Clinical teaching and learning: from theory and research to application

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doi: 10.5694/mja10.11473

An abridged version of this article appeared in the printed journal — download pdf

Series Guest Editor
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Summary

- Learning in the clinical setting is the cornerstone of medical school education, but there are strong imperatives to optimise the ways in which students acquire clinical expertise.
- Deliberate practice is characterised by attention, concentration, effort and repetition of skills; it is an important tool for developing and maintaining professional expertise.
- Research has led to a greater understanding of how medical students develop core clinical skills, especially in the areas of diagnostic reasoning, communication and physical examination.
- Advances in information technology and instructional design are helping to strengthen the links between formal educational activities and opportunistic learning in the clinical setting.

Clinical education provides medical students with the opportunity to develop a wide range of skills through experience with patients and their problems.[1] Its strengths are that it is highly relevant to future professional practice, integrates students into health care teams and provides role modelling by clinical teachers.[1,2] It has been criticised, however, for being haphazard, lacking in evidence-based rigour and failing to provide students with adequate opportunities for observed practice.[1,3,4] Furthermore, clinical education in Australia is currently challenged by increasing student numbers, changing health care practices and service pressures, all of which limit the time clinicians can devote to teaching. There are strong imperatives, therefore, to optimise the effectiveness and efficiency of the way students develop clinical expertise.[5] Here, we discuss aspects of theory and research that inform educational practice in the clinical setting, specifically in relation to clinical skills acquisition.

Generic learning theories and research

Over the past few decades, developments in cognitive learning theories have led to a greater understanding of how students acquire clinical expertise.[6] A number of key principles have emerged that are supported by substantial research activity. Foremost among these is that students learn more effectively if:

- instruction is systematically organised and coherently sequenced, with well defined objectives and meaningful theoretical frameworks to guide both formal and opportunistic learning;[1,6,7]
- the educational opportunities provided are appropriate for the students' stage of intellectual development; and
- skills acquisition takes place within the context in which it is to be applied (known as "situated learning").[8]

Students need to be able to actively build on their knowledge and skills through interplay of existing expertise with new experiences.[6] They also need opportunities to consolidate their new-found knowledge and skills by practice in a variety of clinical environments.

Deliberate practice

Cognitive psychology research has shown deliberate practice to be an important tool for developing and maintaining professional expertise.[9] It is characterised by attention, concentration, effort and repetition of skills until performance becomes fluent.[9] Deliberate practice is facilitated by deconstructing tasks into their component elements to reduce the cognitive load on students during learning.[10] Students are then able to concentrate on higher-order processes, such as problem solving and metacognition (that is, analysis of the thought processes used during learning).[2] Observation and feedback based on well defined outcome measures are essential components of deliberate practice, helping students to focus on areas of strength and weakness.[4] Effective feedback by teachers is also critical for developing reflective practice, whereby students learn to analyse their own performance and identify their individual learning needs.[11] Teachers and students have combined responsibility for optimising the effectiveness of deliberate practice in clinical skills acquisition (Box 1).

Specific areas of research in clinical skills development

Significant advances have occurred in specific as well as generic domains of clinical skills acquisition. Core areas such as diagnostic reasoning, physical examination and communication in the clinical setting provide illustrations of these advances.

1 Deliberate practice: responsibilities of teachers and students

Clinical teacher	Student
Knowledge of developmental level	Attention and concentration
Task definition and deconstruction	Effort
Management of cognitive load	Reflection
Observation	Repetition
Feedback	Perseverance

Diagnostic reasoning

Experience with a range of analytical and non-analytical strategies is required for the development of expertise in diagnostic reasoning.[12] Students need familiarity with analytical techniques, such as formal hypothesis generation, to keep diagnostic possibilities open during the reasoning process and to avoid the pitfalls of premature closure. They also need to become practised in non-analytical methods, such as pattern recognition, for efficiency and to avoid inappropriately focusing on trivial or distracting features. Studies have shown that formally teaching analytical and non-analytical reasoning processes simultaneously to novice students, rather than either approach alone, develops greater diagnostic accuracy.[12] Most of this research, however, has been conducted using visual recognition of electrocardiogram patterns,[12,13] and whether the findings can be generalised to the more complex context of clinical consultations remains to be demonstrated.

