Notes on contributors

NISHA DOGRA is a Senior Lecturer and Honorary Consultant in Child and Adolescent Psychiatry at the University of Leicester. Her research interests include diversity and more specifically cultural diversity training for medical students, effective methods of training, evaluation of training and young people's perceptions of mental health services.

MARI LLOYD-WILLIAMS is Director of the Community Studies Unit at the University of Liverpool and a consultant in palliative medicine at the Royal Liverpool Hospital and Marie Curie Hospice Liverpool. She has experience in the research, implementation and development of effective communication skills for medical staff and multiprofessional teams.

RACHEL MORAKE is senior lecturer and head of department at Medunsa. She is involved in the development of Mainstreaming Gender into South African Higher Education curriculum. Her research interest is in developing effective training methods of effective communication skills for medical students and people in the health sciences.

Acknowledgement

The British Council and the Department for International Development, South Africa funded the travel, living and accommodation costs of the visits for this project.

References

BODYCOTT, P. & WALKER, A. (2000) Teaching abroad: lessons learned about inter-cultural understanding for teachers in higher education, *Teaching in Higher education,* 5(1), pp. 79–94.

DOGRA, N. & STRETCH, D. (2001) Developing a questionnaire to assess student awareness of the need to be culturally aware in clinical practice, *Medical Teacher*; 23(1), pp. 59–64.

GENERAL MEDICAL COUNCIL (1993) *Tomorrow's Doctors* (London, General Medical Council).

Teaching problem solving and decision making in undergraduate medical education: an instructional strategy

HUGO VAN PUYMBROECK[1], ROY REMMEN[1], JOSETTE DENEKENS[1], ALBERT SCHERPBIER[2], ZENO BISOFFI[3] & JEF VAN DEN ENDE[4]

[1]Centre for Family Practice, University of Antwerp, Belgium; [2]Educational Institute, Faculty of Medicine, University of Maastricht, The Netherlands; [3]Institute for Tropical Diseases at Negrar, University of Verona, Italy; [4]Institute for Tropical Diseases, University of Antwerp, Belgium

SUMMARY *Actual changes in the context of real care along with their impact on current practice modes prompted the authors to develop a new instructional strategy, which aims to improve the diagnostic reasoning competence of medical undergraduates. In this strategy the use of visual representations is promoted. A diagnostic panorama represents differential diagnosis. A diagnostic diagram exposes the diagnostic reasoning process. This paper outlines the strategy and its assumptions.*

Introduction

Solving patient problems and making defensible decisions is at the heart of undergraduate medical training (GMC, 1993). Cognitive psychologists feel that both competences should be acquired in a problem-based learning environment close to reality (Regehr & Norman, 1996). As for medicine, 'reality' means the context of real care.

In fact, this context is changing in a revolutionary way (Towle, 1998). Three broad evolutions can be identified: a move towards evidence-based medicine, cost-effective patient management and shared decision making (Dowie, 1996). Their influence on current practice modes prompts medical education to pay attention to them.

Challenged by the issues raised above, we developed an instructional strategy that attempts to improve our undergraduates' diagnostic reasoning competence. Visual representations are used to make the diagnostic process explicit. This paper describes our strategy, its strengths and weaknesses and the way we use it at the vocational training level for general practice.

Curricular context

At the University of Antwerp (Belgium), vocational training for general practice starts during the seventh year. We offer a four-month course in which we focus on the essentials of communication, clinical epidemiology, evidence-based problem solving and decision making. Two four-hour workshops are offered weekly. Each workshop (10–15 students) addresses five different patient problems. All cases form a portfolio of problems relevant for general practice. Pairs of students prepare one case by working up a written clinical vignette describing a patient's chief complaint(s) and some extra notes. During the workshop, both students present and discuss the way they worked through the case. Preparation and presentation are structured by a pedagogical model, which uniformly covers three steps.

