

# Commercial Premixed Parenteral Nutrition and Its Potential Role in Pediatrics

Amrita Singh, MD<sup>a</sup> Daniel Rauch, MD<sup>b</sup>

Total parenteral nutrition (TPN) and peripheral parenteral nutrition (PN) are commonly used for patients who cannot meet their nutritional needs orally or via a feeding tube. These patients benefit from PN to optimize their nutritional status. PN can be manufactured by companies in premixed, standardized bags, or the nutrients can be compounded in individual pharmacies in their respective hospitals or even outsourced to a compounding pharmacy. Although a variety of standard premixed PN solutions are available and used by adult patients, this practice is rare in pediatrics. Internationally, premixed PN solutions for adults are much more common as well. More than 80% of European adult patients receiving PN are given premixed PN.<sup>1</sup> However, in pediatrics, PN bags are more commonly custom-made, starting with a base dextrose solution with amino acids and other nutrients added. This process allows for precise delivery of individualized, specific content to each patient. Typically, pharmacists make these bags in the pharmacy or outsource to a compounding pharmacy. This approach may present an opportunity for error or microbial contamination. The compounding process is labor intensive and expensive. Due to the time it takes to produce these individual solutions, many pharmacies have a daily deadline before which PN orders must be received. Orders not completed before this deadline are often not filled, leaving the patient without PN for that day. Premixed PN solutions would decrease or eliminate many of these issues. Adult data have shown that commercial premixed solutions can meet a majority of PN needs while reducing cost, error, and infection.<sup>3</sup>

Several previous studies have linked the use of PN with the development of bloodstream infections.<sup>3</sup> These infections are often due to factors associated with the PN bags, not the central lines they are delivered through. Further assessment shows that there is a significantly lower risk of bloodstream infections when dealing with premixed PN solutions versus custom solutions. This finding translates into shorter lengths of stay<sup>2,3</sup> and lower cost.<sup>4</sup>

In 2003, the Joint Commission issued a statement that medications be standardized as much as possible to improve patient safety. In response, the American Society for Parenteral and Enteral Nutrition convened a task force to address this issue. A statement from the society called for standardizing the PN production process to improve patient safety and clinical appropriateness and to maximize resource efficiency.<sup>5</sup>

Opponents of using standardized PN solutions believe that pediatric patients, unlike adults, have different needs and gut absorption depending on their age. The present study examined if pediatric PN orders are similar to adult PN orders in that a few standard base solutions of dextrose and amino acids would satisfy most patients' needs. Our hypothesis was that there would likely be little variety in PN composition between patients, and that most general pediatrics patients would not require a unique PN mixture. In addition, we compared the composition of these solutions versus PN options currently available on the commercial market.

---

[www.hospitalpediatrics.org](http://www.hospitalpediatrics.org)

DOI:10.1542/hpeds.2015-0147

Copyright © 2016 by the American Academy of Pediatrics

Address correspondence to Amrita Singh, MD, Pediatric Hospital Medicine, Department of Pediatrics, Baylor College of Medicine, Texas Children's Hospital, 6621 Fannin St A220, Houston, TX 77054. E-mail: [axsingh@texaschildrens.org](mailto:axsingh@texaschildrens.org)

HOSPITAL PEDIATRICS (ISSN Numbers: Print, 2154-1663; Online, 2154-1671).

**FINANCIAL DISCLOSURE:** The authors have indicated they have no financial relationships relevant to this article to disclose.

**FUNDING:** No external funding.

**POTENTIAL CONFLICT OF INTEREST:** The authors have indicated they have no potential conflicts of interest to disclose.

<sup>a</sup>Department of Pediatrics, Baylor College of Medicine, Houston, Texas; and <sup>b</sup>Department of Pediatrics, Mount Sinai School of Medicine, Elmhurst, New York

## METHODS

Patients were identified by conducting a retrospective chart review using an Epic electronic medical record database (Epic Systems Corporation, Verona, WI). The search criteria looked to identify children aged 1 to 18 years needing PN at Texas Children's Hospital between September 2010 and September 2013. Included were patients admitted to the general pediatrics service for common acute pediatric diseases. The general pediatrics units were included in the search criteria. Critically ill patients in the PICU and step-down unit were excluded; also excluded were subspecialty patients with complex chronic medical conditions requiring long-term PN admitted to the subspecialty units. Many subspecialty patients had preexisting conditions (eg, short bowel syndrome, renal failure on dialysis) for which they required highly customized PN. The purpose of the present study was to determine if general pediatric patients used similar PN solutions and if this population could benefit from premixed PN solutions.

