Traditionally, the most hypermetabolic of all surgical diseases, appropriate nutrition has formed the basis of modern burn care. Today, I would like to review some of the highlights of that history, of where we in burn care have already been in delivering nutritional support for our patients and to promote continued research for the future.

I submit that much of the improvement in burn mortality during the last quarter century (Figure 1) has come in conjunction with improvements in nutrition. During my nearly 30-year involvement in burn care, I have had the opportunity to see dramatic changes in nutritional management, many the result of this Association’s leaders. In the 1970s, it was well known that acutely injured patients could not use nutritional substrates for the first several days to a week after injury. There was, therefore, no need to feed them. Full nutrition was achieved when the team got around to it, often 7 to 10 days after the burn. Consequently, malnutrition was endemic, and burn patients often had the classical appearance of skin, bones, and a hank of hair.

Although incremental changes have been made in topical and wound care, a review of surgical textbooks from the early 1980s show, by today’s standards, a striking lack of urgency in achieving adequate nutritional replacement. This was a time when Sir David Cuthbertson’s concept of metabolic ebb, or shock phase and the later flow phase divided into catabolic and anabolic portions, was an important part of our culture. The fact that posttraumatic ileus lasted a relatively long time, was a tenet that I think many trauma/critical care people still believe. I hope to show you that the American Burn Association (ABA) and its members have played an important role in defining this change.

Looking back, it seems as though the burn team has always been interested in nutrition. In 1956, 13 years before this organization’s formation, our first ABA president, Dr. Curtis P. Artz, recognized the special needs of the burn patient. It’s amazing how concepts change! Nutrition then was discussed as “achievable without forced feeding through an intragastric tube.” Today, we take that for granted. Some of his patients approached 5000 calories per day. That’s pretty good without a tube. This early formula was based on weight alone, with suggested intakes of 60 to 90 kcal and 2 to 3 g of protein per kilogram body weight. This was an era before small, soft tubes and commercial tube feedings. Those feedings were often the blenderized contents of a regular hospital tray thrown into a blender along with extra milk and, voila, tube feedings. Tubes clogged a lot in those days, especially if they had coleslaw on the tray. It was not as easy as today, where the exact contents are listed on the side of the can and the bulk sterile feeding comes with all of the needed vitamins and minerals.

Those of us growing up in burn care in the late 1970s and early 1980s were raised on the Curreri Formula as a simple prediction of metabolic needs. P. William Curreri, later to become the 16th ABA President, was at the University of Texas Southwestern and Parkland then, along with Janet Marvin and Doctor Charles Baxter. One wonders how well Charlie accepted this when he burned himself and was under those junior authors’ tender, loving care. Their 1974 article in the Journal of the American Dietetic Association set the scene for what was to become the well-known Curreri Formula. This suggested that daily
caloric needs could be met by the sum of 25 times the weight in kilograms plus 40 times the %TBSA burn size. The derived numbers were fairly large but still workable.

One area in which the burn center excels is in achieving adequate daily nutrition, although often not as well as we physicians think. This function is often still not achieved by our trauma brethren with recently published guidelines recommending that enteral nutrition be started within 24 to 48 hours of admission to the intensive care unit. No rush there. In Figure 2, we see the percent of recommended daily nutrition delivered to one of our own trauma patients admitted to the surgical ICU with a gunshot wound of the leg and massive soft-tissue loss. Despite being endotracheally intubated, the old ways of the surgeon and anesthesiologist can die hard, and the patient was kept NPO before each operative débridement, delayed débridment, and cancelled débridment, with 18% of his calculated daily needs being met up until day 15, when he was transferred to the burn service for wound care and treated as the rest of the burn population with no NPO for the operating room.

Although not part of our ABA leadership, the godfather of total parenteral nutrition is Dr. Stanley J. Dudrick, then at the University of Pennsylvania along with Doug Wilmore and Jonathan Rhoads. Remember, these were the classic studies with matched sets of beagle puppies; half fed intravenously and half fed regular puppy chow. Wilmore later went to Brooke to continue pioneering nutrition studies in burn patients. Their 1968 article in Surgery led to major changes in the way we dealt with critically ill patients. Into the mid-1970s, usage was still rare enough, where in a large teaching hospital only one patient would be on total parenteral nutrition (TPN), usually some poor cancer patient who got the chance to meet every medical and nursing student on campus as we were dragged by to see the Holy Grail. In those days, patients died directly from TPN mistakes. Amino acids were chloride salts rather than the acetate salts we have today, making hyperchloremic metabolic acidosis a real risk. We discovered the importance of vitamins and trace minerals when the hardworking intern forgot something vital. There was individual ordering with subsequent mistakes. In those good old days, you carried a book in your pocket with the secret formula. It was prone to errors, primarily of omission. Now we have a routine system with checks, balances, and alarms already written in. In the late 1970s and early 1980s TPN became “the thing” in the intensive care unit (Figure 3). Since then, usage has decreased in inverse proportion to our aggressiveness in enteral feeding our patients. In the early 1980s,
we often fed our patients when their ileus finally resolved, an event for which we could wait 7 to 10 days. At that time, 30% of our burn ICU patients required TPN because of inability to tolerate an enteral diet. The burn center was “the” place to go to learn about TPN. Today, TPN usage is a dodo bird, so low as to be episodic. When presently used, both resident and staff have to drag out the textbook to read how to do it again, with usage usually related to some type of a general surgery complication such as an abdominal compartment syndrome. This is at the same time that acute cholecystitis has nearly vanished as a burn complication.

