Fluids and Electrolytes with Clinical Applications

A Programmed Approach

THIRD EDITION

Joyce LeFever Kee

Fluids and Electrolytes with Clinical Applications

A Programmed Approach

THIRD EDITION

Joyce LeFever Kee

Associate Professor
Coordinator of the Undergraduate Field of Study
College of Nursing, University of Delaware
Newark, Delaware

175 YEARS OF
1807 JW 1982
PUBLISHING

A Wiley Medical Publication
John Wiley & Sons
New York·Chichester·Brisbane·Toronto·Singapore

Library of Congress Cataloging in Publication Data:

Kee, Joyce LeFever.
Fluids and electrolytes with clinical applications.

(A Wiley medical publication)
Bibliography: p.
Includes index.
1. Body fluid disorders—Programmed instruction.
2. Water-electrolyte imbalances—Programmed instruction.
3. Body fluid disorders—Nursing—Programmed instruction.
4. Water-electrolyte imbalances—Nursing—Programmed instruction. I. Title. II. Series. [DNLM: 1. Nursing—Programmed texts. 2. Water-Electrolyte imbalance—Nursing texts. 3. Water-Electrolyte imbalance—Programmed texts. WY 18 K26f]

[RC630.K43 1982] 616.3'9 82-1883
ISBN 0-471-08989-3 AACR2

Printed in the United States of America

10 9 8 7 6 5 4 3 2 1

Preface

Nurses are involved continually in the assessment of fluid and electrolyte imbalance. Medical advances and treatment have made fluid and electrolyte imbalances more prevalent, and thus have increased the nurse's role. Every seriously ill person is prone to develop one or more imbalances, and even those who are only slightly or moderately ill may develop them. Nurses are responsible for maintaining homeostasis of fluid and electrolyte balance when caring for all ill patients. After completing this book, the participant should understand more fully the effects of fluid and electrolyte balance and imbalance on the body in many conditions and clinical situations.

The third edition of this programmed text, *Fluids and Electrolytes with Clinical Applications*, expands on the nurse's role in relation to nursing assessment of fluid and electrolyte imbalances and includes physiologic factors of five electrolytes, urine electrolytes, nursing assessment in parenteral therapy, physiologic changes in burn shock, and lists of nursing actions. This edition contains two new sections: Children with Fluid Imbalance, and Trauma: The Acutely Injured, both in Chapter 6. Each chapter has been carefully reviewed, expanded, and updated.

Fifteen new tables have been added for a total of 78 tables and diagrams, each followed by frames that help participants gain a deeper understanding of the material.

There are 14 sets of situational reviews with answers throughout the chapters. These situational reviews contain case studies of patients with various fluid and electrolyte problems. The student nurse and the graduate nurse can easily apply these case studies in clinical practice. Throughout the text many practical nursing applications are given to help with nursing assessments.

There are 14 sets of nursing actions following each situational review. These lists of nursing actions should be helpful to both the student and graduate nurse for clinical application of fluid, electrolyte, and acid-base concepts.

The content of this text has been geared to three levels within the nursing profession. First, it is intended for beginning students who have had some background in the biological sciences or who have completed an anatomy and physiology course. Second, it is for students who have a sufficient background in the biological sciences, chemistry, and physics but who need to learn about parenteral therapy and clinical conditions situations. Many of these students might wish to review the entire text to reinforce their previous knowledge and/or to increase their skills in handling practical nursing assessments and interventions. Finally, this book is intended to aid graduate nurses in both reviewing and increasing their knowledge of fluid and electrolyte changes so they can assess their patients' needs and improve the quality of patient care.

The participant will work at his or her own pace while learning the principles, con-

cepts, and applications of fluids and electrolytes as presented in this text. This self-instructional method of learning will also aid the instructor in using class time to better advantage. This book will enable students to apply their knowledge to other clinical situations in their clinical practicum.

