

Intuition and evidence — uneasy bedfellows?

Trisha Greenhalgh

SUMMARY

Intuition is a decision-making method that is used unconsciously by experienced practitioners but is inaccessible to the novice. It is rapid, subtle, contextual, and does not follow simple, cause-and-effect logic. Evidence-based medicine offers exciting opportunities for improving patient outcomes, but the 'evidence-burdened' approach of the inexperienced, protocol-driven clinician is well documented.

Intuition is not unscientific. It is a highly creative process, fundamental to hypothesis generation in science. The experienced practitioner should generate and follow clinical hunches as well as (not instead of) applying the deductive principles of evidence-based medicine.

The educational research literature suggests that we can improve our intuitive powers through systematic critical reflection about intuitive judgements — for example, through creative writing and dialogue with professional colleagues.

It is time to revive and celebrate clinical storytelling as a method for professional education and development. The stage is surely set for a new, improved — and, indeed, evidence-based — 'Balint' group.

Keywords: *evidence-based medicine; clinical judgement; intuition.*

Stories of intuition

A few years ago, while doing a general GP locum, I visited a 58-year-old man who had been complaining of abdominal pain for three days. He was on long-term steroids (which had probably been commenced decades ago for asthma). He was very overweight and lying the wrong side of a sagging double bed. His Lloyd George notes consisted of a single page. Apparently, he had no previous medical history and had not consulted his GP for over 15 years. His wife was extremely anxious, because they were foster parents and due to take in a recently orphaned teenager. He had to be fit to drive the next day.

He admitted to being constipated, and his abdominal pain was probably no worse now than two days ago. Physical examination — inasmuch as I could complete one — was unremarkable. His abdomen was only mildly tender and the bowel sounds were normal. He grunted a bit, but that was all. In view of the steroids, I sent him into hospital, and the registrar put him on 'four-hourly observations'.

That night, I went home and told my husband that I had seen a man who was going to die. He did indeed die, four days later, despite normal bloods and observation chart throughout. Postmortem showed a strangulated volvulus.

This story raises a number of questions about the appropriate clinical management of the patient in hospital, but I include it here to show that intuitive insights are commonplace in general practice, and they may or may not save lives. They are rarely as impressive as the one I first heard quoted by Professor Nigel Stott (and which I subsequently analysed in detail) from a GP in Cardiff: 'I got a call from a lady saying her three-year-old daughter had had diarrhoea and was behaving strangely. I knew the family well, and was sufficiently concerned to break off my morning surgery and visit immediately.'

This GP's hunch led him to diagnose correctly, and treat successfully, a case of meningococcal meningitis on the basis of two non-specific symptoms reported over the phone — an estimated 'hit rate' for that particular GP of one in 96 000 consultations, and a veritable *tour de force* for clinical intuition. The intuitive judgements we make on a daily basis in clinical practice are generally less dramatic but no easier to explain on a rational level.

What is intuition?

Few doctors dispute that intuition plays a part in their practice, but there has been relatively little formal research into how (and to what extent) intuition contributes to decision-making in the clinical setting. The term evades a precise definition, but it is probably useful to describe its key features (Box 1).

Mystery writer Sir Arthur Conan Doyle, a medical doctor himself, likened the work of a detective — solving a crime — to that of a doctor diagnosing a mystery illness from subtle

T Greenhalgh, OBE, MD, FRCP, FRCGP, professor of primary health care, Department of Primary Care and Population Sciences, Royal Free and University College Medical School, London. This essay is based on the 2000 George Swift Lecture, delivered to the Wessex Faculty of the Royal College of General Practitioners at the Guildhall, Winchester, on 12 October 2000.

Address for correspondence

Professor T Greenhalgh, Open Learning Unit, Department of Primary Care and Population Sciences, Royal Free and University College Medical School, 2nd floor, Holborn Union Building, Highgate Hill, London N19 3UA.

Submitted: 15 January 2001; Editor's response: 6 June 2001; final acceptance: 24 July 2001.

©British Journal of General Practice, 2002, 52, 395-400.

