Information Mastery

Decision-making and dealing with information overload

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Introduction

Practising medicine involves making decisions. Evidence-based medicine is founded on the idea that decision-making in health care should incorporate the best available evidence in conjunction with the experience of the clinician and the views of the patient[1]. Everyone with an interest in healthcare – health professionals, patients, managers and the wider public – expects to see the findings of important research incorporated into clinical practice without undue delay. Failure to use evidence optimally leads to inefficiency and a reduction in both quality and quantity of life for patients[4]. In the NHS, evidence-based guidance is sometimes under or over implemented, with considerable variations in uptake[3]. Why should this be? The answer lies, at least partly, in the 'professional bureaucracy' nature of the NHS[4]. Unlike traditional bureaucracies, with their strong internal hierarchies, front-line clinical staff have a large measure of control and influence over day-to-day decision-making, which is greater than staff in formal positions of authority[4]. Adoption of evidence into practice therefore depends ultimately on decisions to change made by individual people. Ideas about how people learn, how they make decisions and how they can better manage information can help teachers and learners identify, evaluate and incorporate evidence appropriately into their practice, and can help practitioners in making decisions better, both for and with patients. This chapter is necessarily conceptual, and establishes the importance of teaching these ideas for clinical practice. The optimal ways *in which* to teach them have yet to be fully elucidated but, like the recognition in the 1980s of the importance of teaching consultation skills, that gap is not a reason to let these ideas be side-lined or neglected.

Summary

- Being a clinician entails making decisions. This in turn requires the identification, recall, interpretation and application of large volumes of information.
- Ideas about how people learn, how they make decisions and how they can better manage information can help teachers and learners identify, evaluate and incorporate evidence appropriately into their practice, and can help practitioners in making decisions better, both for and with patients.
- Humans normally make decisions based on their own mental map of information and the internalised tacit guidelines ('mindlines') they construct, largely from brief reading and talking to other people.
- Clinicians can **hot-synch** their minds with the evidence they need to be able to manage the conditions they see commonly. Instead of unfocused reading or attending teaching sessions with a generic curriculum, the 'golden' one hour a week most people can devote to CPD can be spent reviewing summaries of evidence produced by trusted, public sector organisations

covering conditions in one's practice.

- Patients and their health care practitioners rate being up to date with recently published research very highly. In order to meet this need a **foraging** service is required – a service that surveys the literature (and other sources of information) and alerts health professionals to that new information which is both important and likely to be useful to them.
- In addition to foraging and hot-synching, clinicians need an approach to finding information, when they are 'stuck'. This is called **hunting** and is an approach which enables clinicians to find useful information rapidly when they need it, and also enables them to know that they have found the best answer, not just *an* answer. This is a more directed and refined approach than simply searching Medline or Google Scholar.
- Understanding what the numbers in a summary of evidence are saying is a necessary requirement for modern healthcare. Without this, professionals and the public are susceptible to manipulations of their concerns and hopes. In turn this undermines the goals of informed consent and shared decision making.

How do people learn?

Educational theory is covered in much greater depth in the book *Chapter 10: Five Pearls of Educational Theory*. However, the summary that follows is provided to set the scene for the remainder of this chapter. The traditional model of teaching and learning sees learners as empty vessels to be filled with knowledge, with the teacher deciding what the learner should know and the learner learning it in the teacher-approved form[5]. Moreover, it assumes that people will automatically know what to do, and will do it, in response to the factual information they have been told. The limitations of this approach are readily apparent: it is common experience that good practice is rarely universally agreed upon or adopted quickly. In fact, an approach which (perhaps tacitly) implies 'a doing unto, by someone who knows more, to someone else' is actually likely to hamper change – especially if those at the receiving end perceive themselves as experienced, proficient practitioners[6].

A learner/adopter-centred approach

Two important developments have increased understanding of learning and teaching. The first is the influence of cognitive psychology: the science which describes how humans think. It is now generally recognised that humans do not passively accumulate knowledge but that learning involves creating a complex, personal, mental map[7,8]. In contrast to the 'push' approach of the traditional model of teaching and learning, contemporary adult learning theory encourages more of a 'pull' approach, in which individual learners are more in control of the learning process. The teacher's role is understood as being to help learners build new knowledge and understanding from and onto their prior knowledge[7,8].

