The Development of a Clinical Skills Laboratory at Ross University School of Veterinary Medicine

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Summary — Dedicated clinical skills laboratories (CSLs) that make use of models, mannequins and simulators, are being increasingly established in medical and veterinary schools. These have been commonplace in medical schools for more than two decades, but their incorporation within the teaching of veterinary curricula has occurred much more recently. In 2007, a decision was taken to establish a CSL at Ross University School of Veterinary Medicine. We considered the range of skills that we wished to teach, the physical space and equipment needed, the storage and air conditioning requirements, the facilities needed to deliver PowerPoint lectures and case study presentations, and other essentials necessary to handle cadaver specimens. We converted an appropriate campus building to our needs, hired teaching staff, and started to source models and mannequins for the teaching of veterinary clinical skills. In 2010, 177 senior students completed a survey evaluating their experiences within our CSL. Student satisfaction was generally high, with 95% of respondents feeling that the CSL had improved their psychomotor skills. However, 15% felt that the models were insufficiently realistic. Our clinical skills programme has since developed considerably, and it currently offers instruction in a diverse array of surgical, medical and other clinical skills. We hope that this description of our experiences may assist others embarking on similar projects elsewhere.

Key words: *clinical skills, Three Rs, veterinary curriculum, veterinary education, veterinary student.*

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Introduction

The development of an appropriate range of surgical, medical and other technical skills, along with interpersonal skills such as communication and teamwork, problem-solving, and analytical and attitudinal competencies, are all very important goals for future veterinary and medical professionals. Hence, they are at the forefront of the teaching goals of veterinary and medical schools. In recent years however, several trends have altered the teaching of such clinical competencies to veterinary and medical students.

Of particularly importance has been the increasing awareness of clinical errors as a cause of adverse patient outcomes, particularly in human medicine and surgery, which has subsequently led to increased focus on patient safety (1). Additionally, this field has benefitted from the on-going evolution of educational research and theory pertaining to the

systematic teaching and standardised assessment of clinical skills. This has included increased recognition of the limitations of experiences acquired during clinical rotations. These experiences, despite their rich potential for clinical learning are, by their very nature, intrinsically opportunistic rather than standardised as a result of being affected by varying caseloads, instructor personalities and clinical environments. There has been similar recognition of the limitations of assessments during clinical rotations, which can also be affected by varying caseloads and interactions between student and instructor personalities (2).

Traditionally, manual skills have been acquired through practice on animals. Availability and financial constraints have made this approach more difficult. Alternatives to live animal surgical training can involve the use of cadavers (3). Although the use of isolated organs may enable the student to practice a technique without using the complete cadaver, cadaver access is sometimes limited and could become less available in the future. Additionally, many institutions have faced significant budgetary restrictions in recent years, accompanied, in some cases, by increasing student numbers. Societal attitudes toward educational animal use — particularly when invasive procedures are involved — have also changed in recent decades, accompanied by regulatory upgrades, which have rendered some traditional uses of animals in the teaching of clinical procedures less acceptable from both societal and regulatory perspectives.

The utilisation of models (i.e. simulators) by instructors to teach skills, and by students to learn and practise those skills, is not completely new in veterinary medicine (4–9). In recent years, a wide variety of alternatives to traditional animal-based laboratories have been developed (10, 11). Evaluations of the educational efficacy of such alternatives have generally been very positive (12, 13), and students are increasingly requesting their use (14). Accordingly, medical and veterinary schools worldwide have been increasingly establishing dedicated laboratories or centres (clinical skills laboratories [CSLs]) for teaching a range of surgical, medical and other clinical skills by using models, mannequins and simulated (or even real) clinical patients, such as those with chronic, stable conditions. Such simulated patients can be living (e.g. trained volunteers or patients, as used by medical students), or artificial (e.g. low-, medium- or high-fidelity mannequins, which reproduce the relevant characteristics of real patients with low, medium or high degrees of realism, respectively).

CSLs offer the potential for learning experiences graded to the needs, experiences and competency level of individual students, or student cohorts. They allow repetitive practice, even of procedures that are clinically uncommon or associated with relatively high risk, in environments that are comparatively ‘low stakes’ and free from stress.