- rapid, unconscious process
- context-sensitive
- comes with practice
- involves selective attention to small details
- cannot be reduced to cause-and-effect logic (i.e. B happened because of A)
- addresses, integrates, and makes sense of, multiple complex pieces of data

Box 1. Features of intuition.

physical signs. Indeed, Conan Doyle is said to have based the character of Holmes on one of his own medical teachers at Edinburgh. In *The Memoirs of Sherlock Holmes*, Holmes states: 'It is of the highest importance in the art of detection to be able to recognise out of a number of facts, which are incidental and which are vital'.²

In one of the first Sherlock Holmes novels, Holmes is asked to explain a particularly impressive and obscure feat of reasoning, and responds as follows: 'From long habit the train of thoughts ran so swiftly through my mind that I arrived at the conclusion *without being conscious of intermediate steps*' (my italics).

Educationalists Hubert Dreyfus and Stuart Dreyfus, writing about intuition in industrial engineering, concluded that 'Experienced intuitive [practitioners] do not attempt to understand familiar problems and opportunities using calculative rationality ... When things are proceeding normally, experts don't solve problems and don't make decisions: *they do what normally works*' (my italics).³ Like Conan Doyle, Dreyfus and Dreyfus present intuition as a method of problem solving that marks the expert out from the novice, and they acknowledge the elusive nature of the intuitive method. Experts themselves can rarely provide an immediate, rational explanation for why they behaved in a particular way.

Box 2, which is based on real-life observations, shows excerpts from four clinical 'clerkings' of a single patient. The different problem-solving approaches adopted by clinicians at varying stages of training illustrate stages in the classification that Dreyfus and Dreyfus derived from observations of professional engineers. According to them:³

- The *novice* practitioner is characterised by:
 - rigid adherence to taught rules or plans;
 - little situational perception; and
 - no discretionary judgement. The *competent* practitioner:
 - is able to cope with 'crowdedness' and pressure;
 - sees actions partly in terms of long-term goals or wider conceptual framework; and
 - follows standardised and routinised procedures.
 - The *expert* practitioner:
 - no longer relies explicitly on rules, guidelines, and maxims;
 - has an intuitive grasp of situations based on deep, tacit understanding; and
 - uses analytic (deductive) approaches only in novel situations or when problems occur.

In general, we are at our most intuitive when doing our regular job and dealing with patients whom we know well. In unfamiliar situations, we resort to a more formal and rational

Third-year medical student

'Mr Brown is a 38-year old computer operator who attended the Accident and Emergency department with a bad feeling in his eye. The history of the presenting complaint was that it was there when he woke up at 7.15 am on Wednesday morning. When he was a little boy he had had an operation on his eyes for squint. He is up to date on his jabs ...'

Fifth-year medical student

'This 38-year-old male attended with a feeling of grit in his right eye. The eye also had a yellow discharge. He could still read the paper with that eye. He had not had any previous episode like this. His visual acuity was 6/6 bilaterally. His pupils were equal, concentric responding to light and accommodation ...'

Casualty officer

*'38 year old male
Gritty Rt eye 2/7; no h/o trauma
Purulent discharge
Vision 6/6, 6/6
No PMH of note
Rx: G. chloramphenicol to Rt eye q.d.s.
Review: See GP 1/52'*

GP

*'Rt conjunctivitis
Chloramphenicol drops
See S.O.S.'*

Box 2. Examples of clinical clerking styles of health professionals at different stages of training.

approach based on explicit (and defensible) professional rules. The skill of the expert is to respond to the subtle cues that signal a need to shift between the two approaches. The GP who writes the single word 'conjunctivitis' in a medical record may live to regret it when the patient subsequently sues for a missed diagnosis of uveitis.

Evidence-based medicine — objective science or intellectual imperialism?

Evidence-based medicine, which rose to prominence in the late 1990s, was based on principles developed by Sackett and colleagues that are listed in Box 3. Given their clear commitment to raising standards of clinical care, it is hard to understand precisely why the evidence-based medicine movement has drawn both passionate criticism⁴⁻⁷ and undisguised mirth⁸ from so many sources. Clinicians in particular have claimed that the patient's unique and complex predicament is poorly served by applying a recommendation derived, however objectively, from an average result in a select population sample. As Goodman puts it, just because the average woman in the United Kingdom is a dress size 16 it does not mean that all women should wear that size clothes.⁵