Most of the study children were admitted to the hospital with a diagnosis that limited their oral intake for a certain amount of time. The most common diagnoses included were pancreatitis, complicated pneumonia, perforated appendicitis, and ileus. The initial PN order was reviewed for percent dextrose and amino acid content, and these values were recorded in an Excel spreadsheet. The results were analyzed to

see how much variation existed between these PN orders; the frequency of each bag was also calculated. Other information such as TPN versus peripheral PN, gender, and weight was recorded. PN compositions, specifically dextrose and amino acid amounts, were compared with standard bags already produced commercially for pediatric populations.

## RESULTS

Of the 160 eligible patient charts reviewed, 100 met the inclusion criteria. Sixty patients were excluded after chart review because they were found to be complex or subspecialty patients with reasons for baseline dextrose and amino acid variations. Of the 100 patients included, little variation was noted in PN composition in terms of dextrose and amino acids. Only 3 different PN solutions accounted for a majority (82%) of the total solutions. A bag composed of 12.5% dextrose and 2.2% amino acids comprised 38% of the total; dextrose 20% and amino acids 3% comprised 32% of the total; and dextrose 12.5% and amino acids 3% comprised 12% of the total (Fig 1). The final 18% of solutions were made up of the remaining 13 different PN formulations.

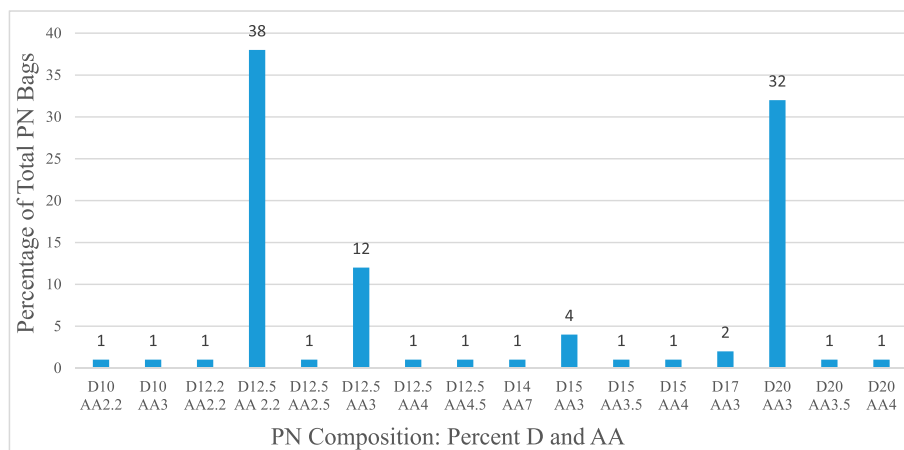
## CONCLUSIONS

Physicians, especially pediatricians, have been reluctant to embrace the practice of using premixed PN. There is a lot of skepticism associated with this approach for unclear reasons. Interestingly, the

movement toward premixed, standardized, medications to improve patient safety has been almost seamless.<sup>4</sup> Why not the same for PN? Premixed PN solutions as well as medications can save the pharmacy a significant amount of time and error by expediting or eliminating the compounding process.

There were limitations with the present study that provide opportunities for future research. We did not look at the electrolyte values of the PN solutions. This added step was beyond the scope of our study but certainly plays an important part. Commercially available PN solutions provide many different formulations with a variety of electrolyte concentrations. Furthermore, we only studied the initial PN ordered on day 1. Studying subsequent days of PN and the variation between bags would be very important moving forward. Our hypothesis was that there would be very little meaningful change in subsequent days, or even if there was, it could also be met by using premixed PN solutions.

Three standard PN solutions would have met >80% of the initial PN orders at a larger tertiary care children's hospital. These 3 compositions are the default choices under "standard" in the electronic medical record PN order set, which likely largely influenced their ordering. Resident physicians are the primary individuals ordering PN at this specific institution. The standard PN constituents were decided on by pharmacists and nutritionists at the



**FIGURE 1** Frequency of PN compositions. AA, amino acids, D, dextrose.

study hospital, not by a national committee. Currently, there are no commercially available products in the United States with these exact dextrose and amino acid compositions, although they come close. Thus, our institution did not look toward commercially available products when deciding the composition of the standard PN. There would be great utility in approaching the hospital board making this decision and determine if the available commercial products could be adopted and the slight variation changed in the electronic medical ordering system. To the best of our knowledge, no investigations have been conducted into whether there would be any negative effects of changing the electronic ordering standard TPN orders to match those commercially available. Commercially available products have slightly higher amino acid content than what is used at our specific hospital. Other

tertiary care children's hospitals are using PN solutions that are very similar to commercially made PN. We realize that not all patients would be able to be treated with premixed PN, but we believe that a great majority could. The PN needs of most general pediatrics patients' would be met by a small range of formulations. There may be a market for pediatric standard premixed PN that could improve patient safety and decrease cost.