Other research has sought to identify ways of enhancing expertise in specific elements of the reasoning process, so students can appreciate not only the relative diagnostic potency of the information they gather from patients, but also develop purposeful approaches to data collection during clinical encounters.[14,15] This recognises the need to move away from traditional methods that emphasise extensive and uncritical data collection using long unstructured lists, before formal consideration of potential diagnoses.[15]

Problem representation

One area of interest has been structured learning in problem representation; that is, converting patient information into an abstract form for reasoning. Problem representation can lead to improved pattern recognition by triggering memory, so related knowledge can be retrieved.[16] It can be facilitated by using semantic qualifiers, which are paired and contrasting descriptors that help to distinguish between potential diagnoses.[14] A simple example of a pair of semantic qualifiers is "acute" versus "chronic", as applied to the symptom diarrhoea (Box 2). In one study, training junior medical students to use semantic qualifiers led to better abstract transformations and recall of findings,[15] but performance was highly context dependent, and further research is needed to explore the systematic application of this technique.

Hypothesis generation

Hypothesis generation can be enhanced by using strategies such as the contrastive approach,[17] which involves comparing the similarities and discriminating features of two to three competing diagnoses at the same time. The contrastive approach can introduce students to the use of likelihood ratios for key features of common symptoms. For example, in a patient with transient loss of consciousness, there is a high likelihood that the diagnosis is seizure, rather than syncope, if tongue biting is a feature.[18] Hypothesis generation can also be enhanced by using scheme-inductive reasoning frameworks derived from basic anatomical relationships, pathophysiological correlations or disease classifications (Box 3).[19] These presentation-specific frameworks can be used to define the initial range of enquiry, help students understand the relevance of the data they collect, and strengthen the development of prototypes of common and serious conditions for pattern recognition. Most of the research related to this technique has focused on its use as a substitute for problem-based learning.[19] Its applicability in clinical settings is yet to be defined, although it is increasingly being used as a basis for organising student textbooks.

Evidence-based physical examination

Teaching physical examination skills

Medical education research has also focused on the most effective methods of teaching students physical examination skills.[20,21] This has occurred against a background of increasing emphasis on applying evidence-based standards to physical diagnosis, based on research into the sensitivity and specificity of individual manoeuvres and enabled by technological advances such as magnetic resonance imaging and echocardiography.[22] This change in emphasis has been reinforced by the publication of guidelines for reporting research in studies of diagnostic accuracy, The Standards for Reporting of Diagnostic Accuracy (STARD) initiative,[23] and is reflected in the increasing number of publications on the robustness of the elements of the physical examination.[24]

2 The use of semantic qualifiers

Diarrhoea is classified as "acute" if it has been present for a short time, usually 1 or 2 days. This raises a particular set of diagnostic possibilities, most of which are infectious in nature. In contrast, diarrhoea of more than 4 weeks' duration is defined as "chronic", with the cause less likely to be infectious and more likely to be due to conditions such as inflammatory bowel disease or irritable bowel syndrome.

In this scenario, a student specifically enquires about the duration of a patient's diarrhoea while eliciting the cardinal features of the symptom:

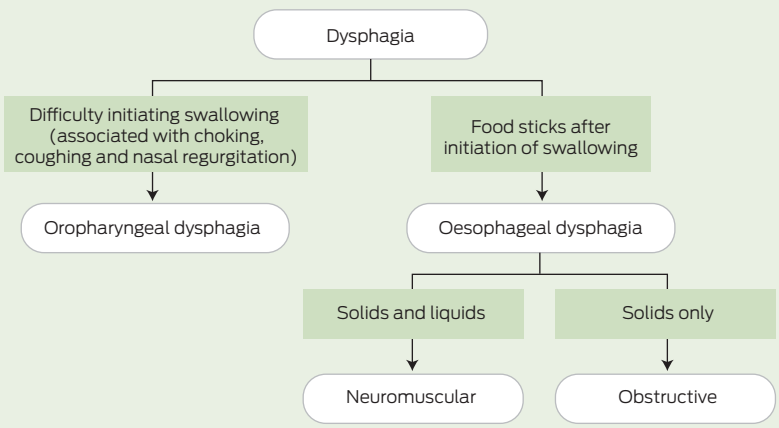
Patient: *… it's been going on for quite a while. My children had a virus they picked up at school and I thought I had got it from them. But they're better now and I've still got really loose bowel actions.*

Student: *So the diarrhoea has been going on for a while now. How long is that?*

Patient: *… about 2 months. And I've still got some crampy pain in my stomach and I seem to have lost a bit of weight. I have always had a fairly sensitive stomach but this seems a lot worse than usual …*