Learning as participation as well as acquisition of knowledge

The second development is a recognition that thinking about learning solely in terms of acquiring and personally making sense of things is not enough[9]. Learning can alternatively be seen as participation: a process of becoming a member of and contributing to the development of a 'community of practice'[9,10]. Examples include a group of GPs or a practice team. This model of learning is implicit in some aspects of traditional apprenticeship models

and in the development from novice to expert practitioner. However, it is not simply about learning how to work within established ways of doing things[10]. It also entails the creation of knowledge at the level both of individuals and also the system(s) in which they practice[10]. In this model of learning, the community of practice is seen as having ways of thinking, sets of values, and expectations of behaviours which are associated with its particular culture. People new to it start by hearing and using terms which express these concepts, but do not fully understand them in their deeper senses. As they develop their membership they are increasingly able to engage in and contribute to the communal development of these concepts, and the community's 'sense-making' of new information or circumstances[10]. This takes place on individual and inter-individual levels[10]. Just as different organs combine to form a living body, so the individual members influence and are influenced by the whole community of practice[9].

How do people make decisions?

All decision-making in healthcare requires the recall, interpretation and application of large volumes of information. The processes humans use to handle large volumes of complex information are the same, whatever the context or type of information[11]. There is a limit to the amount of information humans are able to use in decision-making: when faced with a large quantity of it, the portion actually used is usually truncated so as to make a 'good enough' decision. This phenomenon is known as 'satisficing'[11]. The over-arching theory which unifies many theories of decision making (called 'dual process theory') describes two broad processes which humans use to make decisions (**Figure 1**)

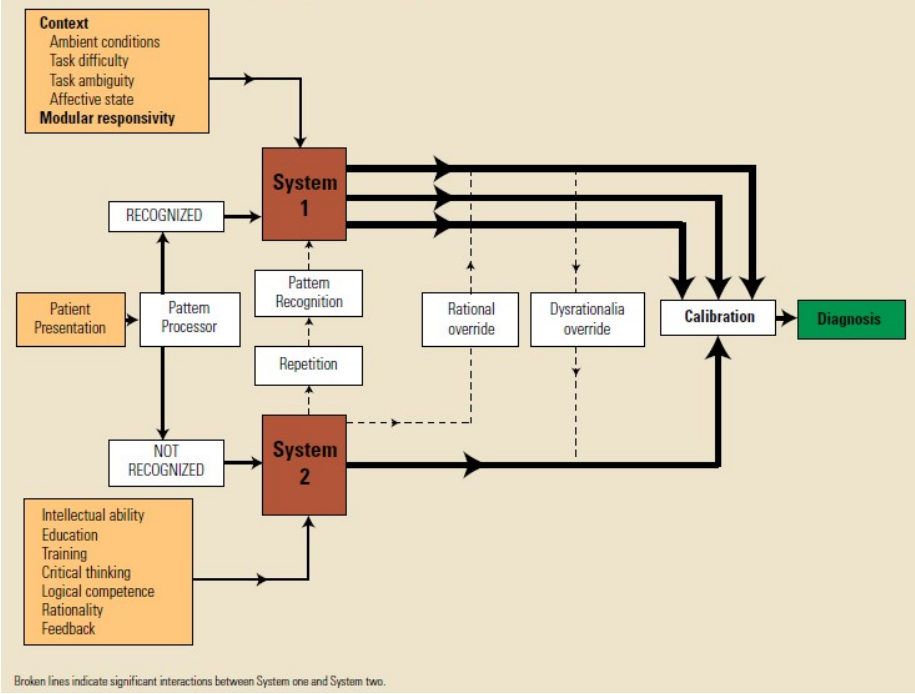
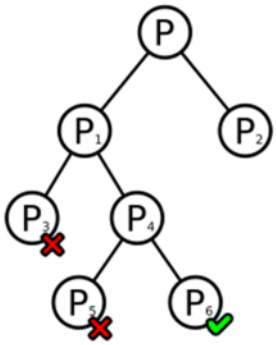


Figure 1: Schematic model for diagnostic decision making

Reprinted from *Croskerry P. Context is everything or how could I have been that stupid? Healthc Q. 2009; 12:e171-6.*

Humans tend to favour the intuitive, automatic way of processing information known as **System 1 processing**. This involves the construction and use of mental maps and patterns, shortcuts and rules of thumb (heuristics), and 'mindlines' (collectively reinforced, internalised tacit guidelines[12]). These are usually based on undergraduate teaching, brief written summaries, personal experience, talking to colleagues (the community of practice) and seeing what they do[12,13,14]. Mindlines are developed and reinforced through experience, repetition and interactions with others in the community of practice[12,13,14].



The alternative – **System 2 processing** – involves a careful, rational analysis and evaluation of all the available information. Neither System 1 nor System 2 should be regarded as 'good' or 'bad'. System 1 processing can provide life-saving decisions very quickly. For example: child with neck stiffness, photophobia and a non-blanching rash –> meningococcal septicaemia –> intravenous antibiotics. On the other hand, System 2 processing can locate information which enables a decision to be made when System 1 is incapable of doing so. However, System 2 processing takes more time and this may not be consistent with the pace required of clinical practice. Gaps between evidence and practice occur when a clinician develops a pattern of knowledge, which is then relied on for decisions using System 1 processing, without the activation of a System 2 check (which could be as simple as checking that the person with suspected meningococcal septicaemia is not allergic to the proposed antibiotic).

