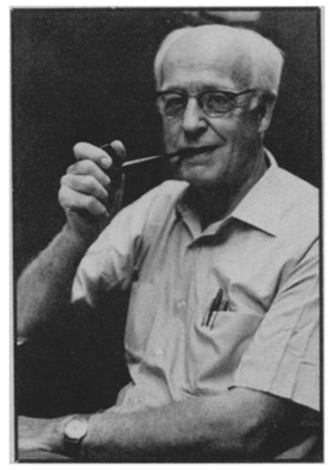
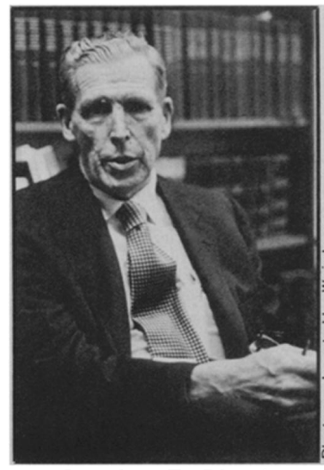
Nutrition Through A Needle: Closing Pandora's Box



Harry Vars



Jonathan E. Rhoads

Photos: Janet H. Weinberg

by Janet H. Weinberg

Harry Vars and his students at the University of Pennsylvania at Philadelphia, tinkering with beagles and homemade equipment, invented a special technique of intravenous feeding in the late 1940's.

The technique was modified for use in hospitals, and burst forth in 1968 under the tongue-twisting label of "hyperalimentation." It captured the attention and hopes of many physicians and promised to be a life-saving tool.

And it has, to a large degree, fulfilled those initial hopes. Surgeons in hospitals around the world now use hyperalimentation in the treatment of various types of intestinal ulcers, cancers and blockages. But the silver lining has a dark cloud. The technique has taken lives, too, pointing up the aseptic conditions in many hospitals and the less than vigilant care given some critically ill patients. Many recent articles in the medical literature explore these problems, and SCIENCE NEWS discussed them with the "fathers" of the technique.

Until Vars, C. Martin Rhode and William M. Parkins published their work with dogs in 1949, animals (and patients) could not be fed entirely through a needle. Solutions fed through peripheral (arm, leg, etc.) veins must be isotonic—have salt and sugar contents approximately equal to those in blood. If the solutions are hypertonic —having a greater salt and sugar concentration than blood—the veins can be damaged. Because of the isotonic limitation, each liter of regular intravenous feeding solution can provide only about 400 calories.

But the average resting individual requires 1,400 calories per day, and patients with infection and fever require many more. Burn patients often need between 7,000 and 10,000 calories per day. The problem is that the body cannot process and excrete the water from all the liters of intravenous fluid required to provide adequate nutrition. So doctors had to give some solid foods to ill patients and risk infecting ulcers and surgical incisions, or watch them slowly starve and grow weaker from poor nutrition.

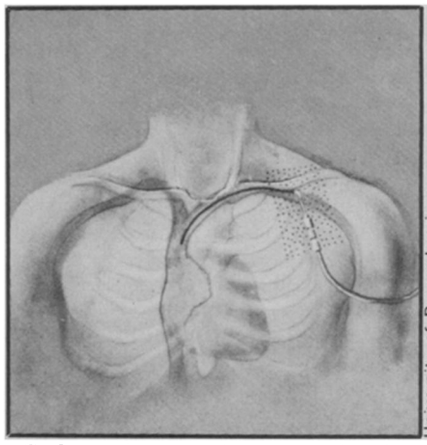
Vars found, using adult beagles, that by inserting a sterile catheter through a vein below the collarbone and into the large superior vena cava, a hypertonic nutrient solution could be used. The large blood flow in the veins dilutes the solution, and full nutrition, with total intestinal rest, is possible.

Hyperalimentation also controls another nutritional problem—nitrogen balance. For protein formation and tissue repair to take place, more nitrogen must be taken in than excreted. But too much can poison the system, so the balance is crucial. With hyperalimentation, this can be controlled.

Vars also tested the technique on puppies, to see if proper growth would take place. Special care had to be given to approximating the levels of nutrients needed, because they are dumped into the blood (not absorbed selectively by the intestines), and "overdoses" can occur. And without the addition of inorganic phosphate, a condition called hypophosphatemia can occur, leading to mental anomalies and muscle weakness, and, if severe, death.

With the right combinations, the puppies grew normally, expanding the possibilities for hyperalimentation to include feeding infants born with defective intestinal tracts. Two physicians at the University of Pennsylvania's medical school, Jonathan E. Rhoads and Stanley J. Dudrick, adapted the technique for use on people and began using it successfully in the late 1960's.

Since then, hospitals all over the world have used the technique. Rhoads says that the success of the technique has "surpassed our initial expectations. Not only were we able to meet patients' current nitrogen and nutritional requirements, but exceed them, and allow for growth and weight gain in infants and wasted adults. We also found that 70 percent of intestinal fistulas [finger-like outpockets] closed by themselves without further surgery because of the improved nutrition."



University of Pennsylvania

Catheter inserted into central vein.

But the story of this "back door discovery," as Vars calls it, does not end here. Not long after the technique caught on, it brought unexpected problems and unwanted risks. Reports of fungal infections associated with hyperalimentation continue to appear in medical journals, and one group links the technique with basic malfunctioning of the body's defense system. When the solution is formulated improperly, hypophosphatemia can result. A Minnesota team reported in the June 20 NEW ENGLAND JOURNAL OF MEDICINE that in phagocytes such as white blood cells, the ATP molecules (energy storing units within the cell) might become so depleted that the cell is no longer able to function as a scavenger of foreign invaders.

