Kneebone, R.L., Baillie, S. Contextualised Simulation and Procedural Skills: A View from Medical Education.
Journal of Veterinary Medical Education (2008), 35(4), 595-598.

Contextualised Simulation and Procedural Skills: A View from Medical Education

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Abstract

Simulation offers an attractive solution to the profound changes affecting traditional approaches to learning clinical procedural skills. Technical developments in physical models and virtual reality computing make it possible to practise an increasing range of procedures 'in vitro'. However, too narrow a focus on technical skill can overlook crucial elements of clinical care such as communication and professionalism.

Patient focused simulation (the combination of a Simulated Patient with an inanimate simulator or item of medical equipment) allows clinical procedures to be practised and assessed within realistic scenarios which recreate clinical challenges by placing a real person at the centre of the encounter.

This paper draws on work with human clinical procedures, exploring the parallels with veterinary practice and highlighting possible developments in client focused simulation. The paper concludes by arguing for closer collaboration and dialogue between the medical and veterinary professions, for the benefit of both.

Background

In human clinical practice, profound changes in the landscape of care are revolutionising the way healthcare professionals learn procedural skills. Traditional approaches based on an extended apprenticeship are no longer feasible. In the case of surgery, for example, patients used to stay in hospital for many days before and after routine operations. Now operations are carried out in specialist units and patients are discharged within hours of their procedure. This dramatically reduces potential contact time with medical students and other learners.

Radical reductions in working hours mean that students may qualify as doctors without having performed or even witnessed many of the procedures which would have been second nature a generation earlier. Moreover, major changes in public expectations and an altered ethical climate mean that it is no longer acceptable for students and inexperienced doctors to perform procedures on real patients without adequate training. There is clear evidence that recent graduates lack confidence about their ability to perform clinical procedures safely and well.[1] And it seems likely that such pressures will only increase.

The veterinary profession is facing similar training issues. The number of students has risen in recent years, and providing sufficient opportunities to develop the required skills, particularly practical ones, has become increasingly challenging. Veterinary schools are placing more emphasis on providing tertiary referral services and therefore, by implication, students' access to first opinion material is more limited. Compared with doctors, veterinarians face the additional challenge of treating a diverse range of species, and are often required to function as both surgeon and physician. Although there is now a move towards post graduate specialisation, many veterinarians still work in mixed practice and veterinary graduates are required to demonstrate a basic level of proficiency for the common domestic species e.g. as defined in the UK by the Royal College of Veterinary Surgeons Day One Skills.[2] Questions are also being asked about the use of animals as an educational resource and there are moves to look for alternatives where possible.[3]

This changing world demands that we radically rethink how students should learn the clinical skills that will underpin their practice throughout their careers. It is no longer justifiable to believe that students, doctors and veterinarians will simply 'absorb' the skills they need by osmosis. A clear structure for learning is needed together with new approaches and innovations to supplement existing training methods.

Educational theory

What can educational theories tell us about learning procedural skills? Elsewhere Kneebone has set out four theoretical approaches.[4] In summary, these are as follows.

The **acquisition of technical expertise** requires sustained deliberate practice, underpinned by the determination to improve. Evidence from domains within and outside medicine show that truly expert performance requires a minimum of 10 years of intense and focused preparation, supported by feedback from skilled teachers.[5,6] Simply repeating a procedure is not enough - the learner's active engagement is essential. To use a clinical example, assisting at procedures and operations is an important part of learning but on its own is not sufficient.

The role of the **tutor** is crucial but often under-recognised. Vygotsky's concept of the Zone of Proximal Development (ZPD) is useful here.[7,8] The ZPD is where a learner can do things with expert tuition and support which they could not do on their own. To be effective, such support must be sensitive to an individual learner's stage of development and should 'fade' when no longer needed. Contemporary aids to clinical learning (such as simulations and e-learning programs) can be seen as resources within the ZPD.[9]

The **context of practice** is also crucial to effective learning. Clinicians function within communities of practice and learning, where experienced and inexperienced professionals work together to provide patient care.[10,11,12] According to this view of apprenticeship, novices learn as much from being part of a community of which the expert is also a part as they do from direct tuition. Such communities of practice play an essential role in the construction of professional identity.

