Fluid and Electrolyte Balance

Nursing Considerations

Third Edition

Norma M. Metheny

Lippincott

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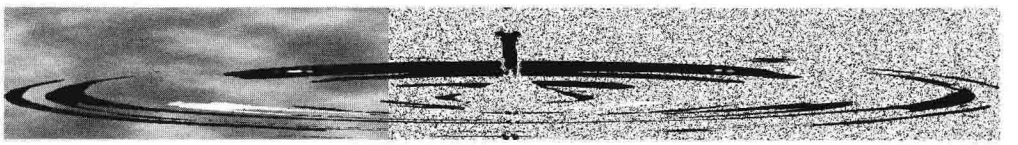

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This book is dedicated to Virginia Henderson
for her great and sustained contributions to nursing practice

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PREFACE

The third edition of *Fluid and Electrolyte Balance: Nursing Considerations* carries on in the tradition established by the prior editions of this textbook. It provides current and comprehensive information related to the nursing care of patients with fluid, electrolyte, and acid–base imbalances in a readable and user-friendly manner. Because concepts of fluid and electrolyte balance apply to a broad spectrum of patient problems, the book's scope is wide. While written simply, to promote ease of understanding for students, it contains enough information to stimulate the interests of advanced practitioners. The most current research findings related to conditions affecting fluid and electrolyte balance are integrated throughout the text. All chapters have been completely revised and updated with an increased emphasis on providing care to patients in long-term and ambulatory care settings.

ORGANIZATION

The basic organization remains unchanged. As in prior editions, the first three units present concepts fundamental to understanding the clinical chapters that follow. Unit I—Basic Concepts—includes a chapter on fundamental concepts and definitions, and a completely revised nursing assessment chapter. Unit II—An Overview of Fluid and Electrolyte Problems—provides chapters on fluid volume imbalances, sodium imbalances, potassium imbalances, calcium imbalances, magnesium imbalances, phosphorus imbalances, and acid–base disturbances. Case studies are included to enhance understanding of specific imbalances. Unit III—Parenteral and Enteral Nutrition—has been completely revised and updated to reflect the latest developments in parenteral fluid administration as well as in parenteral and enteral nutrition. Unit IV—Clinical Situations Associated with Fluid and Electrolyte Problems—contains the bulk of the clinical chapters. Included are chapters on gastrointestinal problems, fluid balance in surgical patients, hypovolemic shock in trauma and postoperative patients, heart failure, renal failure, diabetic ketoacidosis and hyperosmolar syndrome, fluid balance in the brain-injured patient, acute pancreatitis, cirrhosis with ascites, oncologic conditions, and pregnancy. The final unit (Unit V)—Special Considerations in Children and the Elderly—offers a concise explanation of special fluid and electrolyte problems in the very young and the very old.

The book retains its strong nursing focus to help facilitate integration of the information into nursing practice. In all chapters, pathophysiology is discussed to promote an understanding of rationales for nursing interventions. Assessment of fluid and electrolyte balance, based on an understanding of pathophysiology, is integrated throughout the textbook. Because monitoring for the occurrence or worsening of imbalances is an integral part of the nurse's role, patients at risk for specific imbalances are identified throughout the text, as are the common indicators of these problems. Examples of nursing diagnoses related to fluid and electrolyte problems are presented when appropriate, followed by a description of nursing interventions. By their nature, these interventions often involve manipulation of fluid and nutrient intake; therefore, the electrolyte content of common beverages and foods is included as appropriate.

NEW TO THIS EDITION

Each chapter has been completely reviewed, revised, and updated to reflect the latest developments in the study of fluid and electrolyte balance. Extensive reference lists are provided to allow the reader to

pursue particular areas of interest. These references include the most recent nursing and medical research related to fluid and electrolyte balance, as well as classic work that provides the foundation for current practice. For example, the most current research findings regarding the management of sodium imbalances in postoperative and neurological patients is included.

The book's layout and design have been updated to promote easy access to material. Information on providing care in the home and community has been integrated throughout the book. Clinical tips are highlighted for easy identification when information is needed in a hurry.

