

Decimal numbers and safe interpretation of clinical pathology results

Michael Sinnott,^{1,2} Robert Eley,^{1,2} Vicki Steinle,³ Mary Boyde,⁴ Leanne Trenning,¹ Goce Dimeski⁵

¹Emergency Department, Princess Alexandra Hospital, Brisbane, Australia

²Southside Clinical School, The University of Queensland School of Medicine, Woolloongabba, Queensland, Australia

³Department of Mathematics Education, University of Melbourne, Melbourne, Australia

⁴Department of Cardiology, Princess Alexandra Hospital, Brisbane, Australia

⁵Chemical Pathology, Princess Alexandra Hospital, Brisbane, Australia

Correspondence to

Dr Robert Eley, Southside Clinical School, The University of Queensland School of Medicine, Emergency Medicine Research Program, Princess Alexandra Hospital, Woolloongabba, QLD 4102, Australia; r.eley@uq.edu.au

Received 15 July 2013

Revised 15 August 2013

Accepted 19 August 2013

Published Online First

16 September 2013

ABSTRACT

Objective To determine the understanding of decimal numbers by medical laboratory scientists, doctors and nurses.

Methods A Decimal Comparison Test determined the comprehension of decimals numbers. Additional questions sought the participants' understanding of concentrations and reference ranges, and their preferences for the presentation of clinical pathology results.

Results Of the 108 participants, 40% exhibited poor comprehension of decimal numbers. One-third of the medical laboratory scientists, a quarter of doctors, and half the nurses were characterised as lacking numeracy skills. The majority of participants (60%) thought it would be safer for results to be presented as whole numbers rather than as decimals with leading zeros.

Conclusions The number of laboratory and clinical staff who show numeracy issues that could lead to misinterpretation of clinical pathology results and contribute to medical error strongly supports recommendations that pathology results should be presented as whole numbers.

INTRODUCTION

The potential for error during interpretation of clinical pathology results that are presented as decimal numbers has been noted. White and Farrance¹ stated 'it is better to use whole numbers to avoid errors, due to possible confusion of decimal places'. More recently others have stated 'it has generally been found that decimal point placement causes confusion' and 'it is easier to interpret results that are integers'.^{2,3} This presumed potential for misinterpretation prompted the ESC/ACC/AHA/WHF Task Force for the Universal Definition of Myocardial Infarction^{4,5} to recommend a unit change so that troponin results are expressed in whole numbers. Our study tested the assumption that clinical and laboratory staff may demonstrate a misunderstanding of decimal numbers that could contribute to medical error.

MATERIALS AND METHODS

This was a prospective study of medical laboratory scientists, doctors and nurses working in the Emergency, Cardiology and Clinical Pathology Departments at a large metropolitan tertiary referral hospital in Australia.

The first part of the study tested the comprehension of decimals using a Decimal Comparison Test (SMART test) (figure 1). This SMART test⁶ contains 16 pairs of decimal numbers each of which has to be identified as greater than, smaller than or

equal to its pair. A diagnostic code (table 1) is generated from the responses.

The second part of the study used a series of questions to seek the participants' experience in interpreting decimals, their understanding of concentrations and reference ranges, and their views on the presentation of results.

RESULTS

The questionnaire was completed by 23 laboratory scientists, 51 nurses, 31 doctors and three unidentified (total n=108).

Participants' understanding of decimal numbers

Results from the SMART test (table 1) identified that 39.8% of the respondents exhibited some lack of comprehension. This was evident in 34.8% of laboratory scientists, 25.8% of doctors and 51.0% of nurses. The most common diagnostic category for nurses was 'integrating decimals with zero' which accounted for more than half their errors. Half the errors for the laboratory scientists and the doctors were attributable to 'money thinking'.

Recognised problems in interpreting test results

Seventeen (16.0%) participants admitted they had difficulty in interpreting clinical pathology results which were presented as decimal numbers. Troponin was identified as one which created difficulty. However 13 of these 17 (76.5%) respondents tested as 'Experts'. By contrast, 93.6% (59 of 63) of participants who stated that they had never experienced any difficulty were shown to have poor comprehension.

For each pair of numbers, select the correct statement from the drop down box

0.4	*	0.36	3.0	*	3
0	*	0.00	0.216	*	0.37
0.74	*	0.4	0.731	*	0.73100
0.80	*	0.8	0.3	*	0.426
0.35	*	0.42	3.92	*	3.4813
7.942	*	7.63	3.72	*	3.073
0.6	*	0	0.8	*	0.0008
8.41237	*	8.41	3.77	*	3.7777

↑
Is equal to
Is greater than
Is less than

Figure 1 The SMART test.

To cite: Sinnott M, Eley R, Steinle V, et al. *J Clin Pathol* 2014;**67**:179–181.

