# Methods

Akelina, Y. (2003). **Applying the "3 Rs": training course in surgical techniques.** *Lab Animal* 32(1): 41-44. ISSN: 0093-7355
**Abstract:** As the use of surgical procedures in rodents becomes increasingly common in biomedical research, institutions face the challenge of ensuring that personnel are properly trained to perform these procedures. The author describes a microsurgery training course in use at Columbia University. ( 3 Refs.)
**Descriptors:** curriculum, laboratory animal science, education, microsurgery, veterinary, teaching methods, mice, rats, instrumentation, surgery.

Ayoubi, S., P. Ward, S. Naik, and M. Sankaran (1992). **The use of placenta in a microvascular exercise.** *Neurosurgery* 30(2):252-254. ISSN: 0148-396X (print); ISSN: 1524-4040 (online)
**Abstract:** Twenty-five human placentas were studied for suitability in a microvascular exercise. The size and useful length of vessels were measured, and different microvascular anastomoses were performed. The size of the placenta vessels compared well with reported sizes of intracranial arteries. We suggest the use of placenta by neurosurgeons as complementary to experimental animals in microvascular training.

Berkenstadt, H., Y. Munz, O. Rubin, A. Ziv, G. Trodler, and A. Blumenfeld (2006). **Evaluation of the Trauma-Man simulator for training in chest drain insertion.** *European Journal of Trauma* 32(6): 523-526. ISSN: 1439-0590
**Abstract:** Background: The Trauma-Man(R) simulator (Simulab, USA) was announced by the American College of Surgeons as a legitimate alternative to the advanced trauma life support (ATLS) animal surgical skill station. The aim of this study was to evaluate chest drain insertion training using the simulator. Methods: Twenty-four experienced physicians and 42 ATLS course participants performed chest drain insertion using the simulator. Additionally, the ATLS course trainees performed the task in the animal skills laboratory. Following training they all completed a subjective questionnaire. Results: Experts rated the various steps required for chest drain insertion similar to the human equivalent, with median scores of 4 or 5 (scale of 1-6) for all steps and recommended the use of the simulator for the training of no-vice doctors in performing the procedure (score 5.5 +/- 0.8, median 6 in a scale of 1-6). Experts recommended that the area allotted for chest drain insertion in the simulator will be modified in the cephalad direction to correspond with the guidelines of chest drains insertion. ATLS course participants found the simulator superior to the animal model only in teaching anatomical landmarks, whereas the animal model was found to be superior in teaching tissue dissection and chest drain fixation. Conclusion: The Trauma-Man(R) simulator is an efficient training tool for the chest drain insertion. Minor changes are recommended for the enhancement of the simulators' realism.
**Descriptors:** chest tube insertion, Trauma-Man, Simulab, ATLS, simulation.

Berry, M., T. Lystig, J. Beard, H. Klingestierna, R. Reznick, and L. Lönn (2007). **Porcine transfer study: virtual reality simulator training compared with porcine training in endovascular novices.** *Cardiovascular and Interventional Radiology* 30(3): 455-461. ISSN: 0174-1551 (print); ISSN: 1432-086X (online)

**Abstract:** PURPOSE: To compare the learning of endovascular interventional skills by training on pig models versus virtual reality simulators. METHODS: Twelve endovascular novices participated in a study consisting of a pig laboratory (P-Lab) and a virtual reality laboratory (VR-Lab). Subjects were stratified by experience and randomized into four training groups. Following 1 hr of didactic instruction, all attempted an iliac artery stenosis (IAS) revascularization in both laboratories. Onsite proctors evaluated performances using task-specific checklists and global rating scales, yielding a Total Score. Participants completed two training sessions of 3 hr each, using their group's assigned method (P-Lab x 2, P-Lab + VR-Lab, VR-Lab + P-Lab, or VR-Lab x 2) and were re-evaluated in both laboratories. A panel of two highly experienced interventional radiologists performed assessments from video recordings. ANCOVA analysis of Total Score against years of surgical, interventional radiology (IR) experience and cumulative number of P-Lab or VR-Lab sessions was conducted. Inter-rater reliability (IRR) was determined by comparing proctored scores with the video assessors in only the VR-Lab. RESULTS: VR-Lab sessions improved the VR-Lab Total Score (beta = 3.029, p = 0.0015) and P-Lab Total Score (beta = 1.814, p = 0.0452). P-Lab sessions increased the P-Lab Total Score (beta = 4.074, p < 0.0001) but had no effect on the VR-Lab Total Score. In the general statistical model, both P-Lab sessions (beta = 2.552, p = 0.0010) and VR-Lab sessions (beta = 2.435, p = 0.0032) significantly improved Total Score. Neither previous surgical experience nor IR experience predicted Total Score. VR-Lab scores were consistently higher than the P-Lab scores (Delta = 6.659, p < 0.0001). VR-Lab IRR was substantial (r = 0.649, p < 0.0008). CONCLUSIONS: Endovascular skills learned in the virtual environment may be transferable to the real catheterization laboratory as modeled in the P-Lab.

Bigeleisen, P.E. (2003). **Building a modern cadaver museum**. *JBC—The Journal of Biocommunication* 29(3): 2-5. ISSN: 0094-2499 (Print)
**Abstract:** Over the past five years I've created a permanent cadaver museum at The University of Rochester School of Medicine and Dentistry using the technique of plastination. I dissected cadavers, plastinated them and painted them to highlight the following structures.: the brachial plexus and its branches, the spinal cord and nerve roots, the sympathetic chain along with the lumbar and sacral plexuses, the sciatic nerve and its branches and the airway. I use these prosections to assist in teaching threedimensional anatomy along with regional anesthesia and airway management to my anesthesia residents.

Blaschko, S.D., H.M. Brooks, S.M. Dhuy, C. Charest-Shell, R.V. Clayman, and E.M. McDougall (2007). **Coordinated multiple cadaver use for minimally invasive surgical training.** *JSLS--Journal of the Society of Laparoendscopic Surgeons* 11(4): 403-407. ISSN: 1086-8089 (print)
**Abstract:** BACKGROUND: The human cadaver remains the gold standard for anatomic training and is highly useful when incorporated into minimally invasive surgical training programs. However, this valuable resource is often not used to its full potential due to a lack of multidisciplinary cooperation. Herein, we propose the coordinated multiple use of individual cadavers to better utilize anatomical resources and potentiate the availability of cadaver training. METHODS: Twenty-two postgraduate surgeons participated in a robot-assisted surgical training course that utilized shared cadavers. All participants completed a Likert 4-scale satisfaction questionnaire after their training session. Cadaveric tissue quality and the quality of the training session related to this material were assessed. RESULTS: Nine participants rated the quality of

the cadaveric tissue as excellent, 7 as good, 5 as unsatisfactory, and 1 as poor. Overall, 72% of participants who operated on a previously used cadaver were satisfied with their training experience and did not perceive the previous use deleterious to their training. CONCLUSION: The coordinated use of cadavers, which allows for multiple cadaver use for different teaching sessions, is an excellent training method that increases availability of human anatomical material for minimally invasive surgical training.

Cockram, M.S., K. Aitchison, D.D. Collie, G. Goodman, and J.A. Murray (2007). **Animal-handling teaching at the Royal (Dick) School of Veterinary Studies, University of Edinburgh.** *Journal of Veterinary Medical Education* 34(5): 554-560. ISSN: 0748-321X (print)
**Abstract:** This article describes the teaching of animal handling at the Royal (Dick) School of Veterinary Studies, University of Edinburgh, as part of an animal husbandry course during the first two years of the veterinary curriculum. Basic methods of handling and restraint appropriate for the wide range of animal species that might be encountered in veterinary practice are demonstrated in practical handling classes. Students are given opportunities to practice the techniques under supervision. Additional handling experience is available during extramural studies in animal husbandry at a variety of establishments. Students are formally examined on their ability to handle and restrain animals, and each is required to reach a threshold degree of competence before progressing to the clinical years.

Dewhurst, D., S. Cromar, and R. Ellaway (2006). **RECAL: Creating Computer-assisted Alternatives Using a Sustainable Learning Objects Approach.** *ALTEX* 23 Suppl: 54-57. ISSN: 0946-7785 (print)
**Abstract:** The mainstay alternatives to using animals in higher education are multimedia computer-assisted learning (CAL) programmes simulating practical pharmacology classes. CAL development intrinsically ties the educational content and learning design to the authoring application. As technologies change, authoring applications become obsolete, leaving edevelopment at further expense as the only option. RECAL is based on principles of standards, objects and reusability and is developing methods and tools to break this cycle by disaggregating existing CALs to separate their constituent learning objects from the runtime environment. This has improved their longterm viability and facilitated their adaptation by teachers to meet divergent learning needs.

