

## This Week's Citation Classic®

Wilmore D W, Groff D B, Bishop H C & Dudrick S J. Total parenteral nutrition in infants with catastrophic gastrointestinal anomalies. *J. Pediatr. Surg.* 4:181-9, 1969. [Children's Hosp. Philadelphia, and Dept. Surgery and Harrison Dept. Surgical Res., Sch. Med., Univ. Pennsylvania, Philadelphia, PA]

Using a technique of total parenteral nutrition developed in the laboratory, 18 infants with complex gastrointestinal anomalies were supported with intravenous feedings. This is the first documentation of the dramatic and successful impact of total parenteral feedings when combined with well-planned operative care. [The *SCI*® indicates that this paper has been cited in more than 130 publications.]

### Growth in Infants Receiving Intravenous Nutrition

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The year was 1968. Methods of patient support, such as mechanical ventilation and hemodialysis, were being upgraded and expanded for use in intensive care patients. A major problem existed, however, in the delivery of adequate nutrition to catabolic patients with gastrointestinal dysfunction. Safe and effective techniques of parenteral nutrition did not exist.

I was a resident in surgery at the time and worked with a young surgical staff surgeon, Stanley J. Dudrick. The laboratory effort was supported and encouraged by the chairman of surgery at the Hospital of the University of Pennsylvania, Jonathan E. Rhoads. Our scientific mentor was a very wise nutritional biochemist, Harry M. Vars.

Our group had developed a method of parenteral feedings that relied on the continuous infusion of a hypertonic nutrient solution into the superior vena cava. The high blood flow through this large central vein rapidly diluted the nutrient mix, and the energy, amino acids, vitamins, minerals, and trace elements were subsequently delivered throughout the body. When this method was utilized in beagle puppies, we demonstrated that the infusion of intravenous nutrients could support growth and development in

animals.<sup>1</sup> The question was, though, could we achieve the same results in humans?

Our first baby was an infant with congenital atresia of the small intestine.<sup>2</sup> Multiple abdominal operations were performed, but adequate delivery of nutrients by the enteral route was impossible. We were asked by the child's physician and parents to feed the baby by the intravenous route. Using local anesthesia, we placed a catheter via the external jugular vein and directed it into the superior vena cava. We tunneled the catheter under the skin behind the ear (a technique used for the placement of ventriculo-venous shunts used in the treatment of hydrocephalus) and allowed the catheter to exit through the skin in the occipital region of the head.

We made all of our own intravenous solutions and added the appropriate electrolytes to them daily. We used an infusion pump and an in-line filtration system; at the time, both techniques were novel approaches in intravenous therapy. The infusions went smoothly and, to our delight, the infant started to grow, not only in weight but also in length and head circumference.

Other infants who were candidates for this therapy were admitted to the surgical intensive care nursery. The hospital received babies with omphaloceles and gastroschisis. We treated a number of infants with intravenous nutrition and appropriate operations, and all survived—a remarkable achievement.

Since this initial experience, intravenous feedings have become standard medical practice in both adult and pediatric medicine. About 3-5 percent of all hospitalized patients now receive parenteral nutrition, and the methods used are only slight modifications of the original techniques described in this and other papers.<sup>3</sup>

Unlike adults, babies demonstrate multidimensional growth when nutrients are administered. This paper reports for the first time that growth and development can be achieved in a group of infants fed exclusively by the intravenous route.

1. Dudrick S J, Wilmore D W & Vars H M. Long-term parenteral nutrition with growth in puppies and positive nitrogen balance in patients. *Surg. Forum* 18:356-7, 1967. (Cited 50 times.)
2. Wilmore D W & Dudrick S J. Growth and development of an infant receiving all nutrients exclusively by vein. *J. Amer. Med. Assn.* 203:860-4, 1968. (Cited 195 times.)
3. Wilmore D W. The practice of clinical nutrition: how to prepare for the future. *J. Parent. Enter. Nutr.* 13:337-43, 1989.