INFINITE HOMOGENEOUS MEDIA	30
POTENTIALS IN NONHOMOGENEOUS MEDIA	34
APPLICATIONS OF VOLUME CONDUCTION PRINCIPLES	36
4. DIGITAL SIGNAL PROCESSING	41
<i>Terrence D. Lagerlund</i>	
DIGITAL COMPUTERS IN CLINICAL NEUROPHYSIOLOGY	41

DIGITIZATION	44
COMMON USES OF DIGITAL PROCESSING	47
AVERAGING	48
DIGITAL FILTERING	49
TIME AND FREQUENCY DOMAIN ANALYSIS	50
5. ELECTROPHYSIOLOGIC GENERATORS IN CLINICAL NEUROPHYSIOLOGY	53
<i>Terrence D. Lagerlund</i>	
PHYSIOLOGIC GENERATORS	53
STRUCTURAL GENERATORS	58
6. CLASSIFICATION OF WAVEFORM CHARACTERISTICS	63
<i>Jasper R. Daube</i>	
CONTINUOUS WAVEFORMS	63
EVENT RECORDING	66
7. ALTERATION OF WAVEFORMS AND ARTIFACTS	69
<i>Jasper R. Daube</i>	
PHYSIOLOGIC ALTERATION OF WAVEFORMS	69
ARTIFACTUAL WAVEFORMS	72
 SECTION 2. ELECTROPHYSIOLOGIC ASSESSMENT OF NEURAL FUNCTION	
 Part A. Cortical Function	
8. ELECTROENCEPHALOGRAPHY: GENERAL PRINCIPLES AND ADULT ELECTROENCEPHALOGRAMS	77
<i>Donald W. Klass and Barbara F. Westmoreland</i>	
CLINICAL USEFULNESS OF ELECTROENCEPHALOGRAPHY	77
DISPLAY OF ELECTROENCEPHALOGRAPHIC ACTIVITY	78
ACTIVATION PROCEDURES	80
ARTIFACTS	82
NORMAL ELECTROENCEPHALOGRAPHIC ACTIVITY OF ADULTS	82
BENIGN VARIANTS	87
PATHOLOGIC ACTIVITY	90

ELECTROENCEPHALOGRAPHIC MANIFESTATIONS OF FOCAL INTRACRANIAL LESIONS	94
ELECTROENCEPHALOGRAPHIC MANIFESTATIONS OF DIFFUSE ENCEPHALOPATHIES	100
EVALUATION FOR SUSPECTED BRAIN DEATH	104
9. ELECTROENCEPHALOGRAPHY: ELECTROENCEPHALOGRAMS OF NEONATES, INFANTS, AND CHILDREN	108
<i>Barbara F. Westmoreland</i>	
NEONATAL ELECTROENCEPHALOGRAPHIC PATTERNS	108
DEVELOPMENTAL CHANGES DURING INFANCY, CHILDHOOD, AND ADOLESCENCE	113
BENIGN VARIANTS IN CHILDREN	115
ABNORMALITIES	116
10. AMBULATORY ELECTROENCEPHALOGRAPHY	124
<i>Jeffrey R. Buchhalter</i>	
INDICATIONS	124
TECHNOLOGY	125
CLINICAL APPLICATIONS	126
11. PROLONGED VIDEO ELECTROENCEPHALOGRAPHY	129
<i>Cheolsu Shin</i>	
EQUIPMENT	130
CLINICAL APPLICATION	131
12. ELECTROENCEPHALOGRAPHIC SPECIAL STUDIES	137
<i>Terrence D. Lagerlund</i>	
QUANTITATIVE METHODS OF ELECTROENCEPHALOGRAPHIC ANALYSIS	137
MAGNETOENCEPHALOGRAPHY	144
13. ELECTROENCEPHALOGRAPHIC RECORDINGS FOR EPILEPSY SURGERY	146
<i>Gregory D. Cascino</i>	
CANDIDATES FOR EPILEPSY SURGERY	147
EXTRACRANIAL ELECTROENCEPHALOGRAPHY IN PARTIAL EPILEPSY	148
CHRONIC INTRACRANIAL MONITORING	151
ELECTROCORTICOGRAPHY IN EPILEPSY SURGERY	157

