



**National
Association of
Neonatal
Nurses**

Medication Safety in the Neonatal Intensive Care Unit

Position Statement #3055

NANN Board of Directors
July 2011

The incidence and consequences of medication errors in the neonatal intensive care unit (NICU) setting demonstrate the importance of established safety procedures and guidelines for the prescribing, dispensing, and administration of medications. As the professional voice of neonatal nurses, the National Association of Neonatal Nurses (NANN) recommends that appropriate measures and education be made available to everyone who prescribes or administers medications in the NICU and that members be proactive in participating in the development and implementation of safe medication practices in the NICU.



Association Position

Procedures, safeguards, and strategies that ensure accurate administration of medications to the smallest and most fragile of patient populations are in the forefront of concerns for bedside practitioners in the neonatal intensive care setting. Healthcare providers need to ensure that drug therapy achieves maximum benefits and avoids therapeutic disasters (Zenk, Sills, & Koepfel, 2003). Organizational, environmental, and human factors need to be taken into consideration when policies and procedures for medication administration and safety are being developed.

Background and Significance

Despite efforts in the United States to standardize a definition of *medication error*, various definitions are used in the literature, in national organizations, within hospitals, and among healthcare professionals. For the sake of simplicity in this position statement, a medication error is any “preventable event that may cause or lead to inappropriate medication use or patient harm while the medication is in the control of the health care professional” (National Coordinating Council for Medication Error Reporting and Prevention [NCCMERP], n.d.). Although it is known that 1 in 10 patients worldwide is affected by medical errors (World Health Organization [WHO], 2007), the exact incidence of medication errors in the NICU is unknown. This lack of data is due in part to the various definitions of medication error used and to the multiple methods of data collection techniques employed in published research studies. Because voluntary reporting and retrospective reviews identify only a fraction of all medication error events, the number of medication errors reported is less than the number of errors that occur.

Although establishing the frequency of medication errors in the NICU is difficult, published studies indicate that medication errors in the NICU are common, ranging from 13 to 91 medication errors per 100 NICU admissions (Kaushal et al., 2001; Ross, Wallace, & Paton, 2000; Simpson, Lynch, Grant, & Alroomi, 2004; Vincer et al., 1989). In addition, NICU patients are more likely to experience a medication error than other hospital patients (Sharek et al., 2006) and to experience more harm when a medication error occurs. The incidence of medication errors occurring during the care of infants of 24–27 weeks’ gestation age is reported as high as 57%, compared with 3% reported in the care of full-term infants (Kugelman et al., 2008). These data demonstrate that NICU patients require additional systemwide safeguards against medication errors and that healthcare providers must be especially vigilant when working with medications in the NICU.

Because of the vulnerable nature of NICU patients, the complexity of the medications used, and the challenges of the NICU environment, preparing and administering medications for neonatal patients are inherently risky. The structure and process of the system need to take into account both human factors and workplace hazards (Samra, McGrath, & Rollins, 2011). Medication administration

can be compromised on multiple levels. At the level of the point of care, the design and malfunction of medical devices and equipment are contributing factors. At the organizational level, staffing levels, look-alike and sound-alike drug names, inadequate education for staff, cost-cutting measures, and the environmental design of the unit can contribute to medical errors (Handyside & Suresh, 2010).

Patients in the NICU are undergoing maturational changes in drug-sensitive areas such as the renal and hepatic systems and thus may have variable responses to drugs as well as to their disease process. Medications are universally weight-based, requiring calculations for each dose. NICU patients often have long hospital stays, which increases their exposure to medications and medication errors. In premature infants, the immaturity of developing body systems affects the absorption, distribution, metabolism, and excretion of drugs and therefore an exponential risk for medication errors is present (Stavroudis, Miller, & Lehmann, 2008). Finally, wrong-patient errors are common, with a reported incidence of 11%–25% of reported medication errors (Gray et al., 2006). NICU patients are nonverbal and unable to actively participate in the patient identification process, which increases the likelihood of wrong-patient errors. Also, keeping identification (ID) bands in place on the smallest patients can be challenging because of their fragile skin, their small wrist and ankle size, and the need to remove the bands for placement of intravenous (IV) lines. One research study documented the lack of ID bands in 20%–80% of NICU patients (Gray et al.).

