Medical Education

Insights into some aspects of clinical education – I. clinical practice

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This paper examines *why* there is a need for a theoretical base to medical practice, *what* this theory should encompass and *how* it should be taught. It will be suggested that such insights are necessary for rational curriculum development and teaching at all levels of medical education and that a strong theoretical base is essential for good clinical practice. The theme is in line with the General Medical Council (GMC) recommendations¹ to 'instruct less and educate more'. In keeping with this, at graduation the young doctors are seen equipped with certain skills and theoretical concepts which are associated with attitudes that make them ready to take on supervised responsibilities and participate in learning throughout their postgraduate life. Such a framework for curriculum development looks beyond arguments about territorial rights and the division of the number of teaching hours, to providing a unified motif for a faculty.

An understanding of the theoretical basis of clinical practice is needed if professionals are to build on their knowledge throughout their working life and generalize from experience. This privileged knowledge brings with it obligations to develop certain attitudes and skills related to the practice of the profession. Foremost is the ability to communicate with patients and colleagues and the responsibility to remain life-long learners to keep professional knowledge up to date.

It is suggested that the content of this learning must undergo radical revision. Not only should it include the biomedical sciences, but – to keep up with needs concomitant with the advent of modern technology which now dominates medicine – there should be a shift in emphasis to encompass theories of explicit, ethical clinical decision making.

A scheme is presented for educational change that is based on a theory for medical education. It is proposed that such educational theory is a necessary basis for rational change and successful

innovation towards an undergraduate curriculum that will be meaningful for the student as prospective postgraduate trainee and clinical practitioner.

To achieve curricular aims, there must be a review of teaching to take account of the individual needs of learners. This calls for a reorientation of teacher perceptions about learning, and development of the curriculum and of assessment techniques consistent with curricular objectives.

An agenda is offered for change within existing institutional settings which requires strong leadership and a spirit of dedication and cooperation from the faculty.

A theory for clinical practice

A major distinguishing feature of professionals is that they possess theoretical knowledge upon which they can base their actions.² Such theoretical understandings allow professionals to generalize and deal with hitherto unmet situations. Effectively, this was Flexner's design for medical education, when he recommended the introduction of a rigorous foundation in the biological sciences as a prerequisite to clinical training.³ It was envisaged that practitioners would then be prepared to use theory when appropriate, departing from apprenticeship programmes, which lacked such theoretical basis and aimed more at achieving competence at performing routine psychomotor skills.

Over the last two decades it has been recognized that the purely physical aspects of the study of man were insufficient for an understanding of health and disease and that psychological as well as social factors merited equal attention in the medical curriculum.⁴ Accordingly, the original list of anatomy, physiology, biochemistry and other biological sciences has been enlarged to include the psychological, behavioural and social aspects of medicine. This shift from the purely biological perspective on disease to the psycho-socio-biological model⁴ increased our understanding of health and disease with an improvement in the doctor's approach to the patient.

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This additional perspective, however, continued to see preparation for practice consisting of insights into the functioning and behaviour of people. What we need to see is if this theory is appropriate and sufficient for the practice of clinical medicine as a profession and what it is about theoretical knowledge that makes it effective when put into practice.

We shall look at the present theoretical basis of undergraduate medical education and some of the evidence that shows its strengths and weaknesses. We shall then make suggestions on how to remedy some demonstrable deficiencies, and recommend a particular theoretical perspective for medical education to adopt if we are to implement successful and necessary change.

The thesis proposed is that we need an additional theoretical base for the practice of medicine to keep up with the new developments that have occurred since the beginning of this century when the present structure was devised. There is still a need for a knowledge of the biological, behavioural and social sciences to develop causal arguments that rely on an understanding of the structure and function of the body in health and disease, as well as the relationship of a person to society. These considerations are, however, insufficient in themselves for modern medical practice. With modern technology, particularly imaging techniques, many of the skills of clinicians have been surpassed, though, as we shall argue, not superseded by the machine. There is still a need for doctors to be able to think about how and why disease develops and how symptoms are produced, but much of this is now done by the new technology, and often better than by the most expert of clinicians. It is difficult indeed to compete with the imagery of magnetic resonance or the functional descriptions of PET scanners. Furthermore, there is a tendency for clinicians not to rely on the basic science theory as was envisaged in the curriculum. As will be shown, what is taught to students is not applied consistently, or all that well by the practitioner.

