

Hyponatremia Secondary to Home Parenteral Nutrition Error

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The Case

A 4-year-old (former 33-week premature) boy with a complex medical history including gastroschisis and subsequent volvulus in infancy resulting in short bowel syndrome, central venous catheter placement, and home parenteral nutrition (PN) dependence was admitted with hyponatremia (serum sodium 126 mmol/L) identified on routine outpatient laboratory screening. He had no clinical changes that would have predisposed him to electrolyte abnormalities: no reported changes in stool output, emesis, adjustments to his enteral feeding regimen, medication changes, or recent infections at the time of hospital admission.

Sodium levels normalized within 24 hours of initiating compounded IV fluids with similar dextrose and electrolyte content as the home PN solution. A pharmacist from the home infusion pharmacy notified the physician that an error in home PN mixing had been identified with omission of sodium acetate for several weeks prior to admission. Upon further review, it was discovered a new file had been created for this chronic PN patient by the home infusion pharmacy; the PN formula in this file was transcribed erroneously without sodium acetate by one of the home infusion center pharmacists. This error resulted in only 20% of the patient's prescribed sodium being mixed into the home PN solution for several weeks, resulting in hyponatremia and unnecessary hospital admission. Previously written parenteral nutrition orders were reviewed by the physician and dietitian; the sodium acetate and other macronutrient and micronutrient components were confirmed as correct by the ordering physician and home infusion pharmacist. The patient returned home on a proper PN regimen, less than 48 hours after admission.

The Commentary

By Kelly Haas, MD, and Andrew Lee, PharmD

Pediatric intestinal failure occurs when the remaining intestine cannot perform adequate digestion and absorption of nutrients and fluid for a child to grow and survive.¹ Causes of intestinal failure often involve short bowel syndrome and include necrotizing enterocolitis, gastroschisis, volvulus, intestinal atresias, long-segment Hirschsprung's disease, and other rarer genetic conditions.² Thus, children with intestinal failure require long-term support with intravenous fluid, electrolytes, and nutrition in the form of parenteral nutrition (PN). Parenteral nutrition comprises a sterile solution of water, electrolytes, dextrose, protein, fat, vitamins, and minerals that is carefully tailored to each patient's needs. Management of intestinal failure involves slowly increasing nutrition enterally, reducing parenteral nutrition, and supporting growth and development, while minimizing complications.³ Multidisciplinary management of these complex patients following an intestinal rehabilitation program, advancements in parenteral lipid preparations, improved central line care, and prevention of liver disease associated with intestinal failure have led to improved patient survival over the past decade.^{4,5}

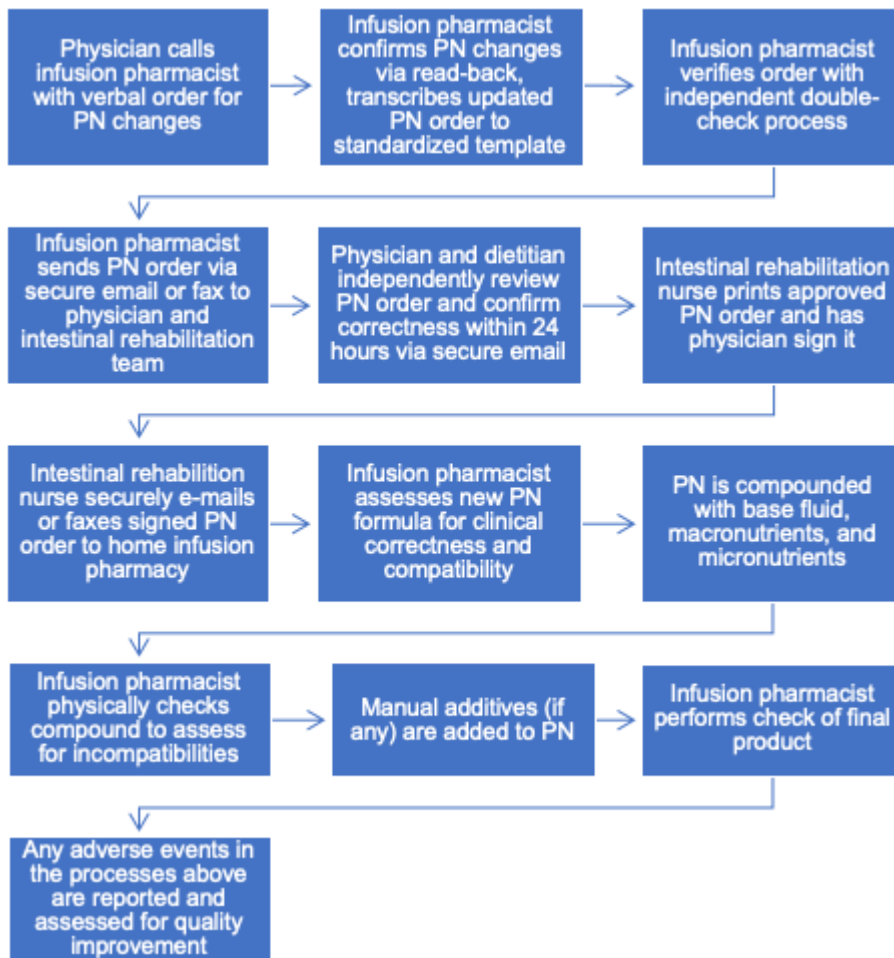
Home PN administration is a [complex endeavor](#), particularly in the [pediatric population](#), requiring collaboration among an intestinal rehabilitation team including physicians, home health and outpatient clinic nurses, dietitians, pharmacists, and the patient's family. The PN components are determined by a physician and dietitian, and communicated to the home infusion pharmacist via written or verbal orders. Changes are typically made to the PN components every few weeks to months depending on a patient's laboratory testing, stool output, and enteral nutrition. These orders are reviewed and verified by the home infusion pharmacist and the PN is compounded, labeled and delivered to the patient, where the patient, or patient's family, administers the PN via central venous catheter. Due to the complexity of this therapy, parenteral nutrition is classified as a high-alert medication by the [Institute for Safe Medication Practices](#).⁶ As seen in this case, there are multiple steps in the process of home PN ordering, compounding, and administration where errors can occur.