By clarifying the time course, the student can use the semantic qualifier "chronic" to categorise the patient's diarrhoea. The use of this descriptor enables the student to start thinking about potential diagnoses in a purposeful manner. ◆

3 A scheme-inductive reasoning framework for dysphagia



The shift to evidence-based physical diagnosis, however, has not been universally translated into educational practice, with an apparent reluctance to omit unreliable elements of the examination from clinical teaching and learning.[3,25] Students have less time available to focus on useful clinical practice skills if they are required to learn and practise outdated manoeuvres. This situation extends to assessment; checklists for physical examination stations in Objective Structured Clinical Examinations do not consistently reflect current diagnostic standards.[25,26] It has been argued recently that the lack of an evidence-based approach to developing checklists affects test validity,[26] which has implications for standard setting as well as interpretation of research findings in this area.

Acquiring the necessary psychomotor skills

Growing awareness of the need to refine the content of the physical examination has been paralleled by research into the way students acquire the psychomotor skills required to perform individual manoeuvres. Studies have specifically explored the effectiveness of structured approaches in facilitating deliberate practice of manoeuvres and identification of abnormal signs. For example, it has been shown that formal instruction in peripheral neurological examination conducted in a clinical skills centre provides a better foundation for skills acquisition than unstructured bedside teaching.[27]

Hypothesis-driven physical examination

Research in this area has been broadened by using the hypothesis-driven physical examination as an educational tool. This derives from studies of expert clinicians showing that they more readily identify physical signs if diagnostic possibilities are kept in mind during the examination.[21] Medical students have been shown to develop better physical diagnostic skills if they learn to examine patients using hypothesis-driven rather than rote approaches, and if they focus on a small number of prototypical cases within diagnostic categories.[21]

Communication skills

Effective communication is essential for accurate and efficient data collection, developing rapport with patients and facilitating teamwork with other health professionals. Communication skills training is therefore an essential component of medical school programs,[28] as reflected nationally in the Australian Medical Council standards.[29] There has been much discussion in the research literature, however, about perceived deficiencies in existing models of instruction.

One criticism is that communication skills training is often delivered as an isolated subject, away from the context in which it is applied, rather than being included with instruction in core skills, such as history-taking or physical examination.[30] Moreover, training remains largely relegated to the early campus-based years of medical courses.[30] This can result in novice students being presented with advanced skills, such as breaking bad news or dealing with complex psychosocial issues, before opportunities arise for applying these skills in clinical practice. These factors may in part explain the observation that communication skills decline across the medical course.[31]

There is a strong argument for the clinical learning environment being both necessary and suitable for communication skills training. This is supported by the growing recognition of discipline-specific communication demands and skills. In emergency medicine, for example, interruptions, time pressures and patients with undifferentiated problems create unique communication challenges. Developing an integrated teaching program for communication skills requires linking research into the communication needs of specialties, identifying constraints and opportunities, and consulting with major stakeholders.[32] Other advances include policy changes requiring curriculum renewal in training and assessment in the medical specialties, as well as assessing communication skills, and the development of models and programs that integrate communication skills training into clinical settings.[30]

Application of theory and research

The successful incorporation of educational theories and research into clinical training requires strategic planning and strong faculty leadership, as well as close collaboration between academic educators, clinical teachers and student representatives.[2,5] This process is enabled by strong curriculum design based on clear learning goals and systematic approaches to formal educational activities. It applies developmentally targeted learning frameworks and evidence-based curriculum materials to enhance learning, as well as specific techniques promoting situated learning, such as embedding medical interviewing and physical examination manoeuvres into diagnostic reasoning tasks to optimise problem-solving and skills acquisition.[21]

To ensure optimal integration of theory and research into educational practice, there need to be strong links between formal educational activities and opportunistic learning in the clinical setting.[2] Effective strategies for promoting constructive alignment between formal and opportunistic learning include specifically drawing on students' clinical experience during formal educational sessions and providing clinical teachers with curriculum materials for use in the ward or clinic. Modern information technology facilitates this process, and has largely eliminated the problem of disseminating curriculum materials to dispersed learning environments. Clinical teachers and students alike now have ready access to evidence-based information and high-quality multimedia presentations for teaching and learning, although to be maximally effective these resources need to be integrated into learning frameworks and kept up to date.[2]

