chloride injection, death resulted from as little as 11 mL/kg/d.

Following toxicity reports and the deaths of infants in the early 1980s, the FDA issued a very strong recommendation to stop the use of fluids preserved with benzyl alcohol for use in neonates as a flush solution or to reconstitute medications.

Sodium Chloride Injection, USP, is a sterile isotonic solution of sodium chloride in water for injection. It contains no antimicrobial agents but has approximately 154 mEq each of sodium and chloride ions per liter. It may be used as a sterile vehicle in solutions or suspensions of drugs for parenteral administration.

Besides its use to reconstitute medications for injection, sodium chloride injection is frequently used as a catheter or IV line flush to maintain patency. Catheters or IV lines are constantly used to infuse fluids and IV medications and draw blood for laboratory analysis, among others. Usually, 2 mL is used to flush the line after each use or every 8 hours if the line is not used.

Bacteriostatic Sodium Chloride Injection, USP, is a sterile isotonic solution of sodium chloride in water for injection. It contains one or more suitable antimicrobial agents, which must be specified on the labeling. Sodium chloride 0.9% renders the solution isotonic. For the reasons noted for bacteriostatic water for injection, this solution may not be packaged in containers larger than 30 mL. When this solution is used as a vehicle, care must be exercised to ensure compatibility of the added medicinal agent with the preservative or preservatives and with the sodium chloride.

Bacteriostatic sodium chloride injection is also used to flush a catheter or IV line to maintain its patency. When used in only small quantities for flushing lines and reconstituting medications, the amount of benzyl alcohol is negligible and safe. But in neonates, especially premature infants with very low birth weights, accumulation of benzoic acid and unmetabolized benzyl alcohol may occur as a result of liver immaturity. Because of their low physical weight, their acute illness and consequent need for medications, and the frequent use of the umbilical catheter for various purposes, these patients may receive much more flush solution relative to their body weight than adults. Thus, bacteriostatic sodium chloride injection also carries the warning NOT FOR USE IN NEONATES.

Suffice it to say that benzyl alcohol may be present in other parenteral medications, and the pharmacist must be vigilant for its inappropriate use in neonates. Generally speaking, however, the amount of benzyl alcohol received through this means is negligible compared to the amount received from flush solutions. Preferably, the medication is available in a preservative-free formulation (i.e., single-use dose), and that should be used. However, if such a formulation is not available and there is no alternative, a medication preserved with benzyl alcohol may still be used if the physician's clinical judgment is that the risk-to-benefit ratio is appropriate.

Ringer's Injection, USP, is a sterile solution of sodium chloride, potassium chloride, and calcium chloride in water for injection. The three agents are present in concentrations similar to those of physiologic fluids. Ringer's is employed as a vehicle for other drugs or alone as an electrolyte replenisher and plasma volume expander. *Lactated Ringer Injection, USP*, has different quantities of the three salts in Ringer injection, and it contains sodium lactate. This injection is a fluid and electrolyte replenisher and a systemic alkalizer.

Nonaqueous Vehicles

Although an aqueous vehicle is generally preferred for an injection, it may be precluded by the limited water solubility of a medicinal substance or its susceptibility to hydrolysis. When such physical or chemical factors limit the use of a wholly aqueous vehicle, the pharmaceutical formulator must turn to one or more nonaqueous vehicles.

The selected vehicle must be nonirritating, nontoxic in the amounts administered, and not sensitizing. Like water, it must not exert a pharmacologic activity of its own, nor may it adversely affect the activity of the medicinal agent. In addition, the physical and chemical