The role of numeracy in diabetes care

Gill Teft

Article points

1. People with any medical condition will have to use skills around numeracy on a daily basis.
2. For people with diabetes in particular, numerical skills are needed to interpret blood glucose readings, read food labels, calculate the carbohydrate content of foods and calculate insulin doses.
3. Four of the studies reviewed indicated that even people with good literacy skills frequently had problems with numeracy.
4. This review revealed that there is little evidence that numeracy skills, or a lack of them, are being taken into account when designing education support for people with diabetes. Healthcare practitioners may also need to consider their own numeracy skills.

Key words

- Education
- Literacy
- Numeracy

Gill Teft is Course Tutor HIDE Diabetes Course, University of the Highlands and Islands Millennium Institute, Highlands, Scotland.

Numeracy is an important aspect of literacy but has no internationally agreed definition; however, it may be broadly be defined as the ability to understand and use numbers in daily life tasks that require the use of numbers and are common to everyone in every walk of life. For those with a medical condition, and especially those with diabetes, there is a frequent need to use numbers to manage their condition. Daily tasks for people with diabetes include reading food labels, interpreting blood glucose readings, managing prescriptions and appointments and, for some, carbohydrate counting and adjusting insulin doses. In this short literature review, the author identifies that poor numeracy is a common but often unrecognised problem. It is suggested that actively assessing an individual's numeracy skills and providing educational materials that are appropriately tailored to their numerical ability may help to improve self-care.

Literacy is commonly understood to mean a set of tangible skills, particularly the cognitive skills of reading and writing (United Nations Educational, Scientific and Cultural Organization [UNESCO], 2006); however, it is also recognised that there is no standard international definition of literacy. UNESCO suggest that to really clarify its meaning, there should be a broader definition, such as the following:

> *"A person is functionally literate who can engage in all those activities in which literacy is required for effective functioning of his group and community and also for enabling him to continue to use reading, writing and calculation for his own and the community's development."*

The World Health Organization (WHO, 1998) suggests that health literacy represents the cognitive and social skills that determine the motivation and ability of individuals to gain access to, understand and use information in ways that promote and maintain good health. It is clear from both the UNESCO and WHO definitions that literacy is perceived as a living, changing concept rather than simply the ability to read and write. Literacy also involves the application of the reading and includes the ability to understand and use that information.

Numeracy, similarly, may be more complex than simply being able to understand and use numerical information. Huizinga et al (2008a) suggest that it is not only being able to understand arithmetic calculations, but is also being able to understand concepts that people use every day; for example, time and currency, measurement, and logical and graphical representations.

Research clearly suggests that low levels of literacy and numeracy are associated with poorer health outcomes and levels of treatment adherence (Ancker and Kaufman, 2007; Nelson et al, 2008; Rothman et al, 2008). In the UK and the USA, there are high levels of poor literacy and numeracy (Rothman et al,

2008; Kerr and Marsden, 2010). In the UK it is recognised that there are higher levels of poor literacy and numeracy compared with other countries with 75% of the adult population having numeracy levels lower than the level of a good pass at GCSE and 56% having literacy skills below this level (House of Commons Public Accounts Committee, 2009).

Attempts are being made to address these issues through Skills for Life programmes (launched by the Department for Education and Skills in 2001, although the responsibility was taken over by the Department for Innovation, Universities and Skills in 2007). Some success is being achieved as basic literacy and numeracy skills were improved in 2.25 million adults between 2001 and 2007, which was a target to achieve by 2010 (House of Commons Public Accounts Committee, 2009). However no re-evaluation has yet been undertaken to establish if this has resulted in an improvement in the national statistics.

It is also apparent that people with any medical condition will have to use skills around numeracy on a daily basis. For instance, numerical skills are needed for taking the correct number of medications at the right time, ordering new prescriptions to ensure they do not run out, managing calendars to attend clinic appointments and in making informed decisions about the potential efficacy of any treatment that is recommended to them.

For people with diabetes, this is even more challenging as managing the condition may also involve the need to interpret blood glucose readings, read food labels, calculate the carbohydrate content of foods and calculate insulin doses. The implications of getting these mathematical calculations wrong is enormous in terms of over- or underdosing insulin as well as affecting the individual's ability to manage the condition on a daily basis and achieve long-term good glycaemic control. Indeed, NHS safety alerts issued by the National Patient Safety Agency (NPSA, 2010) show that incorrect doses of insulin have been administered by people with diabetes and by healthcare practitioners (HCPs), which in some cases have resulted in death.