Another problem, Rhoads says, is that some patients with a latent form of diabetes are "activated" by the presence of so much glucose and cannot

Starve the tumor, feed the rat: Nutritional disease control

Hospitalized patients, especially those receiving hyperalimentation, could be treated more efficiently if more were known about their exact nutritional requirements, Harry Vars says. Such basic nutritional studies are going on in many laboratories, and Vars' group is exploring the interface between nutrition and the disease state. He is working with rats to study the nutritional requirements of tumors. "We are hoping to find a diet that is suitable to the rat but not the tumor, then use such a diet in conjunction with tumor inhibiting agents."

Like the beagles before them, Vars' rats are fed through catheters. Hyperalimentation is a useful tool in nutrition research because it allows for precise control over the elements of the diet. Whereas the specific contents of most whole foods are unknown, a known element can be deleted from the parenteral diet and the effects studied. A biochemist at the University of Missouri Medical School at Columbia, Robert L. Wixom, fed himself through a vein for several months to determine if histidine is an essential amino acid. His team will publish the results soon, he says.

Some German workers, Vars says, have "tailored a whole variety of amino acid mixtures, some of which, they say, are better for use in one diseased state, and some for others. Some day, we may be able to treat the ulcerative colitis patient with one exact diet and the patient with a broken bone another." But right now, this line of research is in its infancy, he says.

Vars, now a professor emeritus, is quite hopeful about the future of nutritional treatment of disease, and has, perhaps, the best perspective. During his long and distinguished career, he has watched the progress in the field of nutrition research turn from a trickle of information to a great flood.

"You must remember that the first vitamin wasn't discovered until 1926, and the last ones, vitamin B_{12} and folic acid, were found just before 1940. Essential fatty acids were not known until about 1930 and the role of vitamin deficiencies in disease is also very recent." When Vars started his research on dogs, he used wire and roller skate ball bearings and speedometer cable to put together his experimental setup, and solutions were all hand-prepared. Now, the nutrient solutions are available commercially, and the equipment he uses is sophisticated and expensive. "Sometimes," he says, "further research and discovery must wait for technology."

"When you consider how far we have come in nutrition research in just 50 years, the future looks very promising indeed. Over each decade in science, there is a returning to the 'soil' of the same topics, and more 'diamonds' are picked up each time. Each order has a different terminology and thinking, but each adds much more to the body of knowledge. This is equally true in the field of nutrition research."

continue with total parenteral feeding (parenteral means through the veins, not the intestines.) Swedish and American groups are experimenting with emulsified fat as a calorie base.

But infection is by far the worst problem. The frequency of blood infections (septicemia) caused by bacteria and fungi ranges from 8 to 50 percent, depending on the study. A University of Minnesota School of Medicine study in 1971 showed the longer a patient is given total parenteral feeding, the more likely he is to contract a blood infection. Septicemia can and has proved fatal to patients in a weakened condition. Culturing the tips of the catheters used to deliver the nutrient solutions has shown that bacterial and yeast (a type of fungus) colonies can inhabit the catheters. A physician treating a severely ill patient is forced, therefore, to weigh the risks of infection with the benefits of intestinal rest and proper nutrition. The technique, Rhoads says, is now used only when it is absolutely necessary.

Rhoads, however, is not overly discouraged by the growing number of reports of infections. "There is still a question of whether hyperalimentation is responsible for the infections. I really don't know for certain where they are coming from." Aseptic technique, though, is the leading suspect, he says. "Operating room technique must be used for the introduction of the catheter," including sterilization of the skin with iodine, absolutely sterile instruments, and proper bandaging to exclude airborne organisms.

He also warns that the infusion catheter should not be used for administering medicines or blood, as is sometimes done. "There is often a strong temptation to use this ready means of access to the patient's blood," especially if the patient's peripheral veins are damaged. "But this temptation must be overcome."

Dudrick and three colleagues at the University of Texas Medical School at Houston published an article this spring in SURGERY, GYNECOLOGY AND OBSTETRICS outlining the procedures that must be taken in patients with potential sepsis. In addition to those procedures already mentioned, they included several others: Nutrient solutions should be prepared only under a filtered air, laminar flow hood; an experienced physician should be present when the catheters are inserted; X-rays should be taken to ensure correct placement of the catheter; and most important, total parenteral feeding should be attempted only by a dedicated team. Edward M. Copeland III, one of the authors of the article, told SCIENCE NEWS that the University of Texas uses a "highly motivated team approach, with only interested physicians and registered nurses. Under this system, we have reported the lowest rate of infection thus far, only 2.2 percent." This is quite good, he says, considering the highly debilitated patients.

If the problem of infection can be tracked down and eliminated, hyperalimentation holds great promise for the future. "If methods could be found for making the procedure safe," says Rhoads, "it could be used, or at least tried out, for shortening convalescence in the hospital and getting patients back to work. So many patients routinely lose 10 to 15 pounds after moderately severe operations such as gall bladder removals and ulcer operations. If we could avoid that degree of wasting in postsurgical patients through the optimal nutrition that hyperalimentation represents, people might have a much shorter recovery time.

"Dr. Dudrick has suggested several intravenous systems," Rhoads says, "in which separate component solutions could be put up between two sheets of plastic with valves to occlude the channels. Then, by squeezing the compartments, the sodium and potassium and glucose and vitamins, etc., could be combined without ever opening the system and exposing it to bacteria and fungal infections."

If patients are given vigilant care, sterile solutions with the proper ingredients and monitored closely for infections, blood infection rates should go down, and the use of hyperalimentation can be expanded, Rhoads says. □