

Contributors to This and Previous Editions xv Preface xvii Acknowledgements xxi Master Competency Checklist xxii

PART ONE Foundations of Therapeutic Modalities

1. The Basic Science of Therapeutic Modalities 3 William E. Prentice and Bob Blake Forms of Energy 3 Electromagnetic Energy 5 The Relationship Between Wavelength and Frequency 5 The Electromagnetic Energy Spectrum 6 How Is Electromagnetic Energy Produced? 7 Effects of Electromagnetic Radiations 7 Laws Governing the Effects of Electromagnetic Energy 9 Electromagnetic Energy Modalities 11 Thermal Energy 12 Thermal Energy Modalities 13 Electrical Energy 13 Electrical Energy Modalities 13 Sound Energy 14 Sound Energy Modalities 14 Mechanical Energy 15 Mechanical Energy Modalities 15

2. Using Therapeutic Modalities to Affect the Healing Process 19

William E. Prentice

Summary 15

How Should the Clinician Use Therapeutic Modalities in Rehabilitation? 19
The Importance of Understanding the Healing Process 21
Inflammatory-Response Phase 21

Fibroblastic-Repair Phase 24
Maturation-Remodeling Phase 25

Factors That Impede Healing 25

	How Should Therapeutic Modalities Be Used Throughout the Rehabilitation Process? 27 Using Modalities in the Immediate First Aid Management of Injury 27 Modality Use in the Inflammatory-Response Phase 29 Modality Use in the Fibroblastic-Repair Phase 29 Modality Use in the Maturation-Remodeling Phase 30 Indications and Contraindications 31 Other Considerations in Treating Injury 31 Summary 33
3.	The Role of Therapeutic Modalities in Wound Healing 37 Pamela E. Houghton
	Introduction 37
	Superficial Hot and Cold 38 Effects of Hot and Cold Agents on Blood Flow 38 Hydrotherapy 39
	Electrical Stimulation 40
	Ultrasound 46
	Laser 49 Effects of Laser on Tissue Repair 49
	Ultraviolet Light 51
	Pneumatic Compression Therapy 54
	Review of Clinical Research Evidence 54
	Choosing the Best Modality for the Treatment of Delayed or Nonhealing Wounds 57 Contraindications 58 Summary 59
4.	Managing Pain With Therapeutic Modalities 71 Craig R. Denegar and William E. Prentice
	Understanding Pain 71 Types of Pain 72
	Pain Assessment 72 Pain Assessment Scales 73
	Goals in Managing Pain 75
	Pain Perception 76 Sensory Receptors 76 Cognitive Influences 77
	Neural Transmission 78 Facilitators and Inhibitors of Synaptic Transmission 79 Nociception 80

Neurophysiologic Explanations of Pain Control 82 The Gate Control Theory of Pain 82 Descending Pain Control 83 B-Endorphin and Dynorphin in Pain Control 84 Summary of Pain Control Mechanisms 85 Pain Management Summary 90 PART TWO **Electrical Energy Modalities** 5. Basic Principles of Electricity and Electrical Stimulating Currents 97 Daniel N. Hooker and William E. Prentice Components of Electrical Currents 98 Electrotherapeutic Currents 99 Generators of Electrotherapeutic Currents Electrical Circuits 101 Series and Parallel Circuits 102 Current Flow through Biologic Tissues 103 Choosing Appropriate Treatment Parameters Waveforms 104 Waveform Shape 104 Pulses versus Phases and Direction of Current Flow 105 Current Modulation 108 Frequency 110 Intensity 111 Duration 111 Polarity 111 Physiologic Responses to Electrical Current Direct and Indirect Physiologic Effects Nerve Responses to Electrical Currents Muscular Responses to Electrical Current 120 Biostimulative Effects of Electrical Current on Nonexcitatory Cells 122 Clinical Uses of Electrical Stimulating Currents 123 High-Volt Currents 124 Asymmetric Biphasic Currents (TENS) 135