The **affective** component of learning is very powerful but frequently overlooked. Its effects can be positive (e.g. inspirational teaching) or negative (e.g. deliberate humiliation). A positive emotional climate can greatly benefit learning, but this needs to be created deliberately rather than left to chance.

Based on the above theories, an ideal learning environment would allow learners to practise on simulators repeatedly, with expert support and feedback when needed. Such practice would be closely aligned with the learner's clinical environment and would take place within a supportive, learner-centred learning milieu. Yet all too often, courses are one-off encounters, designed according to the needs of the institution providing them rather than the learners who attend.

Simulation

So how are clinicians to learn how to carry out procedures? Simulation offers an attractive alternative to practising on real patients, and a wide range of physical and computer-based simulators exists.[13] Simulation is also being increasing adopted in veterinary training.[14]

By working on models, the argument goes, learners can gain necessary skills without jeopardising the safety of the patient (human or animal). But what are these necessary skills, and can simulation indeed provide them? And how does simulation fit alongside the educational theories outlined above?

Much emphasis has been placed on the acquisition of technical skill. Simulation, whether bench top models or sophisticated virtual reality (VR) computer programs, offers the opportunity to practise repeatedly. Used systematically, such practice can lead to expertise, especially if sustained. But this raises important issues around the extent of practice required. Since there is so much variation within any group of learners, it is impossible to be prescriptive about hours required to achieve given levels of competence. A more compelling argument is for competency-based training, where learners continue to practice until they reach a desired level of skill. Yet simulator use is frequently episodic, governed by practical issues of access and availability rather than a structured curriculum which ensures a steady consolidation of skills through repeated opportunities for practice. Although much remains to be learned about how best to use simulation for learning practical skills, it seems that simply providing a simulator will not necessarily ensure effective learning, any more than providing clinical exposure will guarantee a given outcome.

A more serious criticism of simulation is that too much emphasis on technical skill offers an oversimplified picture which misses important elements of clinical practice. This is not to underplay the importance of technical skill, nor to undervalue the usefulness of initial practice, especially for novices. However the wider context of care is missing when learners practise on benchtop models representing isolated body parts, and procedures learned in a skills centre may bear little relation to the learner's community of practice.[10] Becoming expert in a simulator can give a misleading sense of confidence, hiding the messy, uncertain and unpredictable nature of clinical reality.

Experience in the workplace is a vital element of clinical training. In an increasingly busy workplace and with increasing student numbers, there is a risk that students will not be able to benefit fully from this valuable learning opportunity unless they have been adequately prepared. Clinical skills centres offer a crucial role here, but opportunities will be lost unless such centres can mirror clinical practice. An oversimplified, 'sanitised' form of skills training may interfere with professional learning rather than reinforcing it.

Technical skills are just one part of a wider picture. Clinical procedures require the integration of technical expertise with communication, teamworking and other skills, all requiring high levels of professionalism. A major problem with simulators (as opposed to simulation) is that they cannot recreate the subtleties of human interaction, however technologically sophisticated they may be. Yet it is the human element that constitutes the unpredictability and challenge of clinical practice. In the veterinary field, the clinician has the added complexity of dealing with both the patient and the client.

In human practice, these issues are addressed to some extent by the high fidelity simulations developed by anaesthetists for team-based crisis management. These complex scenarios, equipped with sophisticated mannekins, allow rare or safety-critical events to be practised by teams of professionals working together. However, such simulations focus on dramatic events requiring urgent intervention and can divert attention from important but more mundane practices which ensure the safety of routine care.[15] Performing a straightforward procedure in the clinic or operating theatre, for example, demands vigilance and situational awareness to ensure that small dysfunctions are noticed and corrected early, without escalating into serious problems. It seems likely that similar issues will affect veterinary training.

The challenge is to use simulation in a way which reflects actual practice, without producing either an unrealistic fragmentation into component tasks, or undue emphasis on major crises. Ideally, simulation should recreate the characteristics of *routine* clinical practice, ensuring a balance between technical skills and human relationship s which reflects the uncertainties of real life in the workplace. So how can this functional realism be achieved?