Table 1 Results of the smart test

Diagnostic category	n	%	Explanation for diagnosis
Expert	65	60.2	Almost all items answered correctly
Problem integrating decimals with zero	18	16.7	A decimal number without a whole integer (eg, 0.1234) is considered smaller than the number zero
Money thinking	12	11.1	Digits after two decimal places ignored (eg, 0.12 and 0.1213 are the same)
Problem with repeating notation	6	5.6	Repeating numbers (eg, 0.4 and 0.444 are the same). Otherwise decimal numbers compared well
Problem with zeros	4	3.7	The significance of the zero in a number is ignored (eg, 0.66 and 0.606 are equal)
Errors, no pattern, incomplete	3	2.8	Several misconceptions may be used simultaneously, or result from carelessness
TOTAL	108	100.0	

Comparison of changes in concentration

Two examples, each containing two cases of changes in concentration were presented, and for each example participants had to indicate which case had increased most relative to the other case. Half the participants were incorrect in the first example and 30% in the second (table 2).

Reference ranges

Participants were asked whether values were normal or abnormal relative to reference ranges (table 3). Results suggest that as the number of decimal places exceed two, the number of false results increases.

Preferences

Sixty percent of the participants stated that their preference was for results to be presented as whole numbers. Finally, participants were asked the question 'in a busy and noisy emergency department, which of the following presentations of Troponin results would be safer for clinicians?' Results are presented in table 4. Of the 82 participants who expressed an opinion, 62.2% thought that the whole number (Format B) would be safer. One participant made the comment that 'reporting small numbers always leaves the door wide open for mistakes'.

Table 2 Ability to calculate a change in concentration

Which has increased more?	n	%
<i>Example 1</i>		
Case A; the concentration has increased from 40 to 200 mg/mL		
Case B; the concentration has increased from 0.04 to 2.0 ng/mL		
Case A has increased more	10	9.2
Case B has increased more (correct)	52	48.2
They have both increased by the same factor	46	42.6
Total	108	100.0
<i>Example 2</i>		
Case C; the concentration has increased from 0.006 to 0.36 µmol/L		
Case D; the concentration has increased from 6.0 to 36.0 µmol/L		
Case C has increased more (correct)	71	65.7
Case D has increased more	18	16.7
They have both increased by the same factor	18	16.7
Blank	1	0.9
Total	108	100.0

Table 3 Ability to compare to a reference range (RR)

Example of reference range (RR)	Normal		Abnormal		Blank	
	n	%	n	%	n	%
If RR is <0.4, the value of 0.51 is	2	1.8	105*	97.2	1	0.9
If RR is <0.55, the value of 0.2 is	105*	97.2	2	1.8	1	0.9
If the RR is >0.37, the value of 0.216 is	9	8.3	98*	90.1	1	0.9
If the RR is >0.093, the value of 0.21 is	93*	86.1	14	12.9	1	0.9

*Correct option.

Table 4 Preference for presentation

Preference	n	%
Format A: A zero preceding a decimal (eg, normal range <0.04 µg/L)	31	31.7
Format B: A whole number (eg, normal range <40.0 ng/L)	51	50.4
No opinion	25	17.7
Total	107	100

When asked what they thought would be the preference of others, only 14% (n=15) thought that Format A would be preferable, and only five of the 23 scientists considered that format A would be a 'safer presentation' for Troponin results.

LIMITATIONS

In a busy clinical setting, time pressure is placed on the clinicians. Not adding time pressure to the online test may have underestimated the rate of error expected in the clinical setting.

DISCUSSION

This study clearly demonstrated that a proportion of laboratory scientists and clinicians have trouble in understanding numbers with decimals which may affect their interpretation of test results. The study provides clear evidence to support recommendations that clinical pathology results should be expressed in whole numbers.¹⁻⁴ We believe providing this evidence base will result in faster uptake of these recommendations.

Only 16% of the respondents recognised that they had difficulty in interpreting decimal numbers, however, over twice that proportion were shown to exhibit misunderstanding. This relatively common lack of self-awareness, or insight into one's own innumeracy, could compound the risk of errors in clinical practice and provides more reason to remove the potential problem.

Take-home messages

- ▶ Poor comprehension of decimal numbers was illustrated by many laboratory and clinical staff.
- ▶ Resultant misinterpretation of test results is a potential source of medical errors.
- ▶ Whenever possible, pathology results should be presented as whole numbers.

Correction notice This paper has been corrected since it was published online. Goce Dimeski has been added as an author of this paper.

Acknowledgements We thank Beth Price and Eugene Gvozdenko from the University of Melbourne for their assistance with the SMART test website.

Contributors MS was responsible for conception, design and interpretation. RE and VS are responsible for design, data analysis and interpretation. MB and LT are responsible for collection and assembly of data. RE wrote the first draft of the manuscript and all authors contributed to the final version.

Funding This work was supported by a research grant from the Queensland Emergency Medicine Research Foundation. QEMRF-EMSS-12-184

Competing interests None.

Ethics approval The University of Queensland, The University of Melbourne and Metro South Human Research Ethics Committees.

Provenance and peer review Not commissioned; externally peer reviewed.

Data sharing statement Unpublished data are held by the Emergency Department at the Princess Alexandra Hospital by the lead author. The authors are happy to share those data upon request.

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