

Monitoring in Anesthesia and Perioperative Care

Monitoring in Anesthesia and Perioperative Care is a practical and comprehensive resource documenting the current art and science of perioperative patient monitoring, addressing the systems-based practice issues that drive the highly regulated health care industry of the early 21st century.

Initial chapters cover the history, medicolegal implications, validity of measurement, and education issues relating to monitoring. The core of the book addresses the many monitoring modalities, with the majority of the chapters organized in a systematic fashion to describe technical concepts, parameters monitored, evidence of utility, complications, credentialing and monitoring standards, and practice guidelines.

Describing each device, technique, and principle of clinical monitoring in an accessible style, *Monitoring in Anesthesia and Perioperative Care* is full of valuable advice from the leading experts in the field, making it an essential tool for every anesthesiologist.

David L. Reich, M.D. was named Professor and Chair of Anesthesiology at the Mount Sinai School of Medicine in New York in 2004, where he had been Co-Director of Cardiothoracic Anesthesia since 1990. Dr. Reich's research interests include neurocognitive outcome following thoracic aortic surgery, outcome effects of intraoperative hemodynamics, medical informatics, and hemodynamic monitoring. He has published more than 90 peer-reviewed articles and more than 30 book chapters, and he is an associate editor of the text *Cardiac Anesthesia* and editor-in-chief of *Seminars in Cardiothoracic and Vascular Anesthesia*. He is a member of the International Organization for Terminology in Anesthesia (IOTA) of the Anesthesia Patient Safety Foundation and works with that group, the International Health Terminology Standards Development Organisation (IHTDSO), and High Level Seven International (HL7) to create international standards for anesthesia terminology for electronic patient records.

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Monitoring in Anesthesia and Perioperative Care

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Foreword

Carol L. Lake

Training and practicing the specialty of anesthesiology, and specifically cardiac anesthesia, during the last three decades of the 20th century provides a unique perspective from which to address the state of clinical monitoring for health care. The advent and growth of sophisticated physiologic monitoring clearly advanced the anesthesiology subspecialty of cardiac anesthesia, and vice versa. Likewise, it seems especially prudent that Dr. David L. Reich, a cardiac anesthesiologist, and many of the chapter authors, represent the subspecialty of cardiac anesthesia.

From using a manual blood pressure cuff, precordial stethoscope, and a finger on the pulse to the current American Society of Anesthesiologists standards of monitoring the patient's oxygenation, ventilation, circulation, and temperature continually (usually with pulse oximetry, electrocardiogram, end-tidal carbon dioxide, temperature, inspired/expired anesthetic gases, and automated blood pressure cuff during general anesthesia) was the great leap forward in perioperative monitoring in the 20th century. Similarly, the plethora of devices developed during the past century to allow monitoring of depth of anesthesia, respiratory compliance, ventricular contractility, coagulation, tissue oxygenation, and blood flow, rather than only basic cardiovascular parameters such as heart rate and blood pressure, is truly amazing progress. The past and present of physiologic monitoring are represented in the history chapter and the chapters on equipment, procedures, techniques, and technologies, respectively, in this book. Unfortunately, at the present time, many of the critical incidents during anesthesia still result from inadequate or incomplete monitoring of the patient, the anesthesia machine, or the patient-machine interface.

What is the future for monitoring in health care in general and anesthesiology, critical care, and pain management in particular? With the miraculous advances in clinical monitoring have come associated challenges that are addressed in this book. How can information overload from monitors be minimized? How are trainees educated and trained in multiple monitoring techniques? How can practitioners beyond training maintain their skills with infrequently used, complex monitors? How will future anesthesiologists and intensivists know whether a new device or monitoring technique is useful and reliable? Has a cost-benefit analysis of a specific monitor demonstrated effectiveness? Similar demanding questions need to be answered. Finally, is the ongoing research to develop new

devices or techniques to monitor parameters currently judged difficult to assess, such as intraoperative, global cerebral or renal function, being adequately supported? Dr. Reich and his many distinguished contributing authors provide a comprehensive practical review of these questions while preparing the reader to confront these future monitoring challenges.

Information overload occurs when there are many parameters to observe, necessitating the provision of alarm systems, set to indicate when a particular parameter or device is outside set limits. However, these same alarms do not always indicate true life-threatening emergencies. Attending to false alarms adds to the workload and encourages ignoring them, obviously to the detriment of the patient if the alarm is not false. Ways to prioritize and display alarms, and to prevent unnecessary alarms, will continue to be the subject of research until user-friendly, ergonomic, common anesthesia workstations exist.

Reliance on alarms may also encourage inattention by the person providing anesthesia or critical care. Although a recent single-institution study demonstrated that intraoperative reading and nonpatient-related conversation did not adversely affect recognition of a randomly illuminated alarm light (Slagle JM, Weinger MB. Effects of intraoperative reading on vigilance and workload during anesthesia care in an academic medical center. *Anesthesiology* 2009;110:275–283), recognizing an impending disaster *before* the alarm sounds may save precious seconds, and those seconds count if you or your loved one is the anesthetized or critically ill patient.