Other critics have challenged the primacy accorded by evidence-based medicine to the randomised controlled trial for assessing the efficacy of interventions, and to epidemiological data for predicting the course of illness. They claim that decision makers in both these fields should also look systematically and rigorously at the evidence from basic science that underpins physiological and pharmacological processes,¹⁰ economic evidence (about the costs of interventions and the values through which society allocates limited resources for health care),^{11,12} philosophical and ethical evidence (about the nature of clinical method and the prior-

- Clinical decisions should be based on the results of high-quality epidemiological studies, clinical intervention trials, and other robust research designs on human subjects.
- The prognosis of disease, and the benefits and harms of different management options, should be expressed as mathematical estimates of probability and risk.
- Randomised controlled trials are more valid and generalisable than 'anecdotal' evidence when assessing interventions.
- Secondary sources of research, especially systematic reviews and the guidelines derived from them, can summarise the relevant research evidence on a topic and provide the busy clinician with a useful short cut to the 'clinical bottom line'.
- The recommended approach to clinical problems is as follows: formulate a focused question, search the literature for relevant research evidence, appraise the evidence for its validity and usefulness, and apply the results.

Box 3. Principles of evidence-based medicine.⁹

ities of good clinical practice),^{13,14} psychological evidence (about the patient's values and preferences and how to establish them),^{15,16} contextual evidence (about the family and social systems in which any individual's illness experience and health goals are embedded),^{17,18} and organisational evidence (about the professional and administrative systems within which health interventions are developed, evaluated and delivered).¹⁹

The contribution of evidence-based medicine to improved patient outcomes in general practice is incontestable. The old-fashioned family doctor, for example, was frequently to be heard reassuring elderly patients that although their blood pressure was 'a bit high', it was 'nothing to worry about at your age and certainly not worth treating'. Large, prospective randomised controlled trials have shown precisely the opposite — that even the elderly have substantial reduction in their risk of stroke if blood pressure is treated to below the target level of under 160/90.²⁰ Differences between groups are large and consistent throughout many trials. It has, furthermore, been estimated that finding and treating moderate hypertension in older people will save more lives than any other single intervention in primary care.²¹ Of course, we all know that certain elderly people would be better off not taking the standard recommended tablets for their blood pressure, perhaps because they have expressed a preference for non-drug measures or because they suffer from relevant comorbidity. 'Breaking the rules' in individual cases is entirely justified. Despite claims to the contrary by their critics, the founding fathers of evidence-based medicine never claimed that evidence from clinical research trials should be sought or applied in a vacuum. Indeed, one of the most widely cited paragraphs ever published in the *BMJ*, states that:

*'The practice of evidence-based medicine means integrating individual clinical expertise with the best available external clinical evidence ... By individual clinical expertise, we mean the proficiency and judgement that individual clinicians acquire through clinical experience and clinical practice'.*²²

The emotive nature of the ongoing debate is helped nei-

ther by both sides' sanctimonious claim to the moral high ground nor by the inconsistent way in which writers use the term 'evidence'. In some publications, 'evidence' has a narrow definition related to the results of rigorous clinical trials and observational studies (as in 'the hierarchy of evidence'⁹), but in others the term is used to refer to any factor that can and should influence clinical decision-making — including costs, patient preferences, ethical considerations, and socio-political context.^{23,24} Another source of confusion is the gap between what practitioners of evidence-based medicine say and what they actually do. For example, the spate of research trials inspired by Sackett that classified clinical decisions as 'evidence-based' or 'non-evidence-based' on the basis of whether the medication prescribed in each case had ever been the subject of a randomised controlled trial,^{25,26} were examples of the very 'cookbook medicine' that these authors had previously dismissed as naïve and reductionist.^{22,27} An article that purported to be a systematic review of, and response to, arguments against evidence-based medicine remained within this limited conceptual framework and failed either to acknowledge or address more fundamental epistemological criticisms.²⁸

Other criticisms notwithstanding, if evidence-based medicine really values 'clinical experience and judgement', its leading proponents surely have a responsibility to take that concept out of its black box and define precisely how it interacts with evidence in the decision-making process. What follows is an attempt to do just that.

The nature of clinical decision-making

There are three widely held myths about clinical decision-making — first, that it is an entirely logical and deductive process; secondly, that experts think more logically than novices; and thirdly, that more knowledge leads to better decisions.

