The Architecture of Medical Simulation - Collaborative Design Approach brings sophistication to teaching with procedure-specific silicone simulation

Ben Croudace *(1)*
Maurice Brygel *(2)*

(1) Director, MediModels, Jolimont, WA, Australia
(2) Maurice Brygel MB.BS, D.A, F.R.A.C.S , General Surgeon, Associate Professor, Notre Dame Medical School. Melbourne, Australia

Corresponding author:
Maurice Brygel MB.BS, D.A, F.R.A.C.S , General Surgeon, Associate Professor,
Director of Melbourne Hernia Clinic
Notre Dame Medical School,
Melbourne, Australia
Email: *mbrygel@netspace.net.au*

Abstract

Advanced manufacturing technologies are improving both the practice of medicine and the teaching of medicine. This paper reviews the application of specific simulation using life-like physical models in the teaching of surgical techniques to medical and surgical students. The direct engagement of the teaching professionals in the design of the models,and as an ongoing strategic partnership and usage feedback loop, to address specific clinical pathogies and procedures and provide better teaching outcomes.

Key words: teaching, surgery, medical models, simulation,

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Introduction

MediModels contacted the Royal Australasian College of Surgeons (RACS) to discuss their current simulation model needs and find out about their engagement with simulation in a general sense.

Until recently surgical procedures and training were carried out under an apprenticeship style system. Here a student, young doctor or surgical trainee observed and assisted the surgeon on the live patient and by a series of steps incrementally developed the skills needed in performing an entire operation. When the surgeon was happy the trainee had acquired the skills they were allowed to proceed and eventually operate independently This process was carried out in theatre on live patients.

With technological advances, medico legal pressures and so many new operations being devised, this system has become outdated.

As a result skill training laboratories were developed and are an integral part in the development of surgeons. These centres allow the practitioner to perform the most basic techniques such as incisions, knot tying and suturing, to major surgery. With the introduction of endoscopic surgery and radical new procedures on all regions of the body the apprentice system did not work as well. Skills required, for example knot tying, were more technically difficult. The skills laboratory is now used for all types of orthopaedic procedures, vascular procedures and the very common gall bladder and hernia operations. The supervisor can be happy the trainee has the skills before actually touching the patient.

But it was not just for these complex procedures that more training is required. As part of the ongoing pursuit of excellence, continuing education has become mandatory. It was expected by the profession and also by the community. The

skills laboratory and workshops helped achieve these goals of teaching new skills and maintaining them.

In Medical training, young doctors were not exposed to some of the most basic skills such as the diagnosis and surgery of skin lesions, ingrown toe nails, suturing, lacerations and drainage of an abscess.

As a result there were many practitioners in both the city, rural and remote areas deficient and lacking confidence in these skills. They required additional training.

Associate Professor Maurice Brygel took a special interest in teaching these skills. He has been designing, producing and conducting training programmes at the Royal Australasian College of Surgeons in Melbourne Australia for many years. He expanded his training both in the State of Victoria and across Australia to most capital cities and rural communities in Queensland.

Maurice Brygel is Associate Professor at Notre Dame Medical School in Australia, is director of the Melbourne Hernia Clinic, and Sydney Hernia Centre and Melbourne Haemorrhoid and Rectal Bleeding Clinic.

Early in his career Maurice saw the need for further education in these clinical and surgical skills. He passes on the clinical knowledge from his own teachers which has been handed down from generation to generation.

Initially he developed a series of books and videos, entitled the Video book of Surgery. However, the doctors still need to practice even though the videos did demonstrate the techniques.

This resulted in the development of a series of workshops on common conditions seen in general practice. These have a variety of titles including Brygel's Surgi Skills, SOS (Surgical Office Skills) and skin cancer.

One particular topic is the treatment of ingrown toenails. Ingrown toenails are a common condition generally affecting adolescents. They usually occurs in the big toe. They can be quite a painful condition and infection commonly supervenes.

Ingrown toenails can be treated in a variety of ways in the office setting.

Surgical treatment can involve removal of the nail edge, the use of a phenol to ablate the nail bed from which this nail grows. An operation termed wedge resection surgically excises this nail bed. The procedure is commonly performed under a local anaesthetic – and is termed a digital block in the office setting.