The first chapter of the text discusses principles and concepts of fluid changes with clinical applications. Chapter 2 thoroughly covers five electrolytes, their functions, their causes and symptoms, and clinical applications with drug effects and electrolyte replacements. Regulatory mechanisms for pH control, causes and symptoms of acid-base imbalances, and their clinical applications are explained in Chapter 3. Chapter 4 deals with classifications of parenteral solutions with osmolality, hyperalimentation, and clinical applications, including rate and calculating intravenous administration and the nursing assessment and rationale in the management of parenteral therapy. Chapter 5 discusses four main clinical conditions: dehydration (extracellular fluid volume deficit), edema (extracellular fluid volume excess), water intoxication (intracellular fluid volume excess), and shock. Shift in extracellular fluid volume or fluid shift to the third space is explained. These four clinical conditions are programmed in detail to enable the student or graduate nurse to recognize these conditions when they occur. Included are physiologic factors, the causes and symptoms, clinical applications, a few clinical examples, and clinical management of the four conditions. Chapter 6 presents nine clinical situations in which severe fluid and electrolyte imbalances can occur: children, the aged, gastrointestinal surgery, trauma, congestive heart failure, cirrhosis of the liver with ascites, renal failure with peritoneal dialysis, burns, and diabetic acidosis. This chapter includes physiologic factors, clinical applications, clinical examples, and clinical management. Because these situations occur frequently, the nurse must understand the fluid and electrolyte changes that could result in the life or death of a patient.

Summary questions at the end of each chapter permit the participant to review what he or she has learned. These questions may also serve as an overview of the chapter after the behavioral objectives have been studied.

Two appendices are included: Osmolality of Solutions, and Fluid, Electrolyte, and Acid-Base Assessment Tool. These appendices could act as guides for determining the osmolality of certain solutions and for assessing fluid, electrolyte, and acid-base imbalances.

A glossary is included covering words and terms used throughout the text. It should aid the student who has only some preparation in the biological sciences.

I would like to express my appreciation to the students who used this programmed text in its various forms before the first edition was published. By testing their acquired knowledge and ability to apply it after they had read the manuscript, I was able to make necessary changes to improve the text. For the second edition, my deepest appreciation to Gale Buonanno, Susan Cross, Elizabeth Griffiths, Diane Hanna, Laurie Jones, Kathy Kochan, Debra McCoy, Vickie Payne, Susan Skross, Tommie Lou Smith, June Taylor, Pamela Welch, and Barbara Witt. These nursing students tested the revisions for the second edition and made valuable suggestions for additions to, omissions from, and clarification of frames and material covered.

For this third edition, I wish to extend my deepest appreciation to the following

professors and students in the College of Nursing, University of Delaware, for their helpful suggestions: Elizabeth Jenkins, Instructor, for Chapter 4; Carolyn Freed, Assistant Professor, for the section on trauma; Nancy S. Engel, Instructor, and Janis B. Smith, Instructor, and senior students—Sharon E. Baker, Bonita Barnett, Susan Bunting, Marianne Buzby, Martina M. Ciambella, Jeanne Marie Cost, Laureen A. Eick, Cynthia L. Flowers, Kim Frances, Kathy Glendenning, Alicia Halloran, Karen Hom, Mary Lou Jackson, April Nai, Susan Osworth, Sonya L. Peterson, Lois M. Showalter, Lorraine Shump, Judy Thornton, Robin Thornton, Sharon Turnbaugh, and Barbara Witmer—for the section on children with fluid imbalance.

I would also like to extend my sincere appreciation to Katherine Kee, for her secretarial assistance in the preparation of this book; to Eric Gregory, for his illustrations; and to Linda Turner, Assistant Editor at John Wiley & Sons, for her helpful suggestions and assistance with this revision.

Joyce LeFever Kee

Instructions

TO THE INSTRUCTOR

Much class time is frequently spent on reviewing material or presenting new material that could easily be given through programmed instruction. This method of instruction enables the teacher to minimize the time spent in lecture on fluids and electrolytes and, thus, to devote more time to clinical conferences and seminar classes as they relate to clinical situations with fluid and electrolyte imbalance.

