

SECOND EDITION

NUTRITION SUPPORT FOR THE CRITICALLY ILL PATIENT

A GUIDE TO PRACTICE

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EDITED BY GAIL A. CRESCI



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Foreword

During the latter half of the twentieth century and to the present day, critical care of seriously ill or injured patients has evolved to become the highest priority for most, especially skilled, health-care teams in most hospitals in the United States and throughout the world. Indeed, we are rapidly approaching the point at which hospitalized patients will consist of those requiring highly specialized intensive care services in various critical care units by highly talented and motivated comprehensive teams of health-care professionals, using state-of-the-art knowledge and technology, and those with complex acute or chronic disorders or conditions that cannot be treated adequately or practically on an ambulatory basis, or in an alternate health maintenance and care facility, or at home. The vast majority of patients requiring medical and/or surgical services will be treated in same-day or short-stay facilities and discharged promptly to their homes or to appropriate assisted living facilities for recovery, convalescence, and rehabilitation. Many of the hospitalized patients will belong to opposite ends of the life cycle, that is, the pediatric and geriatric age groups, especially the latter group, which is the most rapidly increasing segment of the population in this country. Not only do these cadres of hospitalized patients experience the highest incidences of critical illnesses, complications, and collateral conditions, but a majority of them will also exhibit some form of undernutrition or malnutrition prior to, or at, admission or will develop nutritional deficiencies or aberrations during the course of their diagnostic and therapeutic interventions throughout their hospitalization. The adage that “No disease process, injury, or major disorder can be expected to respond as favorably to therapeutic medical and/or surgical treatments when the patient is malnourished or undernourished as when the patient is optimally nourished” remains as true today as when it was first uttered, perhaps by Hippocrates, centuries ago. This fact alone justifies the production of this second edition of *Nutrition Therapy for the Critically Ill Patient: A Guide to Practice* by Gail A. Cresci, PhD, RD, and the distinguished cast of colleagues and authors that she has assembled to share their vast expertise, in depth and in a broad field of nutrition-related topics. Moreover, in more than three dozen chapters, the editor and her contributors have conscientiously and effectively addressed and dealt with the most important of the myriad complex aspects of nutrition therapy in critically ill patients, which is highly essential to their survival and subsequently to the quality of their lives.

The advancements in the field of both critical care and nutrition therapy during the past 50 years have been truly phenomenal, have occurred in symbiosis with each other, have revolutionized the care and management of critically ill patients, have saved countless lives, have changed the practice of medicine forever, and will undoubtedly improve the morbidity, mortality, and other outcomes in this vital arena of health-care endeavor as progress continues in the future. During the past 55 years of my education, training, and practice of medicine, surgery, and nutrition support, I have been privileged to witness and/or participate in a virtual revolution in the care of critically ill patients, which, in retrospect, borders on the unbelievable. When I was a medical student from 1957 to 1961 at the University of Pennsylvania School of Medicine, the only formal nutrition taught in the curriculum was a one-hour lecture on vitamin deficiencies; clinical *intravenous therapy* consisted of peripherally administered 5% dextrose in water, saline, or lactated Ringers solution with added vitamin C and the B complex vitamins, and some potassium; tube feedings were used rarely and usually consisted of blenderized house diets infused into the stomach by a large nasogastric tube or occasionally through a large gastrostomy tube; jejunostomy tube feedings, usually consisting of blenderized foods, were highly problematic, and no special partially digested food substrates acceptable for infusion into the duodenum or jejunum had yet been developed; and no intensive care, critical care, or special care units were available in the Hospital of the University of

Pennsylvania, which comprised largely multiple 40-bed *Florence Nightingale Wards*, and some semiprivate two-bed rooms and private single-bed rooms. Caring for critically ill patients at that time was difficult and frustrating, without adequate designated special space, special skilled nurses, special dietitians/nutritionists, and special equipment, supplies, resources, and access. Moreover, it was well known among the medical students and house officers that a critically ill patient was more likely to receive more, better, and more effective care in an open ward than in a relatively isolated and confined private or semiprivate room.

Several events during my senior year in medical school and my internship transformed both me and the hospital as health-care providers. The Department of Surgery acquired limited amounts of experimental intravenous protein hydrolysate solutions and intravenous cottonseed oil emulsion for limited patient use, and I was privileged to participate in some clinical trials of these new, revolutionary, intravenous nutritional substances. Early in my internship year (1961–1962), I became acutely aware of, and deeply disturbed by, the lethal effect of severe malnutrition and undernutrition upon the outcomes of major surgical patients, especially those with complex problems requiring multiple operative procedures. Even more disconcerting to me was our inability to provide adequate nutrition to patients with major disabilities of, or other impediments to, the use of the gastrointestinal tract. This stimulated me to undertake basic and clinical investigations, which eventually led to the development of the first successful technique of long-term total parenteral nutrition (TPN).