On the other hand, participation in harmful live animal use, such as that occurring in surgical training laboratories, can create high levels of stress that have the potential to adversely affect cognitive processes necessary for effective learning. Veterinary student surveys (15-16) have indicated that students are often distracted from relevant concepts by the plight of their animals and the necessity of concentrating on maintenance of life and anesthetic depth. Prior practice of surgical procedures in a relatively stress-free environment, on the other hand, is likely to lower student stress and increase procedural competence, the first time live animal surgery is performed.

CSLs also offer great potential for standardisation of the learning experience and assessment processes for students. Feedback can be provided directly from class instructors, appropriately trained simulated patients, or from real patient ‘instructors’. Alternatively, feedback can be delivered at a later time if students are filmed and then evaluated by instructors, other students and/or themselves, as might occur during clinical

skills examinations or in tutorials centred around team-based case management exercises.

The first such CSLs were established in medical schools more than two decades ago, but their incorporation within veterinary curricula has occurred much more recently. Literature on setting up a skills centre provides in-depth suggestions and helps to avoid mistakes (17-20), but this literature mainly lists numerous considerations relevant to the establishment of skills centres that focus on human medical training.

Ross University School of Veterinary Medicine (RUSVM) was accredited by The American Veterinary Medical Association in 2011, and graduates around 300–400 students annually. In 2007, a decision was taken to create a CSL at RUSVM. The first among a multitude of reasons for this initiative was a desire to ensure the long-term capacity for the utilisation of leading educational technologies, as part of a broader goal to maximise the clinical competency and confidence of RUSVM's increasingly large student cohorts, before they entered full-time clinical placements in their final year.

This paper describes the planning and creation of the RUSVM CSL. Prof. Grevemeyer established the RUSVM CSL, and Prof. Knight directed it from 2013-2014. We hope our description will provide insight into and guidance on the relevant design considerations and implementation stages for others similarly considering the establishment of CSLs based on the use of models, mannequins and simulators, rather than traditional live animal use.

Design Goals [L1]

When planning the development of our CSL, we were faced with several key considerations, such as the skills taught, the facilities and equipment required, and the appropriate staffing levels.

Skills taught [L2]

The clinical competencies required of new veterinary and medical graduates include surgical and medical skills, physical examination and laboratory skills, problem solving, critical reasoning, history taking, and team work, organisational, communication, attitudinal and other interpersonal skills.

Our initial goals were to create a centre that would provide our students with a solid grounding in basic medical and surgical skills prior to the final full-time clinical year of their curriculum, without the stress that is often associated with performing surgery or invasive procedures on living animals.

Our clinical skills curriculum was designed to introduce basic skills such as phlebotomy and surgical instrument handling into the first semester of our curriculum, and to progressively build the skill set with every subsequent semester, in a vertically integrated fashion. As suggested by others (e.g. Dacre *et al*. [20]), who recommend integrating clinical skills instruction within existing curricula as much as possible, we have also sought to match the skills we teach with the theoretical components of our curriculum. More advanced surgical skills, for example, are taught concurrently with our surgical theory course, whilst also building on more basic skills taught earlier within the CSL programme.

Facilities [L2]

We wanted to provide facilities and equipment that would allow clinical skills to be taught and assessed in a systematic and standardised manner to large numbers of students, in all semester stages of the curriculum. We also wanted to ensure that sufficient space and facilities were available for teaching a more substantial range of skills, to allow our programme to expand in the future, beyond the initial focus on a limited range of surgical skills.

It was felt that a CSL should be attractive to students and staff, readily accessible to students from all areas of the campus, and have after-hours access as an option for certain self-directed learning exercises. Ideally, it should be designed and furnished with tables and equipment amenable for teaching a range of surgical and medical skills, and be of adequate size to teach a class of around 25–30 students with 4–6 instructors (as is the case with most of our sessions). However, with a view to 'future-proofing' the facility to allow for the continued increase in cohort sizes over time, it was felt that the CSL should be designed to be twice as large as the existing RUSVM laboratories, with twice the number of teaching staff available. This would then limit the repetitions of each laboratory session necessary to accommodate all of the students in one semester stage, which would be considerably less tedious and time-consuming for the teaching staff.

