Nurse Education Today 31 (2011) 815–818

Contents lists available at ScienceDirect

Nurse Education Today

journal homepage: www.elsevier.com/nedt

Numeracy skills of nursing students

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ARTICLE INFO

Article history:
Accepted 14 December 2010

Keywords:
Maths
Calculations
Nurse
Error
Drug calculations
Student nurses
Patient safety

SUMMARY

Research has highlighted poor mathematical ability amongst qualified and student nurses. Three major classifications of errors: i)conceptual, ii)arithmetical and iii)computational have been identified. These errors involve being unable to formulate an equation from information given, unable to operate a given equation, or simple arithmetical errors respectively. The objective of this study was to determine if a sample of Australian second year undergraduate nursing students, from the state of Victoria, could accurately calculate drug dosages and perform some basic mathematical calculations that would be required in the workplace.

A descriptive survey collecting demographical data, attitudes towards drug calculation performance and basic mathematical and drug calculation questions was administered to the 52 undergraduate nurses who participated in the study.

The average score was 56.1%. Interestingly 63.5% of the students denied any drug calculations issues. On average those who completed a minimum of year 12 mathematics, or who had entered the course directly from secondary education achieved scores over 50%. Of all the errors that occurred 36.0% were conceptual, 38.9% were arithmetical and 25.1% were computational.

Some Victorian nursing students currently have deficiencies in performing accurate calculations, with both arithmetical and conceptual errors, indicating fundamental flaws in their mathematical understanding and demonstrating an unacceptable level to practice safely.

Introduction

The ability to perform drug calculations accurately is an essential skill for practicing nurses in all settings around the world. It is assumed that when administering drugs to patients, the drug dose calculation performed by nurses is always 100% accurate. Incorrect drug dosage in patients can result in under-dosing, overdosing leading to adverse complications, and at worst, death.

Errors associated with medications account for up to 20% of all hospital based health-care errors in Australia and cost approximately $380 million to the public hospital system annually (Northern Sydney Central Coast Area Health Services, 2008).

A review of the literature has revealed an alarmingly low level of accuracy when performing mathematical calculations in the nursing discipline. Studies dating back to the 1930s have consistently noted poor mathematical ability amongst nurses in both pre and post-registration groups (Wright, 2004, 2005, 2006; Grandell-Niemi et al., 2001, 2006; Blais and Bath, 1992; Wilson, 2003; Faddis, 1939; Munday and Hoyt, 1965; Brown, 2002, 2006; Sander and Cleary, 2004; Pozehl, 1996; Santamaria et al., 1997; Hutton, 1998a,b; Cartwright, 1996). Some reasons suggested for this poor performance include skills decay, through lack of regular drug calculation practice in the work environment, the presence of equipment that automatically performs the calculations, length of time in the job, and other factors such as poor mathematical education during primary and secondary schooling, and pressures associated with caring for the patient at the time when drug calculations are required (Wright, 2005; Weeks et al., 2000; Hutton, 1998a; Beilock and Carr, 2005; Kellogg et al., 1999; Kapborg, 1995). Other studies have found there is also a decline in mathematical performance amongst nurses and various other groups, including undergraduate psychology students and qualified paramedics, when they are in a high-pressure or stressful situation, even if that stressor is simply time (Beilock and Carr, 2005; Kellogg et al., 1999; LeBlanc et al., 2005; Ashcraft and Kirk, 2001).

Various studies have categorised the errors that have occurred and three distinct groups have emerged. The first group is referred to as conceptual errors. These are the most common type of error found in the literature, and involve the inability to formulate the mathematical question correctly from the information given. Arithmetical errors form the second group and occur when a person is unable to operate

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doi:10.1016/j.nedt.2010.12.014

an equation correctly. The final group, computational errors, involve miscalculation of simple functions such as multiplication, division, subtraction or addition (Wright, 2005; Grandell-Niemi et al., 2001; Blais and Bath, 1992; Wilson, 2003; Weeks et al., 2000; Pentin and Smith, 2006).

The Victorian Certificate of Education (VCE) comprises of the final two years of secondary schooling whereby Australian students in the state of Victoria work towards graduating from secondary school. During the VCE there are three levels of mathematics in each of the final two years of secondary schooling. In year 11 this ranges in increasing order of difficulty from Foundation Maths to General Maths and finally Maths Methods at the more complex end of the spectrum. In year 12 this ranges from (again in increasing order of difficultly) from Further Maths to Maths Methods and finally Specialist Maths (The Victorian Curriculum and Assessment Authority, 2010). The mathematical prerequisites for entry into the Bachelor of Nursing (BN) courses in Victoria, Australia, differ significantly. Some Victorian universities have no mathematical prerequisites for their nursing courses. Others require any level of maths during year 11 and no mathematics during year 12, no mathematics during year 11 and any maths during year 12 and finally either year 11 General Maths or Maths Methods, or any maths in year 12 (Monash University, 2010; Latrobe University, 2010; Australian Catholic University, 2010; Deakin University, 2010; RMIT, 2010).