Additional case studies in a variety of areas have been added with an eye toward supporting critical concepts with immediate clinical relevance. Examples of new material are case studies on postoperative shock due to hemorrhage and trauma, sodium imbalances in premenopausal women, safe intravenous sodium administration, hyperphosphatemia from hypertonic sodium phosphate enemas in an elderly patient, multiple electrolyte imbalances in an adolescent with anorexia nervosa, pH disturbances associated with vomiting and diarrhea, postoperative hyponatremia, postoperative hypocalcemia following neck surgery, and imbalances associated with congestive heart failure, renal failure, uncontrolled diabetes mellitus, head injuries, pancreatitis, cirrhosis of the liver, pregnancy, and oncologic conditions. Other case studies include diarrhea in an infant and hypernatremia in an elderly patient with Alzheimer's disease.

A new chapter, "Hypovolemic Shock in Trauma and Postoperative Patients," is included in this edition, reflecting the complex nature of this topic. In addition, the nursing assessment chapter (Chapter 2) has been extensively revised to include information on sophisticated monitoring of physiological changes with pulmonary artery catheters. More information on the care of geriatric patients has been integrated throughout the text, as well as in the geriatric chapter, to help the reader deal with the growing elderly population. Information pertaining to patients receiving parenteral and enteral nutrition has been increased, with the addition of extra tables to help the reader locate important information quickly. Also, information to help nurses provide care for home patients with fluid and electrolyte problems has been integrated throughout the text. For example, sick day rules for diabetic patients have been updated, and information related to the safe use of laxatives and enemas has been included to allow nurses to prevent fluid and electrolyte imbalances through education of home patients and their families.

I wish to acknowledge the skilled master clinicians who have thoroughly revised their chapters to reflect current practice, and also the contributors to prior editions. Because of these individuals' high level of expertise, the information presented in their clinical chapters is pragmatic and ready for application to practice.

Fluid and Electrolyte Balance: Nursing Considerations, third edition, was written with the intent of fostering critical thinking in those providing care to patients with potential or actual fluid and electrolyte disturbances. Designed for students and practicing nurses, it provides the necessary information to deliver safe, effective, scientifically based nursing care.

Norma M. Metheny

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Lisa Stead, *Associate Editor*
Brian MacDonald, *Nursing Editorial Assistant*
Nancy Berliner, *Project Coordinator*

Fluid and Electrolyte Balance

Nursing Considerations

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UNIT FIVE

Special Considerations in Children and the Elderly

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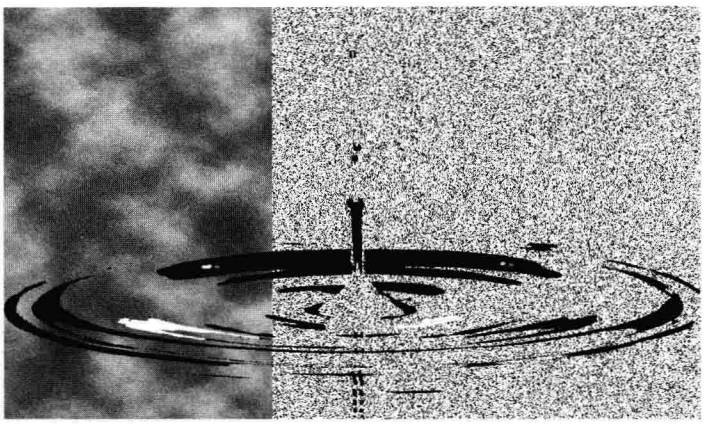
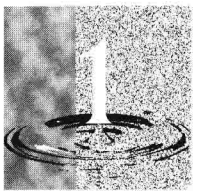
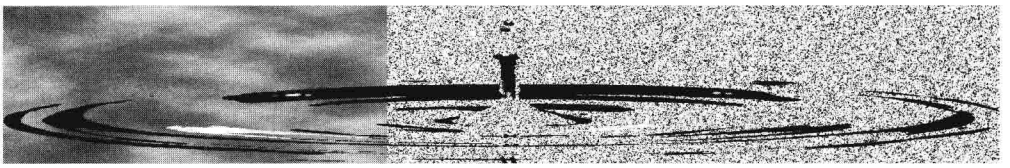