Patient focused simulation (PFS)

One possibility is to combine humans with inanimate simulators. Patient focused simulation is the combination of a Simulated Patient (SP) with a physical model or VR simulator. SPs are professional actors, trained to play the role of a patient and to give focused feedback. Such hybrid simulations offer a more authentic experience, tapping into many elements of actual clinical practice by requiring each learner to communicate with a human being while performing a procedure. In our experience, this creates a rich yet safe environment for learning and assessment which overcomes many of the limitations of orthodox simulation.[16]

The research group at Imperial College London has explored PFS at different levels of complexity and challenge and across a range of different human procedures. These include work with commonly performed procedures such as urinary catheterisation and venepuncture;[17] endoscopy;[18] and surgical operations under local anaesthesia such as carotid endarterectomy.[19] We have also explored the potential of creating different levels of challenge within scenarios, with patients who are distressed, angry, disabled or unable to speak the clinician's language.[20] In one scenario, for example, a hostile and abusive patient with an infected toe requires an intramuscular injection of antibiotics. The patient's anger (convincingly portrayed by an actor) can easily result in the learner over-focusing on the technical task and losing sight of the wider clinical picture, such as failing to ask about possible allergy to antibiotics.

In veterinary medicine, as an extension of the communication skills modules that allow students to practice dealing with clients in routine consultations and difficult situations,[21] there is also scope to combine the actor (simulated client) with a simulator. One example used a VR simulator in a role-play exercise to let students practise diagnosing bovine fertility cases while also having to deal with the 'farmer'.[22]

From this work it seems clear that PFS (or a veterinary equivalent) offers a different qualitative experience, one which taps into clinical practice to create powerful learning. This approach combines the benefits of simulation (safety; supportive learner-centred environment; focused feedback from expert clinicians and 'patients') with the challenges of real life (interacting with real people; linking simulation with actual practice). Crucially, video recording of procedures allows learners to see themselves as others see them.

Wider applications

It can be difficult enough for a novice clinician to interact effectively with one patient in a clinical encounter. But many consultations involve several people at a time. Patients may present with relatives, while doctors have to work with others in their clinical team. In paediatrics, for example, a doctor will often have to talk to one or both of the patient's parents while carrying out a procedure such as taking blood or siting an intravenous infusion. This demands a high level of interpersonal skill. PFS has much to offer here, in recreating such encounters and providing clinicians with feedback about their performance.

There are obvious parallels with veterinary practice. In small animal practice, the veterinarian has to establish a relationship with an animal and its owner often dealing with emotional situations. Performing a procedure on a cow or horse under the scrutiny of a farmer or horse owner can be highly stressful, especially when the clinician is inexperienced or lacks confidence. The new graduate must also learn to communicate appropriately with clients, understanding and using their 'language'. Additionally, as a farm is run as a business the financial implications of any recommendations must be considered while ensuring the welfare of the animal/s is safeguarded

Technology developments

Advances in simulation technology offer solutions to some of these problems. Physical mannekins are becoming increasingly sophisticated and are often computer enhanced, providing a wide range of cases and feedback on performance, and reacting to the trainee's actions. Virtual reality simulators can track learners' movements as they manipulate instruments on a screen. Recent developments in haptic technology allow a learner to practise internal examinations, building up a touch picture while being 'led' along a pre-recorded expert path, gaining an insight into the expert's technique and allowing for repeated unsupervised access to the training environment. However, unless such added functionality is also situated in clinical 'reality' the full potential of such technology may not be realised. Patient focused simulation offers major benefits in this area.

However, on a cautionary note, those who create new teaching tools and methods have a responsibility to demonstrate their validity.[23] New simulations, whether involving technological advancements or innovative new uses, should take place within a rigorous framework of evaluation.

Conclusion

It seems likely that simulation will play a growing role in medical and veterinary education in the future. Advances in simulator technology, together with innovative approaches such as PFS, make simulation increasingly attractive as a parallel to clinical experience.

It is crucially important that simulations be designed and validated to meet the needs of our learners, and not solely be driven by and respond to advances in technology. PFS, like any innovation, must be examined critically and evaluated with rigour and detachment. The affordances of technology need to be matched with the needs of learners and set within a theoretical framework that allows us to make defensible decisions about how to design educational programmes and allocate resources. And these programmes themselves must be evaluated with the same rigour as the simulations that are used within them.

