

## Patient Safety Tip of the Week

### April 21, 2020 Parenteral Nutrition Safety Issues

Parenteral nutrition (PN), often called total parenteral nutrition or TPN, is a valuable therapy we use in most hospital settings and other medical venues. But it has largely escaped our attention from a patient safety perspective. That’s surprising since PN issues played a significant contributory role in the Josey King tragedy ([Niedowski 2003](#)) that was a seminal event in the patient safety movement. And we’ve often seen complications related to the catheters and lines used to administer PN.

A great review of parenteral nutrition safety issues was just recently published ([Mirtallo 2020](#)) and it sure opened our eyes! Pharmacists Jay Mirtallo and Phil Ayers begin by acknowledging that adverse events (AEs) related to PN are rarely reported but are likely to be associated with harm when they do occur.

They go on to describe the components of the PN system: assessment by dietician or nutrition support service, determination of indication for PN, order, review and verification of order, compounding and preparation of the PN, dispensing (which includes labeling and delivery), administration by a nurse or caregiver (includes patient ID verification and ensuring appropriate access, infusion rate, pump function, and infection control measures), monitoring (the venous access device, metabolic response, disease outcomes), and again restarting the cycle with assessment. Similar to the medication use process, each of these steps presents an opportunity for error, so it’s surprising we don’t hear about more errors in the PN process. Each step also requires documentation, which also gives rise to opportunities for error if that documentation is not accessible (or simply ignored) by all parties on the overall process or if the terminology between systems is not compatible.

The authors cite statistics from studies they had previously been a part of. One study ([Sacks 2009](#)) had found an overall incidence of medication errors to be 15.6 errors/1000 parenteral nutrition prescriptions compounded. Of those errors, 1% occurred during the prescription process (and was detected before preparation), 39% occurred during the transcription process, 24% during preparation, and 35% during the administration process. Most errors (91%) were considered nonharmful, but 8% contributed to or resulted in temporary harm to a patient.

The second study ([Seres 2006](#)) reported on a survey by the American Society for Parenteral and Enteral Nutrition (ASPEN). Almost two-thirds of the survey respondents reported observing 1 to 5 PN-related errors per month. 71% of errors were related to PN

electrolytes. Respondents estimated that 35% of the errors required increased monitoring, 25% resulted in harm, 3.3% were almost fatal, and 1.5% were fatal.

Another review ([Mirtallo 2004](#)) found the following serious outcomes resulting from PN errors:

- Hyperglycemia/glucose overdose
- Hypoglycemia/glucose underdose
- Zinc overdose
- Hyperkalemia
- Hypermagnesemia
- Iron overload
- Calcium/phosphorus precipitation

Also, product shortages over the years have sometimes resulted in micronutrient deficiencies of copper, selenium, and thiamine.

ISMP's Michael Cohen, writing in JPEN ([Cohen 2012](#)), noted the following issues in parenteral nutrition:

- wrong dextrose concentration
- confusion of 5% dextrose with concentrated potassium chloride
- catheter misconnections
- infusion of PN via epidural catheter
- insulin/heparin additives (due to confusion with units and dosage designations)

Another review on PN errors reported in ISMP's MEDMARX system ([Storey 2016](#)) found many errors related to omission of ingredients. Fat emulsions and electrolytes were the PN ingredients most frequently associated with error. Insulin was the ingredient most often associated with patient harm. While omission occurred in all modes, it was most common in ordering and transcribing.

Earlier this month, in our What's New in the Patient Safety World column "[More Gems from ISMP](#)", we noted 2 recent ISMP articles, both of which mentioned issues related to parenteral nutrition. ISMP's Targeted Medication Safety Best Practices for Hospitals ([ISMP 2020a](#)) had as its Best Practice #11 "When **compounding** sterile preparations, perform an **independent verification** to ensure that the proper ingredients (medications and diluents) are added, including confirmation of the proper amount (volume) of each ingredient prior to its addition to the final container." Wording in the previous version had focused on high-alert medications and had specifically included parenteral nutrition as being one of the preparations requiring independent verification.