Microcurrent

138

Premodulated Interferential Current 146

Interferential Currents 143

Low-Volt Currents 146

Russian Currents (Medium-Frequency Current Generators) 141

Bone Growth Stimulators 147
Functional Electrical Stimulation 147 Clinical Uses of FES 148
Placebo Effect of Electrical Stimulation 148
Safety in the Use of Electrical Equipment 149 Summary 151
6. Iontophoresis 175 William E. Prentice
Iontophoresis Versus Phonophoresis 175
Basic Mechanisms of Ion Transfer 176 Pharmacokinetics of Iontophoresis 176 Movement of Ions in Solution 176 Movement of Ions Through Tissue 177
Iontophoresis Equipment and Treatment Techniques 178 Type of Current Required 178 Iontophoresis Generators 178 Current Intensity 179 Treatment Duration 180 Dosage of Medication 180 Electrodes 180 Selecting the Appropriate Ion 184 Clinical Applications for Iontophoresis 186
Treatment Precautions and Contraindications 189 Treatment of Burns 189 Sensitivity Reactions to Ions 190 Summary 190
7. Biofeedback 199 William E. Prentice
Electromyography and Biofeedback 199
The Role of Biofeedback 200
Biofeedback Instrumentation 200 Peripheral Skin Temperature 201 Finger Phototransmission 201 Skin Conductance Activity 201
Electromyographic Biofeedback 201 Motor Unit Recruitment 202 Measuring Electrical Activity 203 Separation and Amplification of Electromyographic Activity 203

Converting Electromyographic Activity to Meaningful Information 205 Processing the Electromyographic Signal 205 Biofeedback Equipment and Treatment Techniques 206 Electrodes 207 Displaying the Information 209 Clinical Applications for Biofeedback 210 Muscle Reeducation 210 Relaxation of Muscle Guarding 211 Pain Reduction 212 Treating Neurologic Conditions 212 Summary 212 8. Principles of Electrophysiologic Evaluation and Testing 223 John Halle and David Greathouse Introduction 225 Electrophysiologic Testing Equipment and Setup 226 Electrodes 226 Amplifier 227 Visual Feedback (Oscilloscope) 229 Auditory Feedback (Speakers) 229 Testing Units 229 Eliciting an Action Potential 229 Generating a Record 231 Evaluation of the Peripheral Nervous System 231 Anatomy of the Spinal Nerve and Neuromuscular Junction 232 Sensory Receptor and Size of the Axon 233 Synapse 233 Alpha Motor Neuron 234 Neuromuscular Junction 234 Muscle Fiber 234 The Elements of the Spinal Nerve 234 Testing Procedures 235 Limb Temperature and Age Considerations 235 Nerve Conduction Study 236 The Electromyographic Examination 254 Clinical EMG Procedures 256 Somatosensory Evoked Potentials 265 Electrophysiologic Testing Within the Operating Room 267 Other Electrophysiologic Testing Procedures 267 Requesting NCS/EMG Examinations 268 Conclusion 268 Summary 269

