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Recommended Pinnacle[®] Compounder Ingredient Mixing Sequence

Overview

There is much confusion surrounding the mixing order of TPN ingredients in the market place. The mixing order is further befuddled because of the evolution of TPN preparation from gravity compounding to the use of Automated Compounding Devices (ACDs). This evolution has also included the change in clinical practice from lipids being piggybacked separately to the inclusion of the lipids directly into the TPN volume.

History and Background

The mixing order of TPN solutions has changed from when the TPN was prepared by gravity. Ingredient Package Inserts (PIs) are a reflection of accepted compounding practices at the time the PI was created or last updated. Generally there are no regular updates to PI, so the information contained in the PI can be somewhat dated. These PIs have created confusion from the proper mixing sequence to whether or not lipids can even be added to the TPN.

Discussion

The ingredient mixing sequence for an ACD is based on several parameters. The primary consideration is based on the physical characteristics of lipid emulsions, the pH of dextrose, and the ionic charges from inclusion of electrolyte solutions. The secondary consideration is the physical characteristics of the ACD which include the ACD design requirements and the unique compounding set design of the device.

The Pinnacle design requirements stipulate that the ACD has the ability to prevent lipid hazing when compounding bags sequentially with and without lipids, and that the ACD must also have the ability to fill dual chamber TPN bags in one compounding step. These design requirements necessitate Station 1 to accommodate the lipid emulsion.

The Amino Acid solution will be utilized to provide protection to the lipid emulsion from changes in pH and electrolytes¹. Therefore, the lipid emulsion and amino acid solution are combined before the dextrose and electrolytes in order to lessen the possibility of the cracking of the lipid emulsion.

Neither dextrose nor electrolytes should ever be directly added to lipid emulsions.

Consideration must be given to the sequence of adding additive ingredients. This must take into consideration the volume present in the bag when calcium and phosphate salts are incorporated.

Sterile Water for Injection will be the last base ingredient delivered into the TPN.

The Pinnacle ACD should never be used to deliver both calcium and phosphate salts to the TPN. The solution volume may not be sufficient to prevent the formation of insoluble calcium phosphate precipitate. To assure that the largest fluid volume is present either calcium or phosphate should only be added after all of the base ingredients are present in the TPN. The Pinnacle TPN Manager takes into consideration the decreased fluid volume when preparing dual chamber bags and provides a warning if the possibility of precipitation exists.

Recommendations for the Pinnacle Compounder

Based upon the discussion points, the recommendation for the mixing sequence is lipids, amino acids, dextrose, pool solution, electrolyte “cocktail”, electrolytes, other ingredients and sterile water for injection. The lipid emulsion must be hung on station 1.

The Pinnacle ACD minimum delivery volume is 5 mL. Therefore, consideration must be given to the range of volumes normally required for each ingredient chosen to be hung on the Pinnacle ACD. Choose only ingredients that routinely require more than this minimum volume. Compounding personnel using the Pinnacle Compounder must be aware that any ingredient that falls below the minimum volume must be manually injected. As discussed, calcium salts and phosphate salts must never be hung at the same time as an insoluble calcium phosphate precipitate will be formed. Whether calcium or phosphate is added initially, the TPN must be thoroughly mixed before the latter is added after all ingredients are in the TPN container.

A further recommendation is to pump neutral salts before calcium or phosphate. Examples of these “neutral salts” are potassium chloride, sodium chloride, potassium acetate, and sodium acetate. Introduction of magnesium would follow the neutral salts. Calcium gluconate and calcium-containing “electrolyte cocktails” should be added just prior to the introduction of the sterile water for injection.

Based on these recommendations:

An account preparing TPN doses utilizing a Pinnacle nine station set and requiring a lipid emulsion, an adult amino acid solution, a pediatric amino acid solution, dextrose, sterile water, potassium chloride, sodium acetate, magnesium sulfate and calcium gluconate would have the following compounding sequence recommendation:

Station 1	Lipid Emulsion
Station 2	FreAmine [®] (Adult Amino Acid Solution)
Station 3	TrophAmine [®] (Pediatric Amino Acid Solution)
Station 4	Dextrose 70%
Station 5	Potassium Chloride
Station 6	Sodium Acetate
Station 7	Magnesium Sulfate
Station 8	Calcium Gluconate
Station 9	Sterile Water for Injection

An account preparing TPN doses utilizing a Pinnacle nine station set and requiring a lipid emulsion, an adult amino acid solution, a pediatric amino acid solution, specialty amino acid solution, dextrose, sterile water, electrolyte cocktail, potassium chloride, and sodium acetate would have the following compounding sequence recommendation:

Station 1	Lipid Emulsion
Station 2	FreAmine [®] (Adult Amino Acid Solution)
Station 3	TrophAmine [®] (Pediatric Amino Acid Solution)
Station 4	HepatAmine [®] (Specialty Amino Acid Solution)
Station 5	Dextrose 70%
Station 6	Potassium Chloride
Station 7	Sodium Acetate
Station 8	HyperLyte [®] CR (Electrolyte Cocktail)
Station 9	Sterile Water for Injection

An account preparing TPN doses utilizing a Pinnacle six station set and requiring a lipid emulsion, an adult amino acid solution, dextrose, sterile water, potassium chloride, and sodium acetate would have the following compounding sequence recommendation:

Station 1	Lipid Emulsion
Station 2	FreAmine (Adult Amino Acid Solution)
Station 3	Dextrose 70%
Station 4	Potassium Chloride
Station 5	Sodium Acetate
Station 6	Sterile Water for Injection Potassium Chloride

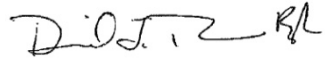
Summary

Patient safety demands that careful attention must be taken when selecting ingredients and determining the compounding sequence of ingredients hung on the Pinnacle ACD.

As stated in the Discussion section, “The Amino Acid solution will be utilized to provide protection to the lipid emulsion from changes in pH and electrolytes¹. Therefore, the

lipid emulsion and amino acid solution are combined before the dextrose and electrolytes in order to lessen the possibility of cracking the lipid emulsion.”

Careful consideration must be taken to prevent calcium phosphate precipitation in the finished TPN dose. To this end, calcium and phosphate should never be hung at the same time on the Pinnacle ACD. Give due consideration to the calcium phosphate solubility when utilizing dual chamber bags.



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^{i 1} Black CD and Popovich NG. (March 1981) A study of intravenous emulsion compatibility. Effects of dextrose amino acids and selected electrolytes. Drug intelligence and Clinical Pharmacy. 15, p.184-193