What has changed with the introduction of high technology is that we are able to make more significant interventions than the doctors of Flexner's era when their armamentarium was limited. As a result, our decisions are much more critical than they used to be. With these interventions come risks and associated ethical decisions about the rights and wrongs of what should be done for patients.⁵ Therefore, with the multiplicity of tests and treatment modalities available for use by all practitioners, it is essential that the modern doctor should be well trained not only in the sort of causal argument that was expected half a century ago, but also in the assessment of risks and benefits and of the ethical dilemmas associated with the provision of medical care. From an increasingly sophisticated

public also come expectations of better communication between patient and doctor and more involvement in decisions about a person's own health.⁶

So, what is proposed here is that we are not all that good at making these increasingly difficult decisions and that the education that is provided to doctors in the theory of decision making is unsatisfactory for professional practice. We need to recognize that this theory should become an integral part of a modern medical curriculum.

With the corollary that doctors should have a certain type of knowledge, must come the recognition that the possession of such privileged knowledge brings with it responsibilities and societal expectations of a certain set of attitudes and behaviours of professionals. These relate to ethical behaviour, an ability to communicate and the reasonable expectation that the professionals will keep abreast of new developments in knowledge necessary for the pursuit of the profession. Most criticism directed against doctors is concerned with these behaviour patterns⁷ and much activity by government and professional organizations is related to difficulties surrounding the continuing education of doctors.

The second proposition put forward is that the available evidence shows that learning in a traditional curriculum is often unsatisfactory and therefore, medical education is in need of educational theory that deals with the demonstrable problems in student learning that hinder the attainment of curricular objectives. The following sections of this paper will present evidence to back up these assertions and argue for the inclusion of theories of clinical decision making in the medical curriculum and for the use of appropriate educational theory for curriculum development and change.

The use of preclinical knowledge in clinical problem-solving

The essential prerequisites to solve a clinical problem using basic science information may be broken down into three components:^{8,9}

- (i) The appropriate *basic science knowledge* required for understanding the clinical case.
- (ii) The appropriate *clinical skills* required to collect the data and to make the correct *interpretations* about the *observations*.
- (iii) The key concept in this paradigm is *the link* that must then be made between basic science and clinical data. For instance, having recognized that a patient is ataxic and knowing that cerebellar disorders give rise to ataxia, the clinician should make the link between the two and deduce that the ataxia demonstrated in the patient may be related to cerebellar dysfunction.¹⁰

In most medical schools the biomedical sciences are introduced before clinical experiences. There is a great deal of anecdotal evidence that the practising clinician either does not apply much of this basic science knowledge, or does so rarely and with difficulty.⁹ That students experience problems in applying theory when taught in this manner has been amply demonstrated. In one such study,¹¹ shortly after passing anatomy examinations, students were asked to relate clinical case vignettes to neuroanatomy. Unlike expert neurologists, they were not able to make the appropriate connections. Similarly, Patel *et al.*⁹ analysing student responses to clinical case descriptions found that pathophysiological explanations were incorrect. The utilization of basic science knowledge altered with increasing clinical experience, but remained inconsistent. They concluded that when basic science information was taught out of the clinical context in which it was to be used, students failed to establish the necessary link between the two domains. They argued that the two formed different knowledge structures which explained why students and clinicians had difficulty in relating basic science information to clinical cases.

The data indicate that in everyday clinical work experts rarely use basic science knowledge in an overt manner. Students have difficulty applying it and like their seniors, rely on other methods to make a diagnosis. Whether this is because the knowledge is inappropriate or because it has been learnt ineffectively, remains to be seen. It is therefore of interest to find out just how clinicians arrive at a diagnosis and how they develop relevant management strategies.