14. MOVEMENT-RELATED POTENTIALS AND EVENT-RELATED POTENTIALS	161
<i>Joseph Y. Matsumoto</i>	
MOVEMENT-RELATED CORTICAL POTENTIALS	161
EVENT-RELATED POTENTIALS	164
Part B. Sensory Pathways	
15. NERVE ACTION POTENTIALS	169
<i>Eric J. Sorenson</i>	
CLINICAL IMPORTANCE	169
PLANNING THE STUDY	172
RADICULOPATHY	172
PLEXOPATHY	173
COMMON MONONEUROPATHIES	173
TECHNICAL FACTORS	175
HUMAN FACTORS	176
METHODS	177
MEASUREMENTS	177
16. SOMATOSENSORY EVOKED POTENTIALS	181
<i>J. Clarke Stevens</i>	
METHODS	182
SOMATOSENSORY EVOKED POTENTIAL INTERPRETATION	190
CLINICAL APPLICATIONS	191
17. BRAIN STEM AUDITORY EVOKED POTENTIALS IN CENTRAL DISORDERS	204
<i>John N. Caviness</i>	
AUDITORY ANATOMY AND PHYSIOLOGY	205
AUDITORY EVOKED POTENTIALS IN NORMAL SUBJECTS	205
METHODS	207
USE OF BRAIN STEM AUDITORY EVOKED POTENTIALS IN CLINICAL PROBLEM SOLVING	207
18. AUDIOGRAM, ACOUSTIC REFLEXES, AND EVOKED OTOACOUSTIC EMISSIONS	214
<i>Christopher D. Bauch and Wayne O. Olsen</i>	
AUDIOGRAM	215
ACOUSTIC REFLEX	216
EVOKED OTOACOUSTIC EMISSIONS	218

19. BRAIN STEM AUDITORY EVOKED POTENTIALS IN PERIPHERAL ACOUSTIC DISORDERS	222
<i>Christopher D. Bauch</i>	
STIMULI	222
INTERPRETATION	223
ELECTRODES	224
APPLICATIONS	224
20. VISUAL EVOKED POTENTIALS	227
<i>John N. Caviness</i>	
VISUAL SYSTEM ANATOMY AND PHYSIOLOGY	227
VISUAL EVOKED POTENTIALS IN NORMAL SUBJECTS	228
METHODS	229
GENERAL PRINCIPLES OF INTERPRETATION OF VISUAL EVOKED POTENTIALS	230
USE OF VISUAL EVOKED POTENTIALS IN CLINICAL PROBLEM SOLVING	230
LOCALIZATION OF VISUAL SYSTEM LESIONS	231
Part C. Motor Pathways	
21. COMPOUND MUSCLE ACTION POTENTIALS	237
<i>Jasper R. Daube</i>	
CLINICAL APPLICATION	238
RECORDING COMPOUND MUSCLE ACTION POTENTIALS	238
STIMULATION	240
COMPOUND MUSCLE ACTION POTENTIAL MEASUREMENTS	242
F WAVES	245
PHYSIOLOGIC VARIABLES	249
COMPOUND MUSCLE ACTION POTENTIAL CHANGES IN DISEASE	250
FINDINGS IN PERIPHERAL NERVE DISORDERS	251
22. ASSESSING THE NEUROMUSCULAR JUNCTION WITH REPETITIVE STIMULATION STUDIES	268
<i>Robert C. Hermann, Jr.</i>	
ANATOMY AND PHYSIOLOGY OF THE NEUROMUSCULAR JUNCTION	268
TECHNIQUE	270
CRITERIA OF ABNORMALITY	276

RAPID RATES OF STIMULATION	276
SELECTION OF NERVE-MUSCLE COMBINATIONS	276
CLINICAL CORRELATIONS	278
23. MOTOR EVOKED POTENTIALS	282
<i>Jasper R. Daube</i>	
MOTOR EVOKED POTENTIAL STIMULATION	282
MOTOR EVOKED POTENTIAL RECORDING	285
MOTOR EVOKED POTENTIAL VARIABLES	285
APPLICATIONS	286
Part D. Assessing the Motor Unit	
24. ASSESSING THE MOTOR UNIT WITH NEEDLE ELECTROMYOGRAPHY	293
<i>Jasper R. Daube</i>	
KNOWLEDGE BASE OF NEEDLE ELECTROMYOGRAPHY	294
CONDUCTING THE NEEDLE EXAMINATION	294
NEEDLE EXAMINATION TECHNIQUES	295
ELECTROMYOGRAPHIC ANALYSIS	297
ORIGIN OF ELECTROMYOGRAPHIC POTENTIALS	299
NORMAL ELECTROMYOGRAPHIC ACTIVITY	299
RECRUITMENT	301
SIGNAL ANALYSIS	305
ABNORMAL ELECTRIC ACTIVITY	307
25. QUANTITATIVE ELECTROMYOGRAPHY	324
<i>Robert C. Hermann, Jr.</i>	
CHARACTERISTICS OF THE MOTOR UNIT POTENTIAL	325
CHARACTERISTICS OF THE RECORDING EQUIPMENT	326
PROPERTIES OF MOTOR UNIT POTENTIALS WITH STANDARD ELECTRODES	328
MOTOR UNIT POTENTIAL COMPLEXITY (PHASES, TURNS, CROSSINGS)	330
PROPERTIES OF MOTOR UNIT POTENTIALS MEASURABLE ONLY WITH SPECIAL ELECTRODES	332
PROPERTIES OF INTERFERENCE PATTERN	333
MANUAL ANALYSIS OF SINGLE MOTOR UNIT POTENTIALS	334