The normal preference for System 1 processing makes it difficult for practitioners to recognise when they need to use System 2 processing instead[11]. Some clinical decision support systems (especially those which force a degree of System 2 thinking when appropriate) have been shown to improve clinical practice significantly[15], including increasing safer prescribing[16]. All practitioners can try to ensure that, when they are appropriately using System 1 thinking, they take a moment to check that the decision they have come to is reasonable. Imagine a consultation with a teenager with frequent coloured circular flashing visual aura lasting for seconds to minutes, which may be clustered, and are followed by a headache with vomiting. If only System 1 processing is used (teenager + visual aura + headache + vomiting), to reach a diagnosis of migraine; without activating System 2 to analyse the parts of the story that don't quite fit (coloured + circular + brief + clustered), then the diagnosis of occipital lobe seizures could be missed[17].

A major challenge for clinicians is to pick out the information they need to inform their practice from the almost daily flood of information they receive (see below). However, even if they succeed in this, the preference all humans have for System 1 processing makes it hard to modify practice in the light of new information which conflicts with one's previous (perhaps tacit) assumptions and knowledge[11].

Shared decision-making

Shared decision-making, involving patients and professionals, is increasingly recognised as an essential part of modern healthcare[18], and indeed is enshrined in one of the most widely quoted definitions of evidence-based medicine[1]. NICE recommends that all patients should have the opportunity to be involved in decisions about their medicines at the level they wish[19]. A study of patients in seven general practices in London in 2007 found that 39% wanted their GPs to share the decision and 16% wanted to be the main (14%) or only (2%) decision maker themselves. Of the remainder, just 17% wanted the GP to be the only decision maker regarding their care[20]. GPs underestimated patients' preference for involvement in 23% of the consultations studied. In a survey by the Picker Institute in 2006, 45% of primary care patients who responded indicated that they had not had sufficient involvement in choosing their medication[21].

Shared decision-making requires health professionals to have the necessary information to hand and to be able to give patients sufficient and appropriate information in a format that they can make sense of and understand[19,22]. However, poor numeracy impairs understanding of health risks and benefits. NICE guidance on involving patients in decisions about prescribed medicines and supporting adherence recommends using, among other things, symbols and pictures to make information accessible[19]. Tools that present information in this way are known as Patient Decision Aids (PDAs)[23]. In contrast to health education materials, which simply provide broad background information, PDAs are tailored to patients' health status and help them to make specific, personal choices about their treatment[24]. A Cochrane review found that PDAs performed better than usual care interventions in terms of greater patient knowledge and lower decisional conflict related to feeling uninformed, or to feeling unclear about personal values[24]. PDAs also reduced the proportion of people who were passive in decision making or who remained undecided post-intervention. Exposure to a PDA with probabilities resulted in a higher proportion of people with accurate risk perceptions. PDAs were found to be no better than comparisons in affecting satisfaction with decision-making, anxiety, and health outcomes[24].

Many PDAs are intended for use by patients largely away from the consultation, to prepare for the discussion with a health professional. However, alternative approaches can also be successful. **Figure 2** displays the effects of statin treatment on 10-year risk of cardiovascular events in a Cates plot (see www.nntonline.net). Two randomised trials evaluated different PDAs about statin treatment with graphics similar to that in Figure 2, compared with usual care[24,26]. Patients who received the PDAs generally had a better idea of their estimated cardiovascular risk and the potential absolute risk reduction with statins, and had less decisional conflict and decisional regret (wishing in retrospect they had made a different choice about whether or not to take the treatment) than did patients in the control groups[25,26].

Figure 2: A Cates plot of the effects of statin therapy on risk of cardiovascular events in people at 20% 10-year risk.