Studies of the diagnostic process

In a series of studies (as summarized by Grant¹²), Gale and Marsden found that clinicians ranging from novice student to the expert, made sense of clinical information 'by recognizing for themselves certain personally important pieces of information'. They called these *forceful features* which could be made up of a number of items of information, individually determined. They suggested that these acted as the key to memory structures, allowing the clinician 'to begin to have ideas about what the clinical information might mean.' They also noted that the same clinical information may prompt different forceful features in different people, without necessarily affecting the diagnosis.

Similar conclusions were drawn about the variable and individualistic use of salient information from a series of studies using case vignettes with experts and students. Clinicians at all levels of expertise made early diagnostic formulations and

then used but a few *critical cues* to make a diagnosis.¹³ Such cues refer to some outstanding characteristic of the case that leads to a diagnosis. The significant difference between the description of forceful features by Gale and Marsden and of critical cues, centres on the question of the ultimate right answer. The concept of the forceful feature suggests that all forceful features are intrinsically 'right' and will be determined by the individual clinician's personal experiences and perceptions. Critical cues have a different meaning. It is accepted that they are individually derived, but there is a belief that some are more representative of reality than others. As a corollary, we should aim to teach the one that represents the true state of affairs, rather than the often idiosyncratic personal experience and judgement of individual clinical teachers. We shall return to this crucial issue in the next section.

We can make a number of generalizations about the process of diagnosis:

1. Early diagnostic formulations are made by expert and novice alike.
2. The expert and, to a lesser extent, novice clinician then concentrates on a few highly critical pieces of information.
3. Revision of diagnostic opinion, in other words, changing the original formulations, will depend on the interpretation of these cues and this is variable.

Three questions arise from these findings¹⁴: (1) What are the sources of the first diagnostic formulations? (2) What makes a cue critical? (3) What methods are used to revise diagnostic opinion?

The source of the first diagnostic formulations

The almost instantaneous occurrence of early formulations suggests that they are likely to depend on the first piece of historical information presented by the patient as well as 'contextual' factors¹⁵ and an assessment of what is most likely on probabilistic grounds. Results of studies from a variety of sources lead to similar conclusions⁸: (1) There is significant individual and, particularly, specialty-dependent variation in the assessment of what is common. (2) There are a number of well-documented heuristics in use and probabilistic considerations are applied inconsistently.¹⁶ (3) Amongst students and experts alike, there is only occasional overt reference to preclinical knowledge.

What makes a cue critical?

The major finding is the variability of assessing a cue as critical. Not only is there marked interspecialty variation, but there are intraspecialty differences as well.¹⁷ As shown by Gale and Marsden (in Grant¹²), rather than using an objective

data base, clinicians rely on personal experience and individual perceptions to make a diagnosis.

What methods are used to revise diagnostic opinion?

A study of the early phase of the diagnostic process¹⁸ indicated that most students used a list of questions which they had learned in clinical tutorials and which related to the early formulations they made. There was little subsequent interaction between the information obtained from the patient and the questioner, so that as a result, original hypotheses were rarely revised. In spite of the demonstrable presence of the preclinical knowledge necessary for solving the problem, there was only a small group of students who referred to it and went through what appeared to be a hypothetico-deductive system of questioning. They found this method difficult and complained about the problems of applying their anatomy knowledge, even though present, to individual clinical cases.

We may conclude that in most instances, accurate probability calculations, or the overt use of biomedical science knowledge are not the basis for revising opinion. Clinicians are more likely to use other methods, especially the heuristics previously referred to. There will be case-to-case variation, with previous experience and probably teaching, as important determinants of the methods used in individual cases.