Tools for opportunistic teaching

Specific tools are available for clinical teachers to use in opportunistic settings, including guides to prioritise content and promote discussion and reflection. Stanford University, for example, has identified for its clinical teachers 25 technique-dependent physical examination manoeuvres it regards as essential for comprehensive and cost-effective medical care.[20] Other resources for supporting opportunistic learning include SNAPPs (Summarise, Narrow down, Analyse, Probe, Plan), an organisational tool that has been shown to improve articulation of reasoning

processes during case presentations,[33] and Bowen's troubleshooting framework for identifying and remediating deficiencies in students' diagnostic thinking (Box 4).[14] Similarly, communication skills training frameworks, such as SEGUE (Set the stage, Elicit information, Give information, Understand the patient perspective, End the encounter), help to provide structured feedback on medical interviews and associated communication tasks.[34]

Improving generic teaching skills

There are also now many opportunities for teachers wishing to improve their generic teaching skills, for either formal sessions or opportunistic encounters.[35] Specific skills for planning teaching sessions, encouraging higher-order thinking, and for observing and giving feedback to students, can be developed, as can strategies to maximise the efficiency of teaching when time is limited, particularly in ambulatory settings.[36]

Broadening the teaching pool

Effective ways of involving patients in clinical teaching include strategic selection of patients to illustrate specific principles or learning frameworks and training patients to lead educational sessions.[37] Other developments include team teaching and broadening the teaching pool to include other health professionals in medical student education. A number of medical schools, for example, have developed formal programs in which nursing staff act as clinical facilitators to support medical student learning in the ward setting.[38]

Supporting students in learning environments

Successfully incorporating developments in educational theory and research into clinical education requires students to be well supported in their learning environments.[2] They need to be able to access and critically appraise information, actively engage in problem solving, and recognise and respond to feedback. They also need to be formally taught the skills of deliberate practice, so they understand its rationale and appreciate the importance of its role in developing and maintaining clinical expertise. This can be facilitated by using tools such as electronic or paper-based logbooks that encourage students to monitor their own learning. Importantly, students need to be equipped with survival skills for clinical environments, which include effective time management, the ability to tolerate uncertainty, and strategies for dealing with psychological issues that can have a negative impact on learning.[2]

Conclusion

Clinical education is constantly undergoing renewal in response to advances in theory development and research, and to changes in medical knowledge and health care practices. Support for clinical teachers and students alike is critical for successfully implementing educational interventions designed to enhance learning in both formal and opportunistic settings. Careful evaluation is important to determine the cost-effectiveness of such interventions and how they affect long-term outcomes.

4 Bowen's framework for troubleshooting students' diagnostic reasoning[14]

Bowen's framework outlines the various components of the clinical reasoning process, including data acquisition and reporting, problem representation, hypothesis generation, cognitive feedback, developmental stage and contextual considerations. For each of these components, there are suggestions for ways of diagnosing students' problems in these areas, as well as teaching strategies to help improve students' reasoning skills.

The following dialogue shows how this approach might be applied in a scenario of a student who has collected data from a patient with chronic diarrhoea. The student has demonstrated impaired cognitive feedback by offering an unlikely diagnosis. The teacher is helping the student to recognise this and to explore potential alternative diagnoses with more perspective.

Teacher: *What do you think is the most likely underlying diagnosis?*

Student: *… um … I think that she might have a pancreatic glucagonoma.*

Teacher: *OK … so tell me the typical features of pancreatic glucagonoma.*

Student: *Well, we saw a patient with this last week on the wards. I think that people with this condition usually have diarrhoea and steatorrhoea … they also get gall bladder problems … and some weight loss …*

Teacher: *… anything else?*

Student: *… um … oh, I think they can also get high blood glucose levels*

Teacher: *How does this compare with what you found out about this patient?*

Student: *Well, she has had diarrhoea for 2 months and a bit of weight loss and steatorrhoea … she hasn't had any gall bladder problems though …*

Teacher: *What else would you need to find out about this patient in order to support this diagnosis?*

Student: *Well, I guess I didn't ask if she had diabetes …*

Teacher: *… OK. We could find that out from her, but do you think pancreatic glucagonoma is the most likely diagnosis here?*

Student: *Uh … I guess not …*

Teacher: *Well, let's think about some other diagnostic possibilities. What are the common causes of chronic diarrhoea?* ◆

Acknowledgements: We would like to thank Dr Eleanor Flynn, Mr Andrew Mulligan and Dr Geraldine Edgley for their helpful comments.

Competing interests: No relevant disclosures.

Provenance: Commissioned; externally peer reviewed.

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