Medications commonly used in the NICU are an independent risk factor for medication errors. These medications often have off-label uses. In 2008 the Institute for Safe Medication Practices (ISMP) published a list of high-alert medications that can cause significant patient harm when used in error. In a recent study, administration of the high-alert medications described by ISMP has been shown to be a risk factor for harm in neonatal patients (Stavroudis et al., 2010). Because very few studies involving many medications commonly used in neonates have been conducted, information about dosing and anticipated side effects is limited and variable. The medications dispensed are often adult-strength, requiring complex, multistep dilutions prior to dispensing or administering them, which increases the opportunity for errors. Recently, ISMP and the Vermont Oxford Network (VON) collaboratively developed a list of standard concentrations of neonatal drug infusions, with the goal of decreasing medication errors and stimulating the development of standardized infusion-device drug libraries (ISMP & VON, 2011). In 2010, WHO published its *Model Formulary for Children*, which built on its 2007 publication, *Model List of Essential Medicines for Children*. This effort was undertaken in order to provide the best information to healthcare providers administering medications to children (WHO, 2010).

The complex, high-acuity NICU environment increases the risk to patients: patient acuity quickly changes, work flow is unpredictable, and distractions are

commonplace. The intensive care unit meets the criteria for a high-risk environment, which requires specialized attention to reduce the risk of medical error (Institute of Medicine, 1999).

Errors can occur at any point along the continuum of medication use. Determining the most common medication error in the NICU is difficult because research results vary. This variation is likely due to the multiple definitions of harm and the varied ways of reporting “near misses” (Stavroudis et al., 2010). Several studies identify administration errors as the most common errors, specifically misprogramming of the syringe pump (Chuo, Lambert, & Hicks, 2007; Ligi et al., 2008). Other studies identify dosing errors during the ordering phase as the most common medication error (Kaushal et al., 2001; Raju, Kecskes, Thornton, Perry, & Feldman, 1989; Simpson et al., 2004).

Healthcare providers report a variety of factors that contribute to medication errors. Increased workload, poor lighting, and distractions and interruptions have all been reported by nurses as contributing factors in medication errors. A number of studies demonstrate that distractions and interruptions during the medication administration process are a major contributing factor in medication errors (Beyea, 2007; Pape et al., 2005; Sumwalt, 1993; Vecchione, 2003). Specific interventions to reduce distractions and interruptions may be an important step in the prevention of medication errors.

The majority of medication errors that occur in the NICU are preventable (Frey et al., 2000; Sharek et al., 2006). Prevention methods cited in the literature include systemwide changes such as computerized physician order entry (Kaushal et al., 2001; Taylor, Loan, Kamara, Blackburn, & Whitney, 2008), the involvement of pharmacists in medication order review and on patient care rounds (Simpson et al., 2004), the standardization of processes, and the promotion of a safety culture. Very few trials comparing the effectiveness of preventive strategies exist in the literature.

Medication safety can be enhanced by technology, hardwired through the use of checklists, standard formularies, and standard drug concentrations, and improved by pharmacists on bedside rounds. At the core of medication safety, however, is the mindful, safety-conscious NICU nurse who is aware of the unique risk factors that exist for the neonate in the NICU environment. Technology alone will not prevent medication errors. Rather, it is the combination of the alert NICU nurse, the appropriate use of technology, and a safety-conscious NICU environment that offers the most comprehensive strategy for preventing medication errors.

Recommendations

The Joint Commission (2010) delineates specific standards in medication safety. Effective January 2011, documented progress toward meeting the following

National Patient Safety Goals is required for accreditation. These four goals apply specifically to medications:

- Goal 1. “Improve the accuracy of patient identification.”—Use at least two patient identifiers.
- Goal 2: “Improve the effectiveness of communication among caregivers.”
- Goal 3: “Improve the safety of using medications.”—Label all medications on and off the sterile field.
- Goal 8: “Accurately and completely reconcile medications across the continuum of care.” (This reconciliation is especially important when patients are transferred from one unit or healthcare facility to another.)

