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# Mechanical Artificial Ventilation

A Manual for  
Students and Practitioners

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With the exception of the section on historical notes, this monograph has been completely rewritten for the Third Edition. The basic format has been retained, with sections on the diagnosis and characteristics of respiratory failure, equipment and hardware, various forms and distinguishing details of respiratory failure, and the physiology of respiration. New subject matter has been added, outdated information eliminated and other material updated.

This is a monograph that will provide a broad introduction to a subject that is of frequent concern to the busy practitioner and of great interest to the great majority of medical students and nurses as well as respiratory therapists. The bibliography provides expansive potential for the serious student of mechanical artificial ventilation.

American Lecture Series®



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THIRD EDITION

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STUDENTS AND PRACTITIONERS

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By

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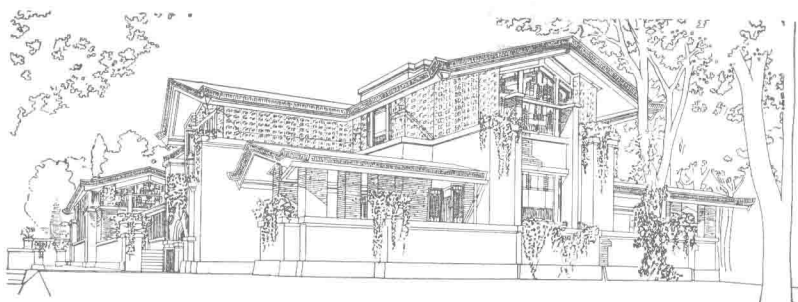
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# Mechanical Artificial Ventilation

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AMERICAN LECTURE SERIES®

*A Monograph in*  
The BANNERSTONE DIVISION of  
AMERICAN LECTURES IN ANESTHESIOLOGY

*Edited by*  
JOHN ADRIANI, M.D.  
*Clinical Associate Professor of*  
*Surgery (Anesthesiology)*  
*Louisiana State University*  
*New Orleans, Louisiana*

## DEDICATED TO

*My son, Paul, who, while I was writing these pages, played his guitar and earned his driver's license, both accomplishments which helped me to relax and concentrate*

*My son, Glenn, who allowed me to share my desk with his microscope for biology homework*

*Elsa, our Norwegian Elkhound, who ate the entire rough draft of Chapter VI*

*My wife, Mary, who maintains that my efforts herein only serve to confuse an otherwise simple process of getting "good" air in and "bad" air out*

## PREFACE TO THIRD EDITION

THE BASIC FORMAT of the book has not changed; I believe it is a workable form of organization, and most of my students like it. The book is still aimed at students—medical, nursing, respiratory therapy, etc.—and practitioners—house officers, internists, surgeons, pediatricians, anesthesiologists—who treat patients in respiratory failure. I have attempted to update it and eliminate some of the out-of-date techniques and equipment with invaluable assistance in this regard from my most capable assistant and good friend, Mr. Robert Bageant. New subject matter has been added as well as some additional information on old subjects. The book is, regrettably, larger. But then, so is the amount of subject material. There seems to be no alternative for a new edition.

As was the case with the first two editions, the Third Edition is not designed to be a complete textbook. It remains an introduction to the field of respiratory therapy, a primer for the student, a stepping stone to the more comprehensive texts in which valuable information is made available by authors of renown and considerable experience. But because of the almost exponential leap in size of the bibliography from that of the last edition, a word of explanation is in order.

Having had the enriching opportunity of association with some fourteen classes of medical students, three classes of respiratory therapy students, and a number of resident physicians of whom I have lost count, I have become impressed with one fact—The really good physicians and good respiratory therapists are good because they have a broad understanding of the pathophysiology of the diseases they treat. I have tried to enlarge this book primarily in that direction.

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*Charlottesville, Virginia*

## ACKNOWLEDGMENTS

I HAVE BEEN NOT ONLY assisted but encouraged in the writing of this book by many people. Dr. Robert M. Epstein, Professor and Chairman of the Department of Anesthesiology, has been most generous with our own departmental resources as well as with support in utilizing the services of our excellent Department of Medical Illustration and Photography. I am grateful to the attending staff of the Anesthesiology Department, who have tolerated my alternating moods of frustration and happiness as the manuscript was developed. My special thanks go to Dr. William B. Hunt, Jr., formerly of the Department of Internal Medicine, University of Virginia, who taught me more internal medicine than he realizes, and to Dr. William R. Sandusky, Professor of Surgery, for his very helpful suggestions on the management of tetanus.

A special note of appreciation is in order for Dr. Douglas W. Eastwood, former Professor and Chairman of Anesthesiology, University of Virginia, from whose original suggestions this book has grown.

I am particularly appreciative of the outstanding help of Miss Mary McChesney, Mrs. Nancy Ragland of the Department of Anesthesiology, and Ms. Robin Alexander and Miss Kathy Bradley of the Respiratory Therapy Department for the long hours of typing, checking references and preparing the manuscript.

The students and teaching therapists of the Piedmont Virginia Community College Respiratory Therapy Training Program and the medical students of the University of Virginia School of Medicine deserve much more credit for this book than they realize. Their interest and enthusiasm, their intelligent questions, their infectious desire to learn, and their kind appreciation of my efforts in this regard have provided me with both the desire to write and a satisfaction for having done so.