Core skills underpin both the medical and veterinary professions – technical expertise, high levels of sensitivity and interpersonal skills, and the ability to manage interact with people while carrying out a demanding task. Similar challenges face both professions – the need to master those core skills in a landscape of decreasing opportunities for workplace training. These challenges must be addressed if we are to ensure the health professionals of the future are equipped with the skills they need.

Simulation is an exciting field with enormous potential. Thoughtfully designed and imaginatively applied, simulation can revolutionise medical and veterinary education. But there is a need for closer collaboration and dialogue between our two professions, forging a creative synergy which can enrich both and make the best use of scarce resources. This is the time to start working together to achieve those common aims.

References

1. Goodfellow P, Claydon P. Students sitting medical finals - ready to be house officers? *J Roy Soc Med* 94(10):516-520, 2001.

2. Royal College of Veterinary Surgeons. Veterinary Education and Training - A Framework for 2010 and beyond. London, Royal College of Veterinary Surgeons, Education Strategy Steering Group, 2001.

3. Hart LA, Wood MW, Weng H-Y. Mainstreaming Alternatives in Veterinary Medical Education: Resource Development and Curricular Reform. *J Vet Med Educ* 32(4):473-480, 2005.

4. Kneebone RL. Clinical simulation for learning procedural skills: a theory-based approach. *Acad Med* 80(6):549-553, 2005.

5. Guest CB, Regehr G, Tiberius RG. The life long challenge of expertise. *Med Ed* 35(1):78-81, 2001.

6. Ericsson KA. Deliberate practice and the acquisition and maintenance of expert performance in medicine and related domains. *Acad Med* 79(10):70-81, 2004.

7. Vygotsky LS. Thought and Language. Hanfmann E, Vakar G. (Eds). Cambridge, Massachusetts, MIT Press, 1962.

8. Wertsch JV. Vygotsky and the Social Formation of Mind. Cambridge, Massachusetts, Harvard University Press**,** 1985.

9. Guile D, Young M. Apprenticeship as a conceptual basis for a social theory of learning. Paechter C, Preedy M, Scott D, Soler J. (Eds). London, Paul Chapman Publishing Ltd**:** 56-73, 2001.

10. Lave J, Wenger E. Situated learning. Legitimate peripheral participation. Cambridge, Cambridge University Press, 1991.

11. Wenger E. Communities of practice. Learning, meaning, and identity. Cambridge University Press, 1998.

12. Goodwin D, Pope C, Mort M, Smith A. Access, boundaries and their effects: legitimate participation in anaesthesia. *Soc Health Ill* 27(6):855-871, 2005.

13. Kneebone RL, Bello F. Technology in surgical education. In: Recent Advances in Surgery. Vol 27. Royal Society of Medicine Press, London, 2005.

14. Scalese RJ, Issenberg SB. Effective Use of Simulations for the Teaching and Acquisition of Veterinary Professional and Clinical Skills. *J Vet Med Educ* 32(4):461-467, 2005.

15. Kneebone RL, Nestel D, Vincent C, Darzi A. Complexity, risk and simulation in learning procedural skills. *Med Ed* 41(8):808-814, 2007.

16. Kneebone RL, Nestel D, Wetzel C, Black S, Jacklin R, Aggarwal R, Yadollahi F, Wolfe J, Vincent C, Darzi A. "The human face of simulation." *Acad Med* 81(10):919-924, 2006.

17. Kneebone RL, Kidd J, Nestel D, Asvall S, Paraskeva P, Darzi A. An innovative model for teaching and learning clinical procedures. *Med Ed* 36(7):628-634, 2002.

18. Kneebone RL, Taylor P, Nestel D, Moorthy K, Bann S, Munz Y, Darzi A. Learning the skills of flexible sigmoidoscopy – the wider perspective… *Med Ed* 37(s1): 50-58, 2003.

19. Wetzel C, Kneebone RL, Woloshynowych M, Nestel D, Moorthy K, Kidd K, Darzi A. The effects of stress on surgical performance. *Am J Surg* 191:5-10, 2006.

20. Kneebone RL, Nestel D, Yadollahi F, Brown R, Nolan C, Durack J, Brenton H, Moulton C, Archer J, Darzi A. Assessing procedural skills in context: exploring the feasibility of an Integrated Procedural Performance Instrument (IPPI). *Med Ed* 40(11):1105-1114, 2006.