The research literature on clinical decision making tells us otherwise. First, the critical importance of experience, context, and familiarity have been persuasively demonstrated by Kathryn Montgomery Hunter, a professor of literature who spent several years watching, and listening to, doctors going about their duties. As her detailed fieldwork showed, clinical decision-making occurs by the *selective* application of general rules to particular individuals and contexts.²⁹ The uniqueness of the individual (comorbidity, values, context, and the physiological idiosyncracies that give rise to murmurs in the normal heart and make one person's pain another's 'tingling' or 'pressure') preclude any purely rule-based method for assigning diagnoses or selecting treatments.³⁰

Hunter concluded:

*'Clinical education is preparation for practical, ethical action: what best to do, how to behave, how to discover enough to warrant taking action, which choice to make on behalf of the patient. [These] choices are governed not by hard and fast rules but by competing maxims ... As lawyers, literary critics, historians and other students of evidence know well, there is no text that is self-interpreting. As rules, these maxims are relentlessly contextual.'*²⁹

Secondly, studies on the development of expertise in clin-

icians confirm the Dreyfus' taxonomy of problem solving: the more experienced a clinician gets, the less logical their decision-making processes are shown to be.³¹

Thirdly, there is a striking absence of studies showing that knowledge *per se* improves decision making. It is well documented that merely having the knowledge at their fingertips in the form of guidelines generally makes no perceptible impact on clinicians' behaviour.^{32,33} For significant and sustained change in clinical behaviour, knowledge of best evidence must be combined with a change in attitude and motivation; structural barriers (such as availability and affordability of a new treatment) must be overcome; and the new clinical behaviour must be both prompted and reinforced.³³⁻³⁶

Even in something as clinically clear-cut as the management of hypertension, the naïve application of 'evidence' without regard to the unique predicament and priorities of the individual patient soon makes the decision evidence-burdened rather than evidence-based.³⁷

In the words of Sir John Grimley Evans:

*'A clinician might be forced by guidelines to make use of evidence that is only doubtfully relevant, generated perhaps in a different grouping of patients in another country at some other time and using a similar but not identical treatment ... [This is] to use evidence in the manner of the fabled drunkard who searched under the street lamp for his door key because that is where the light was, even though he had dropped the key somewhere else.'*⁷

A number of studies by educationalists have begun to throw light on the process by which clinical expertise accumulates. We start by learning detailed 'rules' about the cause, course and treatment of each condition. As we gain knowledge we convert these rules to stereotypical stories (scripts). We refine our knowledge by accumulating atypical and alternative stories via experience and the oral tradition (such as grand rounds, 'corridor consultations', and so on). Furthermore, there is growing evidence that clinical knowledge is stored in our memory as *stories* rather than as structured collections of abstracted facts.^{29,38-40}

Evidence and intuition — a 'zero-sum' equation?

Over the past five years, I have given around a hundred seminars, workshops, and lectures to different groups of clinicians and academics on the general theme of evidence-based practice. I rarely escape without being asked to take a side in the perceived adversarial relationship between those who view themselves as experienced clinicians proud to be practising in the 'old-fashioned' medicine-based method, more or less on intuition, and those (generally younger, computer-literate and possessed of formal post-graduate qualifications) who support the rational, explicit and systematic use of research evidence in the clinical encounter and seek to 'convert' their colleagues to this approach.

This polarity of allegiance has generated another popular myth among clinicians — the notion of a 'zero-sum' relationship (i.e. more of one implies less of the other) between the deductive steps of evidence-based medicine ('the sci-

ence') and the subjective interpretation of the patient's story ('the art') in clinical encounters. This was probably never explicitly argued in print — though some have come close.^{41,42} Advocates of a humanistic, intuitive approach to clinical care appear to assume that at a philosophical level, it is impossible to integrate the 'science' of evidence-based medicine with the intuitive 'art' of clinical judgement, and that while the rules of evidence-based medicine can be taught, clinical intuition is an unfathomable phenomenon that simply 'happens'.