According to Warburton (2010), medication errors are a common cause of patient safety incidents reported to the NPSA's National Reporting and Learning Service as well as a leading cause of serious incidents. In addition, they also suggest that for paediatrics, almost half of the medication errors that were reported were related to incorrect or unclear dose or strength of medicine.

In a study by McMullan (2010), the numeracy skills of nurses when performing drug calculations were explored and it was found that 55% of student nurses and 45% of registered nurses scored <60% in a numerical ability test. When a drug calculation test was carried out results were astonishingly poor with 92% of student nurses scoring <60% and 89% registered nurses scoring <60%.

The Nursing and Midwifery Council (NMC, 2008) require prospective students to supply evidence that their literary and numerical skills is at the level required to undertake nurse training. With regard to numeracy, this includes being able to demonstrate that they can accurately manipulate numbers as applied to volume, weight and length (including addition, subtraction, division, multiplication, use of decimals, fractions and percentages) to include being able to use a calculator (NMC, 2008).

Health literacy and numeracy appears to be an important but under-studied aspect of diabetes care. Therefore, this literature review was conducted to investigate the topic further.

Literature search

To carry out this literature review, the author searched a number of databases including MEDLINE, Embase and PubMed. The focus was on any articles that related to health numeracy alone rather than literacy and numeracy. As there was such a paucity of literature around numeracy alone, review articles were considered particularly useful. Search terms were "health numeracy" and "diabetes numeracy". The search was restricted to English language studies published after 2000.

Overall, 13 relevant articles were identified. Six of these were original studies on numeracy, three

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2. For people with diabetes the implications of getting mathematical calculations wrong is enormous in terms of over- or underdosing insulin as well as affecting the individual's ability to manage the condition on a daily basis and achieve long-term good glycaemic control.
3. Health literacy and numeracy appears to be an important but under-studied aspect of diabetes care. Therefore, this literature review was conducted to investigate the topic further.

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1. A simple definition of numeracy is "the ability to understand and use numbers in daily life".
2. This literature review identified two validated numeracy scales that have been used to determine levels of numeracy skills: the Wide Range Achievement Test, 3rd edition and the Diabetes Numeracy Test.
3. Low numeracy skills have been associated with other health issues; for example, poor anticoagulant control in people taking warfarin, poorer asthma control and increased hospital admissions, obesity and poorer control of diabetes.

were literature reviews, three were commentaries and one was found to be on the psychological approaches to managing numerical information and was discarded.

Definitions of health numeracy

There is no single globally recognised definition of numeracy. Nelson et al (2008) use a simplistic definition:

> ***"The ability to comprehend, use and attach meaning to numbers."***

Golbeck et al (2005), Ancker and Kaufman (2007) and Donelle et al (2009) use a more complex definition:

> ***"The degree to which individuals have the capacity to access, process, interpret, communicate and act on numerical and probabilistic health information needed to make health decisions."***

The majority of articles that were reviewed (Cavanaugh et al, 2008; Huizinga et al, 2008a; Osborn et al, 2009; Kerr and Marsden, 2010) used a very simple definition:

> ***"The ability to understand and use numbers in daily life."***

This definition was chosen by the author as it is simple to understand and applies numerical understanding to daily life.

All of these definitions not only include whether a person is able to understand basic numbers, but also have been broadened to indicate how those skills are applied to daily life.

The literature review identified two validated numeracy scales that have been used to determine levels of numeracy skills. The first is the Wide Range Achievement Test, 3rd edition (WRAT 3) and second is the Diabetes Numeracy Test (DNT), which has two versions – the full with 43 questions or the shortened version with 15 questions. The DNT test was validated in a study of 398 people following development by an expert panel, and was found to have excellent internal and construct validity (Huizinga et al, 2008b). The DNT test is freely available from the Vanderbilt University website (http://bit.ly/qQcUgK).

Importance of health numeracy

Rothman et al (2008) found that approximately one in four people was unable to interpret an appointment slip to determine when their next appointment was due, and 19–33% were unable to work out how many pills they should take for their prescription. These authors did not state how their literature search was carried out; therefore, it is not possible to deduce how comprehensive this review was.

