CONTENTS

1 A Brief History of Fetal Monitoring, 1

Historical Overview, 1 Randomized Trials of Electronic Fetal Monitoring, 2 Research at the End of the Twentieth Century, 4 Fetal Monitoring in the Twenty-First Century, 4 Summary, 6

2 Physiologic Basis for Electronic Fetal Heart Rate Monitoring, 10

Transfer of Oxygen from the Environment to the

Fetus, 10

External Environment, 11

Maternal Lungs, 12

Maternal Blood, 12

Maternal Heart, 13

Maternal Vasculature, 14

Uterus, 15

Placenta, 15

Fetal Blood, 21

Umbilical Cord, 21

Fetal Response to Interrupted Oxygen Transfer, 23

Mechanisms of Injury, 23

Injury Threshold, 24

Summary, 26

3 Methods and Instrumentation, 28

Intermittent Auscultation of Fetal Heart Rate, 28

Description, 28

Leopold's Maneuvers, 31

Utilization and Frequency of Intermittent

Auscultation, 33

Documentation of Auscultated Fetal Heart Rate, 33

Interpretation of Auscultated Fetal Heart Rate, 34

Benefits and Limitations of Auscultation, 34

Electronic Fetal Monitoring, 35

Overview, 35

Converting Raw Data Into a Visual Display of FHR, 36

External Mode of Monitoring, 39

Ultrasound Transducer, 39

Tocotransducer, 41

Advantages and Limitations of External Transducers, 44

Internal Mode of Monitoring, 44

Spiral Electrode, 44

Intrauterine Pressure Catheter, 47

Advantages and Limitations of Internal Monitoring, 50

Display of Fetal Heart Rate, Uterine Activity, and Other Information, 51

Monitor Tracing Scale, 53

Monitoring Twins and Multiples, 53

Artifact Detection & Signal Coincidence with MHR, 58 Telemetry, 61

Troubleshooting the Monitor, 63

Computerized Perinatal Data Systems, 65

Data-Input Devices, 68

Abdominal Fetal Electrocardiogram (fECG) and

ST Segment Analysis, 70

Abdominal fECG and Electromyogram (EMG), 70

ST Segment Analysis, 73

Summary, 76

Uterine Activity Evaluation and Management, 78

Assessment Methods: Palpation and Electronic

Monitoring, 78

Manual Palpation, 78

Electronic Monitoring of Uterine Activity, 79

Stages of Normal Labor, 83

Defining Adequate Uterine Activity, 83

Defining Excessive Uterine Activity, 88

Common Underlying Causes of Excessive Uterine Activity, 91

Interventions to Decrease Excessive Uterine Activity, 91

Diagnosis and Management of Labor

Abnormalities, 95

Latent Phase Abnormalities, 95

Active Phase Abnormalities, 96
Second Stage Abnormalities, 97
Uterine Activity and Oxytocin Use, 98
Summary, 102

Pattern Recognition and Interpretation, 106

The Evolution of Standardized Fetal Heart Rate Terminology, 106

The 2008 NICHD Consensus Report, 107

NICHD Definitions General Considerations, 111

Five Essential Components of a Fetal Heart Rate Tracing, 112

Definition and Physiology of FHR Components, 112

Baseline Rate, 112

Fetal Heart Rate Variability, 116

Sinusoidal Pattern, 121

Acceleration, 122

Decelerations, 124

Early Deceleration, 124

Late Deceleration, 126

Variable Deceleration, 129

Prolonged Deceleration, 131

Standardized FHR Interpretation, 132

Fetal Cardiac Arrythmias, 132

Patterns not Defined by the NICHD, 134

"Wandering baseline", 135

"Lambda pattern", 136

"Shoulder(s)", 137

"Checkmark pattern", 137

"End-stage bradycardia" and "terminal bradycardia", 138

"Uniform accelerations", 139

"Atypical" variable decelerations, 139

Summary, 143

6 Intrapartum Management of the Fetal Heart Rate Tracing, 148

Fundamental Principles, 148
Standardized Management Decision Model, 148
Standard of Care. 150