Approach to Improving Safety & Patient Safety Target

Communication Among Intestinal Rehabilitation Team Members

Multiple studies have demonstrated improved outcomes among children with short bowel syndrome who are managed by a comprehensive multidisciplinary intestinal rehabilitation team.⁷⁻⁹ A standardized, organized approach to reviewing PN orders and communicating changes among members of an intestinal rehabilitation treatment team is an essential step in patient safety.¹⁰⁻¹¹ Orders should be reviewed by the physician and dietitian at each clinic visit, or when new laboratory results are available. Changes in PN components should be clearly communicated and agreed upon by the treating physician and dietitian, and these changes must be accurately and promptly communicated to the home infusion pharmacy. A standardized process for verbal and written communication of PN components and changes should be agreed upon by the intestinal rehabilitation team and the home infusion pharmacy, as shown in the example process map below (Figure 1). Errors in communication can be reduced with verbal read-back of orders received over the phone by the pharmacist, and by promptly updating written orders that are securely and clearly transmitted between the treating physician, dietitian, and pharmacist.

Figure 1. Sample Outpatient PN Order Change Process Map



Parenteral Nutrition Ordering, Verification, and Compounding

The proper compounding of PN components based on written physician orders is an essential step in avoiding patient errors. As demonstrated in this case, an error of omission made when transcribing a new PN file by the home infusion pharmacy went undetected for weeks, leading to electrolyte derangements and hospitalization. According to the American Society for Parenteral and Enteral Nutrition (ASPEN) 2014 [Parenteral Nutrition Safety Consensus Recommendations](#),¹⁰ healthcare organizations (including home infusion pharmacies) should have safety measures in place addressing competency, standardization of PN orders, and review processes. The ASPEN recommendations include:¹⁰

- Extensive education on PN (both didactic and experiential) should be included in acute care, home care, and physician residency training.
- PN education and competency assessment should be available for all healthcare providers involved in the care of patients receiving PN, to be performed at least annually.
- Healthcare organizations shall have a system of evaluating pharmacist competency in reviewing PN orders, ensuring experience such as specialty residency training or board certification in nutrition support, or providing opportunities to participate in focused training in these areas.
- [Computerized prescriber order entry](#) (CPOE) is recommended over handwritten orders; when CPOE is unavailable, a standardized order template in electronic format is preferred.
- Verbal and telephone orders should be avoided insofar as possible.

- PN orders requiring transcription of order information should undergo an independent double-check to ensure accuracy of the PN to be compounded.
- Clinical decision-support tools should be available to alert providers when the limits (i.e. clinical, compatibility) of macronutrients or micronutrients have been exceeded.
- Proper mixing of parenteral nutrition should be ensured by requiring three independent processes for verifying PN orders and components (at order entry, before manual additions, after final compounding).
- PN responsibilities should be performed by trained providers (as described above) who regularly order and review PN.
- The process for reordering PN should be systems-based, holding providers accountable for accurate review of the patient (clinical status, lab values) and each component of their PN.
- Healthcare organizations should have quality improvement programs for reporting, analyzing, and identifying trends in PN-related data and associated errors.

Patient and Family Education

Children who require home PN for nutritional support have a central venous catheter inserted that is accessed by the family, typically on a daily basis, to administer intravenous nutrition. A tunneled, single lumen, cuffed central venous catheter is the recommended central venous catheter for children with intestinal failure who require long-term home PN.¹² Children with central venous catheters are at risk for central line-associated blood stream [infections](#) (CLABSI) due to this long-term indwelling catheter, particularly in the setting of underlying intestinal abnormalities associated with increased risk of translocation of bacteria. Indeed, sepsis remains one of the greatest sources of mortality among pediatric patients with intestinal failure.¹³ Parents who administer home PN should be trained on proper handwashing before manipulating the central venous catheter, aseptic technique for central venous catheter dressing changes, and cleansing of the hub of the central venous catheter with antiseptic solution prior to flushing or administering PN.¹² Pediatric intestinal rehabilitation teams provide rigorous training to families that care for medically complex children with short bowel syndrome who require home PN. Families are taught proper PN administration, central line care, troubleshooting, signs of illness, and how and when to contact their intestinal rehabilitation physician.¹⁴

Take-Home Points

- Successful pediatric home parenteral nutrition requires collaboration among pharmacists, physicians, dietitians, nurses, and patients' families.
- Implementation of a clear process map for communicating changes in PN formulation between physicians, dietitians, and home infusion pharmacists can minimize risk of medical error in communication and documentation of PN components.
- Home PN pharmacies should have proper safety measures in place to prevent transcription and mixing errors, including a verification process for written orders, a standardized process for compounding, and a well-trained staff specialized in PN compounding.

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