There is a large body of evidence to indicate that there is marked individual variation in what experts consider important.¹⁶ Cue weights are poorly quantified. There is an overpowering reliance on individual experience which remains the basis of all clinical work. Similarly, in the novice, the basis of diagnostic formulations will be variable. It will be affected by what they had seen either in the clinic or in the outside world and the way they had been taught. Their use of heuristics is not as good or reliable as that of the expert since they know less. Because learning is so case-dependent and they have less experience, they have less useful knowledge. What they do know, they have trouble in using and applying to the new cases they see. Their knowledge is fragmented and the use of the preclinical, when potentially relevant, is not always reinforced in the clinic. When taught factual information, it will often be contradictory, dependent on the personal experience of the teacher. Personal experience remains paramount in the clinic as a treatment centre and as classroom.

Systematic biases in the process of clinical decision making

The heuristics most frequently used by clinicians when making diagnostic or management decisions

suffer from systematic bias with resultant errors at all levels of expertise.¹⁶ The most commonly used and studied include:

Availability This refers to the probability of salient, rare but vivid events being overestimated, with less salient, but more common events underestimated.

Representativeness In this group of cases probability is judged by similarity of the case to the diagnostic category under consideration. The result is that the probability of rarer diseases is overestimated because the prevalence rate is ignored.

Base rate neglect There is a general tendency to ignore disease prevalence rates in favour of case-specific information.

Context effects The frame in which the case is presented will alter perceptions and bias the decision maker.¹⁹ For instance, the choice of surgery versus radiotherapy in the treatment of cancer will depend on whether the outcome is presented in terms of the likelihood of survival or death.²⁰ Similarly, early information is weighted in excess of later cues.²¹

Laurillard²² makes a strong argument for the importance of context-dependent behaviour dominating practically all aspects of clinical problem-solving. She suggests that what appears irrational or biased decision making, can be explained by the context where the activity was learnt and where it is carried out. Since problem-solving strategies are context-dependent, logically identical problems may trigger different solutions. The features of the situation and the perception of what is required of the problem-solver are therefore fundamental to our understanding of the process.

It follows that, as teachers, we need to find the optimal method of problem-solving for the task and then arrange context to nurture its development in the direction we espouse. This involves value judgements by teachers and is consistent with the assumption that there are 'natural' limitations to so-called rational methods of problem-solving, and that the contextual dependence of the task as well as its counterintuitive nature will make uniformity difficult to implement. There are, of course, those who would assert that such uniformity is not only difficult to achieve but also undesirable.¹² The position taken here is not advocating stifling sameness, but rather, an argument for thoughtful curriculum development, based on what we understand about how people learn to make decisions.

The development of concepts

We may now look at the development of the relation between theoretical concepts taught in the preclinical curriculum and clinical work in more detail. Most of the evidence comes from studies of the use of basic science knowledge by clinicians.^{9,10} Findings from a study of the development of concepts in clinical decision making indicate that the results can be generalized to that sphere.²³

A study that looked at preclinical students solving a diagnostic problem that required knowledge of neuroanatomy,¹⁰ showed no correlation between anatomy knowledge tested in the conventional manner and correct clinical diagnosis. The findings in this group of clinically inexperienced students indicated that they must have referred to anatomy knowledge when diagnosing – else there would be nothing for them to use, since they had no clinical experiences to fall back on – and that at least some of them were capable of using this knowledge the way it was intended in the curriculum. But, this knowledge was not the same as that tested by the conventional tests administered to them and which did not show a relationship to diagnosis. It is likely that what some of the students used, and possibly experts as well, is a distillate of what they had been taught and which in some cases may be indicative of a highly complex understanding of subject matter.

By way of contrast, the inconsistent use of basic science knowledge by clinical students, suggests that the learning of basic science and of clinical work take place more or less independently of each other, at least when taught in a traditional curriculum.⁹ Yet, according to our ideal of a professional, clinical knowledge should be based on the relevant theoretical knowledge, plus the additional knowledge relating to application. At first, however, knowing application, and knowing theory, are unrelated.¹⁰

In expert clinicians, the two domains should become closely interlinked. For instance, on being shown case vignettes, neurologists described 'pictures' of the relevant part of the nervous system triggered by the clinical case.¹¹ This higher level conceptualization of the expert involves structuring of knowledge so that what was learnt in one area is integrated with the other areas of knowing.²⁴ This level of integration of expert knowledge alters the actual nature of the knowledge and not just the structure of memory. How to assist this development is one of the problems facing medical education.