COMPUTER-ASSISTED QUANTITATIVE ANALYSIS OF MOTOR UNIT POTENTIALS	335
AUTOMATED METHODS OF ANALYSIS OF MOTOR UNIT POTENTIALS	337
DECOMPOSITION OF THE INTERFERENCE PATTERN INTO CONSTITUENT MOTOR UNIT POTENTIALS	337
TURNS AND AMPLITUDE ANALYSIS OF THE INTERFERENCE PATTERN	339
POWER-SPECTRUM ANALYSIS	340
26. SINGLE FIBER ELECTROMYOGRAPHY	343
<i>C. Michel Harper, Jr.</i>	
TECHNIQUE	345
PITFALLS OF SINGLE FIBER ELECTROMYOGRAPHY	349
CLINICAL APPLICATIONS OF SINGLE FIBER ELECTROMYOGRAPHY	353
27. ESTIMATING THE NUMBER OF MOTOR UNITS IN A MUSCLE	358
<i>Jasper R. Daube</i>	
MOTOR UNIT NUMBER ESTIMATE BY STANDARD ELECTROMYOGRAPHY	359
MOTOR UNIT NUMBER ESTIMATE BY STANDARD NERVE CONDUCTION STUDIES	360
QUANTITATIVE MOTOR UNIT NUMBER ESTIMATE	361
CLINICAL APPLICATIONS	368
 Part E. Reflexes and Central Motor Control	
28. H REFLEXES	375
<i>Kathryn A. Stolp-Smith</i>	
PHYSIOLOGIC BASIS	375
TECHNIQUE	377
PEDIATRIC H REFLEXES	378
CLINICAL APPLICATION	379
29. CRANIAL REFLEXES	382
<i>Raymond G. Auger and J. Clarke Stevens</i>	
BLINK REFLEX	382
JAW JERK (MASSETER REFLEX)	389
MASSETER INHIBITORY REFLEX	391

30. LONG LATENCY REFLEXES AND THE SILENT PERIOD	394
<i>Joseph Y. Matsumoto</i>	
LONG LATENCY REFLEXES	394
THE SILENT PERIOD	396
31. SURFACE ELECTROMYOGRAPHIC STUDIES OF MOVEMENT DISORDERS	399
<i>James H. Bower and Joseph Y. Matsumoto</i>	
TECHNIQUES	400
NORMAL PATTERNS	401
TREMOR	402
MYOCLONUS	405
DYSTONIA	409
TICS, CHOREA, AND ATHETOSIS	411
SURFACE ELECTROMYOGRAPHIC STUDY OF VOLUNTARY MOVEMENT DISORDERS	411
32. VERTIGO AND BALANCE	413
<i>Robert H. Brey</i>	
OFFICE PROCEDURES AND HISTORY TAKING	414
PHYSICAL EXAMINATION OF THE VESTIBULAR SYSTEM	415
LABORATORY EXAMINATION: ELECTRONYSTAGMOGRAPHY TEST BATTERY	420
OTOLITH ORGAN TESTING	427
SUPERIOR SEMICIRCULAR CANAL DEHISCENCE	427
COMPUTERIZED ROTARY CHAIR TEST (HARMONIC ACCELERATION TESTING)	428
COMPUTERIZED DYNAMIC POSTUROGRAPHY	430
VESTIBULAR REHABILITATION	433
Part F. Autonomic Function	
33. CLINICAL PHYSIOLOGY OF THE AUTONOMIC NERVOUS SYSTEM	437
<i>Eduardo E. Benarroch</i>	
SYMPTOMS AND DISEASES	437
GENERAL ORGANIZATION OF THE AUTONOMIC SYSTEM	438
SYMPATHETIC FUNCTION	439
SYMPATHETIC INNERVATION OF THE SKIN	440