The objective of this study was to determine if undergraduate second year nurses could accurately calculate drug dosages and perform some basic mathematical calculations that would normally be required in the workplace.

Methodology

One hundred and thirty-one second year undergraduate nurses were eligible to participate in this study. The first year students had not yet completed the mathematics education for the course and the third year students were not available due to clinical placements. No exclusions existed as only those who met the inclusion criteria of being enrolled in the Bachelor of Nursing at a Victorian university in Australia were invited to participate. A cross-sectional methodology was used to elicit responses from undergraduate nurses to a series of demographic, drug calculation, and mathematical questions.

The questionnaire consisted of three sections. The first section collected some general demographical data, e.g. age, gender, and educational history. The second section asked the student to identify factors they believe were inhibiting their mathematical performance, and the third section contained a series of questions consisting of various drug calculations and mathematical equations. The validity of the drug calculation questionnaire was confirmed following a review by several undergraduate unit co-ordinators and after being piloted by a group of qualified nurses to ensure the questions were appropriate and similar to the type of drug calculation questions that the students would normally encounter. Changes were made to the questionnaire based upon the feedback obtained.

Students were not informed of the study prior to recruitment to avoid any students studying for the questionnaire. The students were provided with an explanatory statement highlighting the research question, aims of the study and issues such as confidentiality and recruitment. The questionnaire was administered during semester 1, March 2008 at the end of a lecture by a non-teaching member of staff. Students were not permitted to use a calculator but were advised to use the questionnaire form to do all their workings.

When analysing the results the number of correct and incorrect answers were summated. The incorrect answers were then categorised into conceptual, arithmetical and computational errors. The questionnaire results were analysed in relation to the variables identified in the demographic data such as previous education and experience. While 50% has been used as the pass or fail measure, students were also grouped according to a 90% mastery level, so that the results from this study may be compared with other international literature (Blais and Bath, 1992; Jukes and Gilchrist, 2006; Harne-Britner et al., 2006; Bayne and Bindler, 1988; Bindler and Bayne, 1991; Ashby, 1997). Descriptive data analysis was undertaken using SPSS (Statistical Package for the Social Sciences Version 17.0, SPSS Inc., Chicago, Illinois, U.S.A.). Descriptive statistics, percentages, were used to summarise the demographic and outcome data.

Ethics approval was obtained for this study.

Results

Fifty two second year Bachelor of Nursing students (39.7%) participated in this study. The gender distribution was 82.7% female and 17.3% male. The students ranged from 18 to 46 years of age with the majority of students, 76.9% (n = 40) being less than 26 years of age.

Of the students that participated, 90.4% (n = 47) had completed a minimum of year 12 or equivalent level of education. However 61.5% (n = 32) of the total students did not enter their current course directly from secondary education; they either had a gap year, were returning to study, or undertook another course prior to the commencement of the BN. Previous tertiary education had been undertaken by 40.4% (n = 21) of the students' prior to their current course.

As demonstrated in Table 1, only a small proportion of participants 3.8% (n = 2) had some tertiary level mathematics education. Just over a quarter of the students (26.9%; n = 14) had less than a year 12 level of mathematical education. Table 1 lists the levels of mathematical education with the lowest level appearing first, and the highest level of maths listed last.

The second section of the questionnaire collected some brief information on any issues the students believe may be inhibiting their drug calculation performance, and whether they had any previous experience with drug calculations. Two thirds of the students 63.5% (n = 33) believed that they did not have any issues with drug calculations, 75% (n = 39) believed their secondary mathematics education was adequate and 76.9% (n = 40) believed their current tertiary mathematics education was also adequate. However, 59.6% (n = 31) of the students acknowledged a reduction in mathematical skills by attributing this decline to infrequent exposure to mathematics.

Just over half of the students (53.8%, n = 28) identified some previous experience with conducting drug calculations, however this did not appear to assist them, as this cohort of students achieved a mean score of 55.1% on the questionnaire with 35.7% (n = 10) students failing to achieve 50%. Conversely, the students who stated they had no previous experience had a mean score of 57.3% and only 29.2% (n = 7) of students failed to achieve 50%.

The final section of the questionnaire presented the students with twelve mathematical questions, varying in construction from a written problem to basic mathematical equations. The written problems used a medical focus in order to give the students a sense of relevance to their current curriculum.

Table 1
Highest previous maths education.

Previous maths education	Students	
	n	%
High School Maths (<yr12)	14	26.9
Other (incl. interstate maths education)	2	3.8
HSC Maths	2	3.8
VCE Further Maths	7	13.5
VCE Maths Methods	20	38.5
VCE Specialist Maths	5	9.6
Tertiary level maths	2	3.8
Total	52	100