The false dichotomy between evidence-based medicine and clinical intuition, with the former defined as the 'scientific' element, has no sound theoretical basis. Back in 1958, Sir Peter Medawar argued thus:

*'Clinicians who discourse upon the 'spirit of medicine' will always point out that, while there is a large and profoundly important scientific element in the practice of medicine, there is also an indefinable artistry, an imaginative insight, and medicine (they will tell us) is born of a marriage between the two. But then the speaker spoils everything by getting the bride and groom confused.'*⁴³

The 'bride' is Medawar's metaphor for the imaginative, intuitive ('female') approach to problems; the groom corresponds to the objective, deductive rationality conventionally associated with the (male) laboratory scientist. But such a polarity, suggested Medawar, misrepresents the nature of the scientific method. He argued that scientific reasoning is an exploratory dialogue that can always be resolved into two voices: imaginative (hypothesis-generating) and critical (hypothesis-testing). He deplored the popular image of the white-coated scientist doggedly doing experiments to contribute fact after fact to the unproblematic, unidirectional march of scientific progress. 'The initiative for scientific action,' he wrote, 'comes not from the apprehension of facts but from an imaginative preconception of what *might* be true.' In other words, it is the 'bride', not the 'groom' that drives progress in science.

As anyone who has tried to generate research ideas knows, a creative imagination is indeed an essential precursor for a worthwhile research study. But good research ideas cannot be picked out of the sky. Medawar's contention that the *possibility* of truth distinguishes the scientific imagination from the fanciful⁴³ echoes Kant's declaration that 'It must *certainly* be true of every hypothesis that it could *possibly* be true.'⁴⁴

The importance of the patient's unique story is no longer in doubt. According to Macnaughton, the patient's narrative, interpreted by the skilled clinician, provides relevance and context for the illness and offers insights into their beliefs, priorities, and life choices.⁴⁰ But Medawar's axiom, derived from Kant's philosophical writings, suggests that the illness narrative contributes to the science as well as the art of medicine. The unique, individual, contextual, interpreted story *provides insights into what could or might happen* and as such is the raw material from which plausible hypotheses about causation, prognosis and therapy are generated before being tested against research-derived evidence.

Towards a science of intuition

Let us return to the anecdote with which I began this essay and see where the scientific imagination meets the patient's personal narrative. My subconscious hypotheses about what *might* happen incorporated both generalisable, research-derived truths (such as the known masking impact of steroids and the low validity of physical signs elicited in less than ideal circumstances) and unique, contextual ones (including the lack of any previous consultations, the wife's profound concern, and the patient's stoical 'grunt' on examination). When I predicted his impending death, I was not consciously aware of the intermediate steps that led me to my hypothesis, but when I learnt the outcome and sought a debriefing with his regular GP, the pieces of the jigsaw were revealed to both of us. The work of Benner⁴⁵ and Eraut³⁸ (among others) suggests that the insight I gained from critical reflection and discussion with a professional colleague is to be expected. Reflecting retrospectively on the process of clinical intuition (asking, for example, 'Why did I make diagnosis X rather than diagnosis Y at that point?' or 'What prompted me to start/stop that drug?') is a powerful educational tool. In particular, critical reflection on past intuitive judgements highlights areas of ambiguity in complex decision-making, sharpens perceptual awareness, exposes the role of emotions in driving 'hunches' (perhaps also demonstrating the fallibility of relying on feelings alone), encourages a holistic view of the patient's predicament, identifies specific educational needs, and may serve to 'kick-start' a more analytical chain of thought on particular problems. Educational methods aimed at supporting evidence-based practice have been systematically explored and evaluated,⁴⁶ and now feature prominently on the curricula of medical schools, Royal Colleges and service organisations such as Primary Care Trusts.⁴⁷ But educational methods for improving clinical intuition are less well developed, less easy to evaluate in behavioural terms, and generally less credible with decision-makers and policymakers in the health care sector (although there is an emerging literature on their use in management education).⁴⁸

Yet, as the enduring tradition of 'Balint groups' indicates, storytelling and reflective discussion in groups is a time-honoured method for professional development (though they tend to occur outside of formal educational settings and are rarely 'PGEA approved').^{38,49,50} Surely it is time to acknowledge, and take steps to overcome, the false dichotomy between the science and art of clinical practice as taught in undergraduate and postgraduate settings? Having quite rightly placed the principles and methods of evidence-based practice on the mainstream educational agenda, it is now time to raise the status of intuition as a component of expert decision-making, and begin to integrate both group discussion methods⁵¹ and individual reflective writing⁵² alongside the teaching of these skills.

