

Numeracy for Health

Why improving numeracy levels is critical to creating a sustainable NHS and improving health outcomes in the UK.

Introduction

There are many numeracy skills that people need to look after their health. Cancer Research UK recently found that 46% of their sample got the answer wrong when asked whether a risk of 1 in 100, 1 in 10, or 1 in 1000 resulted in more chance of their getting a disease.

As well as understanding risks, patients need numeracy skills to manage their diets, make and keep medical appointments, measure medicine doses, or simply work out a routine for taking tablets throughout a day. Numeracy is also important for navigating the healthcare system and choosing hospital services on the basis of nurse-patient ratios, readmission rates, and friends & family ratings. And it is not just patients' skills which are relevant here.

Numeracy is crucial for healthcare workers who are expected to practise complex calculations in highly critical and stressful situations.

What is the issue?

People need a range of numeracy skills in order to look after their health. These can be as simple as being able to tell the time and identify the time and date of a doctor's appointment. They can also be as complex as working out an insulin dose or whether you're eating a balanced diet. If people have better numeracy skills associated with health literacy, then they are more able to self-manage their healthcare plans, prevent themselves from becoming ill and make better decisions about their care. Numeracy within health is also critical for medical practitioners who have to make complex calculations every day. Improving numeracy skills for both patients and healthcare practitioners can reduce medical error and improve efficiency in the NHS.

Numeracy is a key component of health literacy, the term given to the basic skills essential to understanding, communicating, and caring for health needs. While health literacy is an essential set of skills for both patients and healthcare workers, evidence suggests that the majority of people lack the numeracy skills needed to understand food labels, medicinal instructions, and information given by the NHS in leaflets and online. Whilst 43% of the UK population do not have the adequate literacy skills for today's healthcare system, 61% of the UK population do not have the numeracy-specific health literacy skills needed to maintain their health ([Rowlands et al.](#)).

Notably, there are links between low numeracy levels and socioeconomic inequality. People earning less than £10,000 per year are four times more likely to have inadequate health literacy. Furthermore, those who would rather not, or cannot report their levels of income are almost 6 times more likely to have inadequate health literacy ([Von Wagner et al.](#)^b). This may suggest that those who are on unstable incomes, an hourly wage, or in temporary work are more likely to have lower levels of health literacy and numeracy.

Healthcare workers often lack the numeracy skills needed to enable them to do their jobs safely and effectively. Support staff are expected to understand fractions, decimals, ratios, and percentages, as well as understand charts, handle money, and understand weights and volumes to monitor patient care - often without any training in numeracy skills ([Braddell & Cripps](#)). Despite being more highly educated, doctors and nurses cannot always accurately perform drug calculations, drug percentages and infusion rates ([Rolfe & Harper](#), [Wheeler et al.](#), [McMullan et al.](#)). Concerns that healthcare workers are sometimes unable to consistently perform the numeracy-related tasks needed in their everyday roles are corroborated by the high level of medical error in the NHS ([Vincent et al.](#), [Hogan et al.](#), [Frontier Economics](#)). Whilst further research is needed to establish how improving numeracy could improve patient safety, experts suggest that improving numeracy skills is integral to increasing patient safety and reducing the costs of preventable patient stays ([Weeks et al.](#), [Warburton](#)).

It is evident that low numeracy skills affect the lives of many patients and healthcare workers. This review critiques the research behind this evidence, and looks at how building numeracy skills in health could make a positive impact on patients, inequalities, and the economy.

Why is numeracy different in health?