Then, in its Top 10 Medication Errors and Hazards ([ISMP 2020b](#)), number 10 was that 1,000-fold overdoses with zinc can occur with parenteral nutrition, particularly in children. They cite a case in 2019 involving a child for whom 700 mg instead of 700 mcg of zinc was prescribed when the pediatric PN template defaulted to mg dosing units. They note that this order could not have been changed to mcg had the physician even noticed the error, and that a dose warning was not issued during the prescribing process.

(ISMP had reported a very similar case of zinc overdose due to using mg rather than mcg in its September 6, 2007 Safety Alert). ISMP advises all healthcare providers to build, test, and heed maximum dose warnings in PN order entry systems. That should include a hard stop for critical zinc overdoses (e.g., above 250 mcg/kg for pediatric PN). Pediatric PN templates should default to **mcg dosing units for zinc**, which should also correspond to the way orders are entered in automated compounders. ISMP also encourages drug information database vendors to create needed critical dose warnings for IV zinc and other trace elements, if they do not currently exist.

That's not the first time ISMP has noted problems related to disparity between units used in order entry systems versus those used in pharmacy compounding systems. In 2012 ISMP reported on a case in which orders per kg were confused with orders per day, resulting in a patient receiving a very hypotonic solution due to an unusually large amount of sterile water in the preparation ([ISMP 2012](#)). ISMP again focused on the need to standardize and match dosing units in the prescribing and pharmacy systems. It also emphasized the importance of issuing warnings, using redundancies and independent double checks in steps for verification, and providing clear labelling.

ISMP's recommendations were echoed in a call to action co-published by the American Society of Health-System Pharmacists (ASHP), the Academy of Nutrition and Dietetics (AND), and the American Society for Parenteral and Enteral Nutrition (ASPEN) ([Vanek 2018](#)). Key areas identified by the work group for this publication were:

- standardized PN order and label
- CDS and warnings for macronutrient and micronutrient dosing, toxicity, and incompatibilities
- EHR interfaces, interoperability, and workflows involving automated compounding devices (ACDs) – functionality to improve safety and minimize risk of errors
- ordering cyclic PN, taper up, and taper down
- transition of PN from hospital to home or other alternative care settings and vice versa

Catching errors before they cause harm in patients is critical. In our March 13, 2018 Patient Safety Tip of the Week "[Intercepting Errors](#)" we noted a study that developed an automated medication administration error detection system that focused on reconciling 10 high-risk continuous intravenous infusions and medications prescribed to NICU inpatients ([Ni 2018](#)). Among the targeted medications/infusions, TPN had the second highest medication administration error rate. The automated detection system has the potential to reduce harm exposure significantly for all medications via real-time messaging technology. The study showed the most substantial reductions were realized for long-time intravenous medications/infusions such as TPN and lipid.

The current review by Mirtallo and Ayers ([Mirtallo 2020](#)) also notes that recent introduction of some new lipid injectable emulsions (ILE's) require development of new policies and procedures that take into account special filtering and infusion requirements.

Discussion about CLABSI's (central line-associated bloodstream infections) is beyond the scope of today's column, but just be reminded that PN is a frequent reason for use of central lines or PICC lines. Also, in our January 21, 2014 Patient Safety Tip of the Week "[The PICC Myth](#)" we noted that TPN was one of several significant risk factors for upper extremity venous thrombosis associated with PICC insertion ([Marnejon 2012](#)).

We have one other consideration of our own: what happens when PN infusion is interrupted, either intentionally or unintentionally, particularly when PN is being coordinated with insulin administration? For example, suppose the line for infusing PN becomes inoperable (eg. thrombosis) and the patient is receiving a long-acting insulin. You need to have a protocol in place that would alert you to the danger of hypoglycemia in this instance. That could especially be a problem in patients receiving PN at home. On the other hand, suppose you withhold insulin when you send a patient for a procedure in radiology or elsewhere. You have to remember that the patient might be vulnerable to hyperglycemia if the PN continues while the insulin was withheld.