A number of important specific facilities were included in the CSL at the design and planning stage, namely:

— Equipment to deliver PowerPoint lectures and case study presentations, which (in our case) required the installation of six computers with wall screens.
— Facilities for cleaning and preparing cadaver specimens, which are used in a very small minority of laboratories.
— Sufficient storage for the various models, equipment and consumables.
— High-capacity air conditioning, for the sake of the students, staff, computers and other electronic equipment (and, in our case, for the rubberised/siliconised models, which tend to degrade in the heat and humidity of the Caribbean climate).
— Closed circuit cameras, which continuously record footage that is stored for a period of months. This footage might potentially be viewed for assessment purposes (e.g. if surgical examination results were seriously contested), or if equipment goes missing during a laboratory class (although such events are fortunately rare occurrences).

Communication, history-taking, critical reasoning and problem solving skills are all essential for effective interaction with clients and for conducting veterinary consultations. To help teach these skills, RUSVM designed and constructed a bespoke communications simulation laboratory located close to the CSL. This included a reception area and two consultation rooms equipped with examination tables, basic veterinary equipment, cameras and one-way glass, where simulated consultations could be performed. The video recording playbacks of these consultations could then be discussed by facilitated small student groups in the adjacent tutorial and meeting rooms. In addition to this, a range of models located in the theriogenology barn were incorporated in the CSL. These models are used in the teaching of large animal clinical skills, including palpation, diagnosis of uterine torsion, fetotomy procedures, and the management of vaginal prolapse and dystocia (which is usually practised in bovine simulators).

Equipment [L2]

As our programme has developed, we have had to source further models and mannequins suitable for teaching a range of veterinary surgical and medical skills. Surgical and medical equipment, a vast array of consumables (e.g. suture material), and various components used in making and maintaining the models have also been sourced — often on a large scale, given our student numbers. We have also had to source a range of other equipment needed to run a CSL, such as office computers and supplies, and clinical skills reference books.

Staffing [L2]

Teaching, technical and administrative staff were appointed to work within the CSL. The current duties of the CSL staff include: timetabling (particularly coordinating and scheduling teaching sessions); setting up and clearing away the different laboratory sessions; providing clinical skills instruction; arranging and supervising assessment programmes and examinations; developing and maintaining content for the various courses taught in the CSL; maintenance of equipment inventories; and planning and budgeting.

Exploratory Visits to Other Clinical Skills Laboratories [L1]

To gain an overview of established, successful CSLs elsewhere, in 2008, a number of relevant RUSVM staff visited the School of Medicine Learning Center at Louisiana State University (LSU), and the Surgical Skills Centre at the University of Toronto.

School of Medicine Learning Center at Louisiana State University (LSU) [L2]

The LSU Medical Learning Center faculty generously led a tour of their facility, which comprised a series of multi-functional rooms equipped with models and mannequins, on which various clinical skills could be practised and various medical cases simulated. These were used for training medical students, for providing continuing education to emergency care specialists, and for carrying out investigative simulation of new medical treatments. Interestingly, the Dean's new office had also been strategically located within this relatively new building, which served to emphasise to all the importance of their clinical skills training programme.

Prior to participating in the practical sessions, the LSU students were required to review associated learning materials via a dedicated website and to participate in online quizzes. This familiarised them with the techniques and clinical knowledge associated with each new skill, allowing them to focus more effectively on practising the necessary manual skills during their practical sessions, thereby increasing the efficiency of the learning experience. We subsequently chose to incorporate the same online learning experiences within our own clinical skills instructional programme.

Surgical Skills Centre at the University of Toronto [L2]

The manager of the Surgical Skills Centre at the University of Toronto similarly gave us a tour of their facility and a detailed presentation. We were also provided with a manual that the University of Toronto had developed during the design of their own centre. This

manual explained the role of their training programme and described how the requirements for their Centre were met. These included staffing needs and organisational structure, and the requirements for IT and power supplies, storage space and funding. In addition, it also outlined some of the pitfalls that might be encountered during the design of such a centre, and advice as to how these might be overcome.

We were intrigued to see how so many training models could be created from inexpensive, readily available materials such as bandage material and plastic tubing. The many practical tips we received, along with the detailed systemic overview of the Centre, were to prove invaluable to us during the development of our own CSL.

