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Pediatric Nurse Performance on a Medication Dosage Calculation Assessment Tool

Debra Ridling PhD, MS, RN, NEA-BC*, Pamela Christensen MN, RN-BC, Leslie R. Harder MN, RN-BC, Nancy Gove PhD, Stephanie Gore MSN, RN, PCNS-BS

Seattle Children's Hospital, Seattle, WA

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Background Nurses who care for children must be competent to perform medication dosage calculations because most pediatric doses are weight based and obtained from adult formulations.
Purpose: The purpose of the study was to describe and compare nurse performance on a medication dosage calculation assessment tool, considering work unit, years experience, and certification status.
Design: A secondary analysis of data from 851 Registered Nurses (RN) was completed. Multiple regression was used to model the effect of work unit, certification, and experience on score.
Findings: The mean assessment tool score was 92.4 (47–100). The work unit and the interaction between certification status and experience were significant in relation to score on the calculation assessment.

Background

IT IS WELL known that children are at greater risk for adverse medication events than adults (ISMP, 2013). The increased risk of adverse events in hospitalized children has been reported as three times greater than in the adult population (Kaushal et al., 2001). Improper medication dosing and mode of use are cited as leading causes of medical errors. The United States Pharmacopeia, a recognized standard for drugs in the United States MEDMARX 2006–2007 database identified nearly 2.5 percent of pediatric medication errors led to patient harm, with improper dose/quantity (37.5%) a leading cause (The Joint Commission, 2008). The increased risk is thought to be associated with the wide variation in patient sizes and developmental levels relative to adults. Children's weights vary greatly, ranging from less than one to greater than 100 kilograms, which necessitates multiple dosing regimens (Cousins, Clarkson, Conroy, & Choonara, 2002).

In addition to the wide variation in weight-based dosing, multiple concentrations are required to provide accurate measurement of very small doses in clinically acceptable volumes for administration. Furthermore, there are physiologic considerations that often require weight based medication doses to be altered based on differences in pharmacokinetics between premature infants, newborns, and older children (Cousins et al., 2002).

Many medications are only available in adult doses and forms, which must be adjusted for use in children (Cousins et al., 2002). Adding to the already complex situation is the national crisis of medication shortages, requiring hospitals to obtain non-standard forms and concentrations to meet their patient's needs (Ventola, 2011). As the majority of pediatric doses involve mathematical calculations to determine the correct dose and volume, frequent changes in concentration increases the risk for error. In order for nurses to administer the correct dose of medication, they must have both mathematical and medication calculation competency.

* Corresponding author: Debra Ridling, PhD, MS, RN, NEA-BC.
E-mail addresses: debra.ridling@seattlechildrens.org.

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Mathematical calculation competency is the ability to complete basic math skills such as addition, subtraction, multiplication, division, use of decimals, and fractions. In addition to basic math skills, concepts that are more complex are also required to calculate medication doses including the use of ratios and the conversion of units of measure. Accurate drug (medication) calculation can be further defined as the ability to conceptualize clinical information to select the correct information and formulate the necessary mathematical calculation (Wright, 2007).

Medication Safety Literature

Medication safety literature indicates errors in calculation were a leading cause of medication dose errors in hospitalized patients (Brady, Malone, & Fleming, 2009; Grandell-Niemi, Hupli, Leino-Kilpi, & Puukka, 2003; McMullan, Jones, & Lea, 2010, Tang, Sheu, Yu, Wei, & C.C.H., 2007). The Institute of Medicine seminal publication in 2000, *To Err is Human: Building a Safer Heath System*, reminded us that humans are prone to make mistakes (IOM, 2000). Nurses and other medical staff are no exception to this, highlighting the potential to make an error when performing medication dose calculations. Multiple studies (Grandell-Niemi, Hupli, Puukka, & Leino-Kilpi, 2006; McMullan, Jones, & Lea, 2010; Sheriff, Burston, & Wallis, 2012; Wright, 2013) have emphasized the importance of nurse competency in reducing medication calculation errors.

Registered Nurse (RN) Ability to Calculate Medication Dosages

Unfortunately, numerous studies have demonstrated a deficit in the ability of some RNs to compute medication calculations. Blinder and Bayne (1991) conducted a descriptive study, where they asked 110 experienced RNs from four states in the U.S. to complete a 20-item medication calculation test. They found that 81% achieved test scores of less than 90% with 44% of those scoring less than 70%. Lerwill (1999) conducted a descriptive study enrolling 54 health care professionals who were seeking advanced education in the United Kingdom. Though he did not delineate nurses from other professionals, he reported the average score was 61% on a 10-item numeracy test with 32% of those scoring less than 50%. Oldridge, Gray, McDermott, and Kirkpatrick (2004) conducted a descriptive study, where 111 RNs and other clinicians (pharmacists, surgeons, medical students) were asked to perform five drug dose calculations. Overall, less than 14% of the clinicians answered all five questions correctly and RNs performed the worst compared to the other clinicians. Finally, Grandell-Niemi et al. (2003) conducted a descriptive study, where they asked 308 RNs from a University in Finland to completed a 17-item calculation test. None of the study participants were able to answer all items correctly.

Nursing Student (NS) Ability to Calculate Medication Dosages

Similar performance problems were noted with NSs. McMullan et al. (2010) conducted a cross-sectional study at a United Kingdome University, asking 229 second year NSs and 44 RNs to complete a 15-item numerical ability test and 20-item drug calculation test. Specific for the RNs, 45% failed the numeracy test (median score 63.6%) and 89% failed the medication calculation test (median 40%). The study found no statistically significant difference between years of experience and ability to perform basic numerical skills when combining the SN and RN groups together. Age was determined to be a statistically significant determinant of performance, when comparing the combined groups and numerical ability. Those participants' ≥ 35 years of age outperformed younger participants.

Grandell-Niemi et al. (2006) conducted a descriptive study, enrolling 282 graduating NSs and 364 RNs. They were asked to complete a 29-item calculation test. The mean score was 22.7 out of a possible 29 or 78.3%. RNs who frequently performed dosage calculations in their daily work received higher total scores ($p = 0.014$). No association between age or work experience with mathematical skill was identified. Finally, Fleming, Brady, and Malone (2014)) conducted a descriptive study enrolling 124 new graduate RNs at the time of initial employment. They were asked to complete a 20-item calculation test. Only five participants received perfect scores while the mean score was 60.08% for correct answers.

Nurse medication calculation competency has been fairly well studied, but there remains a scarcity of literature regarding pediatric nurse performance. Given the need to perform more frequent calculations due to weight-based dosing, together with the higher risk for adverse outcomes in the pediatric population, it is important to understand how pediatric nurses perform. Additionally, little has been studied regarding the impact of work unit, years of experience, or certification status in adult or pediatric nurses. Exploring if there is a relationship between such nurse demographics and the ability to accurately perform medication dose calculations is warranted.

Purpose

The purpose of the study was to describe and compare pediatric RN performance on a medication dosage calculation assessment tool (assessment tool) considering work unit, years of experience, and certification status.

Research Questions

1. What were the frequency distributions of the overall medication dosage calculation score across all work units?
2. What were the frequency distributions of the overall medication dosage calculation score by individual work unit, years of experience, and certification status?
3. Were there any relationships between the three demographics (work unit, years of experience, certification status) with the overall medication dosage calculation score?

Methods

The study took place in a 320 bed academic pediatric medical center.