Confirm FHR and Uterine Activity, 150 Evaluate Five FHR Components, 150 A Standardized "ABCD" Approach to FHR Management, 151

A: Assess the Oxygen Pathway and Consider Other Causes of FHR Changes, 153

B: Begin Corrective Measures as Indicated, 156

C: Clear Obstacles to Rapid Delivery, 160

D: Decision to Delivery Time, 160

Expectant Management Versus Delivery, 161

Adjuncts to Electronic Fetal Monitoring, 162

Intrapartum Fetal Scalp pH and Lactate Determination, 162

Fetal Scalp Stimulation and Vibroacoustic Stimulation, 163

Computer Analysis of Fetal Heart Rate, 164 Fetal Pulse Oximetry, 164

ST Segment Analysis, 164

Umbilical Cord Acid—Base Determination, 166

Approximate Normal Values for Cord Blood, 167 Types of Acidemia, 167

Summary, 168

Influence of Gestational Age on Fetal Heart Rate, 172

The Preterm Fetus, 172

Baseline Fetal Heart Rate in the Preterm Fetus, 173 Baseline Variability in the Preterm Fetus, 173 Periodic and Episodic Heart Rate Changes in the Preterm Fetus. 174

Behavior States in the Preterm Fetus, 175

Preterm Uterine Activity, 177

Tocolytic Agents and Effect on Fetal Heart Rate, 178

Monitoring the Preterm Fetus, 179

The Postterm Fetus, 181

Risks Associated With Postterm Pregnancy, 181 Management of Postterm Pregnancy, 182

Summary, 182

8 Fetal Assessment in Non-Obstetric Settings, 188

Emergency Services Department Assessment and Care, 190

Pregnant Trauma Victim Assessment and Care, 193

Maternal-Fetal Transport, Assessment, and Care, 193 Primary and Secondary Survey in the Emergency

Department, 195

Emergent Cesarean Section, 198

Stabilization and Discharge, 198

Non-Obstetric Surgery: Maternal-Fetal Assessment and Care, 199

Surgery When Gestation is Greater Than 24 Weeks, 200 Federal Law and Triage, 201

Summary, 201

9 Antepartum Fetal Assessment, 204

Comparing Antepartum Testing Methods, 204 Methods of Testing, 208

Contraction Stress Test and Oxytocin Challenge

Test, 208

Interpretation and Management, 208

Advantages and Limitations, 209

Procedures for Contraction Stress Testing, 209

The Nonstress Test, 211

Interpretation and Management, 212

Advantages and Disadvantages, 213

The Biophysical Profile, 214

Interpretation and Management, 214

Advantages and Limitations, 215

The Modified Biophysical Profile, 215

Interpretation and Management, 216

Advantages and Limitations, 217

Fetal Movement Counts, 217

Interpretation and Management, 218

Umbilical Artery Doppler Velocimetry, 218

Biochemical Assessment, 219

Amniocentesis for Fetal Lung Maturity, 219

Summary, 222

Patient Safety, Risk Management, and Documentation, 226

Occurrence of Errors, 226

Human Error, 227

Prevention of Errors and Risk Reduction, 230

High-Reliability Perinatal Units, 230

Creating a Circle of Safety™, 231

Guidelines to Promote Safety and Reduce Risks, 236

Management of Risks and Adverse Outcomes, 240

Disclosure of Unanticipated Outcomes, 241

Elements of Malpractice, 241

Notification and Clinical Review, 242

Reporting of Sentinel Events, 243

Documentation, 244

Components of Care: Assessment, Communication, Documentation, 244

Documentation Issues Specific to Electronic Fetal Monitoring, 248

Electronic Medical Records and Information Systems, 252

Summary, 256

11 Obstetric Models and Intrapartum Fetal Monitoring in Europe, 262

Models Of Care, 262

Electronic Fetal Monitoring - Cardiotocography, 263

Quality of EFM-CTG, 264

Guidelines for Terminology and Interpretation, 264

Additional Investigational and Diagnostic Tests, 265

Summary, 278

Appendix A: Amnioinfusion, 281

Appendix B: Instructions for Reviewing Appendix B FHR Tracings, 284

Glossary of Terms and Abbreviations, 315

Index, 322