'Problem-based' curricula introduce preclinical subjects in a clinical context, with the underlying assumption that by removing the artificial barrier between the two, students will appreciate the clinical relevance of what they are expected to

learn.²⁵ Whilst so far there is little evidence that changing the curriculum in this manner will have the effect of helping students acquire the desired concepts for the use of basic science in clinical medicine, a number of such innovative changes have been reported,^{26–28} but still require careful evaluation. We may speculate that re-learning the basic sciences when studying for higher examinations may be the sort of experience that will help graduates appreciate the significance of these subjects for clinical work. To date, there are no studies to evaluate the effectiveness of this sequence in postgraduate medical education.

Overview of the theoretical base of clinical practice

It is time to review what we have said so far. It was suggested that the practice of clinical medicine needs a theoretical base. This assumes that the practitioners will pursue their profession in a manner consistent with this theory. The theory therefore needs to be relevant and accessible for everyday use. We have shown that the so-called basic sciences allow the use of causal arguments and are appropriate in a number of situations. The shift from the purely biological perspective to Engel's psycho-socio-biological model⁴ must be acknowledged as a great advance in medical education. This leap, however, was not sufficient and it is necessary to make another and even more significant shift if we are to retain a relevant and sufficient theoretical foundation for the practice of the profession.

In clinical practice increasingly difficult decisions have to be made with many associated dilemmas about value judgments and problems of weighing the evidence. The presently taught biomedical sciences become insufficient as a theory for this practice and we need an additional theory for making decisions, passing judgments and resolving ethical dilemmas. Students need to be as well versed in these theories as yesterday's students were in the anatomical basis of medicine. With the advent of increasingly sophisticated technology, the balance has in fact altered and the emphasis in basic science teaching may need to shift with it, towards teaching how to deal with these problems of uncertainty and value judgments rather than confining arguments to causal explanations. If the teaching of clinical medicine is to keep pace with the needs of the profession, then such a shift is essential and urgent. Otherwise, many of the decision making prerogatives of the profession will be taken away from it by other bodies, particularly governments who are increasingly involved in the provision of health care.

We have shown that an understanding of decision theoretical concepts is necessary for

clinical practice, because together with all other human decision makers, doctors have difficulty in making consistent and rational decisions that regularly stand up under scrutiny. Decisions are often governed by the context of the case and affected by the personal values and idiosyncrasies of the decision maker as well as certain well described and consistent biases common to all.

Next, we suggested that such theoretical knowledge involves the development of increasingly complex concepts and that the major attribute of expertise is the possession of such concepts.

We have also shown that students have difficulty in developing these and that much present day teaching is based on a theory that does not take sufficient account of what we know about how students learn. This then, brings us to the next section of this paper where we look at some theories of learning and indicate how they become relevant when we wish to introduce change into medical education.

(Part II of this article will appear in the April issue of *Postgraduate Medical Journal*).

