

## Book Review

<b>Title:</b>	<b>Cardiopulmonary Bypass Principles and Practice, 2<sup>nd</sup> Edition</b>
<b>Editors:</b>	<b>Glenn P. Gravlee, Richard F. Davis, Mark Kurusz, Joe R. Utley</b>
<b>Publisher:</b>	<b>Lippincott Williams and Wilkins Philadelphia, PA</b>
<b>Contents:</b>	<b>5 Sections, 35 Chapters, 768 Pages</b>
<b>Reviewer:</b>	<b>Melinda S. Dickes BS, CCP</b>

Techniques and concepts in today's practice of cardiopulmonary bypass are being continually developed and challenged. These changes allow us, as clinicians, to refine and advance our practice for the treatment of heart disease in both adults and children. Techniques such as vacuum-assisted drainage, port-access surgery, rapid autologous prime, and plasmapheresis have expanded the perfusionist's role in the operating room as an integral member of the open-heart team. However, we must not forget that basic physiology and pathology give us the necessary foundation for sound clinical decisions regarding patient treatment.

The first edition textbook of *Cardiopulmonary Bypass Principles and Techniques* has been considered an essential contribution to the study of perfusion for both students and clinicians involved in cardiac surgery worldwide. One then could eagerly expect a second edition to follow with the same precision and knowledge for cardiopulmonary bypass techniques and complications, as well as recent changes and theories. Improving upon a very successful first edition may seem a daunting task however; editors Gravlee, Davis, Kurusz, and Utley have successfully followed their first publication with contributions from over 67 authors. A keynote change to this 2<sup>nd</sup> edition textbook is the addition of a well-known and respected perfusionist to the list of contributing editors, giving the text a much-needed perfusionist perspective to cardiac surgery.

The textbook begins with five sections logically delineating the various aspects of cardiopulmonary bypass from historical aspects to equipment, physiology, hematology, and clinical applications. Each of the sections include several chapters, ranging from two to thirteen, which thoroughly expand upon each section's details. This second edition text also includes a key points portion that follows each chapter, highlighting objectives from each chapter, making it easy for the reader to summarize the chapter's major contents.

Particularly impressive is the introductory section, chapters one and two, which eloquently describe the transition of cardiopulmonary bypass from an idea to physical development. Authors C. Walton Lillehei and Harris Shumacker, Jr. give an extraordinary personal perspective, with notable photographs, to the difficulties and obstacles that were met during the development of today's techniques and extracorporeal equipment.

Section two contains chapters 3–8 and overviews cardiopulmonary bypass equipment. This section has expanded in detail over the first edition textbook by dividing blood pumps, cardiotomy suction and venting, and circulatory assist devices into their own respective chapters. The chapter on blood pumps includes a much more detailed discussion of centrifugal pumps, along with addressing the several different commercially available designs from manufacturers and comparing each of their corresponding performance characteristics.

Chapters 4–7 include information on oxygenator function, circuitry and cannulation techniques, cardiotomy suction and venting, and hemofiltration and dialysis. The second edition text has included information regarding the recent practice of vacuum assisted venous drainage (VAVD) in the cannulation and circuitry techniques chapter.

Chapter eight, circulatory assist devices, contains the major types of the assist devices along with their specific complications. The authors here stress the importance of patient selection in ventricular assist device (VAD) success. Complications, an inevitable and sometimes overwhelming problem in assist devices, are addressed in this chapter. However, a comparison of complications related to each specific assist device may have been helpful. Additionally, since recent research and manufacturer design has allowed many patients to ambulate and return home with assist devices in place, it would have been valuable to convey these issues to the reader.

Section three, physiology and pathology, is the largest and most technical section. It serves to dissect the concepts and consequences behind the use of cardiopulmonary bypass in relation to each end organ system. The section logically begins with a chapter on blood-surface interactions and allows the reader to gather detailed information about the complex blood protein systems and blood cell reactions to cardiopulmonary bypass. Several approaches to the control of the blood-surface interface are discussed with surface-bound heparin, surface-modifying additives, and blood modification. Chapters 10–12 relate the topics of pulsatile bypass, hemodilution and priming solutions as well as hypothermia. Acid-base alterations during hypothermia are addressed along with the management strategies of pH-stat and alpha-stat blood gases. Hypothermia, while

an extremely beneficial adjunct to bypass, is not without consequence and these effects are detailed in chapter 12.

The chapter on myocardial protection, extremely well referenced and technically sound, dissects the pathophysiology of myocardial injury into the three phases in which it can occur: prior to, during, and following cardiopulmonary bypass. Established strategies and elements of surgical myocardial protection are examined, addressing issues such as chemically induced cardiac arrest, avoidance of edema, buffering acidosis, and hypothermia. The authors also stress the management of myocardial calcium, specifically in relation to ischemic-reperfusion injury. Emerging myocardial protective strategies look at the use of oxygen radical therapy, amino acid enhancement, and adenosine. Nitric oxide, whether utilized through supplementation in cardioplegia solution or through modulation of endogenous sources is discussed as an experimental strategy for myocardial protection.

The next three chapters include information on drug pharmacokinetics and pharmacodynamics during bypass, the immune and inflammatory response, and embolic events related to the use of CPB. Chapter 14 Factors such as hypothermia, generation of the systemic inflammatory response syndrome (SIRS), pulsatile or nonpulsatile CPB, CPB circuit components, and alterations in receptor function may all alter drug action during bypass. The systemic inflammatory response is significantly stimulated during bypass and much of the end organ dysfunction following bypass can be related to this. Chapter 16 relates that the most common manifestation of emboli following CPB is cerebral injury, no matter what form the emboli may come in.

