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NMS National Medical Series For Independent Study

Surgery

Sixth Edition

Bruce E. Jarrell
Stephen M. Kavic

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We both thank the many mentors who have advised us each throughout our careers. We are forever indebted to them.

I wish to thank my wife, Leslie, and my wonderful children for all of their support during my career, and for their understanding during the writing of the many editions of NMS Surgery – BEJ

Dedicated to my loving wife Jennifer and to my lovely daughter Emily – SMK

Foreword

It is with tremendous pride that I introduce the sixth edition of NMS Surgery. T is work has occupied a central role in the education of a generation of medical students. T e outline format makes it a superb reference for those learning the basics of surgery and a thorough review for those who already practice our art.

T e current edition has special significance to the University of Maryland School of Medicine. Dr. Jarrell is the Chief Academic and Research Officer and Dean of the Graduate School. He also was my predecessor as Chair of the Department of Surgery. Dr. Kavic is the current program director of our surgery residency. T e chapter authors and contributors include a virtual directory of our trainees and faculty. It is a privilege to be associated with these esteemed educators.

I am continually impressed by the talents of the surgeons and surgeons-in-training at the University of Maryland. T at quality is reflected in the following chapters. I know that you will enjoy this edition as much as I take pride in it.

Stephen T. Bartlett, MD
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Preface

Welcome to the sixth edition of NMS Surgery.

T is book aims to build on the legacy of the previous five editions. We have retained much of the organization and format from the last versions. At the same time, we have strived to make this volume more readable.

It is an increasing challenge to limit content in the face of rapidly expanding surgical knowledge. As in previous editions, the text is not meant to be all-inclusive but rather serves as an introduction for the student of surgery. All of the chapters have been thoroughly reviewed, rewritten, and updated to reflect the current state of the art in surgery.

T ere are dramatic dif erences in the format of this volume. Perhaps most importantly, each section now begins with "Chapter Cuts and Caveats," which are some of the most important principles worthy of the reader's attention. Within each chapter, we have added "Quick Cuts," which are highlights that have been brought out separately from the text. In addition, we have added a new section at the end, "Grade A Cuts," which are pairings that highlight associations in surgical thinking.

For the tremendous work put into this edition, we are indebted to the authors. T eir high-quality and frequently punctual contributions have made our jobs as editors pleasant. We are also grateful to the editorial team at Wolters Kluwer for their guidance and support throughout the process.

T e sixth edition of NMS Surgery is written primarily for students and residents in general surgery, but practicing surgeons as well as physicians in other specialties will no doubt find it a useful reference. We hope that all readers will find that the book represents a declaration of the state of surgical art in 2015.

—Bruce E. Jarrell, MD
—Stephen M. Kavic, MD

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Introduction

Chapter Cuts and Caveats

Part I

CHAPTER 1

Principles of Surgical Physiology:

- Management of sick patients requires resuscitation, with the goal of restoration of perfusion. Quickly and accurately f nding the source of the clinical deterioration and f xing that problem is crucial; otherwise, the resuscitation will ultimately fail to allow adequate oxygen delivery.
- Shock is the state of physiologic decompensation resulting in inadequate tissue perfusion (oxygen demand outstrips oxygen supply).
- Ultimately, no one formula best determines postoperative fluid and electrolyte management.
- High insensible losses (both evaporative losses and leakage into the third space) occur during and after surgical procedures that involve open body cavities; that are invasive and open many tissue planes; that are prolonged; that are associated with sepsis, inflammatory conditions, and ischemia of organs; that result in hypotension; and that are done in emergent settings.
- Hyperkalemia must be treated aggressively to avoid life-threatening arrhythmias. T e best emergent treatment is IV bicarbonate and IV insulin and glucose, which moves potassium intracellularly and lowers serum levels. IV calcium is also useful by affecting the threshold for action potential and decreasing cardiac membrane excitability.
- Adequate oxygenation is assessed by more than blood pressure and pulse. It is also monitored by assessing markers of tissue perfusion (urine output and renal function), oxygenation (chest x-ray and lung auscultation for signs of pulmonary edema, blood oxygenation, and other measures), serum electrolyte levels, pH, arrhythmias, mentation, external signs of hydration state, hematocrit, and the patient's overall appearance.
- When evaluating a patient who is clinically deteriorating, always prioritize the evaluation of diagnoses in your differential that will lead to the fastest and greatest deterioration.
- New anemia in a postoperative patient is surgical bleeding until proven otherwise. Packed RBC transfusion provides excellent physiologic support but has side effects including allergic reactions and the potential for infectious transmission—treat blood like a drug! Clerical error is the most common cause for transfusion reaction.
- Enteral nutrition is preferred in most patients. T e risk of central venous catheters outweighs nutritional benef ts for short-term supplementation if nutritional support is needed for less than 1 week. Low albumin levels correlate with mortality.
- Patients with inadequate oxygenation or increased work of breathing should have ventilatory support: When in doubt, intubate.