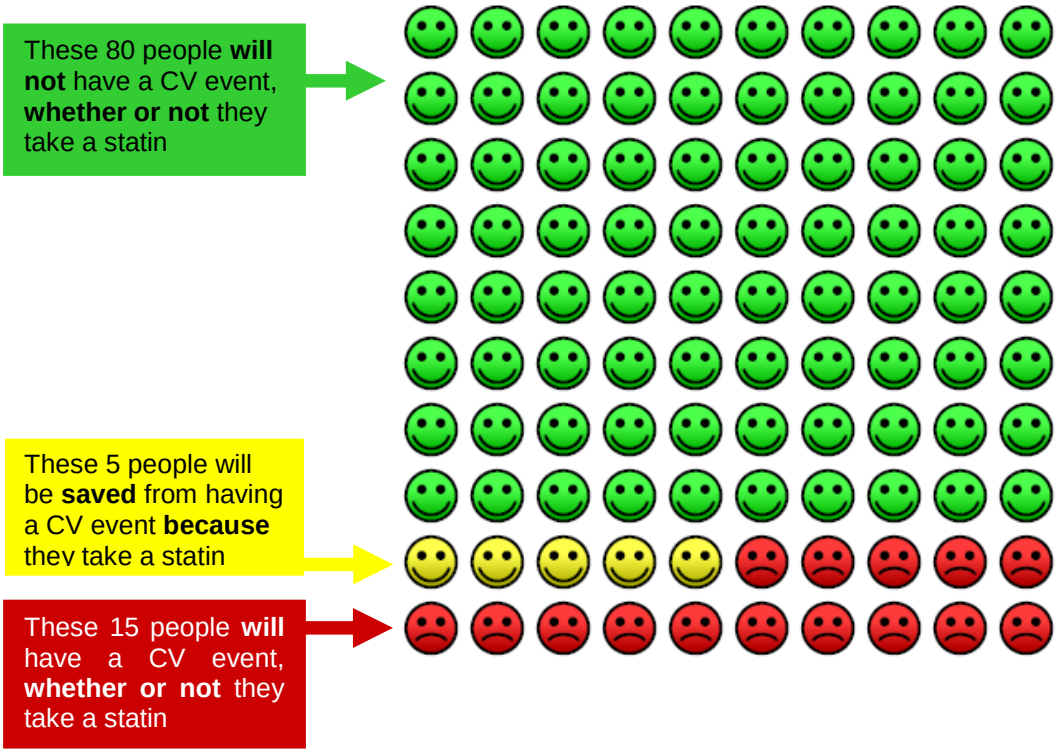
People at 20% risk of CV events over 10 years

Imagine 100 people at this level of risk. In the next 10 years, about 20 (20%) of them will have a CV event. However, if those same 100 people each take a statin for 10 years:

- About 5 people will be 'saved' from having a CV event by taking a statin (the **yellow** faces below).
- About 80 people will not have a CV event–but would not have done even if they had not taken a statin (the **green** faces below).
- About 15 people will still have a CV event (the **red** faces below), even though they take a statin.

But remember

- It is impossible to know for sure what will happen to each individual person.
- All 100 people will have to take the statin for 10 years.



Information management & Information Mastery

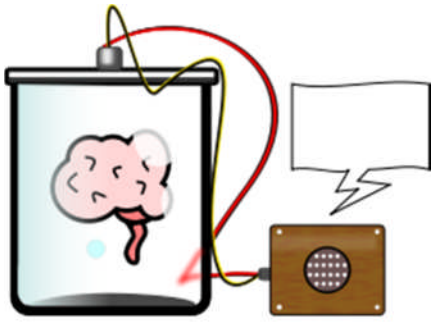
Practitioners are presented with a daily flood of newly published research, guidance, opinion, etc., but face a major challenge in identifying not only the important new information they need, but also that which is out of date among what they already know[27]. To cope with these large volumes of information, practitioners 'satisfice'[11], but the strategies they adopt may carry risks. Many practitioners use expert opinion as a shortcut to information and its application to practice, but experts can be wrong. For example, in one study 53% of the answers given to Dutch occupational physicians by experts of their choice regarding typical questions in their practice were wrong, compared with the answer obtained from a full literature search[28].

It is unrealistic to expect clinicians to be up to date with conditions they rarely see – the volume of data is too large to handle. By the time they see a patient with such a condition it is likely that they will have forgotten what they learned, or remember it incorrectly, or what they learned will have become out of date. For example, it is unreasonable to expect a GP to know without checking (i.e. without using System 2 processing) how to manage hypertrophic cardiomyopathy, but entirely reasonable to expect this of a tertiary centre cardiologist. Similarly, it is unreasonable to expect a cardiologist to be up to date in managing otitis media, but any patient would expect a GP to be expert in this. Effective System 1 processing will permit the GP to assimilate all the information required for expert diagnosis and management of otitis media into a mental map and mindline and activate this for efficient, effective care. 'Information Mastery' describes a system by which busy practitioners can keep up to date and optimise their System 1 processing, and effectively and efficiently use System 2 processing when this is appropriate (and recognise when this is so)[29,30]. There are three complementary components and practitioners need to employ all of them.

