Drug Dosage Calculation Abilities of Graduate Nurses.

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ABSTRACT

This study describes the analysis of the mathematical ability of 220 registered nurses (RNs) from six Victorian universities who applied for a graduate year program at St. Vincent's Hospital Melbourne. Each applicant completed a drug calculation competency test (DCCT) which required them to calculate eleven drug dosages commonly performed by RNs in clinical practice. The results revealed that 58% (n=127) of the 220 applicants were not able to accurately calculate all eleven drug dosages. The results also demonstrated significant differences between applicants from respective universities. The findings suggest that there are fundamental problems with the mathematical competencies of newly graduated nurses. The results also support the assertion that the educational preparation of these nurses at the undergraduate level is deficient in some universities and does not adequately prepare nurses to perform basic drug calculations which are frequently required in the acute setting.

INTRODUCTION

The ability to accurately calculate a drug dosage is a fundamental clinical skill required of all registered nurses. There is an obvious potential to cause serious if not fatal harm to patients if nurses are not able to accurately perform this function. The nurse requires basic mathematical competencies and a knowledge of the relevant formulae and how to manipulate numbers within the formula to accurately perform the calculations. Above all, the nurse needs a sound understanding of the relationship between different units of measurement and the ability to determine, through estimation, the reasonableness of their answer in the context of the question. Both of these aspects are noted as being critical to effective mathematical calculation in the National Statement for Mathematics in Australian Schools (AEC 1990)

LITERATURE REVIEW

The rate and cause of medication errors made by nurses is generally difficult to determine with a high degree of accuracy. This could be partly due to nurses not having recognised the error when it was made and therefore not reporting it (Barker & McConnell 1962, & Ludwig-Beymer 1990). Bindler & Bayne (1991) report error rates of between 5.3 percent to 20.6 percent of administered drug doses. Worrell & Hodson (1989) note that the administration of the wrong dosage is ranked second only to the omission of a drug as the most frequent type of error reported. It would appear logical to suspect that the basis for these rates of error to be due to the mathematical skills of the nurses involved, however, the true basis of the problem may be the way in which nurses are taught to carry out the calculations

during their undergraduate education. This view is supported by Miller (1993), Heck (1994), Gillham & Chu (1995) and Kapborg (1995).

A number of researchers have noted that there may be extraneous factors influencing the performance of nurses during drug calculation tests. Included in these factors are the negative effects of test anxiety on subjects' score. This factor has been reported as a potentially confounding variable by Fulton (1989), however, this view is not supported by McCann Flynn & Moore (1990). A broader view of the possible bases of the difficulties experienced by some nurses in drug calculation is proposed by Badger (1981) and Miller (1989) who both suggest that the problem is linked to the generally lower mathematical achievement of females. This argument suggests that because 94 percent of nurses are female then it is not surprising that they should reflect similar mathematical problem rates to females generally. It should be noted that the purpose of this study was not to investigate the possible effects of these factors, rather, it was to determine the rates and types of calculation errors made by recently graduated nurses and to explore the relationship between the errors made and the universi are female then it is not surprising that they should reflect

drug dosages where the stock strength of the drug was greater than the

requests the flow rate of the IV in drops per minute if the giving set delivers 20 drops to the mL. The error rate of subjects from each university increased in question 10b by an average of 10.5%. It should be noted that giving a correct answer to question 10b is dependent on giving a correct answer to question 10a.

Table 1: Analysis of type of error expressed as a percentage for each university

University	OE	MC	FU
A	48	24	15.3
B	34	25	10.5
C	47	26	10.5
D	40	34	19.5
E	38	23	8.8
F	37	20	11.5

(OE)=Over estimation, (MC)=Metric conversion, (FU)=Formula use.

n=220

Table 1 presents the results of the cohort when errors are grouped by type by university. By collapsing the error rates for each question into three categories of calculation error, a clearer understanding is gained of the major underlying problems with drug calculation by subjects from each university. The markedly higher rate of errors made by subjects from university D in the areas of metric conversions and formula use are noted. ANOVA conducted on the scores for each question supports the assertion that the performance of subjects from university D are significantly below subjects from the other universities, this finding is particularly strong in question 10b ($F,(5,215)=8.45$, $p<0.05$).

DISCUSSION

The finding that 58 percent of subjects were not able to calculate all dosages accurately strongly suggests that there are fundamental problems with the mathematical competencies of newly graduated nurses. The magnitude of the finding is consistent with reports by Worrell & Hodson (1989), Bliss-Holtz (1994) but were higher than the rate reported by Gillham & Chu (1995). Of particular concern was the finding that in some calculations (Question 5, Figure 1) large numbers of subjects produced insulin dosage answers that were ten times greater than the prescribed dose. This potentially lethal dosage of insulin raises the question of the individuals' ability to even approximate a

safe dosage. Gillham & Chu (1995) note the importance of estimation in the prevention of drug dosage errors and they emphasise the need for individuals to have an understanding of basic mathematics and a grasp of drug dosage concepts for them to be able to approximate a safe dosage. Table 1 revealed that this was a common deficiency with subjects from each university.

The relationship between clinical experience and teaching and the formal teaching and assessment of drug calculation is brought into question when error rates of 58 percent are recorded from a group of 220 recently graduated nurses. The profiles of subjects from each of the six universities presented in Figure 1 and the analysis of errors in Table 1 suggest that the there are differences between the universities' ability to prepare graduates to undertake basic dosage calculations. It is beyond the scope of this study to suggest possible reasons for the differences that were noted, however, the factors which may have contributed to the finding are worthy of further investigation. Clarkson (1990) suggests that where identifiable and localised difficulties are found, the problem should be best addressed within the context of specific nurse education programs.

The limitations of the study include the sampling approach which was used. The fact that the sample comprised 220 nurses who had the highest academic grades from the 597 applicants for the GNP. This approach introduced a bias toward the academically better performing applicants. It is therefore not possible to generalise the findings beyond this group of newly graduated nurses. The effect of test anxiety on subjects' performance was also considered to be a potentially confounding variable. A further limitation involves the use of calculators during the testing. It is therefore not possible to determine the actual rate of arithmetical errors which occurred, yet the overall success rates for the cohort were disappointing. It could be argued that the success rate may have been even lower had calculators not been allowed during testing.

Overall the findings of this study suggest that there are significant problems with the ability of graduate nurses to safely calculate common drug dosages. The main areas identified were metric conversion, the use of formulae and estimation. These problems are indicative of inadequate basic mathematical skills and knowledge of drug dosage concepts. If the findings of this study reflect the general drug dosage calculation of newly graduated nurses then there exists a pressing need for both universities and hospitals to identify the causes of the problem and to improve this fundamental competency deficiency.

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