CHAPTER 2

Essentials of General Surgery:

- For wound infections: Abscess must be drained, necrotic tissue must be debrided, crepitus suggests a necrotizing gas-forming infection demanding that the wound be opened, foreign bodies (including tubes or drains) must be removed, and enteric leak must be controlled.

- Systemic antibiotics are not the primary treatment for wound infections.
- Perioperative antibiotics given to patients with clean-contaminated wounds (which are usually closed primarily) reduce the incidence of wound infections and the subsequent risk of hernia.
- Any condition that interferes with the four phases of wound healing (hemostasis, inflammation, proliferation, and remodeling) will impair the rate of healing and the f nal wound strength. Both local and systemic factors have an effect.
- Local factors: Wounds should be free of bleeding, hematoma, gross contamination, and necrotic tissue; wound edges should be free of tension; and local tissue should be healthy and well vascularized.
- Systemic factors that impair wound healing: metabolism, poor nutritional state, zinc and vitamins A and C def ciency, presence of infection, hypoxia, low-flow states, smoking, poorly controlled diabetes, obesity, collagen vascular diseases, and renal and liver failure
- Medications: systemic glucocorticoids, some chemotherapeutic and immunosuppressive drugs, and angiogenesis inhibitors
- Postoperative fevers may result from the 5 W's: wound, water, wind, walking, and wonder drugs.
- Surgical site infections are a major source of morbidity and are most commonly due to skin flora (especially Staphylococcus).
- Nonhealing GI f stulas may result from FRIEND (foreign body, radiation, inflammation, epithelialization, neoplasia, distal obstruction) and often respond to nonoperative management.

CHAPTER 3

Medical Risk Factors in Surgical Patients:

- Assessment of medical risk for invasive surgical procedures includes a thorough history, physical, and laboratory examination.
- Patients with cardiac conditions are at increased risk for cardiac complications following noncardiac surgery, and standardized classif cation systems help stratify risk. Functional capacity more than 4 METs predicts a low risk of postoperative cardiac events. Elective surgery should be postponed at least 4 weeks following acute cardiac events or revascularization.
- All patients should be assessed for the degree of risk for venous thromboembolic events, and prophylaxis with heparin is appropriate for most surgical patients.

CHAPTER 4

Life-Threatening Disorders: Acute Abdominal Surgical Emergencies:

- When evaluating a patient for acute abdominal pain, f rst determine whether the patient has a surgical abdomen on examination, judged by a distressed patient with pain that is severe and generalized and associated with rebound or guarding. Clinical judgment is supplemented by radiographic studies, such as extraluminal peritoneal free air, and laboratory studies, such as f ndings supportive of ischemia, inflammation, acute hemorrhage into the peritoneal cavity, or infection. If the judgment of a surgical abdomen is made, immediate intervention after resuscitation is indicated.
- GI hemorrhage necessitates localizing the bleeding and formulating a plan to control it before surgery. Identifying the source of bleeding in the operating room by evaluating the external surface of the GI tract is very difficult.
- To manage a signif cant GI hemorrhage, balancing three problems simultaneously becomes necessary: volume resuscitation, coagulation defect correction, and identif cation and control of the site of hemorrhage. Transfusion of blood and blood products may be critical in managing all three problems. Transfusion beyond several units results in increased morbidity and mortality because blood and its products have many potential side effects, such as transfusion reactions with anaphylaxis and hemolysis, infectious agent transmission, and immune suppression, among others.
- Location can indicate common pathology: RUQ suggests the biliary tree; RLQ, the appendix; and LLQ, the sigmoid colon.

Chapter 1

Principles of Surgical Physiology

Steven B. Johnson and Matthew Lissauer

FLUID AND ELECTROLYTES

Normal Body Composition

I. Body water: Water accounts for 50%–70% of body weight (the higher percentage in young people, thin people, and man—the lower percentage in older people, obese people, and women). Body water is divided into various intracellular and extracellular compartments (Fig. 1-1).

A. **Two-thirds rule:** T is is a simple method of approximating compartment volume because of the variation among patients and within the same patient. Total body water comprises slightly less than two-thirds body weight.

B. **Plasma volume:** Using the above rule, ~5% of body weight is plasma volume (e.g., 3.5 L for a 70-kg male). Plasma is ~60% of the blood volume (if the hematocrit is 40%); therefore, the 70-kg male has 5 L of blood.

II. Electrolyte composition: Electrolytes determine the amount of water that exists in any one space at any time, and their concentrations and compositions differ between intracellular and extracellular spaces due to ion pumps (principally Na^+/K^+ ATPase), as shown in Table 1-1. Change in osmotic pressure in one compartment causes water to redistribute from the other compartments to regain equilibrium.