Low numeracy skills have been associated with other health issues; for example, poor anticoagulant control in people taking warfarin (Nelson et al, 2008), poorer asthma control and increased hospital admissions (Cavanaugh et al, 2009), obesity (Huizinga et al, 2008a; Cavanaugh et al 2009) and poorer control of diabetes (Rothman et al, 2008; Cavanaugh et al, 2008; 2009; Osborn et al, 2009). Nelson et al (2008) also did not provide details of how their literature search was carried out; however, they were able to link theoretical aspects of numeracy to practical application, identifying that using different methods for displaying numerical data may be of benefit to some individuals (as described below). In addition, they suggest that future research should consider such issues as the perceptions of numerical data and how they are displayed, and assess physician–patient communication around numerical information exchange.

As the desire and ability to have more flexibility around food and to maintain good glycaemic control increases, many people with diabetes are being educated to count the carbohydrate content of food by using, for example, the DAFNE (Dose Adjustment for Normal Eating) and BERTIE (Bournemouth Type 1 Intensive Education Programme) structured education programmes. However, carbohydrate counting is by no means an easy option and may be completely ruled out

for those with insufficient understanding and comprehension of numbers. Kerr (2007) identifies that not being able to understand and use these concepts is likely to have a negative impact on an individual's attempt to achieve good control of their diabetes.

Is literacy a good indicator of health numeracy?

One might imagine that among people with a good quality and duration of education or even with higher education, poor numeracy skills would be less common than among those with poorer levels or shorter duration of education. Indeed, Cavanaugh et al (2009) and Osborn et al (2009) identified an association of low health literacy and corresponding low health numeracy with poorer health outcomes.

Osborn et al (2009) investigated if racial differences were associated with poor numeracy and/or poor diabetes control. Interestingly, the results of this study demonstrated that health numeracy was a stronger predictor of the level of diabetes control than racial difference. However, Cavanaugh et al (2009) found that non-white ethnicity was associated with poorer diabetes control, as was lower income and fewer years of education. The majority of study participants had type 2 diabetes (86%), were white (63%), had more than high school level education (57%) and had previously received diabetes education (83%). Given these demographics, the sample used may not have been truly representative of the general population.

Four of the studies reviewed indicated that even people with good literacy skills frequently had problems with numeracy (Ancker and Kaufman, 2007; Nelson et al, 2008; Rothman et al, 2008; Huizinga et al, 2008a; 2009). Indeed, Nelson et al (2008) suggest that good numeracy skills should not be assumed because of any observable characteristics such as education, oral communication skills or intelligence, but should be actively assessed. Actively assessing numeracy may not usually be considered in any detail and may be difficult to carry out sensitively. Using a validated tool such as the DNT (either the long or short version) may provide a simple unambiguous way of conducting this assessment without causing distress or embarrassment.

Initiatives to assist those with poor numerical skills

This review revealed that there is little evidence that numeracy skills, or a lack of them, are being taken into account when designing education support for people with diabetes. Kerr and Marsden (2010) suggest that some educational materials provided for people on insulin pump therapy require numeracy skill levels equivalent to GCSE A*–C grades in Mathematics. Kellerman and Weiss (1999) considered the educational materials provided by the *Journal of the American Medical Association* to require too high levels of numeracy to be understood by most individuals.

In an attempt to address this gap, Cavanaugh et al (2009) designed an interactive Diabetes Literacy and Numeracy Educational Toolkit (DLNET). This tool consists of 24 interactive modules on a

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1. Presenting information with a positive or a negative bias can affect the individuals with low numeracy skills in terms of their interpretation of information.
2. Assessing an individual's level of numerical skills is important for tailoring education programmes to meet their educational and learning requirements.
3. Once poor numeracy has been identified, the educational materials commonly used may need to be adapted to present information in the most appropriate way, with the provision of numeracy-sensitive interventions.
4. Further study would be useful to establish how common poor numeracy skills are both in people with diabetes and in healthcare practitioners, and what the effect is if numeracy deficits occur both at the same time.

number of topics that may be customised to individual requirements and was created by a multidisciplinary team of experts in diabetes, each of whom had ≥10 years experience in the field. Feedback on the tool was given by educational psychologists and people with diabetes with varying levels of literacy. Importantly, the material has content and is displayed in a format aimed at being easy to read and understand for those with poor literacy and numeracy skills.