Once we have recognised that none of us ever needed to choose between evidence-based medicine and old-fashioned clinical intuition, the stage is surely set for developing an educational method that draws productively on both traditions. Far from being a contradiction in terms, the evidence-based Balint group is surely the epistemological marriage we have all been waiting for.

References

- Greenhalgh T. Narrative based medicine in an evidence-based world. *BMJ* 1999; **318**: 323-325.
- Conan Doyle A. *Silver Blaze*. London: Methuen, 1892.
- Dreyfus HL, Dreyfus SE. *Mind over machine: The power of human intuition and expertise in the era of the computer*. Oxford: Blackwell, 1986.
- Brewin T. Challenging evidence-based medicine. *J R Coll Physicians Lond* 1999; **33**: 484.
- Goodman NW. Who will challenge evidence-based medicine? *J R Coll Physicians Lond* 1999; **33**: 249-251.
- Black D. The limitations to evidence. *J R Coll Physicians Lond* 1998; **32**: 23-26.
- Grimley Evans J. Evidence-based and evidence-biased medicine. *Age Ageing* 1995; **24**: 461-463.
- Isaacs D, Fitzgerald D. Seven alternatives to evidence-based medicine. *BMJ* 1999; **319**: 1618.
- Sackett DL, Richardson WS, Rosenberg WMC, Haynes RB. *Evidence-based medicine: how to practice and teach EBM*. London: Churchill-Livingstone, 2nd edition, 2000.
- Djulbegovic B, Morris L, Lyman GH. Evidentiary challenges to evidence-based medicine. *J Eval Clin Pract* 2000; **6**: 99-109.
- Dowie, J. 'Evidence-based', 'cost-effective', and 'preference-driven' medicine: decision analysis based medical decision making is the pre-requisite. *J Health Serv Res Policy*. April 1996; **1(2)**: 104-113.
- Maynard A. Evidence-based medicine: an incomplete method for informing treatment choices. *Lancet* 1997; **349**: 126-128.
- Tannenbaum SJ. What physicians know. *N Engl J Med* 1993; **329**: 1268-1271.
- Tonelli MR. The philosophical limits of evidence-based medicine. *Acad Med* 1998; **73**: 1234-1240.
- Knotnerus JA, Dinant GJ. Medicine-based evidence, a prerequisite for evidence-based medicine. *BMJ* 1997; **315**: 1109-1110.
- Bensing J. Bridging the gap. The separate worlds of evidence-based medicine and patient-centered medicine. *Patient Educ Couns* 2000; **39**: 17-25.
- Stradling JR, Davies RJO. The unacceptable face of evidence-based medicine. *J Eval Clin Pract* 1997; **3**: 99-103.
- Bonnell C. Evidence-based nursing: a stereotyped view of quantitative and experimental research could work against professional autonomy and authority. *J Adv Nurs* 1999; **30**: 18-23.
- Swales J. The troublesome search for evidence: three cultures in need of integration. *J R Soc Med* 2000; **93**: 402-7.
- Mulrow C, Lau J, Cornell J, Brand M. Pharmacotherapy for hypertension in the elderly (Cochrane Review). In: *The Cochrane Library*, Issue 4. Oxford: Update Software, 2000.
- McCull A, Roderick P, Gabbay J, et al. Performance indicators for primary care groups: an evidence-based approach. *BMJ* 1998; **317**: 1354-1360.
- Sackett DL, Rosenberg WMC, Gray JAM, et al. Evidence-based medicine: what it is and what it isn't. *BMJ* 1996; **312**: 71-72.
- Feinstein AR, Horwitz R. Problems in the 'evidence' of 'evidence-based medicine'. *Am J Med* 1998; **103**: 529-535.
- Buetow S, Kenealy T. Evidence-based medicine: the need for a new definition. *J Eval Clin Pract* 2000; **6**: 85-92.
- Ellis J, Mulligan I, Rowe J, Sackett DL. Inpatient general medicine is evidence-based. *Lancet* 1995; **346**: 407-410.
- Gill P, Dowell AC, Neal RD, et al. Evidence-based general practice: a retrospective study of interventions in one training practice. *BMJ* 1996; **312**: 819-821.
- Greenhalgh, T. 'Is my practice evidence-based?' *BMJ* 1996; **313**: 957-958.
- Straus SE, McAlister FA. Evidence-based medicine: a commentary on common criticisms. *CMAJ* 2000; **163**: 837-841.
- Hunter K. 'Don't think zebras': uncertainty, interpretation, and the place of paradox in clinical education. *Theor Med* 1996; **17**: 225-241.
- Cox K. Clinical practice is not applied scientific method. *Aust NZ J Surg* 1995; **65**: 553-557.
- Boreham NC. Models of diagnosis and their implications for adult professional education. *Studies in the education of adults* 1988; **20**: 95-108.
- Freemantle N, Harvey EL, Wolf F, et al. Printed educational materials: effects on professional practice and health care outcomes. In: *The Cochrane Library*, Issue 4. Oxford: Update Software 2000.
- Wyatt J. Practice guidelines and other support for clinical innovation. *J R Soc Med* 2000; **93**: 299-304.
- Green LW, Eriksen MP, Schor EL. Preventive practices by physicians: behavioural determinants and potential interventions. *Am J Prev Med* 1988; **4(4)**: 101-107.
- Solomon DH, Hashimoto H, Daltroy L, Liang MH. Techniques to