MUSCLE SYMPATHETIC ACTIVITY	440
AUTONOMIC CONTROL OF HEART RATE	441
CARDIOVASCULAR REFLEXES	441
MAINTENANCE OF POSTURAL NORMOTENSION	442
34. QUANTITATIVE SUDOMOTOR AXON REFLEX TEST AND RELATED TESTS	445
<i>Phillip A. Low</i>	
LABORATORY EVALUATION OF AUTONOMIC FUNCTION	445
QUANTITATIVE SUDOMOTOR AXON REFLEX TEST	445
35. ADRENERGIC FUNCTION	451
<i>Phillip A. Low</i>	
SKIN VASOMOTOR REFLEXES	451
36. THERMOREGULATORY SWEAT TEST	458
<i>Robert D. Fealey</i>	
ROLE OF THERMOREGULATORY SWEAT TESTING: CLINICAL SYNDROMES AND PROBLEMS EVALUATED	458
METHOD	459
NORMAL THERMOREGULATORY SWEAT DISTRIBUTIONS	462
REPORTING RESULTS	463
DIFFICULTIES AND PITFALLS IN INTERPRETATION	464
37. CARDIOVAGAL AND OTHER REFLEXES	467
<i>Eduardo E. Benarroch and Phillip A. Low</i>	
HEART RATE RESPONSE TO DEEP BREATHING	467
HEART RATE RESPONSE TO STANDING	469
OTHER TESTS OF CARDIOVAGAL FUNCTION	469
POWER SPECTRUM ANALYSIS	470
THE VALSALVA MANEUVER	470
OTHER TESTS OF AUTONOMIC FUNCTION	474
38. ELECTROPHYSIOLOGY OF PAIN	477
<i>Rose M. Dotson</i>	
QUANTITATIVE SENSORY TEST	477
AUTONOMIC TESTS	481
MICRONEUROGRAPHY	483
LASER EVOKED POTENTIALS	484

Part G. Sleep and Consciousness

39. PHYSIOLOGIC ASSESSMENT OF SLEEP	493
<i>Peter J. Hauri, Cameron D. Harris, and Michael H. Silber</i>	
DEFINITIONS	493
EVALUATION OF SLEEP	497
ASSESSING RESPIRATION DURING SLEEP	504
ASSESSING PERIODIC LIMB MOVEMENTS	510
ASSESSING OTHER PHYSIOLOGIC VARIABLES	511
40. ASSESSING SLEEP DISORDERS	513
<i>Peter J. Hauri, Cameron D. Harris, and Michael H. Silber</i>	
INDICATIONS FOR POLYSOMNOGRAPHY	513
PARTIAL EVALUATIONS	514
PERFORMANCE OF A SLEEP STUDY	515
DISORDERS OF EXCESSIVE DAYTIME SOMNOLENCE	516
PARASOMNIAS	517

Part H. Intraoperative Monitoring

41. CEREBRAL FUNCTION MONITORING	523
<i>Elson L. So and Frank W. Sharbrough</i>	
TECHNICAL FACTORS IN INTRAOPERATIVE ELECTROENCEPHALOGRAPHIC MONITORING	523
SYMMETRICAL ELECTROENCEPHALOGRAPHIC PATTERNS DURING ANESTHESIA	527
PREOPERATIVE FOCAL ABNORMALITIES	527
FOCAL ELECTROENCEPHALOGRAPHIC CHANGES DURING CAROTID ENDARTERECTOMY	528
ELECTROENCEPHALOGRAPHY AND OTHER MONITORING TECHNIQUES IN RELATION TO SURGICAL STRATEGY DURING CAROTID ENDARTERECTOMY	529
ELECTROENCEPHALOGRAPHIC MONITORING DURING CARDIAC SURGERY	530
42. BRAIN STEM AND CRANIAL NERVE MONITORING	532
<i>C. Michel Harper, Jr.</i>	
METHODS	532
APPLICATIONS	535

43. SPINAL CORD MONITORING	539
<i>Jasper R. Daube</i>	
APPLICATIONS	539
MONITORING METHODS	540
ELECTROMYOGRAPHIC AND NERVE CONDUCTION STUDIES	546
TYPES OF SURGERY	547
PRIMARY VASCULAR DISEASE	552
44. PERIPHERAL NERVOUS SYSTEM MONITORING	555
<i>C. Michel Harper, Jr.</i>	
METHODS	555
APPLICATIONS	556
 SECTION 3. APPLICATIONS OF CLINICAL NEUROPHYSIOLOGY: ASSESSING SYMPTOM COMPLEXES AND DISEASE ENTITIES	
45. APPLICATION OF CLINICAL NEUROPHYSIOLOGY: ASSESSING SYMPTOM COMPLEXES	565
<i>Jasper R. Daube and Elson L. So</i>	
CLINICAL NEUROPHYSIOLOGY IN THE ASSESSMENT OF DISEASE	566
WHEN CLINICAL NEUROPHYSIOLOGY CAN HELP	567
SYMPTOM COMPLEXES AND NEURAL SYSTEMS	568
LOCALIZATION OF DISEASE	570
IDENTIFYING DISEASE TYPES	571
PROGNOSIS	572
ASSESSING CLINICAL DISORDERS: ASSESSMENT WITH ELECTROENCEPHALOGRAPHY	575
ASSESSING CLINICAL DISORDERS: ASSESSMENT WITH ELECTROMYOGRAPHY AND NERVE CONDUCTION STUDIES	583
GLOSSARY OF ELECTROPHYSIOLOGIC TERMS	599
INDEX	629