Basic Concepts



Fundamental Concepts and Definitions



- **DISTRIBUTION OF BODY FLUIDS AND ELECTROLYTES**
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DISTRIBUTION OF BODY FLUIDS AND ELECTROLYTES

In the typical adult, approximately 60% of weight consists of *fluid* (water and electrolytes). This fluid is either *intracellular* (within the cells) or *extracellular* (outside the cells). Extracellular fluid (ECF) is further subdivided into *intravascular fluid* (plasma) and *interstitial fluid* (fluid lying between the cells, or tissue fluid) (see Fig. 1-1). Also part of the ECF are transcellular fluids, primarily representing secretions from epithelial cells and having ionic compositions different from the plasma and interstitial fluids. Examples of transcellular fluid include secretions in the salivary glands, pancreas, liver, and biliary tract, as well as fluid in the gastrointestinal and respiratory tracts, sweat gland ducts, cavities of the eyes, cerebrospinal fluid, and kidneys.[1] In adults, two-thirds of the body fluid exists in the intracellular space (primarily in the skeletal muscle mass). The remaining one-third is primarily found between the cells and in the plasma space. Microscopically, one might visualize the body fluids as in Figure 1-2.

Total body water content varies with body fat content, sex, and age. Fat cells contain little water, whereas lean tissue is rich in water. Thus, women have less body fluid than men because they have proportionately more body fat. The elderly have less body fluid than their younger counterparts for the same reason. Obese individuals, in general, have considerably less fluid than those of lean build (see Fig. 1-3).

Infants have a high body fluid content (approximately 70% to 80% of their body weight). In addition to having proportionately more body fluid than adults, infants have relatively more ECF. Indeed, more than half of the newborn's body fluid is extracellular, whereas in the adult only a third or less is extracellular. Because ECF is more readily lost from the body than is cellular fluid, infants are more vulnerable to fluid volume deficit. As infants become older, their total body fluid percentage decreases; the change is most rapid during the first 6 months of life. By the end of the second year, the total body fluid approaches the adult percentage of approximately 60% (36% cellular and 24% extracellular). At puberty, the adult body composition is attained (40% cellular and 20% extracellular). For the first time there is a sex differentiation in fluid content. (See Table 1-1.)

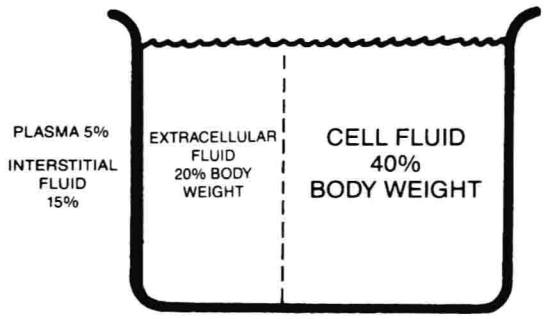

Figure 1–1. Total body fluid, 60% body weight.

After 40 years of age, mean values for total body fluid in percentage of body weight decrease for both men and women; however, the sex differentiation remains. After 60 years of age the percentage may decrease to approximately 52% in men and 46% in women (even less in obese persons). Again, the reduction in body fluid is explained by the fact that with aging there is a decrease in lean body mass in favor of fat. Variations in total body fluid with age are listed in Table 1-1.

Body fluid is composed primarily of water and electrolytes. An *electrolyte* is defined as a substance

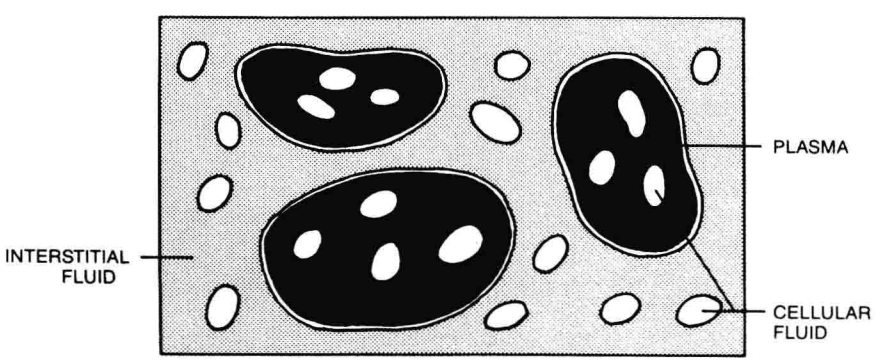

Figure 1–2. Microscopic visualization of body fluid distribution.

