REPORT

ASSESSMENT OF SYSTEMS AND THE KNOWLEDGE THEREOF FOR CALCULATION OF DOSES OF THE MEASURES FOR MEDICATIONS AMONGST MEDICAL STUDENTS, PARTICULARLY OF A MEDICAL INSTITUTION IN INDIA

CHAYNA SARKAR AND BISWADEEP DAS

Department of Pharmacology, Sri Ramachandra Medical College & Research Institute, Porur, Chennai-600 116, Tamil Nadu, India

Sir/Madam,

It is essential for health-care professionals to calculate drug doses accurately (Oldridge *et al*., 2004). An adverse drug event (ADE/an injury related to the use of a drug) is documented to occur during 0.7-6.5% of hospital admissions in the US, 1.5% in the UK, and 1.8% in Australia (Leape *et al*., 1991; Bates *et al*., 1995; Neale *et al*., 2001; Wilson *et al*., 1995). The substantial morbidity and mortality associated with ADE's is well known. In-hospital ADE's (occurring after or causing admission) are associated with longer hospital stays, increased costs of hospitalization and greater risk of death. In a study, the estimated ADE rate during hospitalization was 4.2 events per 100 admissions, with a cost of US$2162 per ADE. In addition, 3.2% of admissions were caused by ADE's, with an associated cost of US$6685 per event. 15% of hospital ADE's and 76% of ADE's causing admission were judged preventable. The annual cost to the organization for events occurring during hospitalization was US$1.7 million, and the cost of preventable ADE's was US$260,000, while the projected costs of preventable ADE's causing admission were $3.8 million. 71% of the serious medication errors occurred at the prescribing stage of the medication-use process (Senst *et al*., 2001). In another study, ADE's complicated 2.43 per 100 admissions to the hospital during the study period. The mean length of hospital stay significantly differed between the cases and matched controls (7.69 vs 4.46 days; $P< 0.001$) as did the mean cost of hospitalization (US$10, 010 vs US$5355 ; $P< 0.001$). The extra length of hospital stay attributable to an ADE was 1.74 days ($P< 0.001$). The excess cost of hospitalization attributable to an ADE was US$2013 ($P< 0.001$). A linear regression analysis for length of stay and cost controlling for all matching variables revealed that the occurrence of an ADE was associated with increased length of stay of 1.91 days and an increased cost of US$2262 ($P< 0.001$). In a similar logistic regression analysis for mortality, the increased risk of death among patients experiencing an ADE was 1.88 (95% confidence interval, 1.54-2.22; $P< 0.001$) (i.e., an almost 2-fold increased risk of death) (Classen *et al*., 1997). ADE's are believed to account for about 4% of hospital admissions (Raschetti *et al*., 1999)

The frequency of drug administration errors (contributing to ADE's) has previously been reported as being as high as 19% of all drug administration episodes, and 17% of these were dose errors (administration of the wrong dose of a drug) (Allan and Barker, 1990; Dean *et al*., 2000; Barker *et al*., 2002). A dose error may be made because a drug is incorrectly prescribed on a chart: a prospective examination of over 36000 prescription charts in a UK teaching hospital over a 4-week period identified an error in 1.5% of prescriptions, 54% of which were associated with the wrong dose (Dean *et al*., 2002).

The inherent knowledge of systems of measure and the contribution of different means of expressing the concentration of drugs in solution to dose error has never been assessed, although it is a fact that medical students and even hospital doctors struggle with the calculations (Rolfe and Harper, 1995). When a drug in solution is administered, the correct volume must be calculated. The steps in this calculation require an understanding of the many different ways that the concentration of a drug in solution may be expressed. The different ways of expressing concentrations of drugs in solution, as ratios (e.g., 1 in 1000) or percentages or mass per unit volume (e.g., milligrams or millimoles per milliliter), are a potential cause of confusion that may contribute to dose errors (Stefanou and Siderov, 2001). As the metric system is based on thousands whilst percentages are based on hundreds, even these simpler means of expressing drug concentration can cause confusion. Calculating the safe volume of drug mixtures or rates of drug infusions are even more difficult, for example, the mixture of 1% lidocaine and 1 in 200 000 epinephrine that is often infiltrated into surgical sites (Lawrence, 1996).