Students and doctors at the tertiary hospitals, where complex surgery is the order of the day rarely had the opportunity to even see or practice this procedure.

Thus these doctors often went to rural or remote areas without the training or confidence to implement these techniques.

Toe model

Years ago a toe model for performing procedures upon was developed and imported from China. The model was fairly simple and it did not reproduce what was required.

In 2017, Maurice began discussions with Medimodels, a new medical simulation startup company based in Western Australia, who had been in discussions with The Royal Australasian College of Surgeons in Melbourne. Medimodels founder, Ben Croudace, developed an interest in medical simulation after spending his early career in Architecture and 15 years in Architectural model making. He is a firm believer in the power, clarity and effectiveness of physical models in teaching and communication. With experience in many model making techniques, including 3d printing, Ben, who himself has also had a life-long interest in the medical fields and health care, is bringing a fresh perspective to medical training through advanced manufacturing techniques in medical simulation.

"Years of working with 3D form in architecture and thousands of hours exploring different model making techniques, has allowed us to apply our knowledge and experience to the human body and make realistic and functional simulation models through collaboration with strategic partners in the medical industry. Our focus is on creating models that produce effective teaching outcomes, so we work closely with clinicians to achieve this. We try to keep flexibility in our manufacturing process so things can be fine tuned over time to add value to our models and to move with the times and our clients' teaching needs."

Working in collaboration, Medimodels and Associate Professor Maurice Brygel developed a sophisticated ingrown toenail model which is now being used throughout Australia and overeas in universities and clinical training workshops. As a result of this interest in ingrown toenails, Brygel's Surgi Skills has developed an online teaching program with videos to support training with the models

On this model doctors can practice:

1. digital block anaesthesia,

2. excision of a nail edge

3. wedge resection, (excision of a portion of the nail bed)

4. the use of phenol ablation

5. bandaging

6. post operative care

Among other things, the ingrown toenail model came out as an easily identifiable need as it was a wide reaching condition. Medimodels started with a number of prototypes and experimented with different ways of making a toe model for toenail surgery. There were many challenges along the way but through a collaborative process they worked with Maurice Brygel, General Surgeon of the RACS, using different trial models and eventually a new toenail model evolved. We were able to apply our 20+ years of model making experience to the needs of the toe model which itself has some innovations derived from architecture in the way it is put together. The main driver here was to directly address the intricacies and key parts of current 'world best practice' surgical toenail procedures, and the nature of the human toe and the way it responds to interaction with a scalpel and other intsturments.

With medical simulation for specific procedures, it is not always about making an 'exact copy' of the human body part, (although realism is important) but more so making a model that has markers and characteristics that form the critical points of the teaching process.

Once design is completed and ready for teaching, Medimodels simulation models typically go through a beta testing phase where feedback is obtained from clinicians on their effectiveness as teaching aids for specific procedures. Feedback is obtained on visual, practical and kinaesthetic aspects of the models such as densities and textures. Once fine-tuning is completed over a trial period they are released to the wider marketplace.

Medimodels are developing simulation products for general and laparoscopic surgery training in gynaecology, podiatry, gastroenterology, ENT, hand surgery, emergency medicine, rhinoplasty and other general surgery applications.

Conclusion

The outcome of the collaborative model design process and ongoing strategic partnership has led to a more effective teaching process and outcome. The closer that a specific procedure simulation can get to real life, the more effective it will be - not only in the classroom, but for the trainee clinician when the skills they learned are transitioned to a live patient. More confidence in surgery through practice on models can be obtained, particularly as the model was originally designed, tested and redesigned in concert with one who intimately understands the intricacies of the physical engagement with the object . Perhaps the ideal is that there is zero difference between the simulated toe procedure and the real toe procedure, and Medimodels and Prof Maurice Brygel have been edging closer to this ideal through new technologies in iterative advanced manufacturing coupled with extensive collaboration between clinician and manufacturer. Medimodels welcomes enquiries from clinicians who are looking to develop a simulation model for a specific teaching application.