Gadgil, U.S. (2007). **Role of simulators in surgical education.** *ALTEX* 24(3): 172-173. ISSN: 0946-7785 (print)
**Abstract:** Technical progress in surgical training and ethical issues are expected to replace traditional methods of resident learning surgery by apprenticeship in the operating room in a stressful atmosphere. With the development of Minimal Access Surgery (MAS) the surgical approach has changed totally, and curriculum-based, hand-on training is gaining importance in learning these new skills. Economic factors and ethical issues of learning basic skills on patients and animal models are driving progressive replacement with clinically closer simulators. There is scope for medical colleges and simulator manufactures to work together to develop scientific simulators and discourage the use of animals for the acquisition of basic skills in surgery. This process can be accelerated only by incorporating simulator-based training modules in the curriculum of medical education. This change in curriculum can motivate the medical

community to look for alternatives to animal use by accepting the 3R principles.

Gallagher, A.G., E.M. Ritter, H. Champion, G. Higgins, M.P. Fried, G. Moses, C.D. Smith, and R.M. Satava (2005). **Virtual reality simulation for the operating room: proficiency-based training as a paradigm shift in surgical skills training.** *Annals of Surgery* 241(2): 364-372. ISSN: 0003-4932 (print); ISSN: 1528-1140 (online)
**Abstract:** SUMMARY BACKGROUND DATA: To inform surgeons about the practical issues to be considered for successful integration of virtual reality simulation into a surgical training program. The learning and practice of minimally invasive surgery (MIS) makes unique demands on surgical training programs. A decade ago Satava proposed virtual reality (VR) surgical simulation as a solution for this problem. Only recently have robust scientific studies supported that vision METHODS: A review of the surgical education, human-factor, and psychology literature to identify important factors which will impinge on the successful integration of VR training into a surgical training program. RESULTS: VR is more likely to be successful if it is systematically integrated into a well-thought-out education and training program which objectively assesses technical skills improvement proximate to the learning experience. Validated performance metrics should be relevant to the surgical task being trained but in general will require trainees to reach an objectively determined proficiency criterion, based on tightly defined metrics and perform at this level consistently. VR training is more likely to be successful if the training schedule takes place on an interval basis rather than massed into a short period of extensive practice. High-fidelity VR simulations will confer the greatest skills transfer to the in vivo surgical situation, but less expensive VR trainers will also lead to considerably improved skills generalizations. CONCLUSIONS: VR for improved performance of MIS is now a reality. However, VR is only a training tool that must be thoughtfully introduced into a surgical training curriculum for it to successfully improve surgical technical skills.

Goldmann, K. and T. Steinfeldt (2006). **Acquisition of basic fiberoptic intubation skills with a virtual reality airway simulator.** *Journal of Clinical Anesthesia* 18(3): 173-178. ISSN: 0952-8180 (Print)
**Abstract:** STUDY OBJECTIVE: To test the hypothesis that a virtual reality (VR) airway simulator (the AccuTouch Virtual Reality Bronchsocopy Simulator; Immersion Medical, Gaithersburg, MD) can be used to teach residents basic fiberoptic intubation (FOI) skills effectively. DESIGN: Observational study. SETTING: University anesthesiology department. INTERVENTION: Supervised training was done using a VR airway simulator. MEASUREMENTS: Time to intubation before and after a 4-day training period using an adult VR FOI scenario and time to intubation using a fresh human cadaver two weeks after the training experience were measured. MAIN RESULTS: Residents were able to significantly improve time to intubation in the VR scenario (114 vs 75 seconds; $P = 0.001$). Novices differed from experienced attending anesthesiologists in time to intubation in the VR scenario, before but not after training (114 vs 79 seconds compared with 75 vs 72 seconds). Novices who had been trained with the simulator performed significantly faster in the cadaver than novices who had not (24 vs 86 seconds; $P < 0.001$). Furthermore, there was no difference in time to intubation in the cadaver between trained novices and experienced attending anesthesiologists (24 vs 23 seconds; $P > 0.05$). CONCLUSION: Use of a VR airway simulator enables anesthesia residents to acquire basic FOI skills comparable to those of experienced anesthesiologists in a human cadaver.

**Descriptors:** fiber optics, methods, intratracheal intubation, respiratory system, teaching, cadaver, computer simulation, humans, biological models.

Guimaraes da Silva, R. M., J.M. Matera, A. A. C. M. Ribeiro (2004). **Preservation of cadavers for surgical technique training.** *Veterinary Surgery* 33(6): 606-608. ISSN: 0161-349
**Abstract:** OBJECTIVE: To evaluate a technique for preservation of organoleptic tissue characteristics (color, odor, texture, and flexibility) in cadavers used for surgical instruction. STUDY DESIGN: Experimental study. ANIMALS: Forty-three canine cadavers. METHODS: Cadavers were preserved with a modified Larssen solution of the Hospital Cochim, Paris and cryopreservation. Tissue handling qualities were evaluated in surgical laboratory sessions. RESULTS: All cadavers kept texture and tissues consistency, especially skin and muscle, similar to those of live animals. Some skin desquamation and pallor of the mucous membranes occurred with repetitive freeze-thaw cycles. CONCLUSIONS: This preservation technique provides acceptable cadaver quality and tissue handling for use in surgical instruction. CLINICAL RELEVANCE: Preparation of patient cadavers by intravascular injection of modified Larssen solution yielded suitable instructional models for surgical training.
**Descriptors:** cadaver, surgery, veterinary, tissue preservation, dogs, education.

Hanlon, A., V. Gath, F. Mulligan (2007). **Practical animal-handling classes at University College Dublin.** *Journal of Veterinary Medical Education* 34(5): 561-565. ISSN: 0748-321X (print)
**Abstract:** The first two years of the veterinary program at University College Dublin (UCD) include two modules whereby students gain experience in basic animal handling. Practical Animal Husbandry uses both lectures and animal handling classes aimed at teaching students to approach, restrain, and carry out routine husbandry procedures on food-producing and companion animals humanely and competently and to be aware of the risks to human health of inappropriate animal approach and handling. Staff and students are given lists of animal-handling competencies designed to ensure that students attain relevant handling skills for beef and dairy cattle, pigs, horses, sheep, cats, dogs, and exotics (e.g., rabbits, guinea pigs). Students are allotted up to 12 weeks of Farm and Companion Animal Experience, an extramural (EMS) activity, according to their prior experience; the objectives are to become proficient in the handling and management of animals and to develop an understanding of the key husbandry factors in food-production systems (milk, beef, lamb, pork) at the farm level. Students are assessed in practical examinations at the end of the second year and cannot progress until they have achieved the required competence. In addition to the pedagogic strategies, special consideration is given to the welfare of the animals used in teaching practicals and to the health and safety of teaching staff and students.

Héon, H., N. Rousseau, J. Montgomery, G. Beauregard, and M. Choiniére (2006). **Establishment of an operating room committee and a training program to improve aseptic techniques for rodent and large animal surgery.** *Journal of the American Association for Laboratory Animal Science* 45(6): 58-62. ISSN: 1559-6109 (Print)
**Abstract:** Investigators of our research facility generally accept the concept of asepsis as an important component of adequate surgical care for animals. However, they experience difficulties putting it into practice, especially in the case of rodents. The reasons for this are

inconvenience, cost, and lack of training. To better assist investigators in the implementation of aseptic surgical techniques in their laboratories, we have created an Operating Room (OR) Committee modeled after OR committees found in human hospitals. A reconstructive surgeon, a veterinarian, a research scientist, a nurse involved in the training of OR personnel, interns, graduate students, and an animal health technician were chosen as committee members in light of their OR and animal care expertise. The first task of the OR Committee was to establish institutional guidelines for aseptic surgery, taking into account the costs imposed on research budgets by these procedures. The OR Committee also supports a complete training program in aseptic surgery techniques, which consists of lectures, a training manual, videos, and a practical course. Furthermore, when experimental procedures require specialized equipment, the OR Committee collaborates with researchers to develop strategies to achieve asepsis. This OR Committee and the training program proved to be important tools to promote and improve the quality of animal care during surgery.