This excellent review by Mirtallo and Ayers ([Mirtallo 2020](#)) really opened our eyes to a topic we've largely neglected. We'll bet that many of you do not even include data on PN errors in your Pharmacy & Therapeutics review programs. We suspect your organizations can also benefit from the many lessons and recommendations in the review.

#### **References:**

Niedowski E. Medical error kills Hopkins cancer patient. The Baltimore Sun (2003); December 19, 2003  
<https://www.baltimoresun.com/news/bs-xpm-2003-12-19-0312190182-story.html>

Mirtallo JM, Ayers P. Parenteral Nutrition Safety. Pharmacy Practice News 2020; April 15, 2020  
<https://www.pharmacypracticenews.com/Review-Articles/Article/04-20/Parenteral-Nutrition-Safety/57830>

Sacks GS, Rough S, Kudsk KA. Frequency and severity of harm of medication errors related to the parenteral nutrition process in a large university teaching hospital. *Pharmacotherapy* 2009; 29(8): 966-974  
<https://accpjournals.onlinelibrary.wiley.com/doi/10.1592/phco.29.8.966>

Seres D, Sacks GS, Pedersen CA, et al. Parenteral nutrition safe practices: results of the 2003 American Society for Parenteral and Enteral Nutrition Survey. *JPEN J Parenter Enteral Nutr* 2006; 30(3): 259-265  
<https://onlinelibrary.wiley.com/doi/abs/10.1177/0148607106030003259>

Mirtallo J, Canada T, Johnson D, et al. Safe practices for parenteral nutrition. JPEN J Parenter Enteral Nutr 2004; 28: s39-s70  
<https://onlinelibrary.wiley.com/doi/abs/10.1177/0148607104028006S39>

Cohen MR. Safe practices for compounding of parenteral nutrition. JPEN J Parenter Enteral Nutr. 2012; 36(suppl): 14s-19s  
<https://onlinelibrary.wiley.com/doi/abs/10.1177/0148607111435332>

Storey MA, Weber RJ, Besco K, et al. Evaluation of parenteral nutrition errors in an era of drug shortages. Nutr Clin Pract 2016; 31(2): 211-217  
<https://onlinelibrary.wiley.com/doi/abs/10.1177/0884533615608820>

ISMP (Institute for Safe Medication Practices). Targeted Medication Safety Best Practices for Hospitals. ISMP 2020; February 21, 2020  
<https://www.ismp.org/guidelines/best-practices-hospitals>

ISMP (Institute for Safe Medication Practices). Start the New Year Off Right by Preventing These Top 10 Medication Errors and Hazards. ISMP 2020; January 16, 2020  
<https://www.ismp.org/resources/start-new-year-right-preventing-these-top-10-medication-errors-and-hazards>

ISMP (Institute for Safe Medication Practices). Mismatched Prescribing and Pharmacy Templates for Parenteral Nutrition (PN) Lead to Data Entry Errors. ISMP 2012; June 28, 2012  
<https://www.ismp.org/resources/mismatched-prescribing-and-pharmacy-templates-parenteral-nutrition-pn-lead-data-entry>

Vanek VW, Ayers P, Kraft M et al. A call to action for optimizing the electronic health record in the parenteral nutrition workflow. Nutr Clin Pract 2018; 33: e1-e21  
<https://onlinelibrary.wiley.com/doi/full/10.1002/ncp.10095>

Ni Y, Lingren T, Hall ES, et al. Designing and evaluating an automated system for real-time medication administration error detection in a neonatal intensive care unit. Journal of the American Medical Informatics Association 2018; 25(5): 555-563 Published: 10 January 2018  
<https://academic.oup.com/jamia/article/25/5/555/4797402>

Marnejon T, Angelo D, Abu Abdou A, Gemmel D. Risk factors for upper extremity venous thrombosis associated with peripherally inserted central venous catheters. J Vasc

Access 2012; 13(2): 231-238

<https://journals.sagepub.com/doi/pdf/10.5301/jva.5000039>



<http://www.patientsafetysolutions.com/>

[Home](#)

[Tip of the Week Archive](#)

[What's New in the Patient Safety World Archive](#)