This study assessed the ability of paraclinical and clinical medical students (third, fifth and seventh semester students) at a South Indian Medical Institution to effective

Corresponding author: Dr Biswadeep Das, Department of Pharmacology, Faculty of Medicine and Health Sciences Asian Institute of Medicine, Science and Technology, 2, Persiaran Cempaka, Amanjaya, 08000 Sungai Petani, Malaysia
Email: biswadeepdas@hotmail.com

Table 1: Results of assessment of knowledge of systems of measure used in pharmacy and calculation of doses of drugs in solution in relation to student seniority

Student seniority(semester)		Third (n=76)	Fifth (n=164)	Seventh (n=108)	Total (n=348)
Qn 1	No. answering correctly	0	0	0	0
	No. attempting question	74	116	66	128
	% answering correctly	0	0	0	0
Qn 2a	No. answering correctly	62	102	72	236
	No. attempting question	74	162	108	344
	% answering correctly	83.8	62.9	66.6	68.6
Qn 2b	No. answering correctly	62	82	72	216
	No. attempting question	74	154	108	336
	% answering correctly	83.8	53.2	66.6	64.3
Qn 3	No. answering correctly	46	108	42	98
	No. attempting question	72	160	90	322
	% answering correctly	63.9	67.5	46.7	60.9
Qn 4	No. answering correctly	58	108	60	226
	No. attempting question	72	160	102	334
	% answering correctly	80.6	67.5	58.8	67.7
Qn 5	No. answering correctly	24	20	4	48
	No. attempting question	72	142	72	286
	% answering correctly	33.3	14.1	5.6	16.8
	Response rate (%)	49.4	88.2	54.5	64.7

No. = Number of students; n = Number of students participating in the assessment in a semester; % answering correctly = ((No. answering correctly/No. attempting question) X 100); Response rate(%) = ((Number of students participating in the assessment in a semester/Total number of students in the semester) X 100)

recall and use of knowledge of systems and measures for calculation of strengths of drugs in solution.

We employed a questionnaire-based survey instrument to assess medical students' awareness of the systems of measure and mathematical calculation of doses of medications in solution. Those participating voluntarily were instructed to answer five selected questions in succession under timed conditions. The questions were devised to test knowledge of medications used across multiple specialities that should be familiar to all students. Answers were submitted anonymously. The entire exercise was conducted on the same day in November 2005 using the same questionnaire in one sitting.

Data regarding mean scores were analyzed using Kruskal Wallis non-parametric tests. Analyses of all other data were based on descriptive statistics. A p value < 0.05 was considered to represent statistical significance.

The results are summarized in table 1. 348 medical students took part in the survey (response rate 64.7%) out of which 76 students (21.8%) were from third semester, 164 students (47.2%) were from fifth semester, and 108 students (31%) were from the seventh semester of the MBBS course. No student was excluded from the analysis. Some students failed to attempt every question.

The overall mean score for all students was only 2.02 out of 5.00 (corresponding to 40.4%) (n=348; range 0-4; standard error (SE) 0.08).

The mean score deteriorated with increasing student seniority; third semester students scored 2.30 (n=76; range 0-4; SE 0.14), fifth semester students scored 2.01 (n=164; range 0-4; SE 0.12), and seventh semester students scored 1.83 (n=108; range 0-3.5; SE 0.28). No student in any of the three semesters could recall the names of the systems of measure used in dispensing medications (viz., Apothecaries', Avoirdupois', and Metric systems). The percentage of medical students answering questions 3, 4, and 5 correctly showed deterioration with student seniority (table 1).

The ability to work with numbers is important to the practice of medicine. However, the ability of medical students to perform the arithmetical calculations required to identify the correct mass or volume of a drug in solution have been addressed in few studies. The relatively simple skills of retaining, recalling and utilizing the systems of measure and applying them for calculating the strengths of drugs in solution are not imparted formally at many medical schools. In this study, a substantial number of medical students have lacked knowledge of systems of measure, had trouble performing

basic numerical tasks and were unable to calculate mathematically the drug mass in solution precisely. The mean score decline indicates that students are not informally picking up the requisite knowledge and skills during the MBBS course.

Medical students expected to transmute overnight into doctors often lack practical preparation. Many house officers feel unprepared to administer intravenous treatment, and many admit to committing errors (Teahon and Bateman, 1993). Unfamiliarity greatly increases the chances of error. Dosing errors are a common source for preventable ADE's. To reduce prescribing and administration errors, hospitals should impart training in medication prescribing principles. To promote safe prescribing and medicine administration, medical schools must teach dose computing skills as part of the undergraduate and clinical pharmacology curricula via structured teaching and assessment (Scobie *et al*., 2003).

Along with intermittent small group tutoring on composing prescriptions and administering intravenous injections under guidance during their paraclinical and clinical years, students should be encouraged during their final medical attachments to compose prescriptions to be countersigned by trained medical staff and to assume an active role in the administration of medications (Langford *et al*., 2001; Sheridan and Pignone, 2002).

APPENDIX

Q1 Enumerate the three systems of measure used in dispensing pharmacy?

Q2 Fill in the blanks in the following:
   a) 1 gram(g)= __ micrograms(mcg OR µg)
   b) 1 milligram(mg)= __ gram(g)

Q3 Express 0.1% w/v as a ratio strength.

Q4 Express 1: 2500 as a percentage strength.

Q5 How much of Lidocaine (an amide type local anesthetic) is there in a 10 mL vial of Lidocaine containing a 2% w/v solution?

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