21. Adams CL, Ladner LD. Implementing a simulated client program: bridging the gap between theory and practice. *J Vet Med Educ* 31(2):138-145, 2004.

22. Baillie S, Mellor DJ, Brewster SA, Reid SWJ. Integrating a bovine rectal palpation simulator into an undergraduate veterinary curriculum. *J Vet Med Educ* 32(1):79 – 85, 2005.

23. Berg D, Raugi G, Gladstone H, Berkley J, Weghorst S, Ganter M, Turkiyyah G. Virtual Reality Simulators for Dermatologic Surgery: Measuring their Validity. *Am Soc Derm Surg* 27(4):370-374, 2001.

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Dear Dr Baker

Many thanks for your email about this paper. We are delighted that you wish to publish it in JVME. Thank you for the opportunity to revise it in the light of your reviewer's comments. We have tried to address these concerns within the paper. I have included some additional responses below.

I hope that our paper will now be suitable for publication in the Journal, but please contact either of us if you have further concerns.

Best wishes

Roger

Reviewer #1:

This manuscript presents a philosophical discussion regarding the dangers of simulating procedural techniques without the contextualization of patient (client) focused simulations (PFS).

Although patient interaction is important, this assumes that students/residents can't dissociate procedural technique from client contexts. Certainly there will be performance variance amongst students/residents to transfer technique with clinical acumen. Dissociation may be considered appropriate, at least until basic skills are mastered.
Response: it was not our intention to suggest that there is no place for isolated technical skills training on models. We have modified our MS accordingly.

Quantification of metrics to determine expertise is not well offered beyond the "ten years of practice" and the use of unqualified terms such as "many" or "adequate training". It would be useful for the authors to present a more convincing case of where transfer has been studied and how it directly affects overall performance (and the variables used to define such) as well as outcomes.
Response: this is a crucial point, but one which is difficult to answer. We have now alluded to the need for competency-based (rather than time-based) training, but in our view there is much still to be learned in this field.

This discussion would benefit from clear delineation of current efforts using simulation.
The authors present somewhat nax00EF;ve attitude as to the practical capabilities and uses for simulation. It appears the authors indict simulation as incomplete. After presenting theories, they describe an "ideal learning environment".
Response: it was not our intention to be negative about the potential of simulation. On the contrary, it is our thesis in this paper that simulation is of crucial importance. However, we believe that it should be seen within a wider context than is commonly the case at present. We have now included a reference to a recent review of current human surgical simulators.

All simulations are closed systems, and subsequently inadequate for an open system, such as clinical practice. One could argue that the discussion would be better served as to: What are specific simulations trying to solve? How are they being applied?, and How successful are they?
Response: we accept that this would be an alternative framework for discussion. However, we have cast our argument from a slightly different perspective. We believe that the other changes we have made to the paper address these concerns.

The authors noted that "simulation use is frequently episodic, governed by practical issues of access and availability rather than a structured curriculum which ensures a steady consolidation of skills." How is this different in the current clinical setting, with limited access to learning resources, and the community of expertise? How would this be different from PFS as these would not be always be available for student practice?
Response: we acknowledge this important point and have modified our conclusion accordingly.

The comment "Although much remains to be learned about how best to use simulations for leaning practical skills, it seems that simply providing a simulator will not necessarily ensure effective learning". Validation is absolutely necessary to gauge whether or not simulations are being appropriately employed.

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Response: we concur with this view, and have strengthened our closing section accordingly.

Later on page 7 the authors state: "However, such (trauma) simulations focus on dramatic events requiring urgent intervention and can divert attention from important but more mundane practices which ensure the safety of routine care." Perhaps the authors expect too much, and wish the simulation to be all things to all people.
Response: we do not agree with this view. Instead we wish to raise awareness of what we consider to be an important limitation of current practice, not so much affecting simulation equipment but more the way it is used.

In their conclusion, the authors call for simulation developers to validate their efficacy.
This is of course, sound advice. If the curriculums are hurried and do not provide time for deliberate practice, than the curriculum may be at fault, not the media and tools used to provide practice.
Response; we agree, and have now addressed this point.

To conform with Journal format, the references in the text must be numbered corresponding with the numbers in the reference list.
Response: this was an oversight which we have now rectified.