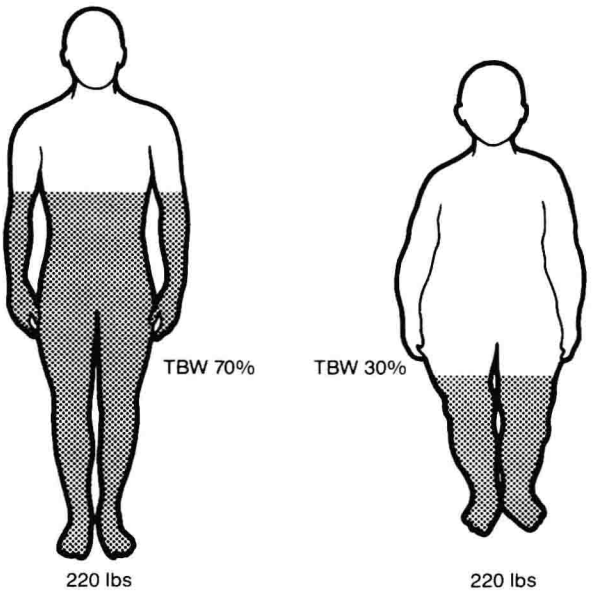

Figure 1–3. Body composition of a lean and an obese individual. Adapted from Statland H: Fluid & Electrolytes in Practice, 3rd ed. Philadelphia, JB Lippincott, 1963; with permission.

that develops an electrical charge when dissolved in water. Examples of electrolytes are sodium, potassium, calcium, chloride, and bicarbonate. Those that develop a positive charge in water are called *cations*; for example, sodium (Na^+), potassium (K^+), calcium (Ca^{2+}), and magnesium (Mg^{2+}). Electrolytes that develop negative charges when dissolved in water are called *anions*; for example, chloride (Cl^-) and bicarbonate (HCO_3^-). In all body fluids, anions and cations are always present in equal amounts, as positive and negative charges must be equal (an electrochemical fact).

The electrolyte content of intracellular fluid (ICF) differs significantly from that of ECF. Table 1-2 lists the electrolytes in plasma (ECF) and Table 1-3 lists

TABLE 1–1

Approximate Values of Total Body Fluid as a Percentage of Body Weight in Relation to Age and Sex

AGE	TOTAL BODY FLUID (% BODY WEIGHT)
Full-term newborn	70%–80%
1 year	64%
Puberty to 39 years	Men: 60% Women: 52%
40 to 60 years	Men: 55% Women: 47%
More than 60 years	Men: 52% Women: 46%

TABLE 1–2

Plasma Electrolytes

ELECTROLYTES	mEq/L
Cations	
Sodium (Na^+)	142
Potassium (K^+)	5
Calcium (Ca^{2+})	5
Magnesium (Mg^{2+})	2
Total cations	154
Anions	
Chloride (Cl^-)	103
Bicarbonate (HCO_3^-)	26
Phosphate (HPO_4^{2-})	2
Sulfate (SO_4^{2-})	1
Organic acids	5
Proteinate	17
Total anions	154

TABLE 1–3

Approximation of Major Electrolyte Content in Intracellular Fluid

ELECTROLYTES	MEq/L
Cations	
Potassium (K^+)	150
Magnesium (Mg^{2+})	40
Sodium (Na^+)	10
Total cations	200
Anions	
Phosphates, Sulfates	150
Bicarbonate (HCO_3^-)	10
Proteinate	40
Total anions	200