In addition to these standards and any applicable state standards, NANN recommends the following practices to those caring for the neonatal population:

For nursing managers and directors

1. As part of creating a culture of safety in the NICU, all staff members are encouraged to report medication errors or potential errors, to be engaged in improving the medication use process, and to regularly share results of medication safety efforts.
2. Medication safety is identified as a core competency for all staff in the NICU, is included in the orientation education given to all new hires in the NICU, and is included in ongoing annual education.
3. All technology that is implemented in the NICU to improve medication safety is evaluated in a multidisciplinary fashion. All aspects of the technology, including its efficacy in enhancing safety and making a positive impact on work-flow issues, are evaluated.
4. The specific environment in which medications are prescribed, prepared, and administered is evaluated, with a focus on lighting, available work space, the control of distractions, the availability of reference materials, and the availability of frequently used supplies.
5. Medication safety is included as part of the NICU performance improvement plan.
6. Clear, specific policies and procedures that outline how medications are ordered, processed, dispensed, administered, and monitored have been established and are accessible to all healthcare professionals involved in the medication use process in the NICU.
7. Any new technology or change in process is evaluated for its effect on outcome improvement.

For every nurse in the NICU

1. Staff members have identified potential and actual risks to medication safety and actively participate in reducing those risks.
2. Staff members attempt to reduce distractions during all phases of the medication process; they avoid interrupting healthcare providers during medication ordering and interrupting other nurses during medication administration.

3. All medication errors and near misses are reported, and specific methods through which an error could have been avoided are listed.
4. Verbal medication orders are avoided whenever possible (Joint Commission, 2009; Stucky, American Academy of Pediatrics [AAP] Committee on Drugs, & AAP Committee on Hospital Care, 2003).
5. The use of a terminal zero to the right of the decimal point is avoided (Joint Commission, 2009; Stucky et al., 2003).
6. A zero to the left of the decimal point is used to avoid dosing errors (Joint Commission, 2009; Stucky et al., 2003).
7. Neonatal weight is confirmed when medications are ordered (Joint Commission, 2009; NCCMERP, n.d.; Stucky et al., 2003).
8. All medications and their calculations are checked by another licensed professional prior to administration (ISMP, 2003; *Proceedings of a summit on preventing patient harm and death from i.v. medication errors*, 2008; Stucky et al., 2003).
9. A list of high-alert medications (e.g., anticoagulants, narcotics, paralytics) within the NICU requiring verifications and signatures by two licensed professionals is available (Joint Commission, 2009; *Proceedings*, 2008).
10. Medication orders are verified prior to medication administration (*Proceedings*, 2008; Stucky et al., 2003), and the five rules of medication administration are followed.
11. Clear policies and procedures for each step in the medication administration process are developed (Stucky et al., 2003).
12. NICU staff members remain current and proficient in the use of medication delivery devices (e.g., infusion pumps, syringe pumps) and are aware of the potential for errors with these devices (*Proceedings*, 2008; Stucky et al., 2003).
13. All staff members who are charged with writing and administering medications are familiar with and have access to error tracking and reporting systems, and an open, just culture for the reporting and reviewing of medication errors is encouraged (Stucky et al., 2003).
14. Standard references for use in drug evaluation, selection, and use have been identified (*Proceedings*, 2008; Stucky et al., 2003).
15. The nursing staff is involved in the development, implementation, and evaluation of medication delivery systems used in the NICU.
16. An adequate number of nursing and pharmacy staff members have been trained in calculating, prescribing, preparing, dispensing, and administering medications to neonates.
17. All healthcare providers who participate in the medication use process participate in educational programs in calculating, prescribing, preparing, and administering medications for neonates (Stucky et al., 2003).
18. Staff members' knowledge of Joint Commission guidelines for ensuring medication safety and reporting medication errors is maintained (Joint Commission, 2009; Stucky et al., 2003).

Conclusions

NICU nurses care for a uniquely vulnerable population of patients who require additional safeguards to ensure that medication errors are prevented and harm mitigated. Medication administration in the neonatal population is a high-volume, high-risk activity with a narrow margin of error between therapeutic benefits and lethal consequences. Working in a multidisciplinary and collegial fashion, NICU healthcare professionals should strive to develop standardized safety practices in the prescribing, dispensing, and administration of medications in the NICU. Along with these efforts, a robust plan for monitoring and reducing medication errors is critical.