Hino, A. (2003). **Training in microvascular surgery using a chicken wing artery.** *Neurosurgery* 52(6): 1495-7; discussion 1497-8. ISSN: 0148-396X
**Abstract:** OBJECTIVE: Microarterial anastomosis is now seldom performed for treatment of atherosclerotic occlusive cerebrovascular disease. However, a small but significant number of procedures still require this technique. When a surgeon's clinical experience is limited, regular practice is required to maintain and improve surgical skills. The present training system involves passage from suturing of synthetic materials (such as Silastic tubes) to practice with experimental living animals or cadavers. However, these methods are neither convenient nor practical for daily exercises and rehearsals. I present a unique training exercise for microarterial anastomosis, using a chicken wing artery. METHODS: A brachial artery can be extracted from a chicken wing. The artery is 5 to 6 cm long and measures approximately 1 mm in diameter. The artery can be used to practice end-to-end, end-to-side, or side-to-side anastomosis under the microscope. RESULTS: Several advantages are noted: the materials are cheap, convenient to manage, and easy to obtain, and neither specific facilities to maintain living animals nor anesthesia is needed. Moreover, the diameter and structure of the material are identical to those of human cortical vessels, making the rehearsal quite similar to the actual surgical experience. CONCLUSION: This exercise is useful not only for young surgeons who wish to learn microsurgical techniques but also for more experienced surgeons who need to maintain or improve their skills.

Katz, R., A. Hoznek, P. Antiphon, R. Van Velthoven, V. Delmas, and C.C. Abbou (2003). **Cadaveric versus porcine models in urological laparoscopic training.** *Urologia Internationalis* 71(3): 310-315. ISSN: 0042-1138 (print); ISSN: 1423-0399 (online)
**Abstract:** INTRODUCTION: Laparoscopy performed on anesthetized pigs is an established training model. In this pilot study, we performed laparoscopy on cadavers as a training modality for urologists participating in a laparoscopic seminar. MATERIALS AND METHODS: We compared data from two consecutive laparoscopy seminars performed at our institution. The first included a laparoscopy session performed on pigs. The second was in the same setup, yet laparoscopy was performed on fresh cadavers. We analyzed and compared the trainees' perspectives regarding the 2 modalities using a 5-scale satisfaction questionnaire. RESULTS: Seven trainees attended the cadaveric and 9 the porcine laparoscopy session. The two groups were similar in terms of age and previous laparoscopic and urological experience. The general

satisfaction of the two training modalities was high in the two groups, as well as their will for another session of the same kind. Yet the trainees ranked their understanding of the surgical anatomy, laparoscopic technique and use of instruments significantly higher in the cadaveric laparoscopy group (p values were 0.007, 0.006 and 0.032, respectively). CONCLUSIONS: Cadaveric laparoscopy may offer an ideal surgical environment allowing dissection and performance of complete procedures. In this pilot study, we conducted the first reported cadaveric laparoscopy training seminar in urology. The trainees preferred the cadaveric laparoscopy and found it superior to porcine laparoscopy. We believe that cadaveric laparoscopy is an important training tool, which may be added to the armamentarium of urological laparoscopy training courses.

Krishnan, K.G., P. Dramm, G. Schackert (2004). **Simple and viable in vitro perfusion model for training microvascular anastomoses.** *Microsurgery* 24(4): 335-338. ISSN: 0738-1085 (print)
**Abstract:** In this report, we describe a novel in vitro perfused microvessel model for training microvascular anastomotic exercises. Arteries and veins with a diameter of ca. 1 mm were explanted from chicken wings. These vessels were cannulated at both ends and mounted on a platform. Preserved, expired whole blood obtained from the blood bank was continuously injected through the proximal catheter, using an automatic perfusor. This in vitro perfused microvessel model exactly simulated the viable small-animal vessels. The setting is very simply and reliably repeated; the materials used are very cheap and universally available. There are no ethical questions involved. Vessels explanted from the human placenta or omentum may be used in a similar manner to gain the "feel" of functioning human microvascular tissue. But such materials are rarer and require the approval of ethical committees.

Kunzel, W. and H. Dier (2001). **Development of a realistic intubation simulator for teaching and training intratracheal intubation in dogs.** [Original Title: Entwicklung und Gestaltung eines Simulators fur Unterricht und Training der intratrachealen Intubation des Hundes.]. *Wiener Tierarztliche Monatsschrift* 88(1): 26-29. ISSN: 0043-535X
**Descriptors:** simulation, models, trachea, veterinary education, intubation.

Lausada, N.R., E. Escudero, R. Lamonega, E. Dreizzen, and J.C. Raimondi (2005). **Use of cryopreserved rat arteries for microsurgical training.** *Microsurgery* 25(6): 500-501. ISSN: 0738-1085 (print)
**Abstract:** Silastic tubes are used as training material for performing microvascular anastomoses. However, silastic texture differs from that of actual blood vessels. In the present work, we evaluate the use of preserved rat arterial segments for training in microvascular anastomoses. One-centimeter-long rat arterial segments were obtained from femoral, carotid, and abdominal arteries, preserved in cold saline solution, and frozen. Trainees performed microvascular anastomoses using the aforementioned material and answered questions about texture, consistency, and wall resistance to the needle, comparing preserved arterial wall and silastic tubes. They were also asked whether the arterial pedicles had a consistency and texture similar to normal vessels, and if they were a more reliable method for practicing microsurgery techniques than synthetic materials. They preferred frozen arterial pedicles over silastic tubes. We conclude that arterial cadaveric segments are a suitable biologic material for microsurgical training. Since

they can be obtained from other experiments, this is an effective way to reduce the number of animals bred and sacrificed for teaching purposes.

Levine, R.L., S. Kives, G. Cathey, A. Blinchevsky, R. Acland, C. Thompson, R. Pasic (2006). **The use of lightly embalmed (fresh tissue) cadavers for resident laparoscopic training.** *Journal of Minimally Invasive Gynecology*13(5): 451-456. ISSN: 1553-4650 (print)
**Abstract:** STUDY OBJECTIVE: The value of a cadaver training program in laparoscopic surgery has rarely been studied. As there is a dearth of cadaver training programs, it is important to evaluate them. The goal of this study was to estimate if our cadaver training program significantly and relatively rapidly taught residents laparoscopic surgical skills. DESIGN: Observational, timed comparative study (Canadian Task Force classification II-3). SETTING: University of Louisville School of Medicine, Fresh Tissue Laboratory, Louisville, KY. PARTICIPANTS: Twenty-nine obstetric/gynecology residents (15 postgraduate year PGY 2 and 14 PGY 3) participated in the study. INTERVENTION: During 5 half days, we compared the performance of each postgraduate year (PGY) 2 and PGY 3 obstetric/gynecology resident to his or her own results on five outcome skills before and after training in lightly embalmed cadavers. The testing was performed at the beginning and at the end of the week so that all improvement was secondary only to the training experience with the cadaver. Residents were assessed using laparoscopic techniques in a physical-reality simulator for three outcomes: bead transfer time, number of beads transferred, and suturing time on a stuffed vinyl glove and in two specific areas of the cadaver pelvis, with one slightly more difficult than the other. Assessment of suturing time was made on the two distinct tasks using the embalmed cadavers. Although the number of residents was relatively small, it covered two levels for one year. MEASUREMENTS AND MAIN RESULTS: The residents were assessed on a simulator before and after laparoscopic surgical training on the cadaver. The median decrease in bead transfer time (task I, simulator) was 38.5 seconds (p=.02); 69% of the residents showed some reduction in time to complete this task. The median increase in the number of beads transferred (task II, simulator) was 2.5 beads (p=.0001); 72.4% of the residents transferred at least one more bead after training. The median decrease in suture time (task III, simulator) was 63.5 seconds (p=.001); 79.3% of the residents performed this task more quickly after training. The median decrease in suture time (task IV, cadaver) was 54.5 seconds (p=.001); 72.4% of the residents showed improved performance on this task after training. The median reduction in suture time (task V, cadaver) was 53.5 seconds (p<.001); 82.8% of the residents completed this task more quickly after training. CONCLUSIONS: This cadaver surgical training program appeared to significantly improve laparoscopic surgical techniques in PGY 2 and PGY 3 obstetric/gynecology residents in a relatively short time. This model teaches residents specific training in the handling and manipulation of tissue as well as practice in surgical techniques for adnexal surgery, pelvic dissection, laparoscopic hysterectomy, and dissection within the space of Retzius that is not possible with mechanical trainers.

