

## **Surgical Education**

## **DURABILITY OF ENDOUROLOGICAL SKILLS: TWO-YEAR FOLLOW-UP STUDY**

*Chatterjee S, Radomski SB, Matsumoto ED*

**PURPOSE:** To assess the long-term durability of endourologic skills among urology trainees after an intensive technical skills training course.

**SUBJECTS AND METHODS:** Seventeen urology residents participated in a 2-day ureteroscopy course at a surgical skills center. Residents performed rigid ureteroscopy and basket manipulation of a small midureteral stone. Performance was assessed immediately after the course and 1 year and 2 years after training. Residents prospectively tracked all ureteroscopic cases in which they were considered the primary surgeon (i.e., performed greater than 75% of the procedure). Performance was measured using a validated global rating score (GRS), checklist score (CLS), and time required to complete the task.

**RESULTS:** Overall, GRS improved over the 2-year follow-up ( $P < 0.001$ ), with most of the improvement occurring in the first year ( $P = 0.03$ ). The CLS and time to complete the task did not change ( $P = 0.08$  and  $0.12$ , respectively). At the 2-year follow-up, the number of cases logged had no significant effect on performance.

**CONCLUSIONS:** Ureteroscopy skills are retained and continue to improve 2 years after completing an intense training session that uses high-fidelity bench models. Ureteroscopic experience is important for the maintenance and development of skills, even though they appear to plateau after 1 year. This result may also reflect a ceiling effect of the assessment tools.

## **COGNITIVE MOTOR LEARNING FOR TEACHING SURGICAL SKILL - HOW DO WE TEACH AND ASSESS SURGICAL SKILLS?**

*Wong JA, Matsumoto ED*

**SUMMARY:** As the practice of surgery evolves, the modalities by which future surgeons are trained must also develop. Traditionally, surgical trainees have learned through a mentorship model, with the majority of cognitive motor learning for surgical skill being initiated and practiced within the operating room. This, however, is no longer the ideal environment in which to acquire surgical skills and, subsequently, many surgical training programs are incorporating the use of other surgical models within their curricula. Training on simulators, ranging from low-fidelity bench models to complex, high-fidelity virtual reality models, seems to be transferable and might prove to be a crucial supplement to the traditional curriculum. Models that are reliable and valid, coupled with objective instruments that measure technical skill, might prove to be useful for evaluation. For a simulator to provide a good assessment of competency, it should either correlate to or predict the person's technical performance in the operating room. More research is, therefore, needed regarding the validity and transferability of various training models, particularly if they are to become a form of assessment for certification or licensure.

## **LOW-FIDELITY URETEROSCOPY MODELS**

*Matsumoto ED*

**SUMMARY:** For several reasons, there has been pressure to seek alternatives to the Halstedian method of surgical training, both for residents and for practicing surgeons faced with a new procedure. The use of bench models to train urology residents in order to maximize their operating-room experience is becoming popular. Realistic latex models and virtual-reality simulators have been introduced. However, the model does not have to look realistic as long as the trainee can practice the pertinent steps of the procedure using the same skills: training on a well-designed low-fidelity model confers the same benefit as training on a high-fidelity model. Bench model training in ureteroscopy appears to have a durable effect on the clinical performance of surgical residents. More research is necessary to validate training on bench models and may lead to more objective measures of surgical competency.

**A RANDOMIZED, CONTROLLED, PROSPECTIVE STUDY VALIDATING THE ACQUISITION OF PERCUTANEOUS RENAL COLLECTING SYSTEM ACCESS SKILLS USING A COMPUTER BASED HYBRID VIRTUAL REALITY SURGICAL SIMULATOR: PHASE I**

*Knudsen BE, Matsumoto ED, Chew BH, Johnson B, Margulis V, Cadeddu JA, Pearle MS, Pautler SE, Denstedt JD*

**PURPOSE:** The need to develop new methods of surgical training combined with advances in computing has led to the development of sophisticated virtual reality surgical simulators. The PERC Mentortrade mark is designed to train the user in percutaneous renal collecting system access puncture. We evaluated and established face, content and construct validation of the simulator in this task.

