Nurse Education in Practice 16 (2016) 33–39

Contents lists available at ScienceDirect

Nurse Education in Practice

journal homepage: www.elsevier.com/nepr

Mathematical calculation skills required for drug administration in undergraduate nursing students to ensure patient safety: A descriptive study
Drug calculation skills in nursing students

Annamaria Bagnasco [a,*], Lucia Galaverna [b], Giuseppe Aleo [a], Anna Maria Grugnetti [a], Francesca Rosa [a,1], Loredana Sasso [a]

[a] Department of Health Sciences, University of Genoa, Via Pastore 1, I-16132 Genoa, Italy
[b] Facoltà di Dipartimento di Scienze della Sanita Pubblica e Pediatriche, Italy

ARTICLE INFO

Article history:
Accepted 16 June 2015

Keywords:
Maths skills
Drug calculation skills
Drug administration
Nursing student
Medication errors
Patient safety

ABSTRACT

In the literature we found many studies that confirmed our concerns about nursing students' poor maths skills that directly impact on their ability to correctly calculate drug dosages with very serious consequences for patient safety.

The aim of our study was to explore where students had most difficulty and identify appropriate educational interventions to bridge their mathematical knowledge gaps.

This was a quali-quantitative descriptive study that included a sample of 726 undergraduate nursing students. We identified exactly where students had most difficulty and identified appropriate educational interventions to bridge their mathematical knowledge gaps.

We found that the undergraduate nursing students mainly had difficulty with basic maths principles. Specific learning interventions are needed to improve their basic maths skills and their dosage calculation skills. For this purpose, we identified *safeMedicate* and *eDose*™ (Authentic World Ltd.), only that they are only available in English. In the near future we hope to set up a partnership to work together on the Italian version of these tools.

Introduction

Patient safety undermined by an increasing number of drug administration errors has raised concerns on a global basis about whether nursing students actually develop the maths skills required to correctly calculate drug dosages (McMullan et al., 2010).

Medication errors have been identified as the most common type of error affecting patient safety and the most common single preventable cause of adverse events and they can occur as a result of mathematical calculation errors and conceptual errors (Fleming et al., 2014).

Nurses need adequate medication calculation skills to provide safe and effective drug administration and management, which is an important component of the nursing profession (Sulosaari et al., 2012).

The growing number of studies and reports addressing the harmful effects of drug administration errors has brought to light a phenomenon whose proportions are greater than expected. In fact, it has been estimated that in the USA, at least 1.5 million patients have been affected by adverse drug events (IOM, 2006). In the United Kingdom, approximately 6000 cases of medication errors are reported every month (NPSA, 2009).

Background

Drug preparation phases include procedures that are potentially subject to errors: the reconstitution of drugs, titration, preparation of solutions, and the calculations made to fraction drugs. Particular attention has always been paid to drug administration in children

* Corresponding author. Tel.: +39 3472721175 (mobile); fax: +39 0103538552.
E-mail addresses: Annamaria.bagnasco@unige.it (A. Bagnasco), lucia.galaverna@unito.it (L. Galaverna), g.aleo@idi.it (G. Aleo), francescarosa@live.it (F. Rosa), L.sasso@unige.it (L. Sasso).
[1] Tel.: +39 3487951066 (mobile).

http://dx.doi.org/10.1016/j.nepr.2015.06.006
1471-5953/

and newborns, due to the higher number of calculations and logical passages required for the preparation of medications (Walsh et al., 2005; Kaushal et al., 2001). In fact, the risks of committing harmful medication errors in children are three times higher than in adults (Kaushal et al., 2001), and the risk of error during the preparation phase ranges between 27 and 60% (Walsh et al., 2005). The estimated rate is equal to 2.3 errors, and 10 "near-misses" per 100 hospitalised children (Kozer et al., 2002).

The most common errors reported during the preparatory phase of drug administration are: using a different drug from the one prescribed, wrong dosage or dilution, and setting the wrong speed of infusion (Wright, 2010; Grugnetti et al., 2014).

In the literature, three key points have been identified:

1) Many nurses and students do not have a full understanding of all the basic mathematical concepts (addition, subtraction, division, and multiplication) and are unable to apply these concepts to medication dosage calculation and use formulas (Wright, 2010).
2) Nurses have major difficulties with percentages, fractions, and equivalences (Wright, 2007, 2009).
3) The Nurse Education in Practice 'Safety in Numbers' Series explores the outcomes of a 20-year programme of healthcare education translation research and education action research that focuses on medication dosage calculation problem-solving (MDS-PS) education, and offers tools that help students to overcome their dosage calculation difficulties and bridge the theory–practice gap (Weeks et al., 2013a,b).