A. **Intracellular (principal osmotic cation is potassium):** has higher concentration of osmotic and oncotic (protein) particles than the extracellular compartment, thus allowing water to flow into the cell, creating turgidity

B. **Extracellular (principal osmotic cation is sodium):** Interstitial and plasma composition is nearly but not quite identical.

Water and Electrolyte Maintenance

I. Water: Required amount depends on the person's weight, age, gender, and illness.

A. **Water calculation methods**

1. **Amount of body water excreted**

a. Most water lost from the body is through urine production; generally, 0.5 mL/kg/hr is the minimum needed to excrete the daily solute load.

> **Quick Cut**
> The compartments are important because calculating fuid losses, blood losses, and amount of resuscitation needed is key to ensuring patients' survival.

> **Quick Cut**
> Two-thirds rule: Total body water = (slightly less than) two-thirds total body weight.

> **Quick Cut**
> Of total body water, two thirds is intracellular and one third extracellular (three fourths = interstitial and one fourth = intravascular).

> **Quick Cut**
> Water follows electrolytes across cell membranes to equilibrate osmolality.

> **Quick Cut**
> Adequate urine output is ½ mL/kg/hr, or about 250 mL/8 hr in adults.

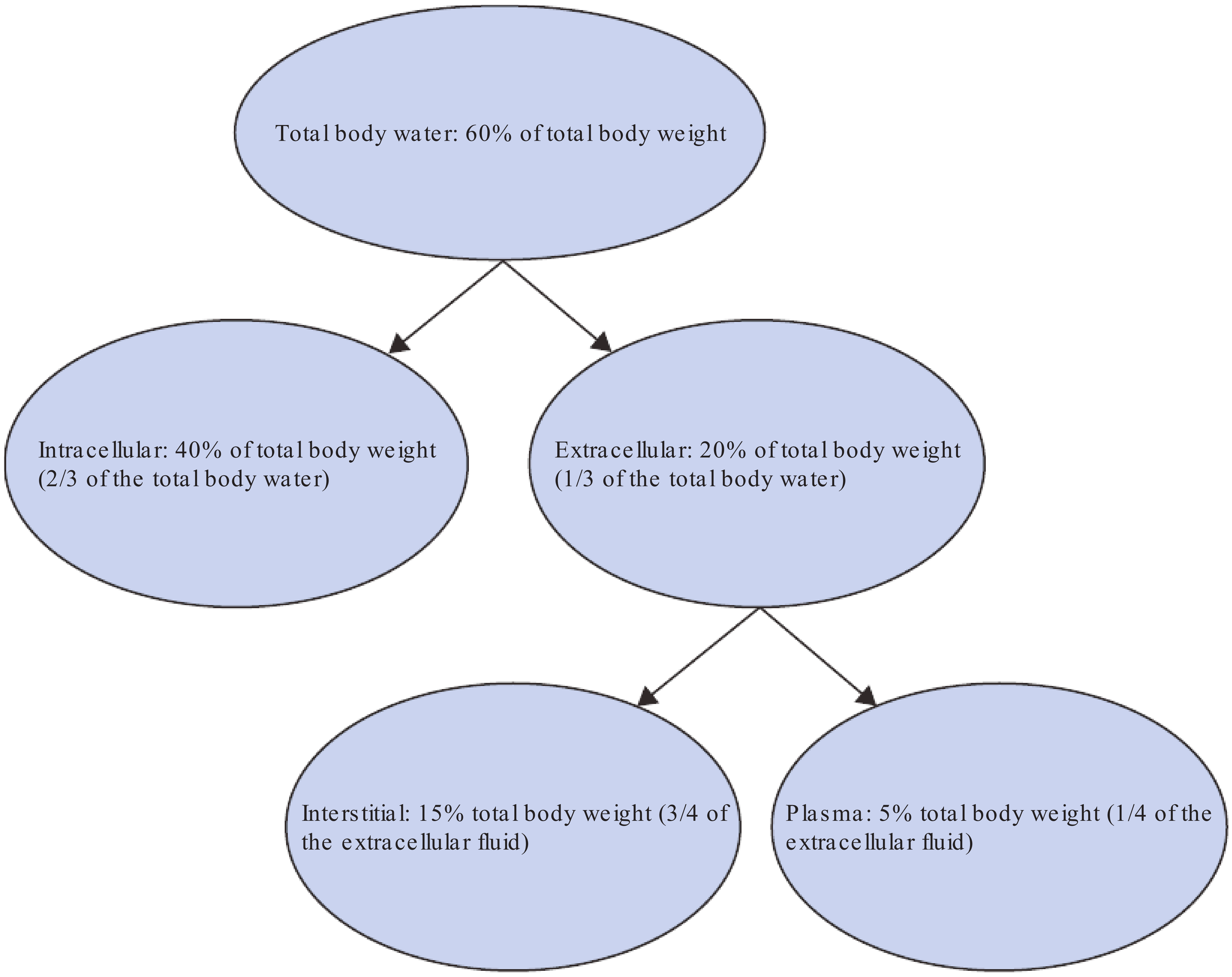

Figure 1-1: Water compartments.

