Editorial

Clinical reasoning in the age of cyber-physical systems

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The third industrial revolution in the 18th century began to blur the boundaries between countries by the proliferation of technological advancements, which led to 'globalisation'. In the context of health care professions education, patients, practitioners, students and educators became parts of a global village as a result. During the latter part of the third industrial revolution, clinical educators faced the primary challenge of adopting expanding technology to help provide a better educational experience for their students and trainees.

In 2016, Klaus Schwab, the founder of the World Economic Forum, proposed the idea of the dawn of the 'Fourth Industrial Revolution' (4IR). The term 4IR refers to how technologies are merging with the physical lives of humans: examples include voice-activated assistants, facial ID (identity) recognition and digital sensors for health care. This revolution is blurring the demarcations of the physical, digital and biological spheres of individuals, and is leading to the formation of 'cyber-physical systems'. Compared with other arms of science, the health and biomedical sciences bear a considerably higher impact of 4IR, with rapid paradigm changes taking place in genetics, robotics and artificial intelligence. Patients, practitioners and educators are fast becoming parts of a single cyber-physical system. Today, clinical educators of health care professionals have become partners or passengers, or at least witnesses, of the Fourth Industrial Revolution. They are facing the challenge of adapting educational concepts, such as clinical reasoning, to suit stakeholders who exist as 'cyber-physical systems'.

In a recent medical education conference in Sri Lanka, one speaker argued that in the era of 4IR patients may even prefer to communicate with 'machines' rather than their doctors in challenging situations, citing the recent developments in 'Google Assistant' as an example. Artificial intelligence has shown signs of surpassing not only the cognitive but also the emotional skills of human beings. It may be

too early to speculate what role we, as health professions and clinical educators, will play in the context of cyber-physical systems; however, given that dealing with uncertainty is an integral feature of clinical practice, the primary goal of health professions education in this era will be the development and adaptation of clinical and moral reasoning skills and reflective skills.

I believe that the use of simulation is the pinnacle of technological advancements in health professions education. It is helping to elevate health services to ultra-safe standards. The debate on the effectiveness of simulation in developing clinical reasoning skills is continuing, however. To foster reasoning skills, the level of fidelity in simulation is not as important as how the simulation is used: a low-fidelity simulation, if used appropriately, may be as effective as a high-fidelity simulation in developing clinical reasoning.[1] As reported by Babla et al. in this issue, basic approaches such as allowing students to develop simulation scenarios based on their learning needs and to work on them, which they call Simprovisation, may help to make simulation more effective for learning.[2]

The workplace, i.e. the place of interaction with real patients, is *the* environment to foster reasoning skills, however. The workplace should be used maximally as a teaching and learning opportunity to develop such skills. In this issue, Williams and Ledger indicate that new doctors develop reasoning skills through 'challenges' in the workplace, which are contextual and often occur out of hours when novice doctors work more independently.[3] Although these challenges can be stressful, they help to foster the personal and professional development of novice doctors. The introduction of an assistantship during the later stages of undergraduate training may help to smooth the transition from 'student' to 'doctor'.[3]

Some students may find it difficult to develop reasoning skills in the workplace, however. Anakin et al. report in this issue that understanding students' learning experiences of reasoning through a sociocultural perspective provides insight into their difficulties.[4] Such understanding appears to help students to engage in more meaningful feedback and collaborative patient care.

Feedback is the cornerstone of developing reasoning skills. The nature of feedback is related to its efficiency and effectiveness. The need for feedback to be specific and individualised has been repeatedly emphasised.[5] Feedback also needs to be in line with the goals of the curriculum. In addition, it needs to be time efficient, especially if it is to be effective in the clinical environment. Sam et al. introduced a feedback framework amalgamating some of these essential features to enhance the quality and quantity of feedback in clinical teaching.[6] The main feature of this framework is that it helps clinical teachers to signpost the curriculum and its outcomes.

The role that teachers play is vital in developing reasoning skills in students. Clinical educators need to be equipped with educational scholarship, otherwise they may face a debilitating barrier: they may be unable to harness the educational underpinning of fostering reasoning skills. In this issue, Gishen et al. argue that the education-related credentials of clinical teachers are a useful way forward in this regard, in spite of several common limitations: clinical educators have multiple roles, and teaching is just one of them.[7] They may struggle with their emotions as a result of the personal, professional and organisational challenges that they encounter in their teaching roles and responsibilities.[8] Pratt recommends that orientation and mentorship programmes need to be introduced, or the scope of existing programmes should be widened, to address these issues.[8] This may help to enhance the quality of student engagement in the teaching and learning process.

As is evident from several studies published in this issue and cited in this editorial, introducing and augmenting the ways and means of imparting and improving reasoning skills to deal with uncertainty will help students, as well as teachers, to face the challenges of this new era. The wider use of technology in education during 4IR will help to promote individualised learning among students and the provision of effective feedback on digital platforms; using digital media will become more and more important. The educational credentials of clinical teachers must be focused upon these aspects. Future research should also explore understanding, interpreting and applying these findings in the contexts of a 'cyber-physical system', which is highly dynamic and rapidly advancing.

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REFERENCES

1. Mok HT, So CF, Chung JWY. Effectiveness of high-fidelity patient simulation in teaching clinical reasoning skills. *Clinical Simulation in Nursing* 2016;**12**(10):453–467.
2. Babla K, Lipton J, Williams S, Chopra P, Thenabadu S. A model for student-led simulation. *Clin Teach* 2020;**17**(1):64–69.
3. Williams D, Ledger A. Starting work as a doctor: challenge is essential. *Clin Teach* 2020;**17**(1):36–40.

4. Anakin M, Jouart M, Timmermans J, Pinnock R. Student experiences of learning clinical reasoning. *Clin Teach* 2020;**17**(1):52–57.
5. van de Ridder JM, McGaghie WC, Stokking KM, ten Cate OT. Variables that affect the process and outcome of feedback, relevant for medical training: a meta-review. *Med Educ* 2015;**49**(7):658–673.
6. Hall C, Peleva E, Vithlani RH, Shah S, Bashyam M, Ramadas M, Horsburgh J and Sam AH, Horsburgh J. FEEDBK: a novel approach for providing feedback. *Clin Teach* 2020;**17**(1):76–80.
7. Gishen F, Gill D, Dacre J. Credentialling medical education. *Clin Teach* 2020;**17**(1):106–108.
8. Pratt M. Evaluation of unsatisfactory student performance. *Clin Teach* 2020;**17**(1):58–63.

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