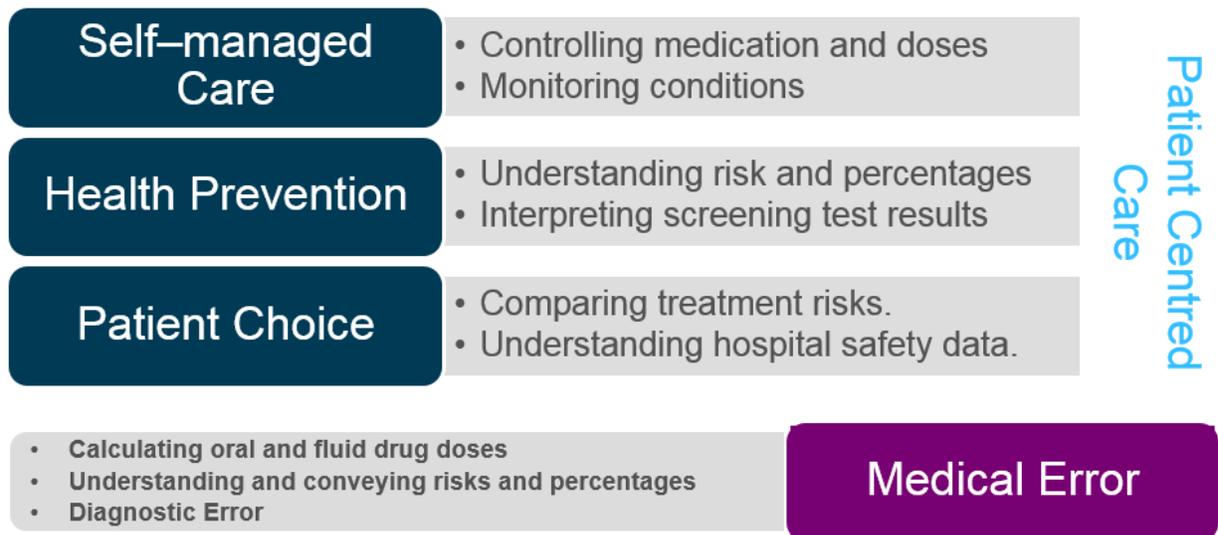
Numeracy is an important life skill. We use it in budgeting and finance, building and construction, cooking, and even planning and time management. But research suggests that numeracy in health involves dealing with types of information with which we may be less familiar. The nature of this information can also increase the anxiety someone may have around numbers as error can have serious, potentially life-threatening repercussions.

Numbers within health are metaphors – for life and death, wellness and illness ([Adelsward & Sachs](#)). Unlike calculating money, or counting eggs in a cake, using numbers in health

can be fundamental to our very survival - through measuring our blood sugar levels, weight, or how big a puff we can blow into a peak flow meter. These scales are complex. They can only give us a representation of knowledge about our health, which must be interpreted according to whether we are old or young, male or female, or have pre-existing diseases. Despite this, patients must make clear objective decisions on their healthcare, such as whether or not to have an operation, take a drug, or how much insulin they should inject after eating lunch.

Decisions on health are particularly difficult given the potential outcomes of patients' choices. Whilst we are beginning to understand the maths anxiety some people can experience when confronted with numbers, this does not even begin to depict the emotional barriers patients may have with confronting evidence concerning their health (Chin, Edwards et al.). Nor does it address a healthcare worker's fears, knowing their numerical ability results in life or death for a patient in their care. This qualitative research suggests that numeracy in health has its own distinctive hurdles which must be addressed in order to reduce the effects of poor numeracy on health and health inequalities in the UK.

The remaining chapters of this review explore the evidence for how low numeracy affects patients' abilities to self-manage their chronic health conditions, take precautions to protect their health, and make good decisions on their care. The final section then looks at healthcare workers and how increasing numeracy skills could decrease preventable medical error, making huge savings in the NHS each year.



Measuring Health Literacy and Numeracy

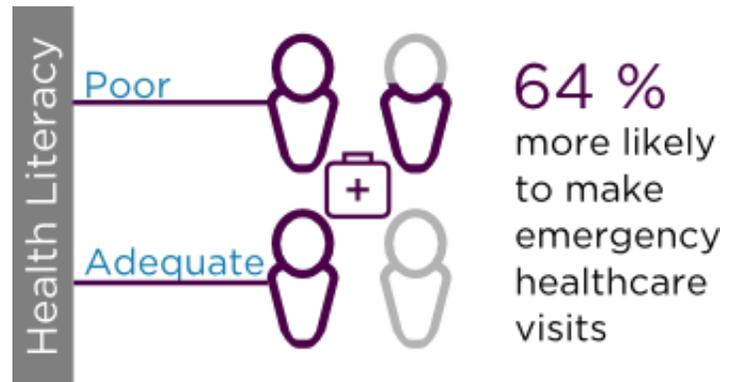
Work is still being carried out to find a comprehensive measure for health literacy which is quick enough to use in long studies and medical practice. The most recent exploration is that of the Newest Vital Sign (NVS) test, which uses a food label and takes just 3 minutes to test both literacy and numeracy skills associated with health. As this research is so new, most studies in this report use alternative measures of health literacy.¹