Our thirtieth President, Doctor Edwin A. Deitch, played a large part in defining gut-mediated sepsis. Since the early 1960s, the concept gradually developed that the patient’s own intestinal tract provided a reservoir of bacteria for systemic infection and endotoxin release. This process required three things: changed intestinal flora, mechanical disruption of the gut mucosal barrier, and impaired immunity. The burn patient was a setup for problems. In part, we became victims of our own success. The stress or Curling’s ulcer is a now a thing of the remote past. The younger physicians and nurses have never seen a patient with a large burn suddenly vomit a blood volume and then die in front of their eyes. A total gastrectomy and esophageal jejunostomy effectively stopped the bleeding but was not a very satisfying operation, especially if it had to be performed through a burned abdominal wall. Anti-acid prophylaxis is very effective in preventing this dreaded complication, although at a price, that is, changing gut flora. One of the common denominators in gut-mediated sepsis has been ischemia with resulting reperfusion mucosal injury.

Our seventeenth President, J. Wesley Alexander, showed us that early feeding was a very necessary part of modern burn care, the sooner the better. Cincinnati has always been a hotbed of nutritional research, and this was no exception. Intestinal mucosal atrophy was shown to occur extremely rapidly after injury, with extent correlating to severity of the traumatic process. This atrophy set the stage for translocation, initiation of the hypermetabolic state and sepsis. Early enteral feeding was shown to prevent gut atrophy and decrease the hypermetabolic response, whereas TPN and the administration of elemental enteral diets did not abrogate this phenomenon.

Accurate estimation of metabolic needs goes beyond formulae, where overfeeding results in fat accumulation and underfeeding in malnutrition. Although the environmental chamber allows control and very accurate measurement of metabolic needs over time as demonstrated by Wilmore, its use is pretty well limited to the research setting. In the early 1980s our 34th President Jeffrey R. Saffle was active in the use of indirect calorimetry for measurement of metabolic demands. This was relatively inexpensive and portable but only gave us a snapshot in time. Jeff is also a driving force in the formation of the Multi-Center Clinical Trials Group of the ABA and National Burn Repository, whose latest report came with your registration information. Did your Burn Center participate in this latest call for data? It should have. As we try to make burn center verification a more meaningful process, participation in the National Burn Repository will be a criterion. The indirect calorimeter gave us a relatively inexpensive, portable method of assessing the

Figure 3. Total parenteral nutrition, burn intensive care unit.
need for nutritional support with dietary intake being adjusted to match these measurements. Dr. Saffle showed that a patient’s metabolic demands had not returned to normal by the time of discharge. A later prospective randomized study using indirect calorimetry to determine feeding requirements showed that the Curreri formula was still a pretty good approximation of patient needs. More recently, 15 years after the fact, he pointed out that calorimetry measurement alone was still not the answer to all of our metabolic questions.

Robert H. Demling from Boston, our 27th President, brought the concept of anabolic steroids to the forefront of nutritional management in the mid-1990s. After all, if anabolic steroids are good for setting professional baseball records, in some different form, they should be beneficial for our own burn patients. Oxandolone, an orally administered testosterone analog, seemed to have many of the characteristics for which we were looking. Those of you who managed to read the most recent issue of the Journal of Burn Care and Research (the one with which your Program book for this meeting was packaged) may have noticed the first multicenter prospective trial produced by our own ABA multicenter trials group, or MCTG for short. This randomized, double-blind trial demonstrated the shorter length of stay in the group given oxandrolone compared with the placebo. Is your burn center participating in this Group?

Our 26th President, Dr. David N. Herndon, and the Galveston burn team have for years been continually attempting to moderate the hypermetabolic response to burn injury and manipulate the accompanying nutritional milieu. The use of beta-blockade in children is one of the methods aimed at achieving this goal, since then having gained widespread acceptance in pediatric burn care. The administration of recombinant growth hormone is working for children, will it work as well for adults? This center’s manipulation of metabolism also has included testosterone, insulin, and insulin-like growth factor. Although beta-blockade combined with growth hormone does not provide a synergistic benefit, are there other combinations that will?

Oxandrolone appears to be finding its niche in the care of patients with large burns. Since the publication of a classic multicenter prospective trial of glucose control showed its benefits, glucose management has gained significant acceptance, although achieving an even balance of avoiding hypoglycemia while adequately treating hyperglycemia is a real clinical challenge, as will be discussed this week by the Chapel Hill Burn Center. Immune enhancement with a variety of formulae, including glutamine, vitamins K and E, essential fatty acid-deficient, ketoglu-tarate, and omega-3 fatty acids, and the roles of micronutrients are being studied and although the concept of enteral immune enhancing diets is an intriguing one, we still are not there yet.

Although we are achieving round-the-clock feeding without interruption for procedures, is this the best possible method? After all, we have spent our lives eating three squares a day plus snacks, some of us with too many snacks. Can we extrapolate what we have learned in children regarding hypermetabolic moderation to adults and to that other extreme of age, the elderly?

With regard to the future, we as a burn community have many challenges. What should we measure? Survival, length of stay, time to 90% wound healing, or something else. Even something as simple as donor site healing is fraught with problems. How does one even create identical sites in this complicated biologic system? Even right and left sites vary by operator handedness. Can we extrapolate data from medical and surgical critical care patients to our own? Our burn gut reaction has always been to say NO and so does a Seattle paper on Clinical Pulmonary Infection Score to be presented this week. After all, the Clinical Pulmonary Infection Score is the gold standard for our surgical ICU colleagues. There is still room for the manipulation of metabolism. The prospect that we will need to rely on multiple modalities in combination is probably our most challenging arena for future research as the possibilities are unlimited. We will truly need multicenter trials to solve this dilemma.

I apologize to those who I left out of this talk. It was not intentional, as virtually all of the ABA leadership and for that matter each of its centers has at one time or another written about burn metabolism or nutrition. If I had an hour or two, I might have been able to mention most of these contributions. Thank you all very much for the honor of being your President this past year.

REFERENCES