Correspondence: Hugo Van Puymbroeck, MD, Centre for Family Practice, Faculty of Medicine, University of Antwerp (Belgium), Universiteitsplein 1, 2610 – Wilrijk, Belgium. Tel: 32.3.820.25.29; fax: 32.3.820.25.26; email: hugovp@pandora.be

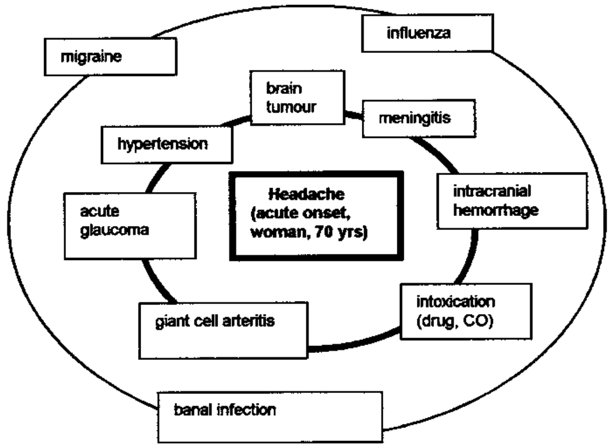

Figure 1. A diagnostic panorama: early generated working hypotheses relevant for general practice addressed on two circles around a pivot ('headache').

The pedagogical model

Step 1: Representing differential diagnosis in a diagnostic panorama

A student starts his/her presentation by outlining the patient's chief complaints on an overhead projector. Peers collect further information by asking questions, e.g. questions about content or context information that is not expressed.

Afterwards, the presenting students outline a first impression of the case by aggregating initial sets of cues as provisional working hypotheses (PWHs). They also suggest a pivot. A pivot is a representation of a single complaint or a set of findings that stand out as important by pointing to PWHs that could inflict serious complications on a patient. Finally, they construct a *diagnostic panorama* (Figure 1).

Diagnostic panoramas are schematic representations of suggested PWHs drawn around a pivot. Each diagnostic panorama displays three parts: the pivot at the centre, surrounded by two circles. Both circles represent competing explanations for the pivot. PWHs on the inner circle must threaten a patient's health seriously and be treatable. If a student ignores one of these, a major mistake with serious consequences may be imposed on the patient. Analysing hypotheses on the inner circle has priority over elaborating PWHs on the outer circle, since the latter represent less life-threatening or less treatable diseases. In addition, students are encouraged to analyse each PWH on the inner circle in order to avoid premature acceptance of a PWH before it is fully verified.

While constructing a diagnostic panorama, the presenting students discuss and refine their drawings by interacting with the audience. They defend reasons why they plot a particular working hypothesis on a given circle. Basically, they reflect on differential diagnosis by using the panorama as reference frame.

Step 2: Representing clinical data evaluation in a diagram

The second step is to revise PWHs by analysing clinical data in more depth. For instance, students may discuss the weight (or power) of data by using likelihood ratios (LRs). LRs are probability ratios of observing a particular finding in patients with or without the disease of interest. Their values may be found in the literature. This, however, is frequently not the case (McGee, 2001). Therefore, we provide a *semi-quantitative reasoning tool* (Table 1). Powers of diagnostic indicators are made explicit by a word or sign score. Each score corresponds to a given range of LRs. One numeral is conceived as representative for that range.

Students may analyse the confirming or excluding power of an indicator by reasoning through the chart given in Table 1. If evidence-based data needed to calculate powers are missing, the students first estimate the indicator's usefulness guided by their own or their tutor's experience-based knowledge. Next, they assign a word or sign score to describe its power. Afterwards, they link this score to a numeral selected as representative for a corresponding LR range. Finally, they use the LOG-10 of this numeral to represent the results of data interpretation in a *diagnostic diagram* (Figure 2).

In this diagram, disease probabilities are plotted on the vertical bar. Mutually independent diagnostic indicators are located on the horizontal bar. A line represents shifts in disease probability provoked by addition or subtraction of the indicator's powers collected during the encounter. Depending on each power, disease probability shifts upward (a confirming step) or downward (an excluding step). At any moment, new information can be provided by the presenting students or the tutor. New cues may activate new PWHs that may reshape the initial diagnostic panorama or diagram.

Table 1. Confirming and disconfirming powers of diagnostic indicators and corresponding LR ranges: a semi-quantitative reasoning tool

Word score for confirming or excluding powers	Sign score for confirming powers	Sign score for excluding powers	Corresponding range of LRs	Representative LR unities within each range	LOG-10 of representative LR unities (used as steps in the diagram)
Not significant			0 to 1	1	0
Weak	(+)	(−)	2 to 5	3	0.5
Good	+	−	6 to 16	10	1
Strong	+ (+)	− (−)	17 to 57	30	1.5
Very strong	+ +	− −	58 to 200 or more	100	2