During the same time period, the hospital remodeled a small area to create its first four-bed surgical intensive care unit (SICU) and another similar area to create an acute coronary care unit (CCU). I was actually the first house officer assigned to the rudimentary SICU that had four beds, each having access to an oxygen supply for delivery by mask or nasal cannula, suction apparatus, a 4 in. diameter continuous EKG monitor, and a skilled nurse (the most important feature). I was the indwelling house officer, and I had a reclining chair in which I could rest or even nap occasionally during the month of my rotation while attending to the continual needs of the most critically ill surgical patients in the hospital. Such was critical care in the early 1960s—but it was a giant step forward in the right direction. By the time I was the chief resident in surgery in 1966–1967, the hospital had added three 12-bed special care units, each individually designed and equipped to provide critical care specifically for patients with surgical, cardiac, or pulmonary problems. Modern monitoring equipment, ventilators, respirators, defibrillators, external cardiac pacing units, supplies and equipment for emergency tracheostomy, venous cutdowns, arterial lines, insertion of chest tubes, ostomy care, and portable fluoroscopic and x-ray equipment were added to the armamentarium of the critical care team.

Although these units were the premier care stations for critically ill patients, they also served as a source of invaluable new information and knowledge as we studied the effects of our efforts upon the patients' clinical courses and outcomes. However, perhaps the most profound advance in this critical area was the acquisition of the first extramural NIH Clinical Research Center in the United States by the Department of Medicine faculty of the Hospital of the University of Pennsylvania. It was there that I was able to carry out the most finite and elegant nutritional and metabolic studies in critically ill patients, with the help and support of an elite, skilled, motivated, conscientious staff of nurses, dietitians, technicians, and physicians who were dedicated to practicing their professions with utmost precision and proficiency in a most collegial and collaborative manner. Intravenous infusion pumps, central venous catheters and infusion lines, laminar airflow areas, and regimens for long-term continuous central venous infusion of TPN were introduced and perfected there to the point that our results could be evaluated, validated, and shared with the critical care community, not only of the United States but also of the world. Principles, practices, and procedures were developed, tested, and standardized as much as possible to ensure their optimal safety and effectiveness with minimal complications, morbidity, and mortality. Special nutrient solutions were developed for patients with renal, liver, and pulmonary failures and metabolic lipodystrophies. Our most notable achievement, however, occurred in the neonatology intensive care unit of our Children's Hospital of Philadelphia, where a severely malnourished infant with multiple congenital anomalies, including

extremely short bowel syndrome (and near death), was nourished entirely by central venous TPN for 45 days. She was the first infant to exhibit normal growth and development long term while being fed exclusively intravenously. This demonstration revolutionized the care of premature infants and all critically ill infants with severely compromised gastrointestinal tracts and secondary malnutrition—and changed the practice of neonatology forever.

The relevance of nutrition therapy for the critically ill patient was obvious, largely as a result of these basic studies, and has spawned myriad investigations in virtually all aspects of nutritional and metabolic support, orally, enterally, parenterally, and in various combinations. Nonetheless, many questions remain to be answered and many problems beg resolution in this vital area of health care as we strive to achieve perfection in nutrition and metabolic support. This textbook, by virtue of the many important areas addressed by the many expert clinician-scientists, will serve to provide the most up-to-date, state-of-the-art data, information, experience, technology, and techniques to help keep both novices and experts informed and aware of the continuous accrual of knowledge applicable to the optimal care of the critically ill patient. However, the reader will also be aware that controversies still exist regarding nutrition therapy, especially in critically ill patients. Among them are optimal dietary composition, early feeding to target goals, hyperglycemia and insulin use, maintenance of euglycemia, early enteral versus parenteral feeding, overfeeding and refeeding syndrome, and the composition and prudent use of lipid emulsions. Additionally, the compositions of amino acid, vitamin, trace element, and immune-enhancing formulations, and their appropriate use, are still controversial. Problems persist relevant to obesity prevention, arrest, and reversal, on one hand, and to the management of various cachexia problems on the other. Persistent areas of special feeding problems include cancer patients, geriatric patients, premature neonates and surgical infants, and patients with severe short bowel syndrome, especially those with associated liver failure. Obviously, much remains to challenge our interests, talents, and ingenuity (and especially, our motivation, persistence, and resilience) as we strive to provide optimal nutrition to all patients under all conditions at all times. As we do so, we will find this guide to practice to be an invaluable asset in our quest to craft and provide optimal nutrition therapy for the critically ill patient. For that, we are deeply indebted to nutritionist and editor Gail A. Cresci and her collaborating authors for so generously sharing with us their expertise, experience, knowledge, counsel, skills, and wisdom.

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Dr. Cresci is the past chair of Dietitians in Nutrition Support, a practice group within the Academy of Nutrition and Dietetics. She has served on multiple national and state society conference planning committees, serving as chair for the ASPEN planning committee. She is the recipient of numerous honors and awards, including the American Dietetic Association Excellence in Practice of Clinical Nutrition, the ASPEN Distinguished Nutrition Support Dietitian Advanced Clinical Practice Award, the ASPEN Promising New Investigator Award, and the Academy of Nutrition and Dietetics Excellence in Practice Dietetics Research Award.

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Section I

*Metabolic Alterations in the
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