Two of these components primarily support effective System 1 processing. Firstly, patients and their health care practitioners rate being up to date with recently published research very highly. In order to meet this need a **foraging** service is required – a service that surveys the literature (and other sources of information) and alerts health professionals to that new information which is both important and likely to be useful to them and, ideally, places it in the context of the rest of the evidence base[29]. Since brief reading is an important shaper of the mindlines which are a key player in System 1 processing, a good foraging service will help ensure those mindlines are up to date and in keeping with current evidence.

Foraging also, importantly, helps clinicians identify when they need to activate their System 2 processing. For example, one might be made aware of the results of the ADDITION-Europe study through a foraging service[31]. This looked at the effect of early intensive multifactorial management (of HbA1c, blood pressure, cholesterol, and prescription of aspirin) on 5-year cardiovascular outcomes in people with newly diagnosed type 2 diabetes

that had been detected by screening. Although some small reductions in disease-oriented outcomes (HbA1c, blood pressure, total and LDL-cholesterol) were seen with intensive management compared with usual care, no statistically significant differences were found in any patient-oriented cardiovascular outcome (i.e. whether patients lived longer or better). If a clinician finds these results surprising, given his or her mindline on type 2 diabetes, it highlights the need to review that mindline and stimulates the clinician to ask questions: what is the value of screening for type 2 diabetes? What is the value of intensive interventions in type 2 diabetes? etc.



This leads to the second element of Information Mastery, called **hot-synching**. Just as users hot-synch their MP3 players with their music playlists, clinicians can hot-synch their minds with the evidence they need to know to be able to manage the conditions they see commonly. Instead of unfocused reading or attending teaching sessions with a generic curriculum, the 'golden' one hour a week most people can devote to continuing professional development (CPD) can be spent reviewing summaries of evidence produced by trusted, public sector organisations covering just the conditions the individual practitioner commonly sees. Hot synching is realistic for busy clinicians, and fits with the human dimensions of information acquisition and decision making. By facilitating targeted, focused 'offline' System 2 processing, it enables clinicians to continue to use the rapid and efficient System 1 processing in the health care setting because their mindlines are based on the best available evidence. Moreover, an effective foraging service will alert them to new, important information published since they last hot-synched on a particular topic[30].

In addition to foraging and hot-synching, clinicians need an approach to finding information when the problem cannot be addressed by the information they hold in their (now evidence-based) mindlines and mental maps; in other words, when they are 'stuck'. This third element of Information Mastery is called **hunting**, and supports System 2 processing. It is an approach which enables clinicians to find useful information rapidly when they need it, and also enables them to know that they have found the best answer, not just *an* answer[29]. This is a more directed and refined approach than simply searching Medline or Google Scholar and is discussed further below. It is admitted that hunting is the component of Information Mastery that clinicians often find the most difficult to use in practice (despite having previous teaching in searching and critical appraisal). Unfortunately, most of the evidence-based medicine movement has concentrated resources almost entirely on teaching this most difficult of the three components of Information Mastery, rather than a more balanced skill set to enable foraging and hot-synching, as well as hunting[30].

Defining and finding useful information

The information that is likely to be the best, that is, the most useful, that clinicians can find, whether foraging, hot synching or hunting is expressed in the usefulness equation (see **Box 1**)[29.30].

Box 1: Usefulness equation[29.30]

$$\text{Usefulness of a piece of clinical information} = \frac{\text{relevance}^{a} \times \text{validity}^{b}}{\text{work required}^{c}}$$

a. Information that is likely to be relevant to frontline care includes that which relates to a feasible intervention and which shows a direct effect on whether patients live longer or better. See also **Box 2**
b. The information's validity depends on factors such as study design, attempts to minimise bias and confounding, and statistical power
c. This is the work required to find the information and by extension, the work required to establish its relevance and validity

The usefulness of a piece of information is directly proportional to its relevance and its validity and inversely proportional to the amount of work required to find it and make sense of it. A piece of information which is both highly relevant and highly valid and which is found easily and quickly is likely to be extremely useful. That same piece of information would be less useful if a great deal of work was required to find it. Equally, a piece of information which is readily available but is either not very relevant or not very valid is also not very useful. In fact it might be positively unhelpful. The relevance of a piece of information is readily assessable and the FOCC mnemonic can be of help (see **Box 2**)[29].