Patients

Self-Managed Care

Poor numeracy affects patients' abilities to manage many chronic healthcare conditions. Findings from the UK suggest that lower health literacy tends towards poor self-management of diabetes treatments. This includes failures to calculate carbohydrate intake and insulin doses, interpreting glucose readings, and knowing when to seek medical help (Cavanaugh et al., Marden et al., Zigmund-Fisher et al.). This is confirmed by research in the USA, where poor numeracy has been related with poorer asthma-related quality of life and more emergency admissions from Asthma patients (Apter et al.). Poor health literacy skills in the USA have also been associated with lower health outcomes amongst patients with chronic kidney disease (CKD) (Fraser et al.), and patients' abilities to manage their cholesterol (Estrada et al.).

When patients are less able to self-manage their care, they are more likely to end up needing emergency care related to their chronic health conditions. Research from the USA found that patients with lower health literacy are 69% more likely than those with adequate health literacy to be admitted to an emergency department (Baker et al.). Even when controlling for comorbidities



and health-related behaviours, those with low health literacy are still 64% more likely than those with adequate health literacy to turn up to A&E (Griffey et al.). Targeting poor health literacy skills could increase patients' abilities to self-manage care and seek early interventions, reducing costly emergency admissions in the NHS. Patients must have an adequate understanding of numeracy to take their own readings for peak flow, blood sugar levels and to know when and where it is appropriate for them to seek medical help. Examples of the kind of complex calculations needed by patients suffering from asthma and diabetes can be seen in **Boxes 1 and 2**. Many of these calculations require Level 2 functional numeracy skills (roughly equivalent to GCSE A*-C) (Kerr & Marden). However,

the Skills for Life Survey showed that in 2011, only 21.8% of the population in the UK had numeracy skills to this level. Numeracy skills in the UK are therefore far below the level needed to ensure NHS patients are able to self-manage their care.

Box 1:

Numeracy in Asthma Care

Potential problems:

- 1) A 22-year-old woman with unstable asthma is asked to record peak flow readings in the grid provided with the device. She is afraid to tell her doctors that she does not understand how to graph the numbers.
- 2) A 30-year-old man is told the Green Zone (the OK zone) is a reading between 80% and 100% of your best reading and the Worry Zone is between 50% and 80% of your best reading. His best reading is 400 L/min but he cannot work out the point that he needs to seek medical help.

Apter et al. (2006, 2008)

The policy drive from the Department of Health to increase self-managed care must be met by a drive to increase numeracy levels in the UK. There are currently concerns that an ageing population and an increase in chronic health conditions, such as diabetes, asthma, and hypertension, is putting financial pressure on the NHS. As a response, policy initiatives have focused on increasing patient involvement in their care, reducing the costs of staff, hospital beds, and resources in the NHS. Care is increasingly being transferred to the responsibility of individual patients.

Alongside this is a growing use of technologies, such as portable monitors and 'telecare', where patients communicate numerical information regarding their weight or blood sugar levels through text messaging as a tool for monitoring their care. However, experts within pharmaceutical and medical technology industries are concerned that patients do not have the basic skills needed to utilise such a technology (Boulos et al., Kerr & Marden).

The Department of Health need to do more to ensure patients are equipped with the right skills to support their plans to increase the use of self-managed care in the NHS. Without improving patients' numeracy skills, policies aimed at increasing patient responsibility could increase healthcare inequalities, and increase the use of emergency services.

Box 2:

Numeracy in Diabetes Care

Calculations requiring Level 2 maths:

- 1) Calculating carbohydrate content in food:

$$\begin{array}{l} \text{Total weight of food (g)/100} \\ \times \\ \text{Carbohydrate content of food per 100g} \\ = \\ \text{carbohydrate content (g)} \end{array}$$

- 2) Sample blood glucose (BG) bolus calculation:

If your insulin sensitivity factor (ISF) is 2.8 mmol/l and your target BG is 6 mmol/l, how much is your BG bolus if your BG is 4.5 mmol/l?

$$4.5 \text{ mmol/l (BG) minus } 6 \text{ mmol/l (target BG)} = 1.5 \text{ mmol/l}$$

$$1.5 \text{ mmol/l lower than target divided by } 2.8 \text{ (ISF)} = 0.5 \text{ units}$$

