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PERSPECTIVE

The need to address poor numeracy skills in the emergency department environment

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Abstract

Substantial evidence exists for lack of numerical skills among many health professionals. Although poor numeracy has long been recognised as a contributor to medication error, other activities for which numerical literacy are required, such as interpretation of diagnostic results, have been largely ignored. Poor self-awareness of lack of numerical literacy increases the risk, especially in the busy and hurried emergency environment. System changes, such as standardising units and improving number presentation, reduce the potential for misinterpretation; however system changes do not address the underlying deficiencies in mathematical skills. The training of doctors in numeracy has been largely ignored. In contrast, education for nurses frequently occurs during both pre- and post-registration programmes. Interventions have had mixed success, although additional emphasis in increasing conceptual understanding of numbers is encouraging. The consequences of poor numerical literacy should be addressed in all clinical staff, not only by practice change to remove the potential for errors to be made, but also complemented by self-awareness and education.

Key words: *emergency department, health professional, key skill, numeracy.*

Importance of numeracy skills in the emergency department

In order to deliver safe care for patients, clinicians require sound skills in numeracy, a trait that has been defined as being 'at-ease with all those aspects of mathematics that enable a person to cope with the practical demands of everyday life and the ability to understand information presented in mathematical terms'.[1]

Most interest and indeed research in the area of numeracy has focused on reduction in medication errors. However, poor numeracy has implications for many other activities undertaken in the ED. These include potential for errors in interpretation of diagnostics results, calculations on fluid balance, nutritional needs, intravenous fluid rates and weight and body mass index, as well as those around plotting and recording data, and understanding research evidence.[2] The potential problems are exacerbated when clinical decisions are made rapidly in a busy ED environment, or in situations where the clinicians have limited patient information to guide them.

Current level of numeracy among healthcare professionals

Many healthcare students and qualified staff do not demonstrate the required levels of numeracy for safe practice. These failings have been demonstrated either directly through numeracy and mathematics tests, or indirectly through their ability to perform drug calculations.[3–5]

Although most published research has involved nurses and nursing students, the ability of paramedics, pharmacists, medical students and doctors to perform simple drug calculations has also been demonstrated.[5–8] For example, a study undertaken in Australia and New Zealand demonstrated that among a group of doctors the percentage answering questions on drug dose calculations accurately ranged from 46% for medical students, 63% for house surgeons and 72% for registrars.[6] Out of 61 participants, only eight participants answered all five questions correctly.

Decimal-centred innumeracy

Misinterpretation and poor understanding of decimal numbers are common components of poor numeracy skills, and different categories have

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been described. Among them *longer is larger* where 4.63 is greater than 4.8 (rationalised because 63 is greater than 8), *shorter is larger* (where 2.6 is considered to be larger than 2.83 because it has fewer numbers), *comparison with zero* (where 0.6 is identified as being less than zero) and *number of digits* (2.4403 is no different than 2.44).[9]

Recognition of the potential for misinterpretation of results expressed with decimals was the major contributory factor to the recent recommendation that troponin values should be presented as whole numbers.[10]

We have recently published what we believe is the first empirical evidence to support this recommendation.[11] In our study comprehension of how emergency doctors and nurses and pathology laboratory scientists interpret decimal notation was determined using an adaptation of the Decimal Comparison Test (SMART test http://www.smartvic.com/)[12] in which the choice of the larger number in 20 pairs of decimal numbers (e.g. 4.63 or 4.8 and 0.02443 or 0.024) allows for a diagnosis of conceptual understanding of decimal notation and characterisation of type of error.

In agreement with previously reported work,[6] our results showed that doctors had the higher level of numerical literacy among the tested groups. Nevertheless, considerable numbers in all three of our groups displayed poor comprehension of decimal numbers.

Self-awareness of innumeracy

Of particular concern in our study was the opinion of the participants about their own numeracy skills. Over 90% of those who stated that they never had experienced a problem with decimal numbers were, upon testing, characterised as having poor understanding. This lack of self-awareness was found in another Australian study where doctors who stated they had 'never' made a mistake in a drug dose calculation scored significantly lower in a calculation test than those who admitted to past errors.[7] Similar results were also found in a study of nursing students in which the majority denied any drug calculation issues but whose average test score was only 51%.[13] Such unfounded confidence is worrying.

Addressing mathematical errors

Mathematical errors might be classified into three groups: conceptual, arithmetical and computational.[13] Conceptual errors manifest as the inability to formulate the mathematical question from the given information (e.g. determine the formula needed to calculate a dose based on weight), whereas arithmetical and computational errors are caused by inability to operate an equation correctly (e.g. interpret and calculate $x^2 + y^2$) and perform simple functions (e.g. division), respectively. Although improving these skills has long been the focus of educational programmes for nurses,[2] they have been notable by their absence for doctors. In one recent Australian study, 79% of the 190 doctors who participated reported never being tested for drug dose calculations during their careers.[7]

Noting that the numeracy skills of nursing professionals had improved little over 20 years, Arkell and Rutter suggested that it was time for re-examination of core numeracy skills and how they are taught, assessed and translated into clinical practice.[5]

Both systems and educational approaches might be used to counter poor skills in numeracy and improve patient safety. The recommendation for presentation of troponin values as a whole number is a systems approach. Other system approaches include the presentation of results, such as placement of commas in long numbers, adequate spacing between dose and unit and standardisation of units.[14,15] All these reduce the opportunity for error; however none address the underlying problem of lack of comprehension or the lack of insight into the problem. For this a formal educational approach is required to improve skills in numeracy.

The future

A 1 h intervention designed to increase conceptual understanding of decimals rather than just teaching procedural rules has been shown to be effective with Australian nursing students.[9] Without question a procedural focus to mathematical competency should not be abandoned; however the promotion of a deeper understanding is required. Furthermore, the concept of a contextualised approach to education addressing local context and discipline has been recognised in Australian interventions.[16,17] These shifts from traditional methods for nursing education are valuable; however lack of numeracy skills are not confined to one profession and similar approaches aligned to clinical practice are needed for other disciplines.

Currently, it would appear that doctors' mathematical competency is assumed. We believe that despite the small body of evidence, there is sufficient indisputable proof that many doctors would also benefit from further education incorporating similar interventions. Other researchers have made the call for increased education in the calculation of drug doses.[6–8] However, as mathematical competency extends far beyond the calculation of drug doses, we suggest that a wider perspective must be taken. Such education should not only be incorporated into the medical degree curriculum and become a component of the training of junior doctors. Testing to illustrate deficiencies and raise awareness is required, ideally followed by contextually appropriate interventions within a clinical setting. Equally pathology services and the drug industry must strive to simplify instructions and report results in whole numbers if patient care errors are to be reduced.

Conclusion

We contend that poor numeracy skills among health professionals extend beyond those resulting in medication error and all have potentially significant adverse consequences to patient outcomes. We believe that in addition to reducing the opportunities for errors though a systems approach to changes in practice, two other approaches are essential. The first is to increase self-awareness of clinicians to their own shortcomings with numeracy per se. The second approach is the

provision of training that incorporates both procedural and conceptual components. This training should occur at both undergraduate and postgraduate stages for all clinical staff, with its practice implemented within individual programmes and ultimately included within professional standards.

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Competing interests

None declared.

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