Box 2: Screening for relevance: the FOCC mnemonic[29]

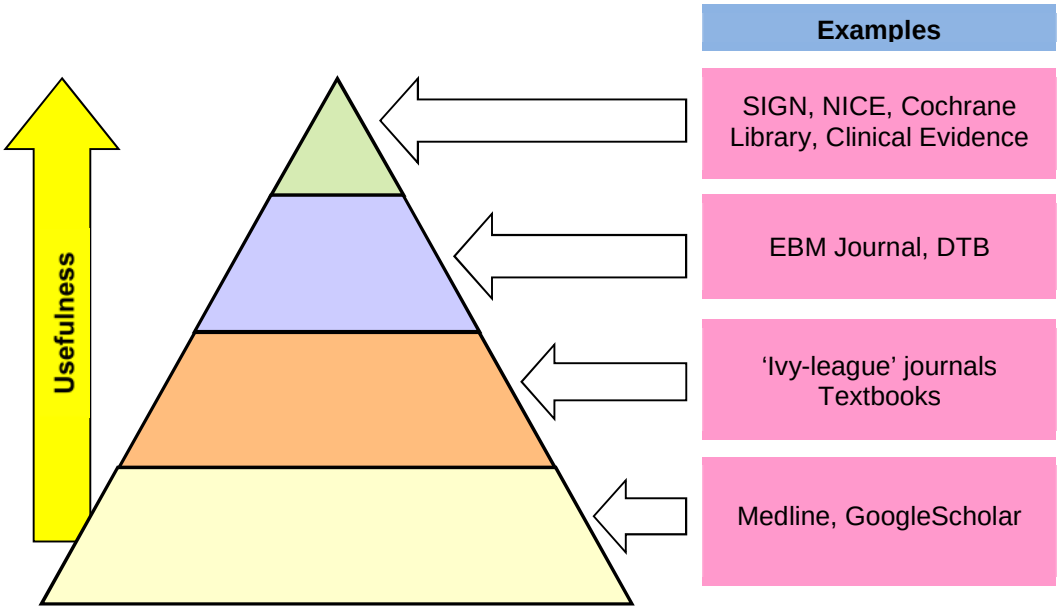
Feasible:	*the intervention is feasible in our clinical practice*
Outcomes:	*the study reports patient-orientated outcomes**
Common:	*the condition or clinical situation is common in our clinical practice*
Change:	*a change in practice might be required if this information is valid and is in keeping with the rest of the evidence base.*

*A patient orientated outcome (POO) is an outcome which is important to patients. For example, a reduction in the rate of heart attacks and strokes, a reduction in the development of diabetic foot ulcers or a reduction in night time wakenings in people with asthma This is in contrast to disease orientated outcomes or DOOs: these do not directly tell us if the intervention helps patients to live longer or live better. They are surrogate markers and are often laboratory tests. Examples include reductions in blood pressure (compared with reductions in clinical cardiovascular endpoints such as heart attack or stroke), HbA_{1C} in type 2 diabetes and peak expiratory flow volume in asthma. These may be useful surrogate measures, which indicate a benefit to patients, but equally they may not, and indeed can sometimes mislead.

When evaluating a piece of information for relevance, unless it has **all** the characteristics in the FOCC mnemonic, it is extremely unlikely to be relevant to the busy clinician and can be ignored or at most read for interest, rather than to keep up to date or to answer a clinical question[29].

Whether foraging, hot-synching or hunting, the information pyramid applies (see **Figure 3**) [29.30]. A key feature of the Information Mastery approach to using high quality information to inform practice is that someone else other than busy front-line clinicians – preferably a trusted public sector organisation or one with a similar ethos – does the selection and critical appraisal.

Figure 3: The Information Mastery pyramid[29,30]



The most useful information sources are at the top of the pyramid. When hunting for information, clinicians need to drill down from the top to find the information they need. An answer found in the sources towards the top of the pyramid is likely to be the best answer available and there is no need to drill further[29.30]. If a resource has NHS Evidence accreditation, users can be assured that processes used to create it are robust and reliable.

At the top of the pyramid, sources such as NICE and SIGN guidance are based on syntheses of all the available evidence, which has been systematically searched for and rigorously appraised, and they provide recommendations for practice which will address most clinical situations. Similarly, the Cochrane Library, Clinical Evidence, and similar synthesised sources of information, produced by trusted and trustworthy providers of information in a timely and up to date manner, are likely to be most useful to busy clinicians.

Next come sources such as the Drug and Therapeutics Bulletin, which publishes high quality evidence-based reviews, and the EBM Journal (see http://ebm.bmj.com/), which scans other journals, assess the validity of evidence presented in them, summarises this and provides a commentary. 'Ivy league' journals, such as BMJ, Lancet, New England Journal of Medicine, etc. come next. The quality of their content is usually high, but some critical appraisal skills are required to assess the articles' validity properly, and many articles will not be relevant.