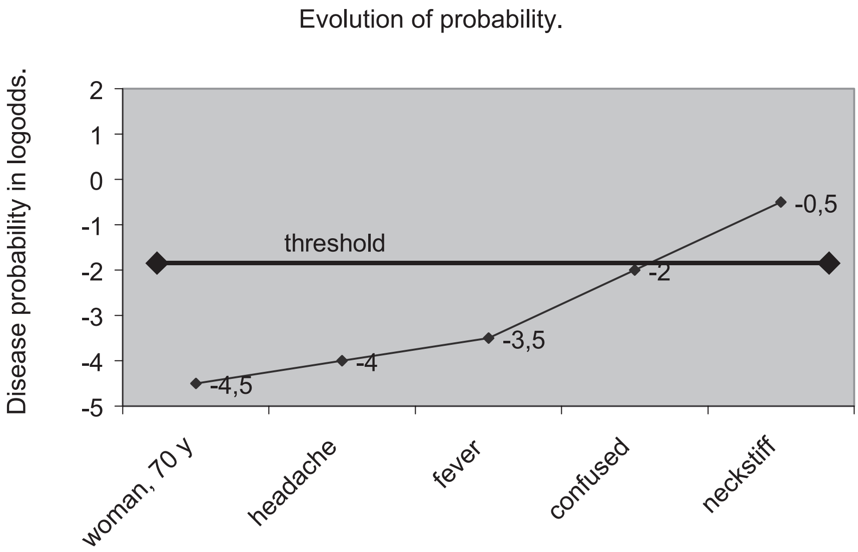

Figure 2. Diagnostic diagram displaying a plausible meningitis case: changes in disease probability provoked by the power of mutual independent diagnostic indicators starting at a prevalence between 1/100.000 (LogOdds = −5) and 1/10.000 (LogOdds = −4).

Step 3: Representing threshold management in the diagram

In order to proceed to management, the students will have to decide which PWH should be retained as final diagnosis. This crucial step deals with a *threshold* approach (Pauker & Kassirer, 1980). A threshold corresponds to a probability level of disease. When exceeded, this probability calls for one choice (e.g. treatment). When short of the value, a different choice is preferable (e.g. observing the patient). At the threshold, the risks and benefits of both choices are of equivalent value (Kassirer & Kopelman, 1991). A threshold can be calculated by using the principles of formal decision analysis. However, as accurate data needed to perform these calculations are frequently not available, we allow the presenting students to estimate a threshold. Their peers may challenge their view. Negotiating a threshold creates opportunities to become aware of different factors that may influence its level.

Once consensus is achieved, an agreed threshold for managing the patient is plotted on the diagram.

Discussion

Basically, our instructional strategy aims to make explicit the key steps in diagnostic reasoning (hypothesis generation, data evaluation and deciding on action). It introduces the nature and features underpinning the logic of these steps.

Strengths of the strategy

The strategy provides a problem-based learning approach (Davis & Harden, 1998). Real patient problems relevant to the students' needs are selected for discussion. It also provides a comprehensive framework for rapid, though critical appraisal of evidence-based along with experience-based knowledge of clinical data. In addition, it encourages students to analyse the risks, benefits and cost-effectiveness of each significant diagnostic action.

We use cooperative learning and small-group teaching, an effective basis for problem solving and decision making (Crosby, 1996; Walton, 1997). Students are expected to collaborate and actively gather information, set and test hypotheses. They balance and share each other's perspectives. Hereby, visual representations serve as communication tools. As documents, they may be used for feedback or assessment purposes.

Vigilance and education on cognitive errors seem to minimize the effects of such errors (Hamm & Zubialde, 1995). When things go wrong, we use our model as a fallback strategy. Students are encouraged to reconsider their reasoning process by using the drawings they made. Reformulating and restructuring a diagnostic problem in this way seems to be beneficial for medical students (Sefton *et al.*, 2000).

Weaknesses of the strategy

Senior students using our strategy seem to perform better than novices. Apparently, our strategy builds on high levels of medical knowledge. This restricts its use to more advanced levels of undergraduate medical education. We also introduce new concepts (e.g. 'diagnostic panorama' instead of 'differential diagnosis'). Therefore, it takes some training to understand the basics of our new model.

Our strategy places high demands on the students and their tutor. Students are encouraged to analyse their own implicit diagnostic reasoning process by the use of an explicit reasoning frame. The tutor monitors this process. Until now, there is less certainty that students and tutor have sufficient motivation, flexibility and training to cope accurately with these tasks.

Conclusion

We believe the greatest attribute of our strategy is its use of visual representations. Besides measuring the outcome of our strategy, future research will therefore go into their psychometric properties. Are they valid and reliable? We will also assess their practicality in real care settings. Can they be used in communication training sessions to let (simulated) patients get insight in the diagnostic reasoning of their doctor? In the end, answering these questions may have a positive effect on the quality of the doctor–patient encounter (Edwards *et al.*, 2002).