Last, but by no means least, I am indebted to my wife, Mary. She is my proofreader, my bibliography checker, my willing and (usually) enthusiastic audience for a new idea, a rewritten paragraph, etc., my pencil sharpener and midnight snack fixer. This book is as much the result of her efforts as anybody's.

TERRING W. HEIRONIMUS, III, M.D.

# CONTENTS

	<i>Page</i>
<i>Preface</i> .....	vii
<i>Acknowledgments</i> .....	ix

## PART ONE WHEN, WHAT AND HOW

### *Chapter*

1. WHEN—THE DIAGNOSIS AND ETIOLOGIES OF RESPIRATORY FAILURE .....	5
2. WHAT—THE DESIGN, FUNCTION AND CARE OF RESPIRATORY THERAPY EQUIPMENT <i>By Robert Bageant</i> .....	13
3. HOW—CLINICAL APPLICATIONS: MANAGEMENT OF THE VARIOUS FORMS OF RESPIRATORY FAILURE .....	93
<b>A. Acute Respiratory Failure</b> .....	93
Crushed Chest Injuries .....	93
Smoke Inhalation .....	97
Pulmonary Embolism .....	99
Pulmonary Edema .....	106
Status Asthmaticus .....	113
The Adult Respiratory Distress Syndrome .....	117
Alveolar Proteinosis .....	132
Postoperative Pulmonary Complications .....	135
Coronary Artery Disease .....	149
Drug Ingestion .....	152
Tetanus .....	158
Cerebral Hypoxia .....	163
Neuromuscular Diseases .....	175
<b>B. Chronic Respiratory Failure</b> .....	180
Chronic Obstructive Pulmonary Disease .....	180

<i>Chapter</i>	<i>Page</i>
Cor Pulmonale .....	191
Kyphoscoliosis .....	196
Pickwickian Syndrome .....	199
Miscellaneous .....	203
<b>C. Diagnostic Techniques and Complications of Treatment</b> .....	207
Chest Physical Therapy, IPPB .....	231
Intermittent Mandatory Ventilation .....	236
Infection, Use of Antibiotics .....	242
Intravenous Therapy .....	246
Nutrition, Total Parenteral Alimentation .....	252

## PART TWO

### WHY

4. PULMONARY PHYSIOLOGY AND ANATOMY .....	265
Control of Ventilation .....	265
Mechanics of Breathing .....	272
The Airways .....	282
Pulmonary Circulation .....	288
Ventilation/Perfusion Relationship and Gas Exchange .....	294
Effects of Mechanical Ventilation .....	298
The Effects of Smoking Cigarettes .....	309
Pulmonary Function Tests .....	312
The Pathophysiology of Hypoxemia, Hypercarbia and Acid-Base Imbalance .....	325
5. OXYGEN .....	363
Oxygen Therapy .....	363
Pulmonary Oxygen Toxicity .....	378
6. AIRWAY HUMIDIFICATION—VAPOR AND AEROSOL THERAPY ...	387
Vapor Therapy .....	387
Aerosol Therapy .....	394
7. ARTIFICIAL AIRWAYS—USES AND COMPLICATIONS .....	402
Endotracheal Tubes .....	402
Tracheostomy .....	408

*Contents*

xiii

<i>Chapter</i>	<i>Page</i>
8. RESUSCITATION—SUCCESSFUL AND UNSUCCESSFUL . . . . .	421
9. THE CRITICAL CARE COMPLEX—ORGANIZATION AND PHILOSOPHY	429
10. HISTORICAL NOTES . . . . .	435
<i>References</i> . . . . .	440
<i>Glossary</i> . . . . .	518
<i>Index</i> . . . . .	523

# Mechanical Artificial Ventilation

"A medical chest specialist is long winded  
about the short winded"

KENNETH T. BIRD  
(1917- )



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PART I

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WHEN, WHAT and HOW

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# CHAPTER 1 WHEN THE DIAGNOSIS AND ETIOLOGIES OF RESPIRATORY FAILURE

*“Diagnosis, n., a physician’s  
forecast of disease by the  
patient’s pulse and purse.”*

AMBROSE BIERCE (1842-1914)  
THE DEVIL’S DICTIONARY

THE INDICATION FOR THE use of mechanical devices to assist or replace the patient’s effort to breathe is the presence of certain forms of respiratory failure. Certain guidelines—arbitrary levels of measureable parameters—usually indicate the need for some form of ventilatory support. These will be subsequently described, but are general indications only. There are exceptions to almost every rule, and personal experience, clinical judgment and etiology of respiratory failure will influence the decision of when or whether to ventilate artificially. The departure from normal ventilatory function toward respiratory failure may be abrupt or a gradual, slowly developing process. The former situation is acute respiratory failure (ARF) while the latter is chronic respiratory failure (CRF).

The first step in the gradually deteriorating form of impaired ventilatory function is respiratory insufficiency, which is defined as the inability to maintain normal blood gas values without some form of increased ventilatory work. This may be manifest as hyperpnea, tachypnea, persistent cough or various combinations of these. Mild to moderate episodes of asthma or early emphysema are examples of respiratory insufficiency.

When blood gas values begin to deviate from normal in spite of increased ventilatory work, one is dealing with respiratory