Liu, A., Y. Bhasin, M. Bowyer (2005). **A haptic-enabled simulator for cricothyroidotomy.** *Studies in Health Technology and Informatics* 111: 308-313. ISSN: 0926-9630 (Print)
**Abstract:** Cricothyroidotomy is an emergency procedure that is performed when the patient's airway is blocked, and less invasive attempts to clear it have failed. Cricothyroidotomy has been identified as an essential skill for military readiness. This training is relevant to more than 40,000

U.S. military medics, and thousands of civilian health care providers. Current training methods use animals, cadavers and plastic mannequins. Animal models do not have the correct anatomy. Cadavers do not have the correct physiology. Mannequins do not adequately cover the full range of anatomical variations. In this paper, we describe our effort to build a computer-based cricothyroidotomy simulator to address these problems.
**Descriptors:** computer simulation, cricoid cartilage, surgery,tracheotomy, touch.

MacIntyre, A., M.K. Markarian, D. Carrison, J. Coates, D. Kuhls, J.J. Fildes (2007). **Three-step emergency cricothyroidotomy**. *Military Medicine* 172(12): 1228-1230. ISSN: 0026-4075 (Print)
**Abstract:** OBJECTIVE: Surgical cricothyroidotomy is the airway of choice in combat. It is too dangerous for combat medics to perform orotracheal intubation, because of the time needed to complete the procedure and the light signature from the intubation equipment, which provides an easy target for the enemy. The purpose of this article was to provide a modified approach for obtaining a surgical airway in complete darkness, with night-vision goggles. METHODS: At our desert surgical skills training location at Nellis Air Force Base (Las Vegas, Nevada), Air Force para-rescue personnel received training in this technique using human cadavers. This training was provided during the fall and winter months of 2003-2006. RESULTS: Through trial and error, we developed a "quick and easy" method of obtaining a surgical airway in complete darkness, using three steps. The steps involve the traditional skin and cricothyroid membrane incisions but add the use of an elastic bougie as a guide for endotracheal tube placement. We have discovered that the bougie not only provides an excellent guide for tube placement but also eliminates the use of additional equipment, such as tracheal hooks or dilators. Furthermore, the bevel of the endotracheal tube displaces the cricothyroid membrane laterally, which allows placement of larger tubes and yields a better tracheal seal. CONCLUSIONS: Combat medics can perform the three-step surgical cricothyroidotomy quickly and efficiently in complete darkness. An elastic bougie is required to place a larger endotracheal tube. No additional surgical equipment is needed.

Marsh, D.J., S.E. Norton, J. Mok, H.D. Patel, and H.C. Chen (2007). **Microsurgical training: The chicken thigh model.** *Annals of Plastic Surgery* 59(3): 355-356. ISSN: 0148-7043
**Descriptors:** microsurgery, anastomosis, femoral artery, medical education, surgery, suturing.

Matsumura, N., N. Hayashi, H. Hamada, T. Shibata, Y. Horie, and S. Endo (2008). **A newly designed training tool for microvascular anastomosis techniques: Microvascular Practice Card.** *Surgical Neurology* published online 23 April 2008. [Corrected Proof]
http://www.surgicalneurology-online.com/article/S0090-3019(08)00028-1/abstract
ISSN: 0090-3019
**Abstract:** BACKGROUND: We report a newly designed training card (Microvascular Practice Card) that is a non-animal practice tool for surgical training and practicing the skills for microvascular anastomosis techniques. METHODS: The Microvascular Practice Card is a pocketbook-sized card that has silicone tubes affixed to it. On the card, 6 small-diameter, 4-cm-long tubes side by side are arranged in 4 directions with both ends secured. The tubes are available in diameters of 2.0, 1.0, 0.5, and 0.3 mm. The thickness of the tube wall is 0.05 or 0.1 mm. The card includes a record area that allows records to be written. Four directional tubes are

arranged on one card, making it possible to practice various directional suturing and anastomosing. RESULTS: Beginners begin to practice suturing with larger diameter tubes (2.0 mm) and refine their skills using 1.0 mm diameter tubes as they get used to the practice. For vascular anastomosis, the card provides for end-to-end anastomosis, end-to-side anastomosis, and side-to-side anastomosis. Furthermore, superfine diameter tubes (0.5 and 0.3 mm) help microsurgeons to gain experience at higher magnifications. Training on this card is performed through a plastic box with a small hole using long microinstruments. CONCLUSION: Microvascular Practice Card is a new training tool for repeatedly practicing microvascular anastomosis in various situations. This non-animal practice tool would help trainees practice under safe and hygienic conditions and reduce the number of laboratory animals used during technical training.

Moorhouse, I., A. Thurgood, N. Walker, B. Cooper, P.F. Mahoney, T.J. Hodgetts (2007). **A realistic model for catastrophic external haemorrhage training.** *Journal of the Royal Army Medical Corps* 153(2): 99-101. ISSN: 0035-8665 (Print)
**Abstract:** External haemorrhage is a significant cause of combat morbidity and mortality. UK DMS have introduced topical haemostatic agents (HemCon, QuikClot) for use as an adjunct to control catastrophic external haemorrhage. Realistic training in new equipment is essential. A model is described that is simple, reproducible, valid, realistic and currently unique in its opportunity to train soldiers to deal with life-threatening external bleeding, without recourse to live animal training. The model has been used successfully to train UK DMS medics, nurses and doctors in Afghanistan.
**Descriptors:** hemorrhage, hemostatics, military medicine, military personnel, educational models, teaching, Afghanistan, catastrophic illness, Great Britain, humans, patient simulation.

Neequaye, S.K., R. Aggarwal, R. Brightwell, I. Van Herzeele, A. Darzi, and N.J. Cheshire (2007). **Identification of skills common to renal and iliac endovascular procedures performed on a virtual reality simulator.** *European Journal of Vascular and Endovascular Surgery* . 33(5): 525-532. [Comment in: *Eur J Vasc Endovasc Surg.* 33(5): 533-535.] ISSN: 1078-5884 (Print)
**Abstract:** INTRODUCTION: There is a learning curve in the acquisition of endovascular skills for the treatment of vascular disease. Integration of Virtual reality (VR) simulator based training into the educational training curriculum offers a potential solution to overcome this learning curve. However evidence-based training curricula that define which tasks, how often and in which order they should be performed have yet to be developed. The aim of this study was to determine the nature of skills acquisition on the renal and iliac modules of a commercially-available VR simulator. METHOD: 20 surgical trainees without endovascular experience were randomised to complete eight sessions on a VR iliac (group A) or renal (group B) training module. To determine skills transferability across the two procedures, all subjects performed two further VR cases of the other procedure. Performance was recorded by the simulator for parameters such as time taken, contrast fluid usage and stent placement accuracy. RESULTS: During training, both groups demonstrated statistically significant VR learning curves: group A for procedure time ($p<0.001$) and stent placement accuracy ($p=0.013$) group B for procedure time ($p<0.001$), fluoroscopy time ($p=0.003$) and volume of contrast fluid used ($p<0.001$). At crossover, subjects in group B (renal trained) performed to the same level of skill

on the simulated iliac task as group A. However, those in group A (iliac trained) had a significantly higher fluoroscopy time (median 118 vs 72 secs, p=0.020) when performing their first simulated renal task than for group B. CONCLUSION: Novice endovascular surgeons can significantly improve their performance of simulated procedures through repeated practice on VR simulators. Skills transfer between tasks was demonstrated but complex task training, such as selective arterial cannulation in simulators and possibly in the real world appears to involve a separate skill. It is thus suggested that a stepwise and hierarchical training curriculum is developed for acquisition of endovascular skill using VR simulation to supplement training on patients.

Neequaye, S.K., R. Aggarwal, I. Van Herzeele, A. Darzi, and N.J. Cheshire (2007). **Endovascular skills training and assessment.** *Journal of Vascular Surgery* 46(5): 1055-64. ISSN: 0741-5214 (print)

**Abstract:** OBJECTIVE: Evolving endovascular therapies have transformed the management of vascular disease. At the same time, the increasing use of non-invasive vascular imaging techniques has reduced the opportunities to gain the required basic wire and catheter handling skills by performing diagnostic catheterizations. This article reviews the evidence for alternative tools currently available for endovascular skills training and assessment. METHODS: A literature search was performed on PubMed using combinations of the following keywords; endovascular, skills, training, simulation, assessment and learning curve. Additional articles were retrieved from the reference lists of identified papers as well as discussion with experts in the arena of medical education. RESULTS: Available alternatives to training on patients include synthetic models, anesthetized animals, human cadavers and virtual reality (VR) simulation. VR simulation is a useful tool enabling objective demonstration of improved skills performance both in simulated performance and in subsequent in-vivo performance. Assessment modalities reviewed include time action analysis, error analysis, global rating scales, procedure specific checklists and VR simulators. Assessment in training has been widely validated using VR simulation. Rating scales and checklists are presently the only assessment modalities that have demonstrated utility outside the training lab. CONCLUSION: The tools required for a structured proficiency based endovascular training curriculum are already available. Organization of training programs needs to evolve to make full use of modern simulation capability for technical and non-technical skills training.