- improve physicians' use of diagnostic tests. *JAMA* 1998; **280**: 2020-2027.
36. Wyatt J, Paterson-Brown S, Johanson R, *et al.* Trial of outreach visits to enhance use of systematic reviews in 25 obstetric units. *BMJ* 1998; **317**: 1041-1046.
 37. Jackson R, Sackett DL. Guidelines for managing raised blood pressure. *BMJ* 1996; **313**: 64-65.
 38. Eraut M. Non-formal learning, implicit learning and tacit knowledge. In: Coffield F (ed) *Informal learning*. Bristol: The Policy Press, 1999.
 39. Cox K. Stories as case knowledge; case knowledge as stories. *Med Educ* 2001; **35**: 862-866.
 40. Macnaughton J. Anecdote in clinical practice. In: Greenhalgh T, Hurwitz B (eds). *Narrative based medicine: dialogue and discourse in clinical practice*. London: BMJ Publications, 1999; 202-211.
 41. Evans M, Sweeney K. *The human side of medicine*. [Occasional Paper 76.] London: Royal College of General Practitioners, 1998.
 42. Willis J. *Friends in low places*. Oxford: Radcliffe, 2000.
 43. Medawar P. *Pluto's Republic* (incorporating *Induction and Intuition in Scientific Thought*). Oxford: Oxford University Press, 1984.
 44. Kant I. *An introduction to logic*. Translated by CK Abbott, 1885. Cited in Medawar P, *ibid*, page 103.
 45. Benner P. *From novice to expert: excellence and power in clinical nursing practice*. Menlo Park, California: Addison-Wesley, 1984.
 46. Dobbie AE, Schneider FD, Anderson AD, Littlefield J. What evidence supports teaching evidence-based medicine? *Acad Med* 2000; **75**: 1184-1185.
 47. Green ML. Evidence-based medicine training in graduate medical education: past, present and future. *J Eval Clin Pract* 2000; **6**: 121-138.
 48. Gregory G. Developing intuition through management education. In: Atkinson T, Claxton G (eds). *The intuitive practitioner: on the value of not always knowing what one is doing*. Buckingham: Open University Press, 2000; 182-195.
 49. Yeheskel A, Biderman A, Borkan JM, Herman J. A course for teaching patient-centered medicine to family medicine residents. *Acad Med* 2000; **75**: 494-497.
 50. Rabin S, Maoz B, Elata-Alster G. Doctors' narratives in Balint groups. *Br J Med Psychol* 1999; **72**: 121-125.
 51. Elwyn G, Greenhalgh T, Macfarlane F. *Groups: a hands-on guide to small group work in healthcare, education, management and research*. London: Radcliffe Medical Press, 2000.
 52. Bolton G. *Reflective practice writing for professional development*. London: Sage Publications, 2001.

Acknowledgements

I am grateful to Dr Peter Toon for introducing me to the writings of Sir Arthur Conan Doyle on intuition.