Micronutrient Requirements of High-Risk Infants

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KEYWORDS

• Micronutrients • Premature infants • Nutrient shortages • Intravenous nutrition • Calcium

KEY POINTS

- Preterm infants have unique and high requirements for bone minerals, including calcium, phosphorus, and magnesium.
- Guidelines for intravenous administration of these minerals emphasize preventing serum abnormalities such as a low or high ionized calcium or total phosphorus.
- A substantial issue, not yet fully resolved, is the ongoing shortage of minerals for intravenous use, requiring complex decision making to achieve the best and safest use of these minerals in high-risk infants.

INTRODUCTION: NATURE OF THE PROBLEM

What Are the Critical Micronutrients to Be Considered and Why?

The term micronutrient, as used in the context of infant nutrition, refers generally to any vitamin or mineral that is required for tissue growth and development as well as cellular or tissue function. This review focuses on the primary bone minerals, along with iron and zinc (Zn). The discussion of iron is limited to consideration of intravenous (IV) protocols for use, and the discussion of Zn is primarily limited to the problem of Zn shortages.

Sources of Financial Support: This work is a publication of the US Department of Agriculture (USDA)/Agricultural Research Service (ARS) Children's Nutrition Research Center, Department of Pediatrics, Baylor College of Medicine, and Texas Children's Hospital, Houston, Texas. Contents of this publication do not necessarily reflect the views or policies of the USDA, nor does mention of trade names, commercial products, or organizations imply endorsement by the US government. Conflicts of Interest: None.

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Clin Perinatol 41 (2014) 347–361
http://dx.doi.org/10.1016/j.clp.2014.02.009 **perinatology.theclinics.com**
0095-5108/14/$ – see front matter

Populations to Be Evaluated

Although the need for these minerals encompasses many groups of high-risk infants, the focus in this article is on 2 groups in particular: infants with intestinal failure, especially those with problems related to anatomic or functional short gut syndrome, and those who are very low birth weight (VLBW), less than 1500 g at birth. Both oral and IV requirements and provision of these micronutrients are considered, but much of the focus is on IV requirements and dosing.

Organization

The bone minerals, calcium (Ca), magnesium (Mg), and phosphorus (P) are considered together, followed by aspects of parenteral requirements for Zn and iron. Included also is a discussion related to nutrient shortages, especially for IV mineral components.

BONE MINERALS: CA, MG, AND P

Ca

One of the most important reasons for providing IV nutrition to high-risk neonates is to provide the bone minerals consisting primarily of Ca, Mg, and P. These nutrients also serve important physiologic functions, which can be critical in the neonatal period. The tools for assessing bone mineral status in the first week of life are minimal and do not fully reflect physiologic functioning.

The most difficult mineral to assess is Ca. For decades, total serum Ca was measured, and some attempted to adjust values for serum albumin. This approach was limited in usefulness at best and led to overly aggressive therapy at times in small infants. More recently, direct measurement of ionized Ca (iCa) has become widely available and used to assess status, but this does not change the fundamental problem that there are few clear data regarding either optimal or safe ranges for iCa in high-risk newborns.

Clinically, it is apparent that very preterm infants tolerate a lower iCa than full-term infants. It is common for a VLBW infant to have an iCa of 0.8 mmol/L without symptoms, whereas a larger infant would likely have neurologic compromise from this level of iCa.

We initiate IV Ca in the first hours of life in high-risk neonates whenever they are being provided with total parenteral nutrition (TPN). At our institution, this group includes VLBW infants, those with abdominal wall or similar abdominal defects, those with major congenital heart disease, and those with congenital diaphragmatic hernia. We provide 1 mmol/100 mL of Ca as part of TPN in a premixed starter TPN solution, which is usually provided at 80 to 100 mL/kg/d. This solution is available throughout the evening at our neonatal intensive care unit (NICU). P (see later discussion) is begun by 24 hours of age, usually at a 1:1 M ratio with Ca. Stability for standard starter TPN is 30 days when stored at 2°C to 8°C. However, sterility is the limiting factor to remain compliant with US Pharmacopeia (USP)-797 standards. USP-797 recommends a 9-day beyond-use date for medium-risk level sterile products.

Advancing to an intake level of 1 mmol/100 mL of Ca is dependent on maintaining an appropriate iCa. Our target range is 0.8 to 1.45 mEq/L in VLBW infants and 1.0 to 1.45 mEq/L in larger infants. Our goal is to reach 1.75 mmol/L administered at a volume of 130 mL/kg/d. At times, we advance to 2.0 mmol/L as well.

We consider the algorithm shown in **Table 1** for management of hypercalcemia in the first week of life in high-risk infants, especially those less than 1000 g birth weight.

P

Serum P is a reasonably accurate marker in early life of P status. However, there are rapid changes that occur even in healthy infants in the first week of life. Initial levels are