You may find it helpful to cover the material in this book by one of these three ways: (1) assigning the students a chapter at a time; (2) assigning the students the first three chapters to be completed by a certain date and the last three by a later date; or (3) assigning the students a given length of time to complete the entire text.

TO THE STUDENTS

Many students believe that the subject of fluids and electrolytes is very difficult to comprehend. This programmed book will provide you with important data on fluids and electrolytes from various aspects, and you will find that this material is not so difficult to understand and retain.

By taking the easy steps provided in this book, you will proceed through the chapters more quickly than you would expect. This book is written on a self-instruction basis so that you may proceed at your own speed. Each step is a learning process. Greater learning occurs if you either complete a chapter or spend a minimum of two hours at one sitting. Never end the study period without at least completing all the frames related to a single topic.

It would be helpful to begin your next study session with the final frames from the previous material, for it will enable you to check your retention of the material that was presented. The situational reviews throughout the chapters give immediate reinforcement of the data learned. The many sets of nursing actions should be useful for applying fluid, electrolyte, and acid-base concepts in various clinical settings. A glossary is included to assist you with words and terms used in the text.

Students, study the diagrams and tables before proceeding to the frames. If you make mistakes in the program, you need not be concerned so long as you rectify the mistakes. This book should increase your knowledge and understanding of fluids and electrolytes and be a great asset in applying this knowledge in your clinical practicum.

Contents

CHAPTER ONE

Body Fluid and Its Function

BEHAVIORAL OBJECTIVES

Upon completion of this chapter, the student will be able to:

Differentiate between the percentage of water found in the average adult body, newborn infant, and the embryo.
Name the three compartments of the body where body water is found.
Name the two classifications of body fluid and their percentages.
Define homeostasis and explain its state in maintaining body fluid equilibrium.
Explain how the body loses and maintains body fluid.
Define osmotic pressure, semipermeable and selectively permeable membranes, and osmol and osmolality, and relate the effects of each in the passage of body fluid.
Differentiate between isotonic (iso-osmolar), hypotonic (hypo-osmolar), and hypertonic (hyperosmolar) solutions, and explain the effects of these solutions on body cells.
Define milliequivalent and milligram and explain their symbols and significance in the body.
Define Starling's Law of Capillaries.
Explain the four measurable factors that determine the flow of fluid between the vessels and tissues and their effects on the exchange of fluid.
Explain the pressure gradient and the significance in colloid osmotic and hydrostatic pressure gradients.
Relate fluid changes that occur to patients in your clinical area.

INTRODUCTION

The human body is a complex machine that contains hundreds of bones and the most sophisticated systems of any structure on earth. Yet, the substance that is basic to the very existence of the body is the simplest substance known—water. In fact, it makes up almost two-thirds of an adult's body weight.

The body is not static—it is alive and solid particles within its framework are able to move into and out of cells and systems, and even into and out of the body, only because there is water.

The basis of all fluids is water, and as long as the quantity and composition of body fluids are within the normal range, we just take it for granted and enjoy being healthy. But, if the water content of the body for some reason departs from this range, the whole delicate balance is disrupted, and disease can find an easy target.

In this chapter, distribution of body fluid, fluid compartments of the body, physics terminology, fluid pressures, and clinical considerations are discussed. There are two situational reviews and two sets of nursing actions.

An asterisk(*) on an answer line indicates a multiple-word answer. The meanings for the following symbols are: ↑ increased, ↓ decreased, > greater than, < less than.

---

1 The greatest single constituent of the body is water, which represents about 60% of the total body weight in the average adult. In the early human embryo, 97% of body weight is water, in a newborn infant 77%.

Label the following drawings with the proper percentage of water to body weight.

a. _____ b. _____ c. _____

---

a. 97%; b. 77%; c. 60%

---

2 In the average adult, the proportion of water to * _____ is 60%.

---

body weight

---

3 Which has the highest percentage of water in relation to body weight?

_____. Which has the lowest? _____.

embryo; adult

4 Can you think of any reason why the early human embryo and the infant have a higher proportion of water to body weight?