Kerr & Marden (2010)

Recommendations:

More work needs to be done to increase numeracy levels amongst patients and families experiencing chronic illnesses. GPs and primary care nurses should provide patients with guidance and support to improve their numeracy. Third party interest groups could also engage with a campaign for numeracy to increase the awareness that good numeracy levels can protect your health. Private sector actors in emerging industries such as those promoting telecare and blood sugar monitors also need to engage in increasing numeracy levels to ensure their consumers have the skills needed to use their products. In doing so, it is important to engage patients with numeracy in their own time, at their own pace, away from the emotional stress of health.

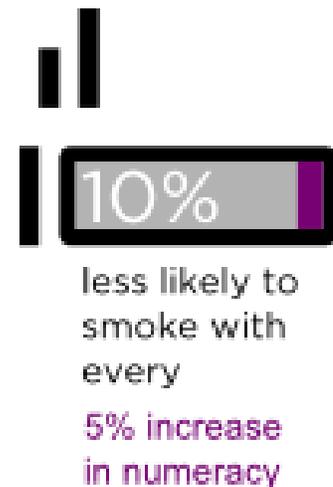
Preventative Care

Poor numeracy levels may also affect people's abilities to prevent ill health. It is difficult to monitor your weight, understand nutritional labels, or count how many units of alcohol you drink a week without good numeracy skills. There is also a growing body of evidence finding that people with lower numeracy levels are less likely to take screening tests, detecting early signs of fatal diseases.

Strong evidence has developed illustrating the relationship between poor numeracy levels and the likelihood of attending and understanding screening tests. Cancer Research UK found that poor numeracy levels affect people's decision to take a bowel cancer screening test, independent of their socioeconomic background. Lower numeracy levels were also related to less knowledge, more negative attitudes, and more defensiveness associated with bowel cancer screening ([Smith et al.](#)). This evidence illustrates the importance of numeracy for gaining an early diagnosis for major life-threatening diseases.

Further research also based in the UK indicates that every 5% increase in health literacy skills gives a 10% increase in the likelihood of participants eating 5 portions of fruit and vegetables a day (95% CI = 1.5%-15%). Similarly, every 5% increase in health literacy decreases the likelihood of smoking by 10% (95% CI = 1.5%-15%) ([Von Wagner et al.^a](#)). However, results suggest that if the survey were repeated the relationship between health literacy and preventative health behaviours may in fact only be very small. More research is needed to establish how poor numeracy levels affect people's likelihood of smoking and eating healthily.

There is also concern that poor numeracy skills affect people's abilities to interpret food labels in order to monitor their diets. In the USA, [Rothman et al.](#) found that low levels of health literacy affected people's abilities to comprehend and use nutritional food labels. However, there have recently been efforts



to improve food labelling in the UK, meaning this relationship may be weaker in the UK population (Figure 1). Further studies need to be carried out in a UK context to understand the effects of low numeracy skills on preventative care in more depth.

The Department of Health have developed major initiatives to encourage people to develop healthy lifestyles. Campaigns such as [5-a-day](#), [Smokefree](#), and [Change4life](#) have attempted to tackle healthy eating, smoking, and alcohol consumption to prevent future ill health. These developments have encouraged individuals to take more personal responsibility for their health outcomes, increasing the need for numeracy skills. Policy initiatives in public health have also centered on encouraging screening, vaccinations, and early diagnosis of life-threatening diseases. Increasing early interventions reduces spending on major treatments and operations needed for late-stage treatment of life-threatening diseases. Putting more emphasis on improving basic skills would enable the Department of Health to reduce spending on major treatments associated with life-threatening diseases and chronic health conditions.