Until now, studies have mainly focused on written tests on dosage calculation in formal educational settings (Weeks et al., 2000; Gray and Jackson, 2004; Wright, 2004, 2005, 2006).

The validity of written tests, as a measure of the drug calculation skills in clinical settings, has been questioned, and the risk of supposing that poor outcomes imply poor clinical competences has also been highlighted in literature (Wright, 2007, 2009). Therefore, it is only possible to claim that nurses' poor calculation skills contribute to therapeutic errors (Wright, 2010).

In this descriptive study, we analysed the maths skills of undergraduate nursing students in Turin with the purpose to: a) identify precisely for which of the maths skills our students had most difficulty calculating drug dosages (whether basic calculation skills, logics, deduction, reasoning, and understanding advanced formulas); b) understand how the students perceived their own maths skills; and c) identify tools that could be used to improve maths skills and their assessment in Italy.

Research design

Participants and setting

Between June and September 2011 (by the end of the academic year 2010–2011), all nursing students enrolled in the I, II and III year of the undergraduate degree course in Nursing at the University of Turin (n. 726) were invited to participate in this study.

In the academic year 2010–2011, we added a 1-h workshop on medication dosage calculation, organised and supervised by an educator with specific expertise on this topic, with a small group of 15–18 students, which included practical exercises correlated to the clinical context, within the following courses:

- Basic clinical nursing IV in the First Year (calculation of drug dosages administered via intramuscular injection, subcutaneously, and orally);
- Clinical nursing methodology in the Second Year (calculation of the infusion rate expressed in ml/hour and drops/minute)
- Paediatric nursing in the Third Year (medication dosage calculation in paediatrics).

Instrument and data collection process

Since in Italy, no studies have ever been conducted on undergraduate nursing students' maths calculation skills for the purposes of drug administration, we decided to use K. Wright's assessment tool and self-assessment questionnaire (Wright, 2005).

On the basis of Wright's assessment tool, the maths test was divided into two sections:

Section A focused on the basic maths skills and included the first 4 areas:

Area 1: calculations with percentages
Area 2: multiplying fractions
Area 3: calculations with fractions
Area 4: divisions and multiplications by 10, 100, and 1000 Section B instead focused on maths calculation skills applied to medication administration, which used medication prescriptions selected from real clinical practice settings, and included:
Area 5: Calculations with proportions (e.g. The vials of Midazalam contain 20 mg in 2 ml. You need to administer 5 mg. How many ml should you draw?)
Area 6: Solving problems on how to calculate medication dosages and solution infusion speeds (e.g. Knowing that the vials of adrenaline always contain 1 g in 1000 ml, you have to give 0.0001 gr. of adrenaline. How many ml should be administered?)

Each Area included 5 items, except for Area 6, which included 7 items. The score for each correct answer was 1, whereas the score for each wrong answer was 0. Only Area 2 had a different scoring scale, where 1 point was attributed when the reduction of the fraction had been done correctly, and the result had been made explicit; 0.75 was attributed when the reduction had been done correctly, but without making the result explicit; 0.25 was attributed when the reduction was incomplete, and the result was not made explicit; and 0 points were attributed when the answer was completely wrong.

A demographic data form was attached to the test, through which the following information was collected: age, gender, address, nationality, education, and year attended.

In addition to the test, we also administered a structured questionnaire consisting of six questions related to the six sections of the test, which was designed to investigate the perception that the students had about their level of math skills achieved in the six areas of the test (Wright, 2005). We used the following scale: *poor*, *sufficient*, *good*. We also asked students to provide a short description of the difficulties they encountered in doing the test.

The students had 30 min to complete the test and the questionnaire, without using calculators. To ensure anonymity, student's names were substituted by a code number, but were also given the opportunity to write their names on their test if they wished to, so that they could have feedback on their maths skills.

Data analysis

The data were included into a table using "Microsoft Excel" – version 2007, and then analysed with SPSS 15.0 software (Statistical Package of Social Sciences Inc. Chicago, IL. USA).

Only Area 2 had a different scoring scale, where 1 point was attributed when the reduction of the fraction had been done correctly, and the result had been made explicit; 0.75 was attributed when the reduction had been done correctly, but without