PART THREE Thermal Energy Modalities

9. Cryotherapy and Thermotherapy 285

William E. Prentice

Mechanisms of Heat Transfer 286

Appropriate Use of Cryotherapy and Thermotherapy Modalities 286

Clinical Use of the Conductive Energy Modalities 287

Effects of Tissue Temperature Change on Circulation 288

Effects of Tissue Temperature Change on Muscle Spasm 289

Effects of Temperature Change on Performance 290

Cryotherapy 290

Physiologic Effects of Tissue Cooling 290

Cryotherapy Treatment Techniques 293

Thermotherapy 311

Physiologic Effects of Tissue Heating

Thermotherapy Treatment Techniques 312

Counterirritants 322

Summary 323

PART FOUR Sound Energy Modalities

10. Therapeutic Ultrasound 363

David O. Draper and William E. Prentice

Ultrasound as a Heating Modality 364

Transmission of Acoustic Energy in Biologic Tissues 364

Transverse Versus Longitudinal Waves 364

Frequency of Wave Transmission 364

Velocity 365

Attenuation 365

Basic Physics of Therapeutic Ultrasound 367

Components of a Therapeutic Ultrasound Generator 367

Physiologic Effects of Ultrasound 375

Thermal Effects 375

Nonthermal Effects 376

Ultrasound Treatment Techniques

Frequency of Treatment 378

хi

Duration of Treatment 378 Coupling Methods 380 Exposure Techniques 381 Clinical Applications for Therapeutic Ultrasound 386 Soft-Tissue Healing and Repair 386 Scar Tissue and Joint Contracture 387 Stretching of Connective Tissue 387 Chronic Inflammation 389 Bone Healing 389 Pain Reduction 391 Plantar Warts 391 Placebo Effects 391 Phonophoresis 393 Using Ultrasound in Combination With Other Modalities 395 Ultrasound and Hot Packs 396 Ultrasound and Cold Packs 396 Ultrasound and Electrical Stimulation 397 Treatment Precautions 398 Guidelines for the Safe Use of Ultrasound Equipment 398 Summary 400 11. Extracorporeal Shockwave Therapy 417 Charles Thigpen History of Extracorporeal Shockwave Therapy (ESWT) 417 Physical Characteristics of Extracorporeal Shock Wave 418 Shock Wave Generation 420 Physical Parameters of Shock Waves 420 Biologic Effects 421 Bone 421 Tendon 422 Clinical Applications 422 Fractures 422 Plantar Fasciitis 423 Medial-Lateral Epicondylitis 425 Calcific Tendinitis of the Shoulder 425 Evaluation of ESWT Literature for Evidenced-Based Practice 426

Summary 426

PART FIVE Electromagnetic Energy Modalities

12. Shortwave and Microwave Diathermy 433

William E. Prentice and David O. Draper

Physiologic Responses to Diathermy 434

Thermal Effects 434

Nonthermal Effects 434

Shortwave Diathermy Equipment 435

Shortwave Diathermy Electrodes 436

Pulsed Shortwave Diathermy 442

Treatment Time 443

Microwave Diathermy 446

Clinical Applications for Diathermy 447

Comparing Shortwave Diathermy and Ultrasound as Thermal Modalities 448

Diathermy Treatment Precautions, Indications, and Contraindications 449

Summary 452

13. Low-Power Laser Therapy 463

Ethan Saliba and Susan Foreman-Saliba

Physics 464

Types of Lasers 464

Laser Treatment Techniques 466

Lasing Techniques 466

Dosage 468

Depth of Penetration 470

Clinical Applications for Lasers 470

Wound Healing 470

Pain 473

Bone Response 473

Suggested Treatment Protocols 474

Pain 474

Wound Healing 475

Scar Tissue 475

Edema and Inflammation 476

Safety 476

Precautions and Contraindications 477

Conclusion 479

Summary 479

PART SIX Mechanical Energy Modalities

14. Spinal Traction 489

Daniel N. Hooker

The Physical Effects of Traction 489

Effects on Spinal Movement 489

Effects on Bone 490

Effects on Ligaments 490

Effects on the Disk 491

Effects on Articular Facet Joints 492

Effects on the Muscular System 492

Effects on the Nerves 492

Effects on the Entire Body Part 492

Traction Treatment Techniques 493

Lumbar Positional Traction 493

Inversion Traction 495

Manual Lumbar Traction 496

Mechanical Lumbar Traction 500

Manual Cervical Traction 509

Mechanical Cervical Traction 510

Indications and Contraindications 515

Summary 515

15. Intermittent Compression Devices 523

Daniel N. Hooker

The Lymphatic System 523

Purposes of the Lymphatic System 523

Structure of the Lymphatic System 524

Peripheral Lymphatic Structure and Function 524

Injury Edema 525

Formation of Pitting Edema 526

Formation of Lymphedema 526

The Negative Effects of Edema Accumulation 527

Treatment of Edema 527

Intermittent Compression Treatment Techniques 529

Inflation Pressures 529

On-Off Sequence 530

Total Treatment Time 530

Sequential Compression Pumps 531

Patient Setup and Instructions 532

xiv Contents

Cold and Compression Combination 535
Indications and Contraindications for Use 536
Summary 537

16. Therapeutic Massage 545

William E. Prentice

Physiologic Effects of Massage 545
Reflexive Effects 546
Effects on Metabolism 546
Mechanical Effects 546

Psychological Effects of Massage 547

Massage Treatment Considerations and Guidelines 547

Equipment 550

Massage Treatment Techniques 551

Hoffa Massage 551
Friction Massage 557
Transverse Friction Massage 558
Connective Tissue Massage 560
Trigger Point Massage 561
Strain–Counterstrain 564
Positional Release Therapy 565
Active Release Technique® 566
Myofascial Release 566

Graston Technique® 568
Rolfing 568

Trager 570

Indications and Contraindications for Massage 570
Summary 571

Appendix A Location of Motor Points 583

Appendix B Units of Measure 587

Answers to Self-Test Questions 589

Index 591