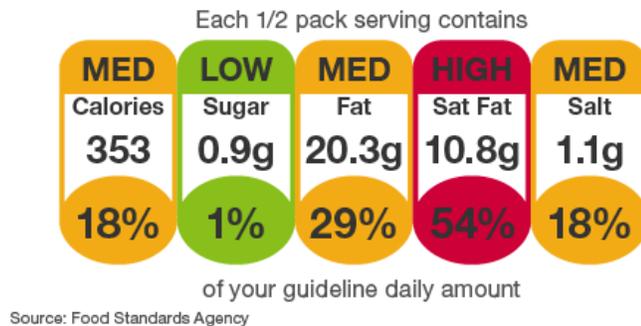


Figure 1: UK Food Label

Recommendations:

Improving numeracy levels is essential for ensuring that public health campaigns reach the people most in need of developing healthy lifestyles to prevent ill health. Further research is needed to build a more in-depth understanding of how health literacy skills affect people’s abilities to prevent ill health. Nonetheless, public health bodies must acknowledge growing evidence that improving numeracy is a significant part of improving people’s health and wellbeing. Further action is needed to include training in basic skills within public health planning, involving second and third sector providers at the community level.

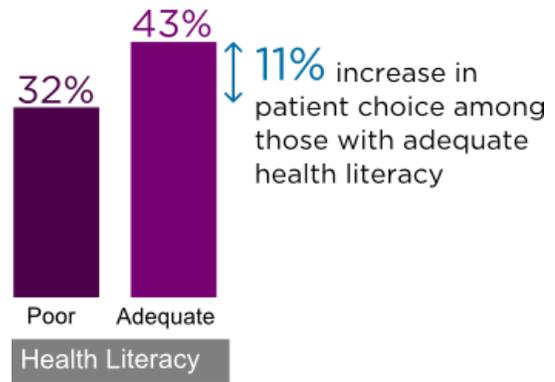
Patient Choice

The Department of Health have pledged that there will be “[No decision about me without me](#)” for all patients using the NHS. They suggest that patients should be empowered to make decisions on their own care. They also hope that increasing a consumer culture through [patient choice](#) will encourage providers to compete on the quality and efficiency of services, reducing overall spending in the NHS. At the same time this means that

patients have more responsibility to understand the potential outcomes of a variety of options for treatment. In order to make these choices, patients must also be empowered with the numeracy skills needed to understand information on services and risk factors.

Patient choice is being implemented through [NHS Choices](#); a website for patients which presents data on different services. (Figure 2). This includes: the percentage of planned hours of registered and unregistered nursing staff actually delivered by the hospital; the percentage of staff or patients who would recommend the hospital to friends or family; and the rate of unplanned readmissions to the hospital. These examples illustrate the degree of numeracy skills expected of patients to make decisions concerning their care.

Concerns over the level of numeracy required of patients by NHS Choices are reinforced by existing research into health literacy and patient choice. A study in the Netherlands found that patients with low self-assessed health literacy skills are less likely to research and choose between healthcare providers ([Rademakers et al.](#)). Similarly in the UK, patients with lower assessed health literacy were found to be less likely to click on links offering further information about colorectal cancer screening. Those with lower health literacy are therefore limited in the knowledge on which they would make their choice ([Von Wagner et al.^b](#)).



Sort by distance	Care Quality Commission inspection ratings	A&E performance	Mortality rate	Recommended by staff	Infection control and cleanliness	Number of patients waiting more than 52 weeks	Friends and Family Test : Inpatient
Brighton General Hospital	Requires improvement Rated on 07 August 2014. Visit CQC profile	88.3% Patients seen within 4 hours	OK As expected in hospital and up to 30 days after discharge (0.9601)	! Among the worst with a value of 56.92%	n/a Data not available	OK No patients waiting more than 52 weeks	n/a Data not available
Royal Sussex County Hospital	Requires improvement Rated on 07 August 2014. Visit CQC profile	88.3% Patients seen within 4 hours	OK As expected in hospital and up to 30 days after discharge (0.9601)	! Among the worst with a value of 56.92%	! Among the worst	OK No patients waiting more than 52 weeks	90% Patients recommend this hospital. 420 responses.

Figure 2: NHS Choices Website

Patients need an understanding of numeracy to be able to make informed decisions on when, where, and how to be treated. [Protheroe et al.](#) have warned that the Department of Health's policy of increasing patient choice may inadvertently increase socio-economic inequalities in health as those with lower health literacy are less able to make the best decisions about their care. Improving health literacy may not only be important to ensure good patient choice, but to ensure Government policy to embed patient choice in the NHS does not increase inequalities in health in the UK.