Although the DLNET was not validated in their randomised controlled study, Cavanaugh et al found that the use of this tool improved diabetes self-efficacy and also improved HbA_{1c} levels over a 3-month period. Interestingly, in this study, HCPs received health communication training, indicating that this was considered important when providing education. In light of this, it may be difficult to establish how much of the improvement in patient outcome was attributed to improved communication skills or the use of the educational material. Nelson et al (2008) suggest that clinicians should not just use material because they have a preference for it but that the content and format of presentation is also important in terms of its use to the patient.

Rothman et al (2008) and Nelson et al (2008) suggest that using different formats to present numerical information may be useful. Rothman et al (2008) suggest that colour-coded devices and picture- or table-based materials may be useful. In addition, Nelson et al (2008) suggest that the way numerical information is presented can have a profound effect on how it is interpreted by those with poorer literacy and numeracy skills. These people tend to focus more on short-term gains/losses over events that may occur in the future. For example, Nelson et al identified that those with poorer skills tended to perceive short-term personal costs (e.g. anxiety, side-effects) as more important than the long-term benefits of reducing cholesterol levels. This is clearly relevant for people with diabetes when they weigh up the short-term risks of hypoglycaemia against the long-term risks of diabetes complications.

Presenting information with a positive or a negative bias can also affect the individuals with low numeracy skills in terms of their interpretation of information. For this, Nelson et al (2008) used an example of data on the effects of surgery versus radiation therapy on the reduction of mortality rates in people with cancer. They found that both the people with cancer and their physicians considered radiation therapy preferable because it was presented as the risk of surviving rather than as the risk of dying.

Nelson et al also identified that presenting information in graphic format and other visual methods such as animations or films enhanced the understanding of numerical information for those with poor numeracy skills. However, Donelle et al (2009) compared the presentation of material about cancer in three different formats – text only, simple bar chart graphs and a combination of text and graphs – and found no significant difference between the groups' interpretations of the information obtained. Although this was a small study (49 participants) and the majority (65%) had at least high school level education, this study did demonstrate a correlation between health literacy skill and income.

Implications for HCPs

Assessing an individual's level of numerical skills is important for tailoring education programmes to meet their educational and learning requirements. The short version of the DNT may be a useful tool for such assessment. The author's correspondence with the Vanderbilt University found that there is no difficulty in changing the units of measure from mg/dL to mmol/L. However, once poor numeracy has been identified, the educational materials commonly used may need to be adapted to present information in the most appropriate way, with the provision of numeracy sensitive interventions. Education materials provided also need to take into account differing levels of numeracy to ensure they are useful and meaningful. HCPs may also need to consider their own numeracy skills.

Limitations

This review raised many more questions than it was able to answer, suggesting that further research is required. For example, specific challenges for those on insulin pump therapy or carbohydrate counting, and the frequency of insulin dosing errors caused by numeracy deficits were not explored. Recent events such as identification of insulin dosing errors in the Rapid Response Alert (NPSA, 2010) have indicated that there are issues related to poor numeracy skills in nurses. Further study would be useful to establish how common poor numeracy skills are both in people with diabetes and in HCPs, and what the effect is if numeracy deficits occur both at the same time. In addition, establishing the most effective way of identifying and addressing these issues to improve patient care and supporting educational materials will be of interest.

Conclusion

Numeracy is an issue that requires overt attention to ensure the individual's level of understanding is clarified. Poor levels of numeracy skills may be much more prevalent than is generally assumed. It is important to recognise that just because individuals have good literacy skills they may not necessarily have good numeracy skills and this applies both to people with diabetes and HCPs, including nurses.

This brief review of the literature has demonstrated that it would be worth exploring this issue further in people with diabetes and making more formal assessments of their literacy and numeracy levels prior to the commencement of any educational interventions. In this way, education can be tailored not only to suit their educational and emotional needs, but also to more adequately address their individual learning needs around numeracy. ■

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Poor levels of numeracy skills may be much more prevalent than is generally assumed. It is important to recognise that just because individuals have good literacy skills they may not necessarily have good numeracy skills and this applies both to people with diabetes and healthcare practioners, including nurses.