The training, retraining, and ongoing evaluation of competence of the anesthesia team to use complex and sophisticated monitoring devices remains an educational conundrum. Although textbooks and lectures continue to be the mainstay of health care educational material, interactive computer programs; standardized patients; part-task trainers; human patient simulators mimicking neonates, children, and adults; and realistic simulation laboratories configured to be operating rooms, intensive care units, emergency departments, or patient rooms appear likely to become the major training and examination venues in the 21st century. A simulation laboratory is an ideal environment to learn to use monitoring devices and techniques and is particularly applicable to demonstration of competence with monitoring techniques.

Are there hazards to the extensive use of monitoring? Possibly. Could the increased technology of monitoring occur at

the expense of clinical acumen? We have already seen that over-reliance on monitors leads to both amusing and deleterious situations, such as the pronouncement of ventricular fibrillation by a new anesthesiology resident when an electrocardiograph lead falls off the patient or the inability to assess anesthetized patient well-being when electrical power is interrupted in a developing country or following a disaster. Could sophisticated 21st-century perioperative monitoring expose the specialty of anesthesiology to eventual substitution by robots with artificial intelligence? Probably not, because the monitors still lack the completeness, continuousness, and adaptability to human natural variation in perioperative situations.

Despite all the extensive and sophisticated devices and techniques described in this book, there is nothing at present that can replace the vigilance of a professional anesthesia or intensive care team providing the human-to-human interaction essential to patient safety and well-being in operating rooms, intensive care units, or the myriad venues in which patients receive general anesthesia or its equivalents. As Dr. Reich's book aptly illustrates, 21st-century monitoring for anesthesiology, pain management, and critical care must focus on striking the optimal balance among such factors as patient safety, cost, clinical outcomes, innovation, and complexity. However, the patient, not the monitor, must always come first!

Preface

Monitoring in Anesthesia and Perioperative Care follows the tradition of previous texts that document the current art and science of perioperative patient monitoring. Additionally, the text addresses the systems-based practice issues that drive the highly regulated health care industry of the early 21st century. The initial chapters cover the concepts of history, medicolegal implications, validity of measurement, and education. The core of the book addresses the many monitoring modalities. To the extent possible, each chapter is organized in a systematic fashion to describe:

1. **Technical concepts:** How does it work?
2. **Parameters monitored:** What information do you get from it?
3. **Evidence of utility:** Is there evidence that it makes a difference in outcome?
4. **Complications:** What harm can it cause?
5. **Credentialing and monitoring standards:** What is the educational or credentialing process, if any?
6. **Practice guidelines:** When should/must I use it?

Ultrasonic guidance of invasive catheterization and regional anesthesia are included as monitoring concepts. The next group of chapters addresses scales and assessments that are increasingly evidence-based documentation standards. Finally, electronic health records, alarm systems, and automated medication delivery systems complete the body of the text. A table in the appendix is intended to help residents and other anesthesia care providers know the typical monitoring modalities that are chosen for major categories of operations.

The target audience for this text is medical students, anesthesia residents, Fellows, nurse anesthetists, anesthesia assistants, and anesthesia and critical care practitioners who are acquiring or updating their knowledge of patient monitoring during anesthesia and the perioperative period. There is significant overlap with critical care monitoring, and the intensive care physician will find nearly all concepts of critical care monitoring to be covered.

Patient monitoring in anesthesia and perioperative care has changed drastically since the specialty of anesthesiology emerged in the 19th century. The pace of that change has accelerated in recent decades as one sees in the preceding texts on the subject, which are snapshots of the monitoring practices of their eras. The earliest of those texts that I located illustrated an important juncture in the art and science of patient monitoring. In these two quotes from the preface of Dornette and Brechner's *Instrumentation in Anesthesiology* (Philadelphia: Lea & Febiger, 1959), we see the point in anesthesia history at which the emphasis shifted from direct patient observation to reliance on mechanical instrumentation:

[The anesthesiologist] feels the pulse and rebreathing bag to determine rate, rhythm and volume of the pulse waves and respiratory efforts. He sees the eye signs and thoracic excursions to assess depth of anesthesia. He hears the sound generated by compression of the brachial artery during auscultation of the blood pressure. He smells the anesthetic atmosphere to determine the approximate concentration of ether or cyclopropane. He tastes the fluid dripping from the epidural needle to differentiate bitter procaine from tasteless cerebrospinal fluid.

[Instrumentation] increases the perceptibility of our senses, and also allows the study of physiologic signals not capable of being detected by these senses.

The monitoring texts in more recent years, including those edited by Lake, Saidman and Smith, Blitt and Hines, Gravenstein and colleagues, and Dorsch and Dorsch, have chronicled these continuing changes in both instrumentation and standards. Their erudition and eloquence set a high standard. The current publication is intended to continue the tradition of anesthesiologists as the leaders in patient monitoring education and standards creation.

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