References

- Beyea, S. C. (2007). Distractions, interruptions, and patient safety. *AORN Journal*, 86(1), 109–112.
- Chuo, J., Lambert, G., & Hicks, R. W. (2007). Intralipid medication errors in the neonatal intensive care unit. *Joint Commission Journal on Quality and Patient Safety*, 33(2), 104–111.
- Frey, B., Kehrer, B., Losa, M., Braun, H., Berweger, L. Micallef, J., et al. (2000). Comprehensive critical incident monitoring in a neonatal-pediatric intensive care unit: Experience with the system approach. *Intensive Care Medicine* 26(1), 69–74.
- Gray, J. E., Suresh, G., Ursprung, R., Edwards, W. H., Nickerson, J., Shiono, P. H., et al. (2006). Patient misidentification in the neonatal intensive care unit: Quantification of risk. *Pediatrics*, 117(1), e43–47.
- Handyside, J., & Suresh, G. (2010). Human factors and quality improvement. *Clinics in Perinatology*, 37, 123–140.
- Institute for Safe Medication Practices. (2003). *The virtues of independent double checks: They really are worth your time!* (ISMP Medication Safety Alert). Retrieved June 10, 2011, from www.ismp.org/newsletters/acutecare/articles/20030306.asp.
- Institute for Safe Medication Practices. (2008). ISMP's list of high-alert medications. Retrieved May 27, 2011, from <http://www.ismp.org/Tools/highalertmedications.pdf>.
- Institute for Safe Medication Practices & Vermont Oxford Network. (2011). Standard concentrations of neonatal drug infusions: A collaborative effort between Institute for Safe Medication Practices (ISMP) and Vermont Oxford Network (VON). Retrieved May 27, 2011, from www.ismp.org/tools/PediatricConcentrations.pdf.
- Institute of Medicine. (1999). *To err is human: Building a safer health system* (L. Kohn, J. M. Corrigan, & M. S. Donaldson, Eds.). Washington, DC: National Academy Press.
- Joint Commission. (2009). *Medication management standards*. Retrieved August 17, 2009, from www.jointcommission.org.
- Joint Commission. (2010) *Critical access hospitals: 2011 National Patient Safety Goals*. Retrieved May 26, 2011, from www.jointcommission.org/cah_2011_npsgs/.
- Kaushal, R., Bates, D. W., Landrigan, C., McKenna, K. J., Clapp, M. D., Federico, F., et al. (2001). Medication errors and adverse drug events in pediatric inpatients. *Journal of the American Medical Association*, 285(16), 2114–2120.