Text books are easier to access, but the validity may not be so high: they might present information selectively and the information may be out of date. Medline and Google Scholar and similar sources at the bottom will provide lots of information, but the usefulness is quite low, because a lot of work is required to filter out the relevant and valid information

Relevance before validity

Screening for validity is more difficult and requires some expertise and also time and frequent practice. There are numerous options for practitioners to acquire and develop these basic skills. However it is reasonably easy to spot the fatal flaws which more commonly occur in randomised controlled trials. These are a general guide and further reading is advised[30].

Is it a high level of evidence?

Wherever possible, decisions should be based on evidence from high quality randomised controlled trials or systematic reviews and meta-analyses of randomised controlled trials. However, such evidence is not always available and it may be necessary to use less robust evidence, such as observational studies (cohort studies and case–control studies), recognising their potential limitations[30].

Is it statistically significant?

The probability that the difference observed is due to the play of chance is indicated by the p value. By convention, if a result could occur by chance less than one time in 20 (or 5 in 100, p = 0.05) then that result is accepted as proven 'beyond reasonable doubt' and said to be 'statistically significant'. If the p value is very small then it is likely that the difference seen is not due to chance. However, the closer the p value is to 0.05 the greater this possibility. 'No statistically significant difference' does not necessarily mean there is truly no difference between the interventions – that might be so, or it might be that the study is underpowered (see below). However, if the p value is greater than 0.05 that single piece of research is not useful to the busy clinician.

There is a link between the p value, statistical significance and confidence intervals. All clinical trials are conducted on a sample of people with a particular clinical condition and the result obtained applies to that sample, not the whole population of people with that condition, which might be different due to the play of chance. In practical terms, the 95% confidence interval (95% CI) gives the range within which it is 95% certain that the true result would lie, if the intervention were applied to the whole population of people with that condition (with a 2.5% chance it could be greater and a 2.5% chance it could be less). Thus the CI gives a helpful measure of the precision of the results. If the 95%CI does not include the 'line of no effect': that is, zero for absolute and relative risk reductions or 1 for relative risks, hazard ratios and odds ratios (see **Box 3**), the p value would be less than 0.05 and the result is taken to be statistically significant (as above). If the 95%CI does include the 'line of no effect' the result is not statistically significant.

Is it clinically important?

It is possible for a study to produce a highly statistically significant result which has very limited clinical value. For example, a difference in time to walk 50 metres might be reduced to a highly statistically significant extent by one treatment compared to another, but in absolute terms the difference might be only a few seconds, or even less[30].

What do the numbers mean?

There will be a key expression of difference in the results – relative risk, relative risk reduction, absolute risk reduction, odds ratio or hazard ratio. There is no shortcut to developing the skills required to gain the essential understanding of what those terms mean (see **Box 3** on the following page)[30].

Were there enough people in the study for long enough?

It is possible to obtain false positive or false negative results with a small randomised controlled trial undertaken for a short period. The number of participants and the duration required for a reliable result are determined statistically by a power calculation. As a general principle, if no power calculation is provided and there were fewer than 200–300 participants, there might be some concerns about the validity of the result[30].

Was the allocation concealed?

The importance of allocation concealment has only recently been recognised. It is not necessary to understand the details of allocation concealment to know that it is important, but in essence the study investigators should not know to which group the potential subject would be assigned **before** enrolling them. It is not the same as blinding, but is in fact a potential source of recruitment bias. Trials with unconcealed allocation consistently overestimate benefit by about 40%[30].

Putting it all together

Being a GP entails making decisions. This in turn requires the identification, recall, interpretation and application of large volumes of information. This chapter has focused on two important components of this: firstly, how people – health professionals and patients alike – make decisions and how these decisions might be made better; and secondly, it offers an approach to managing the large volumes of information with which practitioners are faced almost daily. It might be helpful to reflect critically on one's decision-making in the course of a typical day and consider how much thinking, and what type of thinking, went on for each decision – or indeed, did one just 'know' what to do? What was this based on – what one *knew* to be the evidence, what one *thought* to be the evidence, or what someone else – with all the same cognitive biases as any human – *said* was the evidence?

Probably the aspect of Information Mastery and decision-making in which most clinicians can make most progress, most quickly is the adoption of an effective hot-synching system. This can be followed up by investigating one or more foraging tools. There are many available, and the resources in **Box 4** can help identify those best suited to one's needs. Those resources can also be helpful for readers who wish to develop their understanding of the ideas introduced in this chapter. Above all, seeking out colleagues who want to try a similar approach to better information management and better decision-making – a community of practice – is likely to be extremely helpful in putting these ideas into practice. It is hoped that the ideas discussed in this chapter will assist educators and trainees in teaching, learning and in consultations, to the benefit of the patients for whom we seek to care.