## REFERENCES

1. Maisonneuve N, Raguso C, Paoloni-Giacobino A, et al. Parenteral nutrition practices in hospital pharmacies in Switzerland, France, and Belgium. *Nutrition*. 2004;20(6):528–535
2. Pontes-Arruda A, Zalogá G, Wischmeyer P, Turpin R, Liu F, Mercaldi C. Is there a difference in bloodstream infections in critically ill patients associated with ready-to-use versus compounded parenteral nutrition? *Clin Nutr*. 2012;31(5):728–734
3. Turpin R, Canada T, Rosenthal V, et al. Bloodstream infections associated with parenteral nutrition preparation methods in the United States: a retrospective, large database analysis. *JPEN J Parenter Enteral Nutr*. 2011;36(2):169–176
4. Turpin R, Canada T, Liu F, Mercaldi CJ, Pontes-Arruda A, Wischmeyer P. Nutrition therapy cost analysis in the US: pre-mixed multi-chamber bag vs compounded parenteral nutrition. *Appl Health Econ Health Policy*. 2011;(5):281–292
5. Kochevar M, Guenter P, Holcombe B, Malone A, Mirtallo J, ASPEN Board of Directors and Task Force on Parenteral Nutrition Standardization. ASPEN statement on parenteral nutrition standardization. *JPEN J Parenter Enteral Nutr*. 2007;31(5):441–448

## Commercial Premixed Parenteral Nutrition and Its Potential Role in Pediatrics

Amrita Singh and Daniel Rauch

*Hospital Pediatrics* 2016;6;34

DOI: 10.1542/hpeds.2015-0147 originally published online January 1, 2015;

<b>Updated Information &amp; Services</b>	including high resolution figures, can be found at: <a href="http://hosppeds.aappublications.org/content/6/1/34">http://hosppeds.aappublications.org/content/6/1/34</a>
<b>Supplementary Material</b>	Supplementary material can be found at:
<b>References</b>	This article cites 4 articles, 0 of which you can access for free at: <a href="http://hosppeds.aappublications.org/content/6/1/34#BIBL">http://hosppeds.aappublications.org/content/6/1/34#BIBL</a>
<b>Subspecialty Collections</b>	This article, along with others on similar topics, appears in the following collection(s): <b>Administration/Practice Management</b> <a href="http://www.hosppeds.aappublications.org/cgi/collection/administration:practice_management_sub">http://www.hosppeds.aappublications.org/cgi/collection/administration:practice_management_sub</a> <b>Nutrition</b> <a href="http://www.hosppeds.aappublications.org/cgi/collection/nutrition_sub">http://www.hosppeds.aappublications.org/cgi/collection/nutrition_sub</a> <b>System-Based Practice</b> <a href="http://www.hosppeds.aappublications.org/cgi/collection/system-based_practice_sub">http://www.hosppeds.aappublications.org/cgi/collection/system-based_practice_sub</a>
<b>Permissions &amp; Licensing</b>	Information about reproducing this article in parts (figures, tables) or in its entirety can be found online at: <a href="http://www.hosppeds.aappublications.org/site/misc/Permissions.xhtml">http://www.hosppeds.aappublications.org/site/misc/Permissions.xhtml</a>
<b>Reprints</b>	Information about ordering reprints can be found online: <a href="http://www.hosppeds.aappublications.org/site/misc/reprints.xhtml">http://www.hosppeds.aappublications.org/site/misc/reprints.xhtml</a>

# Hospital Pediatrics®

AN OFFICIAL JOURNAL OF THE AMERICAN ACADEMY OF PEDIATRICS

## **Commercial Premixed Parenteral Nutrition and Its Potential Role in Pediatrics**

Amrita Singh and Daniel Rauch

*Hospital Pediatrics* 2016;6;34

DOI: 10.1542/hpeds.2015-0147 originally published online January 1, 2015;

The online version of this article, along with updated information and services, is located on the World Wide Web at:

<http://hosppeds.aappublications.org/content/6/1/34>

Hospital Pediatrics is the official journal of the American Academy of Pediatrics. A monthly publication, it has been published continuously since 1948. Hospital Pediatrics is owned, published, and trademarked by the American Academy of Pediatrics, 345 Park Avenue, Itasca, Illinois, 60143. Copyright © 2016 by the American Academy of Pediatrics. All rights reserved. Print ISSN: 1073-0397.

American Academy of Pediatrics

DEDICATED TO THE HEALTH OF ALL CHILDREN®