References

- General Medical Council. *Recommendations on Basic Medical Education*. General Medical Council, London, 1980.
- Schön, D.A. *The Reflective Practitioner: How Professionals Think in Action*. Basic Books, New York, 1983.
- Flexner, A. *Medical Education. A Comparative Study*. Macmillan, New York, 1925.
- Engel, G. The need for a new medical model: A challenge for biomedicine. *Science* 1977, **196**: 129–136.
- Reiser, S.J. *Medicine and the Reign of Technology*. Cambridge University Press, Cambridge, UK, 1978.
- Leader. Informing patients about clinical disagreement. *Lancet* 1989, **ii**: 367–368.
- General Medical Council. *Report of a working party of the Education Committee on the teaching of behavioural sciences, community medicine and general practice in basic Medical Education*. General Medical Council, London, 1987.
- Balla, J.I. *The Diagnostic Process. A model for clinical teachers*. Cambridge University Press, Cambridge, UK, 1985.
- Patel, V.L., Groen, G.J. & Scott, H.M. Biomedical knowledge in explanations of clinical problems by medical students. *Med Educ* 1988, **22**: 398–406.
- Balla, J.I., Biggs, J.B., Gibson, M. & Chang, A.M. The application of basic science concepts to clinical problem-solving. *Med Educ* (In the press).
- Balla, J.I. Logical thinking and the diagnostic process. *Methods Inf Med* 1980, **20**: 16–18.
- Grant, J. Clinical decision making: Rational principles, clinical intuition or clinical thinking? In: Balla, J.I., Gibson, M. & Chang, A.M. (eds). *Learning in Medical School: A model for the clinical professions*. Hong Kong University Press, Hong Kong, 1989, pp. 81–101.
- Balla, J.I. The use of critical cues and prior probability in decision making. *Methods Inf Med* 1982, **21**: 9–14.
- Balla, J.I. Changing concepts in clinical education: The case for a theory. In: Balla, J.I., Gibson, M. & Chang, A.M. (eds). *Learning in Medical School: A model for the clinical professions*. Hong Kong University Press, Hong Kong, 1989, pp. 3–18.
- Hobus, P.P.M., Schmidt, H.G.S., Boshuizen, H.P.A. & Patel, V.L. Contextual factors in the activation of first diagnostic hypotheses: expert-novice differences. *Med Educ* 1987, **21**: 471–476.
- Elstein, A.S. On the psychology of clinical decision making: What is a rational expectation? In: Balla, J.I., Gibson, M. & Chang, A.M. (eds). *Learning in Medical School: A model for the clinical professions*. Hong Kong University Press, Hong Kong, 1989, pp. 61–80.
- Balla, J.I., Rothert, M., Greenbaum, D. & Black, N.A. Diagnostic cues in gastroenterology. *Aust NZ J Med* 1983, **13**: 469–477.
- Gibson, M., Balla, J.I. & Biggs, J.B. Student approaches to clinical diagnosis: Relationship to the process of learning. (In preparation).
- Tversky, A. & Kahneman, D. The framing of decisions and the psychology of choice. *Science* 1981, **211**: 453–458.
- McNeil, B.J., Pauker, S.G., Sox, H.C. & Tversky, A. On the elicitation of preferences for alternative therapies. *N Engl J Med* 1982, **306**: 1259–1262.
- Curley, S.P., Young, M., Kingry, M.J. & Yates, J.F. Primacy effects in clinical judgments of contingency. *Med Decis Making* 1988, **8**: 216–222.
- Laurillard, D. Understanding medical students' problem-solving. In: Balla, J.I., Gibson, M. & Chang, A.M. (eds). *Learning in Medical School: A model for the clinical professions*. Hong Kong University Press, Hong Kong, 1989, pp. 119–130.
- Balla, J.I. Evaluation of the development of clinical reasoning. The case of clinical decision analysis. (In preparation).
- Ramsden, P., Whelan, G. & Cooper, D. Some phenomena of medical students' diagnostic problem solving. *Med Educ* 1989, **23**: 108–117.
- Barrows, H.S. & Tamblyn, R.M. *Problem-based learning – An Approach to Medical Education*. Springer Publishing Company, New York, 1980.
- Patel, V.L. & Dauphinee, W.D. Return to basic sciences after clinical experience in undergraduate medical training. *Med Educ* 1984, **18**: 244–248.
- Eizenberg, N. Approaches to learning anatomy: Developing a programme for preclinical medical students. In: Ramsden, P. (ed.). *Improving Learning: New Perspectives*. Kogan Page, London, 1988, pp. 178–198.
- Coles, C. The role of context in elaborated learning. In: Balla, J.I., Gibson, M. & Chang, A.M. (eds). *Learning in Medical School: A model for the clinical professions*. Hong Kong University Press, Hong Kong, 1989, pp. 41–57.