Respiratory Intensive Care of the Adult Surgical Patient

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We dedicate this book to *Jamie Lynn Hanson*, who helped initiate application of many of the principles included in this monograph. Jamie was a graduate of the Master of Medical Science Program in Intensive Respiratory Care/Critical Care Medicine in the Emory University School of Medicine. She was a pioneer in the implementation of good respiratory care of patients in the Surgical Intensive Care Unit at Grady Memorial Hospital in Atlanta. Her vision, persistence, wisdom, and clinical skills made her unusually effective in that role. We join her husband, Tom, and her daughters, Cari and Lori, in their grief after Jamie's death in late winter of 1982-83. She was our friend, our teacher, and a leader in the profession of respiratory care.

Foreword

The last two decades have seen dramatic improvement in the management of problems related to respiratory failure in the surgical patient. In the early 1960s there was a widespread feeling among surgeons that mechanical ventilatory support, more often than not, simply prolonged the patient's life for a short time. In this period, managment of respiratory care was often left to inadequately trained personnel, it was not begun soon enough, and the equipment and techniques were still in the developmental stage. Respiratory failure was implicated as a major cause of death in trauma and sepsis and in severely stressed surgical patients.

The awareness of the magnitude of the problem increased, and the scope and intensity of clinical and laboratory research were enhanced. As several major studies were analyzed it became increasingly clear that ventilatory support should be used early, that patients requiring such support should be cared for in special units (intensive care units), and that specifically trained personnel are required for proper managment of this problem. The resulting changes have revolutionized care of the surgical patient with acute respiratory failure. The knowledge that most patients requiring ventilatory support can and should survive has accentuated the prime importance of excellent respiratory care.

I have worked with Ron Hall and John Bonner for a long time. Our hospitals cover a broad spectrum: a large primary care charity-trauma center, a veterans hospital, and a tertiary care university hospital with its extremely complex patient problems. We have worked together on many severely ill surgical patients with respiratory problems. Drs. Bonner and Hall are experts in this field, not only in terms of the large body of knowledge encompassed by this field but also in how it applies to a single, sick patient. In short, they know whereof they speak, and this book will be of great value to surgeons, anesthesiologists, nurses, physicians' assistants, and all workers in this difficult field.

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Preface

During our training in anesthesiology, a shared interest in human respiration fueled a partially sanctioned participation in the care of critically ill surgical patients, many of whom developed respiratory failure in spite of hours of therapeutic maneuvers. We learned from patients, were stimulated by students of medicine and allied health, and were taught by individuals from anesthesiology, surgery, and medicine. As we discussed pulmonary physiology, wrestled with departmental tradition, and implemented what we understood to be good respiratory intensive care, a kinship evolved among colleagues that crossed traditional medical disciplines. The profession of respiratory therapy accepted us, supported us, and challenged us. We owe a special appreciation for the successful evolution of respiratory care in the Surgical Intensive Care Unit at Grady Memorial Hospital.

It is our intention to provide a text that will be useful to medical students, house staff physicians, critical care nurses, respiratory therapists, and physicians' assistants working with the surgical patient in acute respiratory failure. This book, which describes our methods of management, is intended to be a supplement to bedside experience. We hope it is used to guide thinking about respiratory pathophysiology and treatment and to stimulate discussion among students, house staff, and attending physicians.

In the completion of this book we find ourselves in debt to many, including Karen Berger of Mosby, who literally adopted this project and infused it with encouragement and discipline at exactly the appropriate times. We are grateful to Dr. John Steinhaus, within whose department we have gained our experience, Dr. Dean Warren for his understanding and support, and Dr. Wendell Musser for the special career development of one of us (JTB). We want to thank the nursing staff, the respiratory therapists, and the physicians' assistants in critical care medicine in the Surgical Intensive Care Unit at Grady Memorial Hospital, for it was with their help that many of the ideas in this book were initially implemented. We thank Ina Baskin, Ellen Hall, and Sharon Hurwitz for their secretarial support in preparation of the manuscript. We also thank Peggy Firth and Susan Yakrus, the medical illustrators who worked with us. Finally, we thank our families for their patience and understanding during this endeavor.