Box 3: Expressions of difference[30]

In a fictitious randomised controlled trial lasting one year, **40%** of people taking the control treatment died. Only **30%** of people taking the experimental treatment died over the same period. This difference can be expressed in different ways:

1. The **absolute risk reduction (ARR)**, also sometimes called the risk difference

   Control rate - experimental rate = 40% - 30% = 10%.

   Translating this to natural frequencies, which most people find easier than percentages, out of every 100 people given the experimental treatment, 10 fewer die than would have done if all 100 had taken the control treatment.

2. Absolute difference can also be expressed as a **number needed to treat (NNT)** – the number of people who need to take the treatment rather than the control for one to benefit. The sum to calculate this is:

   NNT=100 ÷ ARR (when the ARR is a percentage) or
   NNT = 1 ÷ ARR (when the ARR is a decimal)

   In the example above, the ARR is 10%, so the NNT is 100 ÷ 10 = 10. For every 10 people who take the new treatment for one year, one does not die who would have done had they all taken the control treatment. The other nine live or die, just as would have happened if they had taken the control treatment. The lower the risk of the event at baseline, the higher the NNT for any given RRR.

3. The **relative risk reduction (RRR)**

   (Control rate – experimental rate) ÷ control rate = (40% - 30%) ÷ 40%
   = 10% ÷ 40% = 25%.

   Relative risk reduction can sound impressive, but this can mislead. The RRR is the same whether the reduction is from 40% to 30% or 0.0004% to 0.0003%. In the latter case, on average, one million people would have to take that medicine for one person to avoid dying, who would have done had they all taken the control treatment. No doubt side effects would affect some of them and there would also be the cost and inconvenience of medicine-taking to consider. Absolute difference is required as well as relative expressions of difference in order to assess the usefulness of a medicine.

4. The difference can also be expressed as a **relative risk** (also sometimes termed **risk ratio**). This is a simple sum:

   Experimental rate ÷ Control rate = 30% ÷ 40% = 0.75.

   That is, the risk of death in the group given the experimental treatment is 0.75 or, in other words, a person given the experimental treatment is 0.75 times as likely to die Note that if there were no difference in rates between experimental and control treatments, the RR would be 1. The RRR can be simply calculated as 1 – RR. If the outcome happened more often in the experimental group than the control group, the RR will be greater than 1. As with the RRR, it must be remembered that the RR is the same whether the reduction is from 40% to 30% or 0.0004% to 0.0003%

5. Odds are sometimes the only way to describe differences, rather than rates. In the example above, the odds of dying with the experimental treatment is 30:70, or 0.43, and the odds of dying with the control treatment is 40:60, or 0.67. Odds are compared in an **odds ratio (OR)**. The OR in this example is 0.43/0.67 = 0.64. An OR is unlikely to be the expression of difference used in a randomised controlled trial written up appropriately. ORs are appropriate to be used in case control studies and some meta-analyses. The odds ratio reduction can be calculated from 1-OR. In this example, The OR reduction is 0.36. This is might seem more impressive than the RRR of 0.25.

6. Another expression of difference often seen is the **hazard ratio (HR)**. This expression of difference cannot be calculated from event rates. It takes into account that during the study events may not occur at the same rate over time or at the same rate in either group. In the example above, if there were 100 participants taking control treatment the first death in that group would have an impact of 1/100 on the population, the second death 1/99 (because only 99 people were left), and so by the time there had been 39 deaths the 40th death would have an impact of 1/61. The HR is calculated by a computer program using the time and number of events as they occurred during the study. It can also take account of participants joining and leaving the study at different times (as studies rarely recruit every participant on day 1, and some participants may drop out part way through for reasons unconnected with the study). The HR should be thought of as broadly equivalent to RR, although the HR may be smaller than RR (so the HR reduction would be greater than the RRR), again providing to the unwary an impression of a more impressive benefit than some other expressions of difference.

Box 4: Resources and further reading

Tufts University School of Medicine (Department of Family Medicine)

- Information Mastery pages: http://familymedicine.tufts.edu/information-mastery.htm.

National Prescribing Centre (NPC)

- Online video: *Making decisions better*: http://www.npc.nhs.uk/evidence/making_decisions_better/making_decisions_better.php
- eLearning resources on evidence-informed decision-making: http://www.npc.nhs.uk/evidence/index.php
- Online video on using patient decision aids (PDAs): http://www.npc.nhs.uk/patient_decision_aids/pda_movie/patient_decision_aids.php
- Directory of NPC-produced PDAs and further information about PDAs: http://www.npc.nhs.uk/patient_decision_aids/pda_movie/patient_decision_aids.php

Dr Chris Cates' EBM site

- Main site: http://www.nntonline.net/
- VisualRx (generates Cates Plots): http://www.nntonline.net/visualrx/

EBM Journal

- http://ebm.bmj.com/

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