*_____.

I asked what you thought. Many people think the extra water in infants acts as a protective mechanism. Since infants have larger body surface in relation to their weight, extra water acts as a cushion against injury.

5 Because fat is essentially free of water, the leaner the individual, the greater the proportion of water in total body weight.

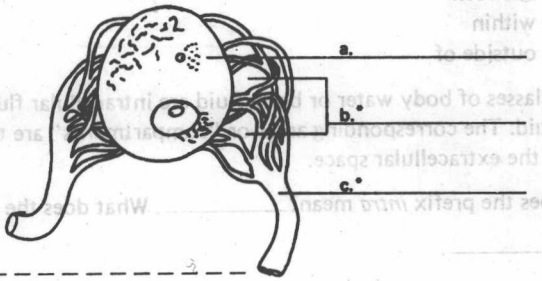
Who has more water as body weight—a fat person or a lean one?

*_____.

lean person

6 This body water is distributed among three types of "compartments:" cells, blood vessels, and tissue spaces between blood vessels and cells, which are separated by membranes.

Label the three compartments where body water is found.

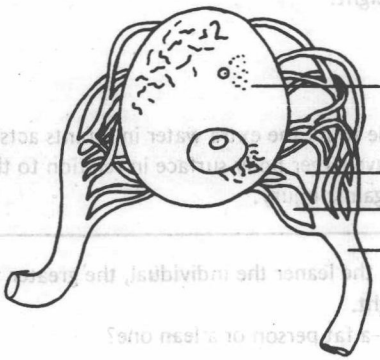


a. cell
b. tissue space
c. blood vessel

7 The term for the water in each type of "compartment" is as follows:

1. In the cell—*intracellular* water or *cellular* water.
2. In the blood vessels—*intravascular* water.
3. In tissue spaces between blood vessels and cells—*interstitial* water.

Label the complete diagram with the proper terms for body water in the three compartments.



---

a. intracellular water
b. interstitial water
c. intravascular water

8 There are three prefixes that will be used frequently in this text:

inter-	between
intra-	within
extra-	outside of

The two classes of body water or body fluid are intracellular fluid and extracellular fluid. The corresponding areas or "compartments" are the intracellular space and the extracellular space.

What does the prefix *intra* mean?_____. What does the prefix *extra* mean? *_____.

---

within; outside of

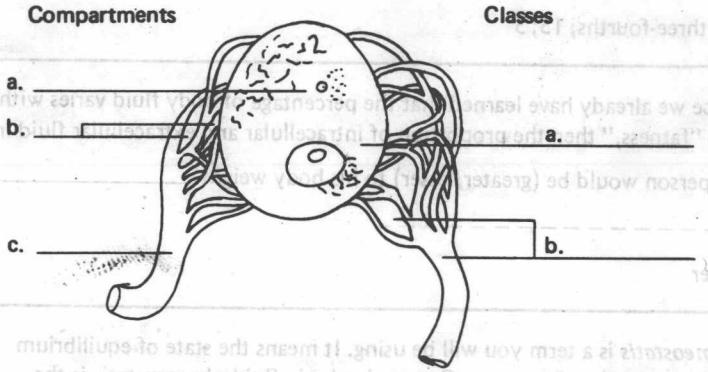
9 Fluid within the cell is classified as intracellular fluid, whereas intravascular fluid and interstitial fluid are classified as extracellular.

The area within the cell is called the _____ space, whereas the tissue spaces between blood vessels and cells, and the area within blood vessels are known as the _____ space.

---

intracellular; extracellular

10 Label the three "compartments" of body water and the two classes of body water.



Compartments
a. cell
b. tissue space
c. blood vessel

Classes
a. cellular or intracellular
b. extracellular

11 Approximately two-thirds of the body fluid is contained in the intracellular space.

We have already said that the total water in the adult body is _____%; therefore, intracellular water must represent _____% of the total body weight, and extracellular water _____%.

60; 40; 20