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History

HERITAGE

The clinician practicing respiratory care in the 1980s is the recipient of a rich heritage of knowledge gathered over centuries. That knowledge was obtained through the curiosity and intellectual honesty of early investigators, most of whom had no grants, libraries, or universities to foster their studies. Scientific and clinical endeavors of early investigators were often silhouetted against a background of political turmoil, superstition, and tenacious adherence to illogical beliefs, so that the progress of respiratory physiology through history has at various times flirted with, cohabited with, or totally abandoned logic (Table 1-1).

But over the eighteenth, nineteenth, and early twentieth centuries, unbiased scientific investigation became more commonplace, and the peer reviewed publications resulting from these studies are now accessible in the world's literature. In the early twentieth century an explosion occurred in the number and types of technologic tools so that the capacity of today's clinician to handle data, measure physiologic events, and communicate has been exponentially expanded.[1]

BASIC CONCEPT OF RESPIRATION

Our understanding of the process of respiration begins with the observations of early investigators, whose curiosity stimulated them to-

Table 1-1
Historical events in respiratory care

Event	Date	Contributors
Death of animals in airtight box	4th century BC	Aristotle
Need for rhythmic air exchange	16th–17th centuries	Vesalius, Boyle, Hooke
Mechanical ventilation	16th–17th centuries	Vesalius, Paracelsus
Phlogiston theory	17th century	Stahl
Discovery of oxygen	18th century	Priestley, Scheele
Role of oxygen in sustaining life	18th century	Lavoisier
Tracheal catheterization	17th century	Hooke
	18th–19th centuries	Fothergill, Snow, Trendelenburg, Macewen, Rowbotham, Magill
Gas analysis	19th–20th centuries	Haldane, Van Slyke, Pauling
Blood P_{O_2}, pH, and P_{CO_2} analysis	19th–20th centuries	Magnus, Sanz, Stow, Severinghaus, Clark
Use of oxygen as drug	20th century	Haldane, Barcroft, Beddoes, Barach
Mechanical ventilators	20th century	Drinker, Shaw, Emerson
Respiratory care units	20th century: late 1950s	Pontoppidan, Bendixen, Safar
High frequency ventilation	1967	Sjöstrand
Intermittent mandatory ventilation	1972	Klein, Kirby, Downs
Distending airway pressure	1878	Oertel
	1938	Barach
	1969	Uzawa, Ashbaugh
	1972	Downs, Civetta, Gabel, Kumal, Pontoppidan, Petty, Laver, Gregory
Invasive indirect left sided cardiac monitoring	1929	Forssman
	1970	Swan, Ganz, Forrester

ward a rational understanding of their surroundings. One of the first observations of respiration was made by Aristotle (384–322 BC) who noted that animals died in a closed airtight box. He believed that the animals died because of inability to cool their bodies.[2] However, Aristotle's observations suggested that a substance essential to life existed in the surrounding atmosphere. The necessity for the presence of that substance in the lungs was supported by the observations of Andreas Vesalius (1514–1564), Robert Boyle (1627–1691), and Robert Hooke (1635–1703). These three scientists noted that rhythmic air exchange was necessary to sustain life in animals whose chests were opened. To support this principle, Hooke constructed a pump that artificially ventilated small animals and successfully sustained life.

The nature of the substance essential for life became more elusive after the phlogiston theory was proposed by Georg Stahl (1660–1734). Phlogiston was thought to be a substance either lost or gained during the process of combustion (oxidation) or "reconstruction" (reduction by heating with charcoal).[3] Joseph Priestly, along with Karl Scheele, discovered oxygen in 1774; Priestly's acceptance of the phlogiston therapy proposed by Stahl delayed efforts to classify oxygen as the gas essential to life. Antoine Lavoisier (1743–1794) is credited with explaining the role of oxygen in sustaining life.[4] The principles of respiration at both the cellular and lung levels