Creating the RUSVM Clinical Skills Laboratory [L1]

Upon on return to RUSVM in 2008, we selected an appropriate campus building with an initial area of approximately 1300 square feet (120m^2), which was originally a cafeteria close to the veterinary teaching hospital. It was felt that this location would give students completing clinical rotations in the hospital, the opportunity to practise certain skills during quiet times, or when their clinical experiences highlighted a need. We converted this building to suit our requirements over a two month period, at a cost of USD 110,000.

Initially, we employed one teaching faculty member and one technician, who began to source models, mannequins, surgical instruments and other necessary equipment. The first CSL sessions held in 2008 were limited to the teaching of certain surgical skills, primarily by using the DASIE™ (Dog Abdominal Surrogate for Instructional Exercise) model, which comprises several layers of foam and fabric with coloured threads to simulate blood vessels, and a length of knitted tube that can be handled surgically like the small intestine (7). As our programme developed, the range of skills taught and models used expanded considerably. We found that some mannequins and simulators are commercially available at relatively affordable prices, while others are significantly more expensive. Accordingly, we have also designed a range of simple models with locally available materials and in-house manufacturing.

RUSVM Clinical Skills Instruction Today [L1]

Our CSL has developed considerably since 2008. In conjunction with our theriogenology barn and communications simulation laboratory, by 2018, our CSL had grown to offer instruction in a wide range of small and large animal surgical and medical skills, as well as teaching important aspects of team work, communication, problem solving and critical reasoning. All of the clinical skills instruction is vertically integrated throughout all semesters of the preclinical curriculum. Skills taught in our CSL now include: aseptic technique; instrument handling; interrupted and continuous suture patterns, including intradermal patterns; knot-tying; clamping and ligation; and simulated ovariohysterectomy surgery. Taught skills of a primarily medical nature include: diagnostic skin scraping; phlebotomy (canine, feline, ovine and bovine); intravenous catheterisation; cardiac and thoracic auscultation; ECG trace recognition; emergency case management in teams, including resuscitation techniques; and thoracocentesis and chest tube thoracostomy procedures.

The skills successfully demonstrated by students in laboratory classes are now recorded in personal assessment profiles within a secure RUSVM website. These profiles can potentially be used for various purposes, such as school accreditation evaluations, job

or internship applications post-graduation, or the design of personalised remediation experiences.

Surgical, medical and other clinical skills are also assessed through practical examinations. Examination tasks are varied, e.g. the performance of a complete ovariohysterectomy (or specific parts of the procedure) on a model, along with other surgical, medical or clinical tasks performed within a series of objective-structured clinical examination stations (OSCEs; described by, for example, May and Head [2]).

To support this programme, by 2014 we had employed numerous additional staff. Our CSL Director and Senior Programme Coordinator are responsible for maintaining the daily functioning of the CSL, including administrative issues (such as laboratory scheduling and maintenance of the CSL timetable), as well as maintenance of the equipment inventory and management of the laboratory budget. We also have three dedicated teaching faculty members, and numerous other staff who divide their duties between the CSL and other teaching and research roles. These faculty members assist with specific teaching or assessment laboratory sessions, and with the design of new models, mannequins and simulators. They also create associated course and laboratory content, including laboratory guides, supplementary learning materials and online quizzes — all of which students are expected to review via our online learning platform, prior to laboratory attendance. We also have five technical staff members, who assist with teaching, model making, and laboratory setting up and clearing away.

Our core of teaching faculty and technicians dedicated to the CSL ensures that we have sufficient staff to teach all laboratory sessions, without too much distraction by other duties. However, recruiting other faculty members to teach in the CSL broadens the range of skills and experience available, and helps ensure the integration — rather than the isolation — of the CSL laboratory sessions within the wider curriculum. We concur with Ledingham and Harden (17), who advised the utilisation of a relatively small core of teaching faculty exclusively dedicated to the CSL, and a wider group of additional staff who have teaching responsibilities shared between the CSL and other clinical settings. We agree that: *"Whatever staffing model is adopted it is critically important that all staff assigned to work in the clinical skills facility have appropriate training in the methods to be adopted and in the objectives of the programme and how these fit in to the overall curriculum."*