Platts-Mills, T.F., M.R. Lewin, J. Wells, and P. Bickler (2006). **Improvised cricothyrotomy provides reliable airway access in an unembalmed human cadaver model.** *Wilderness and Environmental Medicine* 17(2): 81-86. ISSN: 1080-6032 (Print). [Comment in Wilderness Environ Med. 18(2) 147; author reply 147-8]

**Abstract:** OBJECTIVE: Patients with injuries requiring surgical airway management occurring far from medical care might benefit from the availability of a simple, reliable, improvisational method of cricothyrotomy with materials available in a wilderness or prehospital setting. We evaluated an improvised cricothyrotomy device in an experimental, unembalmed human cadaver model. METHODS: A high-flow intravenous spike and drip chamber was cut through the drip chamber and used as the sole apparatus for performing cricothyrotomy on unembalmed cadavers whose anterior neck surfaces and deep tissues were warmed to or near body temperature. Correct placement in the trachea and damage to the posterior wall of the trachea were assessed by either

fiberoptic bronchoscopy or neck dissection. Video recordings were used to time each procedure. Each operator was responsible for both device insertion and bag valve mask attachment and ventilation, modeling as the sole care provider for the patient. RESULTS: One physician and 3 emergency medicine residents, all without previous, specific instruction, performed 10 procedures on 5 female and 5 male unembalmed cadavers weighing a mean of 65 kg (range 45-110 kg). All 10 attempts at placement of the intravenous tubing spike through the cricothyroid membrane were successful. On 2 attempts, the initial placement of the device was incorrect, but the error was immediately identified on attempt to ventilate the patient. Repositioning of the device resulted in appropriate cannulation of the trachea in both attempts. The median time span from manual identification of the cricothyroid membrane to percutaneous access and connection of the bag valve mask with successful ventilation was 27.3 seconds. Violation of the posterior tracheal wall was not seen on any of the 5 procedures in which fiberoptic visualization was available or in the 5 procedures evaluated by neck dissection. CONCLUSIONS: Cricothyrotomy is the quickest and most effective method for obtaining airway access when nonsurgical methods of securing the airway are contraindicated or fail. Although frequently described, no improvised airway devices of this type have been tested in a systematic manner. We tested the reliability and utility of cricothyrotomy with a high-flow intravenous spike and drip chamber. Our results suggest that the spike and drip chamber is a plausible means of temporarily establishing airway access in patients with acute airway obstruction in a wilderness or prehospital environment.
**Descriptors:** airway obstruction, cricoid cartilage, surgery, emergency treatment, tracheotomy, adult, cadaver, humans, methods, video recording.

Proano, L., L. Jagminas, C.S. Homan, and S. Reinert (2002). **Evaluation of a teaching laboratory using a cadaver model for tube thoracostomy**. *Journal of Emergency Medicine* 23 (1): 89-95. ISSN: 0736-4679
**Abstract:** A prior study evaluated the efficacy of a dog laboratory to teach residents chest tube thoracostomy. This study evaluated a similarly structured program using human cadavers. A prospective repeat measure study of chest tube thoracostomy placement training was performed in a university laboratory setting using human cadavers. Ten Emergency Medicine residents were given a written pretest, followed by training. Resident attempts were then timed. The following day, a repeat test was administered. Three weeks later, a third written post-test was conducted. The written test scores improved for every participant. Mean times for procedure completion improved from 86 sec to 34 sec during the first session, and remained stable over 4 attempts from 30 sec to 32 sec during the second session. This approach to teaching clinical procedures should be considered for Emergency Medicine residency programs and for continuing education courses that emphasize procedural skills.
**Descriptors:** emergency medicine, hospitals, teaching, methods, thoracostomy, cadaver, humans, internship and residency; anatomic models, program evaluation, prospective studies.

Rassweiler, J., J. Klein, D. Teber, M. Schulze, and T. Frede (2007). **Mechanical simulators for training for laparoscopic surgery in urology.** *Journal of Endourology* 21(3): 252-262. ISSN: 0892-7790 (print)
**Abstract:** BACKGROUND AND PURPOSE: The introduction of laparoscopic surgery into urology has led to new training concepts differing significantly from previous concepts of training for open surgery. This paper focuses on the type and importance of mechanical

simulators in laparoscopic training. MATERIALS AND METHODS: On the basis of our own studies and experience with the development of various concepts of laparoscopic training, including different modules (i.e., Pelvi-trainer, animal models, clinical mentoring) since 1991, we reviewed the current literature concerning all types of simulators. We focused on training for laparoscopic ablative and reconstructive surgery using mechanical simulators. RESULTS: The principle of a mechanical simulator (i.e., a box with the possibility of trocar insertion) has not changed during the last decade. However, the types of Pelvi-trainers and the models used inside have been improved significantly. According to the task of the simulator, various sophisticated models have been developed, including standardized phantoms, animal organs, and even perfused segments of porcine organs. For laparoscopic suturing, various step-by-step training concepts have been presented. These can be used for determination of the ability of a physician with an interest in laparoscopic surgery, but also to classify the training status of a laparosopic surgeon. CONCLUSIONS: Training in laparoscopic surgery has become an important topic, not only in learning a procedure, but also in maintaining skills and preparing for the management of complications. For these purposes, mechanical simulators will definitely play an important role in the future.

Reinig, K., C. Lee, D. Rubinstein, M. Bagur, and V. Spitzer (2006). **The United States military's thigh trauma simulator.** *Clinical Orthopaedics and Related Research* 442: 45-56. ISSN: 0009-921X (Print)
**Abstract:** Computer-generated virtual environments bring the potential to practice complex mental and physical tasks in safe and controlled conditions. When applied to medical procedures, they could allow students to gain experience with a wide variety of cases, in optimal order, and with no patient risk. The United States military is funding the development of a virtual environment to present a variety of health care providers, including orthopaedic surgeons, with case scenarios based on thigh trauma resulting in femur fractures. Data from the Visible Human project are being used to create the underlying virtual anatomy. This paper discusses an effort to imbue models created from the Visible Human male with thigh trauma related to femur fractures and to display the results in clinically relevant ways including virtual fluoroscopy and radiography, ultrasound, palpation, and nonclinical but educationally useful methods including transparency.
**Descriptors:** computer simulation, femoral fractures, military medicine, thigh, injuries, traumatology, computer-assisted instruction, diagnostic imaging, imaging, three-dimensional, United States

Reuthebuch, O., D. Schmidt, A. Lang, P. Groscurth, and M. Turina (2003). [**Totally artificial training model for coronary heart surgery: the renunciation of animal experiments?**] [Article in German] *ALTEX* 20(1): 17-20. ISSN: 0946-7785 (Print)
**Abstract:** AIM: Animal protection laws will lead to stricter and more selective criteria thus resulting in a decline of available animals. Yet to train cardiac surgical skills a totally artificial training model was developed. DESCRIPTION OF THE TRAINING MODEL: The model is based on differently hardened polyurethane. Cover is a 1:1 replica of the human thoracic wall. Disposable coronaries are integrated in the heart-model. Vessels and part of the ascending aorta can be rinsed. By means of a newly designed air-pump stroke volume, heart-rate and rhythm can be adjusted. EXPERIENCES: Set-up of the model is easy and quick. Accustomed instruments

can be used. Handling of artificial tissue is nature-like. Degree of difficulty is dependent on stroke volume, heart rate, arrhythmia, vessel-size and vessel-quality. CONCLUSION: The phantom helps to achieve confidence in coronary revascularisation. It facilitates an accompanying training for the less-trained as well as the skilled surgeon. The nature-like characteristics will help to reduce animal experiments in future.