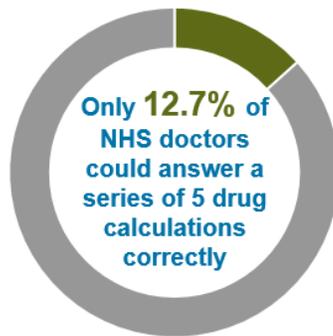
Recommendations:

Empowering patients with choice in the NHS is only possible if patients are simultaneously empowered with the numeracy skills needed to make healthcare decisions. The Department of Health could embed patient learning in the process whereby patients make healthcare decisions. This could be implemented through primary care, including GP surgeries, and the NHS Choices website. Integrating the need for learning in the NHS Commissioning Guidelines would be a good first step to achieving these aims. Third parties promoting patient interests could also offer support to increase numeracy levels for patient choice.

Healthcare Workers

The Department of Health is concerned about the impact of medical error on patient safety in the NHS. They recently commissioned a number of reviews to investigate increasing reports of failures of care, including [The Mid Staffordshire NHS Foundation Trust Inquiry](#) and the [Berwick Report](#). These independent reviews suggested that failings of care were due to a negative culture amongst healthcare workers in the NHS. Amongst the core recommendations is a renewed focus on transforming the NHS into a "learning organisation", where healthcare workers constantly strive to improve their skills and knowledge.

Research confirms that medical error is indeed a risk for patient safety. It is estimated that 4.68% of NHS hospital admissions are due to preventable medical error ([Pirmohamed et al.](#)). Studies focused on hospitals in Greater London found that 5.2% of patients were admitted to hospital due to preventable medical error, suggesting medical error is greater in busy London hospitals than elsewhere in the UK ([Vincent et al.](#)). The real effects of medical error may be even larger, as these studies exclude errors resulting from healthcare workers' failures to communicate instructions to patients. Further estimates suggest that 5.2% of deaths in NHS hospitals are due to preventable medical error each year. Of these deaths, 31.3% are attributable to poor clinical monitoring; 29.7% to diagnostic errors; and 21.1% to poor drug or fluid management ([Hogan et al.](#)). All of



55% of NHS nurses scored over 80% on oral medication and injection calculations



NO nurses scored over 80% on calculations for drug percentages and infusion rates

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only 12.7% of doctors could answer a group of five numeracy questions calculating drug doses correctly (Rolfe & Harper). Nurses have similar issues with numeracy (McMullan et al., Jukes & Gilchrist). A recent study found that only 55% of the Registered Nurses could score over 80% of questions correctly on calculations for oral medication and injections. Nurses appeared to have less numeracy skills relating to drug percentages and infusion rates, as no participants achieved over 80% on these questions (McMullan et al.). In reality, nurses may have even lower levels of numeracy skills, as the participants for this study were recruited through a course for nurse prescribing, and would have started to receive some training related to numeracy. Although further evidence is needed to fully understand the relationship between patient safety and staff numeracy levels, we are beginning to appreciate that more needs to be done to improve and maintain the basic skills of healthcare workers in the NHS.

The economic repercussions of these failures in basic literacy and numeracy skills could be substantial. The Patient Safety Observatory estimates the costs of actual reported preventable medical error per year to be £750m. The real cost is probably higher because they do not account for the under-reporting of medical failures. Frontier Economics suggests the cost is closer to £2.5bn, assuming that the 755,000 extra patients admitted to hospital care a year cost the average price per patient hospitalisation (Vincent et al.). This figure does not include litigation costs, which were £1.3bn in the year 2012/3, and is limited to the economic loss due to unexpected inpatient hospital admission. The economic repercussions associated with inappropriate medicine issued due to diagnostic errors, or treatments in primary care go unaccounted for. Investing in the numeracy skills for healthcare workers may therefore have economic repercussions as well as an effect on patient safety. The Department of Health therefore have a responsibility to make

these tasks require basic skills in numeracy, suggesting numeracy skills may be lacking amongst some healthcare workers in the UK. Experts agree that improving staff skills is key to reducing patient deaths due to medical error in the NHS (The National Patient Safety Authority, Weeks et al., Warburton).

The importance of a renewed focus on learning in the NHS is highlighted by studies evidencing inadequate numeracy levels amongst healthcare staff. Numeracy levels have been found to be insufficient amongst NHS doctors, especially amongst those who are newly qualified or working in the community (Wheeler et al.). Concerns for numeracy levels amongst doctors are not new. Studies from twenty years ago found that

further investigations into how a deficiency of numeracy skills amongst healthcare workers affects medical error and efficiency in the NHS.