Evaluation of our CSL Programme [L1]

Whenever new models have been introduced, we have sought valuable feedback from our students. In 2010, we also conducted a survey in which senior (sixth semester) students were asked to evaluate their overall experience within the CSL, around the time of completion of their CSL courses. A total of 224 students were surveyed over two semesters, with 177 (79%) responding. Students were asked to evaluate laboratory opening hours, instructor availability, online resources associated with the laboratories, model availability and condition, and whether they felt that the laboratories had improved their psychomotor skills. A four-point Likert scale was used, with options to strongly disagree, disagree, agree or strongly agree. The presented research was conducted in an established educational setting involving normal educational practices and is therefore exempt from Institutional Review Board oversights under US regulations (45 CFR 46.101 (b); 21). The survey results showed that:

— 71% agreed or strongly agreed that laboratory opening hours were adequate (126/177);
— 83% agreed or strongly agreed that instructor availability was sufficient (147/177);

— 93% approved of the online resources (165/177);
— 95% approved of the availability and working condition of the models (168/177);
— 95% felt that the CSL sessions had improved their psychomotor skills (168/177).

Additionally, students were encouraged to submit anonymous comments about the CSL, including specific suggestions about potential improvements of our models. Of the 177 students who responded:

— 27 stated that they felt that the models were insufficiently realistic;
— 17 recommended the allocation of more CSL laboratory session time;
— 5 asked for additional models;
— 2 said that the models should 'bleed'.

Recent Developments and Future Goals

To build on the encouraging results to date and ensure that we continue to provide the best educational opportunities with the resources that we have available, we have implemented an active clinical skills instruction research and development programme. The aim of this programme is to develop new teaching models, mannequins and simulators, and to conduct associated educational research, in order to evaluate its impact on important educational outcomes, such as clinical competence and confidence.

Models and simulators must have sufficient fidelity while simultaneously being cost-effective and durable. Recent examples of models and simulators developed by RUSVM, for use in our CSL, include: a feline abdominal palpation model (22); models for teaching small animal thoracocentesis and chest tube thoracostomy (23); models to practise equine phlebotomy and intramuscular injection skills (24), canine otoscopy (25) and canine fundoscopy (26); a fetal calf lower leg model to teach bovine obstetrics (27); and a novel bandage limb model (28). In some cases (25, 27), we have used 3-D printing in conjunction with photographic or MRI imaging, in order to design and create our own models. The increasing affordability of this technology should facilitate its use by other institutions and permit the development of customised models, including the potential for mass production.

Conclusions [L1]

Clinical skills laboratories that are well equipped with models, mannequins and simulators offer several important benefits for veterinary students and educators. They facilitate the progressive development and vertical integration of skills throughout a veterinary medicine curriculum. They also permit standardisation and repetition of both teaching and assessment experiences and can offer exposure, not only to cases and scenarios that are common, but also to those that are clinically less common or associated with relatively higher risks. The associated online learning materials and student databases can facilitate preparation for laboratory sessions and help document the skills mastered. CSLs can also help replace traditional laboratory animal use in teaching, increasing compliance with the Three Rs principles and simplifying compliance with legislation or regulations pertaining to animal use, while eliminating the potential for animal welfare problems or student or staff concerns in this area.

When planning CSLs, key considerations include: a) the range of surgical and medical skills intended to be taught; b) the physical facilities required; c) the models,

mannequins, simulators and consumables; and d) the staffing, organisational and budgetary needs.

CSLs are invaluable in helping to prepare veterinary and medical students for their future clinical roles. We encourage veterinary and medical schools that have not yet established CSLs to consider doing so, and hope that this description of our experiences will provide encouragement and guidance. Further information on the use of the models, mannequins and simulators for veterinary clinical skills training is available via an ever-expanding body of literature, at international conferences such as those run by INVEST (International Veterinary Simulation in Teaching; see http://www.vetedsimulation.com) and NAVMEC (North American Veterinary Medical Education Consortium; see http://www.aavmc.org/NAVMEC/NAVMEC-Future.aspx), and via active online communities of educators such as the Veterinary Clinical Skills & Simulation NOVICE network (www.noviceproject.eu).

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