Reuthebuch, O, A. Lang, P. Groscurth, M. Lachat, M. Turina, and G. Zünd (2002). **Advanced training model for beating heart coronary artery surgery: the Zurich heart-trainer.** *European Journal of Cardiothoracic Surgery* 22(2): 244-248. ISSN: 1010-7940 (print)
**Abstract:** OBJECTIVE: Coronary artery surgery with beating heart technique is gaining increasing popularity. However, it is a challenging technique even for well-trained cardiac surgeons. Thus, a training model for beating heart surgery was developed to increase safety and accuracy of this procedure. METHODS: The model consists of differentially hardened polyurethane resembling mechanical properties of the human heart. The covering used in this model is a 1:1 replica of the human thoracic wall with optionally embedded skeletal structures. Sternotomy, lateral thoracotomy or trocar placement is possible to access the lungs, the pericardium and the heart with adjacent vessels. Disposable artificial coronaries variable in size, wall quality or wall thickness are embedded in the synthetic myocardium. Two-layer vessels, which can simulate dissection, are available. Bypass conduits utilize the same material. Coronaries/bypasses as well as part of the ascending aorta are water-tight and can be rinsed with saline. Lungs can be inflated. A purpose-built pump induces heart movement with adjustable or randomized stroke volume, heart rate and arrhythmia induction. RESULTS: The model was tested in a recent 'Wet-Lab' course attended by 30 surgeons. All conventional instruments and stabilizers with standard techniques can be used. Training with beating or non-beating heart was possible. Time needed for an anastomosis was similar to clinical experience. Each artificial tissue showed its individual nature-like qualities. Various degrees of difficulty can be selected, according to stroke volume, heart rate, arrhythmia, vessel size and vessel quality. The model can be quickly and easily set up and is fully reusable. CONCLUSIONS: The similarity to human tissue and the easy set-up make this completely artificial model an ideal teaching tool to increase the confidence of cardiac surgeons dealing with beating heart and minimally invasive surgery.

Ritter, E.M. and M.W. Bowyer (2005). **Simulation for trauma and combat casualty care.** *Minimally Invasive Therapy and Allied Technologies* 14(4-5): 224-234. ISSN: 1364-5706 (print) ISSN: 1365-2931 (online)
**Abstract:** Training medical providers to care for traumatically injured patients is a difficult undertaking and currently used training strategies are often suboptimal. The further strains placed on trauma care in the military environment only add to the challenge. Simulation applications ranging from simple physical models to complex, computer-based virtual reality systems have either been developed or are being developed to help support and improve trauma care training. Several of these applications have been shown to be as good as or better than the standard training methods they are designed to replace. Simulators are available for training in the treatment of disorders of the airway, difficulty with breathing, and problems dealing with circulation as well as various non-life-threatening but disabling injuries. Some of these simulators have already drastically changed how the standard Advanced Trauma Life Support course is taught. Advances in both technology and application of simulators will continue to

affect trauma skills training for the foreseeable future.
**Descriptors:** CathSim, Trauma-Man, SimMan, EYESi, UltraSim, Virtual IV, virtual reality, simualtors, medical education, training, trauma, military medicine.

Scalese, R.J. and S.B. Issenberg (2005). **Effective Use of Simulations for the Teaching and Acquisition of Veterinary Professional and Clinical Skills.** *Journal of Veterinary Medical Education* 32(4): 461-467. ISSN: 0748-321X (print)
**Abstract:** Simulation technology will feature prominently in this exciting, yet challenging, time for veterinary medicine. The profession is evolving to keep pace with rapid changes in clinical practice, scientific discovery, and educational strategy, while ensuring that it follows the public mandate to produce competent veterinarians. Among the challenges to meeting this educational goal are limitations—due to important issues such as animal welfare—on the availability of real patients for training. Drawing chiefly on the experience in human medicine, this article explores the use of simulations in veterinary medical education to provide safe and ethical alternative opportunities for learners to practice essential clinical and professional skills.

Scerbo, M.W., J.P. Bliss, E.A. Schmidt, S.N. Thompson, T.D. Cox, and H.J. Poland (2004). **A comparison of the CathSim system and simulated limbs for teaching intravenous cannulation**. *Studies in Health Technology and Informatics* 98: 340-346. ISSN: 0926-9630
**Abstract:** The present study describes a comparison between the CathSim VR simulator and simulated limbs for training IV cannulation. Two groups of physician assistant students underwent 2 hours of training on either method. Performance was assessed before and after training with a standardized assessment form. The results showed that all students improved after training, but the degree of improvement was greater for those trained with the simulated limbs. These findings may be due to differences between the two training methods as well as the methodology adopted in the present study.
**Descriptors:** extremities, venous cutdown, humans, user-computer interface, Virginia.

Schijven, M.P. and J.J. Jakimowicz (2003). **Introducing the Xitact LS500 laparoscopy simulator: toward a revolution in surgical education.** *Surgical Technology International* 11:32-36. ISSN: 1090-3941 (Print)
**Abstract:** Minimal invasive surgery has become the primary technique-of-choice for uncomplicated, symptomatic cholelithiasis. Skills needed for performing laparoscopic cholecystectomy cannot be extrapolated directly from the open surgical technique. An obvious need exists for a valid, objective, and repetitive teaching and training setting for minimally invasive surgery. The surgical skills laboratory may have an important role in acquisition of such skills. New technologies, such as virtual-reality surgical simulation, provide objective, trainee-friendly methods of training. Both surgeons and residents believe it is important to train residents in minimally invasive surgical techniques, using virtual-reality surgical simulation within the context of the surgical skills laboratory. This article highlights the features of one of the most promising technical novelties in the area of surgical virtual- reality simulation, the Xitact LS500 laparoscopy simulator.

Schöffl, H., S.M. Froschauer, K.M. Dunst, D. Hager, O. Kwasny, G.M. Huemer (2008). **Strategies for the reduction of live animal use in microsurgical training and education.**

*ATLA—Alternatives to Laboratory Animals* 36(2):153-160. ISSN: 0261-1929 (Print)
**Abstract:** Education and training in microsurgical techniques have historically relied on the use of live animal models. Due to an increase in the numbers of microsurgical operations in recent times, the number of trainees in this highly-specialised surgical field has continued to grow. However, strict legislation, greater public awareness, and an increasing sensitivity toward the ethical aspects of scientific research and medical education, emphatically demand a significant reduction in the numbers of animals used in surgical and academic education. Hence, a growing number of articles are reporting on the use of alternatives to live animals in microsurgical education and training. In this review, we report on the current trends in the development and use of microsurgical training models, and on their potential to reduce the number of live animals used for this purpose. We also share our experiences in this field, resulting from our performance of numerous microsurgical courses each year, over more than ten years. The porcine heart, in microvascular surgery training, and the fresh chicken leg, in microneurosurgical and microvascular surgery training, are excellent models for the teaching of basic techniques to the microsurgical novice. Depending on the selected level of expertise of the trainee, these alternative models are capable of reducing the numbers of live animals used by 80-100%. For an even more enhanced, "closer-to-real-life" scenario, these non-animated vessels can be perfused by a pulsatile pump. Thus, it is currently possible to provide excellent and in-depth training in microsurgical techniques, even when the number of live animals used is reduced to a minimum. With these new and innovative techniques, trainees are able to learn and prepare themselves for the clinical situation, with the sacrifice of considerably fewer laboratory animals than would have occurred previously.

Schöffl, H., D. Hager, C. Hinterdorfer, K.M. Dunst, S. Froschauer, W. Steiner, O. Kwasny, and G.M. Huemer (2006). **Pulsatile perfused porcine coronary arteries for microvascular training.** *Annals of Plastic Surgery* 57(2): 213-216. ISSN: 0148-7043 (Print)
**Abstract:** Microsurgery is today an established technique in specialties such as plastic surgery, neurosurgery, and trauma surgery. However, specialized training is a prerequisite for mastering anastomosis of small-diameter vessels or coaptation of nerves in the operating room. The training should be as realistic as possible and thus, laboratory animals such as the rat are preferably used as a substitute. In an attempt to minimize the use of living animals without jeopardizing a realistic training setting, we developed a pulsatile perfused porcine coronary artery model for microsurgical education. The training model consists of a membrane pump that generates a pulsatile flow within a coronary artery of a porcine heart. The pump is commercially available with a dimension of approximately 130 x 100 x 60 mm and a weight of 190 g. The pump is energized by 220 B and the motor is run on a transformed power of approximately 12 V (range, 1.5-12 V). Different fluids from simple saline solution to theoretically whole blood can be used for perfusion. The membrane pump proved to be very reliable during microvascular training because of its convenient size and wide range of feed rate providing a very realistic training setting. A maximum fluid output of 850 mL/min can be achieved. The pump has a high acceptance in microsurgical trainees evaluated by questionnaires during several microsurgical courses. The pulsatile perfused porcine coronary artery system for microsurgical training enables the trainee to work under the most realistic training settings. It proved to be a valuable tool during microsurgical education, reducing the costs and sparing living laboratory animals. Thus, we can recommend this system to anyone who is involved in training and teaching microsurgical

skills.