Acknowledgements

The authors are indebted to Prof. Dr A. Derese and the Members of the 'Medical Decision Workgroup' (WVVH) for their crucial contributions in developing the strategy.

Notes on contributors

HUGO VAN PUYMBROECK is an Assistant at the Centre for Family Practice, University of Antwerp, Belgium, and a part-time general practitioner. He acted as leading author. Using the results of a literature survey on the need and educational aspects of implementing clinical reasoning and medical decision-making strategies in undergraduate medical education and his empirical expertise with the strategy presented, he adapted it to actual insights on learning and cognition in medical education.

ROY REMMEN is an Assistant Professor at the Centre for Family Practice, University of Antwerp, Belgium, and a part-time general practitioner. He analysed and elaborated the different drafts of the article as major reviewer. He made extensive comments regarding the content, the process and the educational backgrounds of the strategy.

JOSETTE DENEKENS is Professor and Chair of the Centre for Family Practice, University of Antwerp, Belgium. She acted as reviewer on the drafts. Because of her special interests and competence in the field of medical education, her comments on the drafts were very useful for obtaining an insight into the educational advantages and drawbacks of the strategy.

ALBERT SCHERPBIER is Professor and Director of the Educational Institute, Faculty of Medicine at the University of Maastricht, The Netherlands. He acted as reviewer of the drafts. Because of his broad experience in medical education and his competence in the field, his comments and suggestions on the different drafts, especially for developing a research agenda, were indispensable.

ZENO BISOFFI is Internist and Head of Clinic at the Institute for Tropical Diseases at Negrar, University of Verona, Italy. He reviewed different drafts of the article. His major contribution consisted in developing the mathematical aspects of the strategy and translating them into useful tools for practising decision making, even at the bedside of a patient.

JEF VAN DEN ENDE is Professor and Head of Clinic at the Institute for Tropical Diseases, University of Antwerp, Belgium. He acted as reviewer on the major drafts of the article. As he outlined and conceived the major concepts and steps used in the strategy, his comments modelled the vision of the different contributing authors and served as real 'guidelines'.

References

CROSBY, J. (1996) AMEE Medical Education Guide No 8: Learning in small groups, *Medical Teacher*, 18(3), pp. 189–202.

DAVIS, M.H. & HARDEN, R.M. (1998) AMEE Medical Education Guide No 15: Problem-based learning: a practical guide, *Medical Teacher*, 21(2), pp. 130–140.

DOWIE, J. (1996) 'Evidence-based', 'cost-effective' and preference-driven' medicine: decision analysis based medical decision making is the pre-requisite, *Journal of Health Services Research Policy,* 1, pp. 104–113.

EDWARDS, A., ELWYN, G. & MULLEY, A. (2002) Explaining risks: tuning numerical data into meaningful pictures, *British Medical Journal*, 324, pp. 827–830.

General Medical Council (GMC) (1993) *Tomorrow's Doctors: Recommendations on Undergraduate Medical Education* (London, General Medical Council).

HAMM, R.M. & ZUBIALDE, J. (1995) Physicians' expert cognition and the problem of cognitive biases, *Primary Care*, 22, pp. 181–212.

KASSIRER, J.P. & KOPELMAN, R.I. (1991) *Learning Clinical Reasoning*, pp. 25–27 (BALTIMORE, MD, Williams & Wilkins).

MCGEE, S. (2001) *Evidence-based Physical Diagnosis*, pp. 3–22 (PHILADELPHIA, W.B. Saunders).

PAUKER, S.G. & KASSIRER, J.P. (1980) The threshold approach to clinical decision making, *New England Journal of Medicine*, 302, pp. 1109–1117.

REGEHR, G. & NORMAN, G.R. (1996) Issues in cognitive psychology: implications for medical education, *Academic Medicine*, 71, pp. 988–1001.

SEFTON, A., GORDON, J. & FIELD, M. (2000) Teaching clinical reasoning to medical students, in: M. Jones (Ed.) *Clinical Reasoning in the Health Professions*, pp. 184–190 (Oxford, Butterworth-Heinemann).

TOWLE, A. (1998) Changes in health care and continuing medical education in the 21st century, *British Medical Journal*, 316, pp. 301–304.

WALTON, H. (1997) Small group methods in medical teaching, *Medical Education*, 31, pp. 459–464.