Table 1-1: Electrolyte Composition of Various Water Compartments

Electrolytes	Intracellular Compartment	Extracellular Compartment
Anions		
Sodium (Na^+)	10 mEq/L	142 mEq/L
Potassium (K^+)	140 mEq/L	4 mEq/L
Chloride (Cl^-)	4 mEq/L	103 mEq/L
Bicarbonate (HCO_3^-)	10 mEq/L	28 mEq/L
Phosphate (PO_4^{3-})	75 mEq/L	4 mEq/L
Sulfate (SO_4^{2-})	2 mEq/L	1 mEq/L
Calcium (Ca^{++})	<1 mEq/L	5 mEq/L
Magnesium (Mg^{++})	18 mEq/L	2 mEq/L
Organic acids	—	5 mEq/L
Various proteins	40 mEq/L	1 mEq/L

b. T e next highest daily water loss is insensible loss (i.e., sweat, respiration, stool), which is estimated as 600–900 mL/24 hr.

c. Minimal water maintenance for a 70-kg man: (70 kg × 0.5 mL/kg/hr × 24 hours) + 750 mL/24 hr + 1,590 mL/24 hr. (Again, this is the minimum and does not take into account any excess loss such as fever, which will increase the insensible loss.)

2. **Body weight:** T is method is often used for pediatric patients because their body weights vary widely; estimations are 100 mL/kg/day or 4 mL/kg/hr for the f rst 10 kg of body weight, 50 mL/kg/day or 2 mL/kg/hr for the second 10 kg of body weight, and 20 mL/kg/day or 1 mL/kg/hr for each additional kilogram of body weight.

3. **Given amount of water per kilogram of body weight:** T e value used for this method is generally 35–40 mL/kg/day, adjusted higher or lower based on age (older adults often require only 15 mL/kg/24-hr maintenance due to higher fat/lower muscle mass).

B. Evaluating maintenance rates: Patients not only have different maintenance needs, but replacing water or removing excess water may also be of concern (see I C 1). Simple methods in the noncritically ill population to monitor adequacy of fluid administration include the following:

1. **Urine output variations:** If urine output is high (i.e., >1 mL/kg/hr), then less water may be required; if urine output is low, more water may be required, or further assessment may be necessary.
2. **Tachycardia:** can be a sign of dehydration or low intravascular volume

C. Adjusting f uid rates and type for individual patients: First, calculate the patient's maintenance rate, then adjust the amount up or down based on the need for resuscitation, or replacement of gastrointestinal (GI) losses, and the type based on type of losses (Table 1-2).

1. **Injury, illness, and surgery:** Can result in fluid losses due to blood loss, third spacing, insensible losses from diarrhea, fever, etc. Providing more than calculated maintenance fluid to replace losses (e.g., 1.5 or 2 × maintenance) is necessary, and rate adequacy can be judged from the above criteria.
2. **Hypervolemia and diuresis:** Patients who require diuresis already are overloaded with fluid, and intravenous (IV) fluids should be withheld; however, electrolyte or nutritional aspects of fluid administration may require water as a carrier for other substances during diuresis.

Quick Cut
Remember the shortcut for estimating fuid maintenance: The first 20 kg of weight = 60 mL/hr and then 1 mL/kg/hr above that, so a 60-kg person = 100 mL/hr.

Quick Cut
Because water requirements vary. Fever, environmental temperature, and respiratory rate can increase insensible loss and increase maintenance requirements.

Quick Cut
Older adults may not produce as much urine as the young and can be pushed into congestive heart failure (CHF).

Table 1-2: Electrolyte Composition of Gastrointestinal Secretions

Organ	Volume/day	Na^+ (mEq/L)	K^+ (mEq/L)	Cl^- (mEq/L)	HCO_3^- (mEq/L)
Stomach	1–5 L	20–150	10–20	120–140	Nil
Duodenum	0.1–2 L	100–120	10–20	110	10–20
Ileum	1–3 L	80–140	5–10	60–90	30–50
Colon	0.1–2 L	100–120	10–30	90	30–50
Gallbladder	0.5–1 L	140	5	100	25
Pancreas	0.5–1 L	140	5	30 (higher when not stimulated)	115 (lower when not stimulated)