Smeak, D.D. (2008). **Teaching veterinary students using shelter animals.** *Journal of Veterinary Medical Education* 35(1): 26-30. ISSN: 0748-321X (Print)
**Abstract:** Veterinary teaching hospitals (VTHs) are experiencing case-load trends that have negatively affected efforts to prepare students for entry-level veterinary practice, particularly in the area of technical skills training. This article examines the clinical training available to veterinary students through a variety of collaborative shelter models. Benefits and potential problems related to initiating a collaborative shelter clinical training program are reviewed. Collaborative efforts between animal shelters and veterinary schools can provide crucial opportunities for outreach teaching initiatives, particularly for teaching medical and surgical skills.

Sohn, V.Y., J.P. Miller, C.A. Koeller, S.O. Gibson, K.S. Azarow, J.B. Myers, A.C. Beekley, J.A. Sebesta, J.B. Christensen, and R.M. Rush (2007). **From the combat medic to the forward surgical team: the Madigan model for improving trauma readiness of brigade combat teams fighting the Global War on Terror.** *Journal of Surgical Research* 138(1): 25-31. ISSN: 0022-4804 (Print)
**Abstract:** BACKGROUND: Medics assigned to combat units have a notable paucity of trauma experience. Our goal was to provide intense trauma refresher training for the conventional combat medic to better prepare them for combat casualty care in the War on Terror. MATERIALS AND METHODS: Our Tactical Combat Casualty Care Course (TC3) consisted of the following five phases: (1) One and one-half-day didactic session; (2) Half-day simulation portion with interactive human surgical simulators for anatomical correlation of procedures and team building; (3) Half-day of case presentations and triage scenarios from Iraq/Afghanistan and associated skills stations; (4) Half-day live tissue lab where procedures were performed on live anesthetized animals in a controlled environment; and (5) One-day field phase where live anesthetized animals and surgical simulators were combined in a real-time, field-training event to simulate realistic combat injuries, evacuation problems, and mass casualty scenarios. Data collection consisted of surveys, pre- and posttests, and after-action comments. RESULTS: A total of 1317 personnel participated in TC3 from October 2003 through May 2005. Over the overlapping study period from December 2004 to April 2005, 327 soldiers participated in the formal five-phase course. Three hundred four (94%) students were combat medics who were preparing for combat operations in Iraq or Afghanistan. Of those completing the training, 97% indicated their confidence and ability to treat combat casualties were markedly improved. Moreover, of those 140 medics who took the course and deployed to Iraq for 1 year, 99% indicated that the principles taught in the TC3 course helped with battlefield management of injured casualties during their deployment. CONCLUSION: The hybrid training model is an effective method for training medical personnel to deal with modern battle injuries. This course increases the knowledge and confidence of combat medics deploying and fighting the Global War on Terrorism.
**Descriptors:** emergency medical services, emergency medical technicians,military medicine, war, wounds and injuries, anesthesia, animals, models, goats, humans, manikins, terrorism, triage.

Sohn, V.Y., L.A. Runser, R.A. Puntel, J.A. Sebesta, A.C. Beekley, J.L. Theis, N.L. Merrill, B.J. Roth, and R.M Rush (2007). **Training physicians for combat casualty care on the modern battlefield.** *Journal of Surgical Education* 64(4)199-203. ISSN: 1931-7204 (Print)
**Abstract:** INTRODUCTION: Trauma training among nonsurgical physicians in the military is highly variable in amount and quality. However, all deployed military physicians, regardless of specialty, are expected to provide combat casualty care. The goal was to assess the effectiveness of an intense modular trauma refresher course for nonsurgical physicians deploying to a combat zone. METHODS: All graduating nonsurgical residents participated in this 2.5-day course, consisting of 4 modules: (1) didactic session; (2) simulation with interactive human surgical simulators; (3) case presentations and triage scenarios from Iraq/Afghanistan with associated skill stations; and (4) live tissue surgical procedure laboratory. Competency tests, surveys, and after action comments were reviewed and compared before and after course completion. RESULTS: Between May 2005 and April 2007, 60 physicians participated in the course. By specialties, there were 32 internists, 16 pediatricians, 7 general practitioners, 4 obstetricians/gynecologists, and 1 "other" nonsurgical physician represented. Precourse and postcourse tests were administered to 31 of 60 participants. The mean test scores improved from 76% to 96% upon completion of the course ($p < 0.01$). Additionally, self-perceived confidence levels in handling battlefield casualties from questionnaires based on Likert scale responses (1 = not confident, 5 = confident) improved from an average of 2.3 before the course to 3.9 upon completion of the course ($p < 0.01$). CONCLUSION: All military physicians must be prepared to manage combat casualties. This hybrid training model may be an effective method to prepare nonsurgeons to deal with battle injuries. This course significantly improved the knowledge and confidence among primary care physicians.
**Descriptors:** internship and residency, military medicine, war, teaching, traumatology, United States.

Stevens, C.A. and N.D. Dey (2007). **A program for simulated rodent surgical training.** *Lab Animal* 36(9): 25-31. ISSN: 0093-7355 (Print)
**Abstract:** For the inexperienced individual, learning surgical techniques can be taxing. The authors developed a rodent surgery dry lab training program to assist educational and research institutions in providing low-stress training for basic surgical techniques using handmade, cost-effective simulation models. The program not only helps students develop essential skills in basic surgery, but also fulfills the mandate of the 3Rs by allowing students to repeatedly practice and refine their skills on models rather than live animals. This type of training is a valuable tool in bridging the gap between computer training and training with live animals.

Streefkerk, H.J., J.P. Bremmer, M. van Weelden, R.R.van Dijk, E. de Winter, R.J. Beck, and C.A. Tulleken (2006). **The excimer laser-assisted nonocclusive anastomosis practice model: development and application of a tool for practicing microvascular anastomosis techniques.** *Neurosurgery* 58(Operative Neurosurgery Supplement 1): ONS148-56; discussion ONS148-56. ISSN: 0148-396X (print)
**Abstract:** OBJECTIVE: To practice microsurgical skills, several experimental models are available that diminish the need for experimental animals. We defined criteria with which such models should comply, and we tested whether the models described in literature, as well as our own practice model, comply with these criteria. METHODS: We defined the criteria to which

these models should comply, and we performed a literature search on microvascular practice models. During the development of the Excimer laser-assisted nonocclusive anastomosis technique, we designed our own Excimer laser-assisted nonocclusive anastomosis Practice Model (EPM) according to those criteria, and we compared that model with the models described in the literature. RESULTS: All practice models could be categorized into three groups: beginner, moderate, and advanced. Our EPM complies with almost all criteria defined in the beginner and moderate groups and has much in common with the models that are categorized in the advanced group. CONCLUSION: In consideration of the methods to learn microvascular surgical techniques, the EPM can be used for a very long time before the need for living animals arises. This last aspect remains an inescapable condition for practicing microsurgical skills. However, with use of the EPM or another practice model, the amount of experimental animals can be drastically reduced.

Supe, A., A. Dalvi, R. Prabhu, C. Kantharia, and P. Bhuiyan (2005). **Cadaver as a model for laparoscopic training.** *Indian Journal of Gastroenterology* 24(3): 111-113. [Comment in: Indian J Gastroenterol 24(3): 95-96.] ISSN: 0254-8860 (print)
**Abstract:** BACKGROUND: Though minimally invasive techniques now are routine world over, there is need to develop facilities for training surgeons. Laparoscopy performed on anesthetized animals is an established model but is costly and is not easily available. We report on human cadaver as a training modality for surgeons participating in a laparoscopic training course. METHODS: Unembalmed cadavers were used for training surgeons to appreciate anatomy, practice laparoscopic techniques, and deploy equipment and instruments during a laparoscopic training course. Trainees carried out procedures such as cholecystectomy, appendicectomy, splenectomy, intestinal explorations, mesenteric lymph node biopsy, and varicocele-vein occlusion. We analyzed the trainees' perspective regarding cadaver as a model using the 5-point Likert scale. RESULTS: Thirty-two trainees from five consecutive training courses held at our institution expressed general satisfaction over cadaver as a training model, and 96.9% (31/32) rated the training model as highly satisfactory. The trainees ranked as highly satisfactory their understanding of surgical anatomy (29/32; 90.6%), understanding of laparoscopic technique (29/32; 90.6%) and use of instruments (32/32; 100%). The trainees thought such an approach improved spatial perception of anatomy and they perceived it as a valuable educational experience. CONCLUSIONS: Human cadaveric laparoscopy may offer an ideal surgical environment for laparoscopy training courses, allowing dissection and performance of complicated procedures.