Conclusion

National Numeracy believe that more attention should be paid to the effects of poor numeracy on health. This research suggests that it is important to improve numeracy amongst patients, their friends and family, healthcare workers, and the general public to build social networks of skills, supporting people to look after their health. There is sufficient evidence in the literature reviewed to suggest this would enhance the effectiveness of government policies on increasing the involvement of patients in care and reducing medical errors.

This report has argued that improving numeracy skills in the UK is critical for ensuring that patients are safe to self-manage their care, protect themselves from future illness, and make good choices about their treatments in the NHS. Evidence repeatedly points to numeracy as a key indicator for patients' abilities to manage their diabetes care, take screening tests, and live healthily. Despite these benefits, the [Skills for Life Survey](#) found that 49% of the population is working at or below the level expected of a child at primary school. Further research has found that 61% of the UK population does not have the numeracy-specific skills needed to maintain their health ([Rowlands et al.](#)). Whilst further research is needed to develop a measure for health literacy and fully understand the relationships with healthy living and patient choice, it is clear that more work is needed to improve numeracy for health in the UK.

We have also presented evidence for why more attention must be paid to the numeracy skills of healthcare workers in the NHS. Whilst more research is needed to investigate the direct relationship between numeracy and medical error, it is apparent that many errors made by healthcare workers are related to numeracy. The most frequent medical errors include poor drug and fluid management, poor clinical monitoring, and diagnostic errors; all of which require good numeracy levels ([Hogan et al.](#)). The importance of numeracy is reinforced by initial evidence revealing that many doctors and nurses in the NHS do not have adequate numeracy levels to consistently complete the calculations they must carry out on a day to day basis ([Rolfe & Harper](#), [Wheeler et al.](#), [McMullan et al.](#), [Jukes & Gilchrist](#)). Evidence suggests that medical error results in 755,000 more patients being admitted to hospital each year, costing the NHS £2.5bn per annum ([Frontier Economics](#)). Improving and maintaining healthcare workers' numeracy could therefore contribute significantly to reducing this level of medical error, and improving efficiency in the NHS.

This research comes at a time when the Department of Health wants to increase patients' involvement in care and train healthcare workers to improve patient safety in the UK. Policies are being designed to encourage patients to manage their illnesses in their own

homes and make their own decisions about when and where they are treated. At the same time there have been reports marking increasing concern for patient safety in hospital settings. Improving the numeracy levels of both patients and healthcare workers is integral to the success of these policy initiatives. We urge the Department of Health, NHS, and third sector bodies to collaborate with National Numeracy to improve the health numeracy of both patients and healthcare workers, developing a safer and more efficient NHS.

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ⁱ There are a number of different measures used to measure health literacy. Some, such as the REALM, do not test for numeracy skills. These are sometimes used alongside tests such as the Wide Range Achievements Test (WRAT) which tests non-health-related literacy and numeracy.

More commonly, the test for Functional Health Literacy in Adults (TOFHLA) is used to measure health literacy. The TOFHLA was developed in the USA to use real life scenarios in health to measure numeracy and literacy skills directly within a health setting. A shorted version of this test (the STOFHLA) was also verified in the USA. Neither test has yet been verified for a UK population, but [Von Wagner et al \(2007\)](#) adapted, piloted, and used the TOFHLA in a UK population within a larger study.

The only measure for health literacy currently verified for use in the UK is the Newest Vital Sign (NVS). [Rowlands et al.](#) verified this test, originally created in the USA, which uses a food label and just three questions to give a quick test for health literacy and numeracy. It was verified for internal consistency using Cronbach's Alpha Testing, and tested for correlation with the TOFHLA.

There are also surveys such as the European Health Literacy Survey (HLS-EU) which measure self-assessed ability to handle words and numbers in a health-related setting and possible health-related access and outcomes. This was verified across the EU but this process did not include the UK.

Further disease-specific tests are sometimes used to test patients on health literacy or numeracy related specifically to the self-management of their disease. Examples include the Diabetes Numeracy Test (DNS) ([Cavanaugh et al.](#)), and the Asthma Numeracy Test (ANT) ([Apter et al.](#)).