The final five chapters of the section detail the responses of the major organ systems: endocrine and metabolic system, pulmonary, kidney, splanchnic and hepatic, and neurologic. These chapters stress that cardiopulmonary bypass inflicts unique physiologic alterations in all organ systems, ones not found in many other surgical procedures. The recognition and management of these physiologic consequences is critical in patient care.

Hematology is the title of section four and subdivides into five chapters discussing anticoagulation for bypass, heparin neutralization, and hematologic effects of cardiopulmonary bypass, along with management of coagulopathies, and blood transfusion and conservation. Here the editors emphasize the fragility of the patient hemostatic system and how clinicians immensely alter it with the use of cardiopulmonary bypass and by the administration of heparin and protamine. As most clinicians have seen, bleeding and associated coagulopathies following surgery can have a devastating consequence on patient outcome. Understanding each of the components of the hemostatic system along with any mitigating factors than may influence it is necessary in gauging a strategy for the treatment of post-bypass bleeding. Additionally, while blood conservation and transfusion practices have substantially evolved over the

years it is necessary to realize that different modalities exist in cardiac surgery today for blood conservation.

The final section of the textbook is devoted entirely to clinical applications and includes several chapters that address cardiopulmonary bypass management in adults and pediatrics, along with extracorporeal membrane oxygenation (ECMO), non-cardiovascular applications of CPB, perfusion for the thoracic aortic surgery, and port-access surgery.

Chapter 27–29 deals with the conduct of CPB, management of unusual problems, and the termination of CPB respectively. The chapter regarding cardiopulmonary bypass conduct has superseded the first edition in providing a greater amount of information on perfusionist responsibilities prior to and following bypass, along with the importance of protocols and guidelines. New techniques of VAVD and retrograde autologous priming (RAP) are reiterated here. Chapter 28, management of unusual problems during bypass, has progressed from the first edition by addressing problems associated with atherosclerotic aorta, reoperative patients, and patients with religious objection to transfusions.

Preparation for termination from bypass is a crucial time for the perfusionist to begin to assess how the patient may or may not respond to weaning from cardiopulmonary bypass. Knowledge of how to hemodynamically assess the patient prior to CPB separation, along with any potential problem situations including right and left ventricular failure are all thoroughly addressed in Chapter 29. Ventricular assist devices, specifically mentioned as equipment in section two, may need to be reiterated here. This is of particular importance when ventricular support modalities such as inotropes, vasoconstrictors, vasodilators, or intra-aortic balloon pumps (IABP) are inadequate. Many centers are reporting excellent results with the use of a centrifugal pump and an IABP to provide pulsatile flow for short-term assist in post-surgical patients who fail to wean from bypass.

Pediatric cardiopulmonary bypass is devoted entirely to Chapter 30, which focuses on physiologic management, bypass circuits, and termination differences for infant and pediatric cardiopulmonary bypass. The use of deep hypothermic circulatory arrest (DHCA) in the repair of congenital lesions is a more common practice in pediatric cases and as a result issues such as blood gas management, neurologic injury, and hypothermic injury to the brain are discussed at length. Since pediatric and neonatal cardiopulmonary bypass requires varying circuit configurations (dependent upon patient size) differences in bypass circuit components, cannulation, and prime are also examined.

Extracorporeal membrane oxygenation (ECMO), in both adult and pediatric application, follows this chapter. This chapter details the pathophysiology of ECMO and the physiology of the native lung and other major organs during ECMO. Venarterial (VA) and venovenous (VV) ECMO, two different therapies used in treating cardiac and respiratory disease, are also

discussed and compared. Complications can be the determining factor in the survival of many ECMO patients and here the authors stress the prompt recognition and management of these. The later part of the chapter also provides an excellent table for recently published ECMO data and corresponding survival rates.

The final four chapters in this section address CPB support outside the OR, non-cardiovascular applications of CPB, perfusion for thoracic aortic surgery, and port access surgery. Non-cardiovascular applications relate the use of cardiopulmonary bypass for neurologic, urologic, orthopedic, and pulmonary procedures. Liver and lung transplantation, along with unique cases such as accidental hypothermia and anti-neoplastic therapy are included.

Chapter 34, perfusion for the thoracic aortic surgery, includes helpful diagrams on various perfusion setups and cannulation techniques for DHCA. The first edition however, supersedes this chapter by including a discussion of pharmacologic adjuncts, preinduction and anesthetic management, along with techniques of cooling and rewarming. As most of us realize these surgical procedures can be extremely complex and it is the complications that follow, or lack thereof, which ultimately determine the patient outcome. While these issues received noteworthy mention, it would have been appropriate to see some cumulative data regarding patient morbidities and mortalities from several different centers.

In conclusion, the editors of this textbook have done an excellent job of elucidating the new techniques and theories applicable to the practice and management of cardiopulmonary bypass. They have thoroughly delved into the appropriate physiologic considerations behind cardiopulmonary bypass and where appropriate have reiterated concepts pertinent to making sound clinical decisions. Readers can be assured that this text will again serve as a superb resource for all clinicians utilizing cardiopulmonary bypass.