Suzuki, S., N. Suzuki, A. Hattori, A. Uchiyama, S. Kobayashi (2004). **Sphere-filled organ model for virtual surgery system.** *IEEE Transactions on Medical Imaging* 23(6): 714-722. ISSN: 1558-254X (print)
**Abstract:** We have been developing a virtual surgery system that is capable of simulating surgical maneuvers on elastic organs. In order to perform such maneuvers, we have created a deformable organ model using a sphere-filled method instead of the finite element method. This model is suited for real-time simulation and quantitative deformation. Furthermore, we have equipped this model with a sense of touch and a sense of force by connecting it to a force feedback device. However, in the initial stage the model became problematic when faced with complicated incisions. Therefore, we modified this model by developing an algorithm for organ

deformation that performs various, complicated incisions while taking into account the effect of gravity. As a result, the sphere-filled model allowed our system to respond to various incisions that deform the organ. Thus, various physical manipulations that involve pressing, pinching, or incising an organ's surface can be performed. Furthermore, the deformation of the internal organ structures and changes in organ vasculature can be observed via the internal spheres' behavior.

Takeuchi, M., N. Hayashi, H. Hamada, N. Matsumura, H. Nishijo, and S. Endo (2008). **A new training method to improve deep microsurgical skills using a mannequin head**. *Microsurgery* 28(3): 168-70. ISSN: 1098-2752 (online)
**Abstract:** Neurosurgeons need fine and special microsurgical techniques, such as the ability to suture deep microvasculature. Intensive training is required to perform microsurgery, especially in deep microvascular anastomosis. There have been many previous reports of training methods for typical microsurgical techniques, including suturing of surgical gloves, Silastic tubes, living animals, and chicken wing arteries. However, there have been no reports of training methods to improve deep microsurgical skills under the various hand positions specific to neurosurgical operation. Here, we report a new training method using a mannequin head, water balloons, and clay to mimic actual deep microsurgery in the brain. This method allows trainees to experience microsurgery under various hand positions to approach the affected areas located at various depths in the brain from various angles.

Varaday, S.S., S.M. Yentis, S.A. Clarke (2004). **A homemade model for training in cricothyrotomy.** *Anaesthesia* 59(10): 1012-1015. ISSN: 0003-2409 (Print)
**Abstract:** We describe a simple, homemade model for teaching cricothyrotomy. It can easily be constructed from materials found in every anaesthetic room and is cheap, portable and usable several times before requiring replacement. We also describe evaluation of the model in a two-part study. First, 20 anaesthetic trainees, both with and without prior experience of percutaneous cricothyrotomy/tracheotomy, cannulated the 'trachea' using two percutaneous airway sets (Ravussin jet ventilation catheter[VBM] and Mini-Trach II Seldinger[Portex]), then scored the model for realism and usefulness for training. Next, 20 further trainees used the Mini-Trach II Seldinger on both the homemade model and a commercially available cricothyrotomy/tracheotomy trainer (Pharmabotics), scoring both models as before. In the first part of the study, trainees found the homemade model a useful substitute for practice of percutaneous techniques and teaching. In the second part, both models were rated well, with similar scores. The homemade model is an easily assembled alternative to more expensive models. Both experienced and inexperienced trainees find practising on such models useful.
**Descriptors:** cricoid cartilage, surgery, medical education, manikins, thyroid cartilage, tracheotomy, airway obstruction, anesthesiology, equipment design, teaching materials.

Vlaovic, P.D. and E.M. McDougall (2006). **New age teaching: beyond didactics.** *Scientific World Journal* 6: 2370-80. ISSN: 1537-744X (online)
**Abstract:** Widespread acceptance of laparoscopic urology techniques has posed many challenges to training urology residents and allowing postgraduate urologists to acquire often difficult new surgical skills. Several factors in surgical training programs are limiting the ability to train residents in the operating room, including limited-hours work weeks, increasing demand for operating room productivity, and general public awareness of medical errors. As such, surgical

simulation may provide an opportunity to enhance residency experience and training, and optimize post-graduate acquisition of new skills and maintenance of competency. This review article explains and defines the various levels of validity as it pertains to surgical simulators. The most recently and comprehensively validity tested simulators are outlined and summarized. The potential role of surgical simulation in the formative and summative assessment of surgical trainees, as well as, the certification and recertification process of postgraduate surgeons will be delineated. Surgical simulation will be an important adjunct to the traditional methods of surgical skills training and will allow surgeons to maintain their proficiency in the technically challenging aspects of minimally invasive urologic surgery.

Wang, E.E., J.A. Vozenilek, J. Flaherty, M. Kharasch, P. Aitchison, and A. Berg (2007). **An innovative and inexpensive model for teaching cricothyrotomy.** *Simulation in Healthcare* 2(1): 25-29. ISSN: 1559-2332 (print); ISSN: 1559-713X (online)
**Descriptors:** medical education, emergency medicine, inexpensive method, surgery, training, tracheotomy, clinical competencey, controlled study, model, animals, synthetic skin, trachea

Waters, J.R., P. Van Meter, W. Perrotti, S. Drogo, and R.J. Cyr (2005). **Cat dissection vs. sculpting human structures in clay: an analysis of two approaches to undergraduate human anatomy laboratory education.** *Advances in Physiology Education* 29(1): 27-34. ISSN: 1522-1229 (online)
**Abstract:** Many human anatomy courses are taught using cat dissection. Alternatives are available, but information regarding learning outcomes is incomplete. In 2003, approximately 120 undergraduates enrolled in a human anatomy course were assigned to one of two treatment groups. In the control group, students performed cat dissections (emphasizing isolation and identification) of the muscular, digestive, and cardiovascular systems. In the experimental treatment group, students built clay sculptures of each human body system. Student learning was evaluated by using both low- and high-difficulty questions. On pre- and postexperiment control exams, there were no significant differences in student performance. On exams after a cat dissection vs. a human-clay sculpting experience, the students in the human-clay sculpting treatment group scored significantly higher than their classmates in the cat dissection group on both the low- and high-difficulty questions. Student attitudes toward dissection and taking future human anatomy courses were also measured. There were no differences in student attitudes at the beginning of the experiment; afterward, students exposed to a cat dissection experience viewed dissection more favorably than students in the human-clay sculpting treatment group. There were no treatment effects on student willingness to take future human anatomy courses. The experimental design makes it difficult to conclude precisely why students assigned to the human-clay sculpting experience performed better on exams, but as each method was performed in this particular human anatomy course, our data indicate that human-clay sculpting may be a viable alternative to cat dissection in an anatomy course in which the students focus on human anatomy.

Wignall, G.R., J.D. Denstedt, G.M. Preminger, J.A. Cadeddu, M.S. Pearle, R.M. Sweet, and E.M. McDougall (2008). **Surgical simulation: a urological perspective.** *Journal of Urology* 179(5): 1690-1699. ISSN: 1527-3792 (online)
**Abstract:** PURPOSE: Surgical education is changing rapidly as several factors including budget

constraints and medico-legal concerns limit opportunities for urological trainees. New methods of skills training such as low fidelity bench trainers and virtual reality simulators offer new avenues for surgical education. In addition, surgical simulation has the potential to allow practicing surgeons to develop new skills and maintain those they already possess. We provide a review of the background, current status and future directions of surgical simulators as they pertain to urology. MATERIALS AND METHODS: We performed a literature review and an overview of surgical simulation in urology. RESULTS: Surgical simulators are in various stages of development and validation. Several simulators have undergone extensive validation studies and are in use in surgical curricula. While virtual reality simulators offer the potential to more closely mimic reality and present entire operations, low fidelity simulators remain useful in skills training, particularly for novices and junior trainees. Surgical simulation remains in its infancy. However, the potential to shorten learning curves for difficult techniques and practice surgery without risk to patients continues to drive the development of increasingly more advanced and realistic models. CONCLUSIONS: Surgical simulation is an exciting area of surgical education. The future is bright as advancements in computing and graphical capabilities offer new innovations in simulator technology. Simulators must continue to undergo rigorous validation studies to ensure that time spent by trainees on bench trainers and virtual reality simulators will translate into improved surgical skills in the operating room.