- Kugelman, A., Inbar-Sanado, E., Shinwell, E. S., Makhoul, I. R., Leshem, M., Zangen, S., et al. (2008). Iatrogenesis in neonatal intensive care units: Observational and interventional, prospective, multicenter study. *Pediatrics*, *122*(3), 550–555.
- Ligi, I., Arnaud, F., Jouve, E., Tardieu, S., Sambuc, R., & Simeoni, U. (2008). Iatrogenic events in admitted neonates: A prospective cohort study. *Lancet*, *371*(9610), 404–410.
- National Coordinating Council for Medication Error Reporting and Prevention. (n.d.). *What is a medication error?* Retrieved June 2, 2009, from www.nccmerp.org/aboutMedErrors.html.
- Pape, T. M., Guerra, D. M., Muzquiz, M., Bryant, J. B., Ingram, M., Schraner, B., et al. (2005). Innovative approaches to reducing nurses' distractions during medication administration. *Journal of Continuing Education in Nursing*, *36*(3), 108–116.
- Proceedings of a summit on preventing patient harm and death from i.v. medication errors* (sponsored by the American Society of Health-System Pharmacists [ASHP], ASHP Research and Education Foundation, Infusion Nurses Society, Institute for Safe Medication Practices, Joint Commission, National Patient Safety Foundation, and United States Pharmacopeia). (2008). *American Journal of Health-System Pharmacy*, *65*, 2367–2379.
- Raju, T. N. K., Kecskes, S., Thornton, J. P., Perry, M., & Feldman, S. (1989). Medication errors in neonatal and paediatric intensive-care units. *Lancet* *2*(8659), 374–376.
- Ross, L. M., Wallace, J., & Paton, J. Y. (2000). Medication errors in a paediatric teaching hospital in the UK: Five years operational experience. *Archives of Disease in Childhood*, *83*(6), 492–497.
- Samra, H. A., McGrath, J. M., & Rollins, W. (2011). Patient safety in the NICU: A comprehensive review. *Journal of Perinatal and Neonatal Nursing*, *25*(2), 123–132.
- Sharek, P. J., Horbar, J. D., Mason, W., Bisarya, H., Thurm, C. W., Suresh, G., et al. (2006). Adverse events in the neonatal intensive care unit: Development, testing, and findings of an NICU-focused trigger tool to identify harm in North American NICUs. *Pediatrics*, *118*, 1332–1340.
- Simpson, J. H., Lynch, R., Grant, J., & Alroomi, L. (2004). Reducing medication errors in the neonatal intensive care unit. *Archives of Disease in Childhood, Fetal Neonatal Edition*, *89*(6), F480–482.
- Stavroudis, T. A., Miller, M. R., & Lehmann, C. U. (2008). Medication errors in neonates. *Clinics in Perinatology*, *35*(1), 141–161, ix.
- Stavroudis, T. A., Shore, A. D., Morlock, L., Hicks, R. W., Bundy, D., & Miller, M. R. (2010). NICU medication errors: Identifying a risk profile for medication errors in the neonatal intensive care unit. *Journal of Perinatology*, *30*(7), 459–468.
- Stucky, E. R., American Academy of Pediatrics Committee on Drugs, & American Academy of Pediatrics Committee on Hospital Care. (2003). Prevention of medication errors in the pediatric inpatient setting. *Pediatrics*, *112*(2), 431–436.
- Sumwalt, R. (1993). The sterile cockpit. *Aviation Safety Reporting System Directline*, *4*, 1–4. Retrieved February 1, 2008, from http://web.archive.org/web/20070410193354/http://asrs.arc.nasa.gov/directline_issues/dl4_sterile.htm.
- Taylor, J. A., Loan, L. A., Kamara, J., Blackburn, S., & Whitney, D. (2008). Medication administration variances before and after implementation of computerized physician order entry in a neonatal intensive care unit. *Pediatrics*, *121*(1), 123–128.
- Vecchione, A. (2003, November 17). USP drug safety review: Distractions contribute to medication errors. *Drug Topics*, *147*, HSE42. Retrieved August 21, 2009, from

- <http://drugtopics.modernmedicine.com/drugtopics/article/articleDetail.jsp?id=111201>.
- Vincer, M. J., Murray, J. M., Yuill, A., Allen, A. C., Evans, J. R., & Stinson, D. A. (1989). Drug error and incidents in a neonatal intensive care unit: A quality assurance activity. *American Journal of Diseases of Children*, 143(6), 737–740.
- World Health Organization. (2007, May 2). WHO launches “Nine patient safety solutions.” Retrieved May 25, 2011, from www.who.int/mediacentre/news/releases/2007/pr22/en/index.html.
- World Health Organization. (2010, June 18). New WHO guidance to improve use of medicines in children: Model Formulary for Children provides information on how to use over 240 essential medicines. Retrieved May 25, 2011, from www.who.int/mediacentre/news/releases/2010/medicines_children_20100618/en/.
- Zenk, K. E., Sills, J. H., & Koepfel, R. M. (2003). *Neonatal medications and nutrition: A comprehensive guide* (3rd ed.). Santa Rosa, CA: NICU Ink.

Bibliography

- Association of periOperative Registered Nurses. (2006). *AORN position statement on pediatric medication safety*. Denver, CO: Author. Retrieved August 21, 2009, from www.aorn.org/PracticeResources/AORNPositionStatements/Position_PediatricMedicationSafety/.
- Cho, J., & Lambert, G. (2011). Medication errors. In S. J. Yaffee & J. V. Aranda (Eds.), *Neonatal and pediatric pharmacology: Therapeutic principles in practice* (4th ed., pp. 905–916). Philadelphia: Wolters Kluwer/Lippincott Williams and Wilkins.
- Wong, I. C., Wong, L. Y., & Cranswick, N. E. (2009). Minimising medication errors in children. *Archives of Disease in Childhood*, 94(2), 161–164.

Copyright © 2011 by the National Association of Neonatal Nurses. No part of this statement may be reproduced without the written consent of the National Association of Neonatal Nurses.



**National
Association of
Neonatal
Nurses**

4700 W. Lake Avenue, Glenview, IL 60025-1485
800.451.3795 • 847.375.3660 • Fax 866.927.5321
www.nann.org