**SUBJECTS AND METHODS:** A total of 63 trainees underwent baseline testing on the simulator, consisting of percutaneous renal puncture followed by the introduction of a guidewire into the collecting system. Subjects were then randomized to an intervention arm, in which they underwent 2, 30-minute training sessions on the simulator, and a control arm, in which no further training was given, followed by repeat testing. Performance was assessed using a global rating scale and by virtual reality derived parameters.

**RESULTS:** There were no significant differences between the 2 groups with respect to baseline measures. Subjects who underwent training with the simulator demonstrated significant improvement in objective and subjective parameters compared to their baseline performance and compared to the untrained control group. Spearman rank correlations demonstrated a significant relationship between multiple parameters of the objective and subjective data.

**CONCLUSIONS:** Training on the simulator improves virtual reality skills. It may allow trainees to develop the basic skills necessary to perform percutaneous renal collecting system access. Face and content validity were demonstrated and construct validity was supported by establishing convergent validity.

## **LAPAROSCOPIC DECISION MAKING: IMPACT OF PREOPERATIVE READING AND LAPAROSCOPIC EXPERIENCE**

*Samuelson ML, Cadeddu JA, Matsumoto ED*

**PURPOSE:** A competent laparoscopic surgeon requires good technical skills and good surgical judgment. The assessment of technical skills using bench models and simulators has been well studied. However, there has been a paucity of studies examining the cognitive aspects of surgery. We developed a novel tool to assess the procedural knowledge and higher level decision making required for successful laparoscopic nephrectomy. We assessed the effect of laparoscopic experience and the effect of self-preparation or preoperative reading on surgical decision making abilities using a novel assessment tool and methodology.

**SUBJECTS AND METHODS:** A total of 17 novice and advanced urology residents were randomized to preoperative reading or no preoperative reading. Subjects viewed laparoscopic nephrectomy clips and verbalized their thought processes. Their performance was transcribed and blindly rated using a new surgical decision making rating scale.

**RESULTS:** The correlation with overall surgical decision making rating scale score was good for years of training and moderate for the number of laparoscopic cases performed ( $r = 0.7$  and  $0.54$ , respectively,  $p < 0.05$ ). Preoperative reading did not have a significant impact on the overall surgical decision making rating scale score ( $p > 0.05$ ). However, when stratified by laparoscopic experience level (fewer than 10 cases), preoperative reading had a significant impact on the performance of novices with respect to the knowledge components of the procedure but not the judgment domain (each  $p > 0.05$ ).

**CONCLUSIONS:** Overall preoperative reading did not improve the surgical decision making rating scale. Novice procedural knowledge benefited from preoperative reading but not surgical judgment. The surgical decision making rating scale appears promising and it may have future implications for assessing surgical competency.

## **VIRTUAL REALITY URETEROSCOPY SIMULATOR AS A VALID TOOL FOR ASSESSING ENDOUROLOGICAL SKILLS**

*Matsumoto ED, Pace KT, D'A Honey RJ*

**OBJECTIVE:** Virtual reality (VR) simulators are now commercially available for various surgical skills training. The Uro Mentor VR Ureteroscopy Simulator by Symbionix is one system that may revolutionize the way we assess and teach surgical residents. Surgical educators may no longer have to depend on the operating room as the sole venue for teaching residents technical skills. We validated performance on this new system with previously developed assessment tools and compared it to performance on a high fidelity ureteroscopy bench model.

**SUBJECTS AND METHODS:** Urology residents (n = 16) were assessed on their ability to perform cystoscopy, guidewire insertion, semirigid ureteroscopy and basket extraction of a distal ureteric stone on the VR simulator. A blinded examiner assessed subject performance using a checklist, global rating scale and a pass/fail rating. In addition, computer-generated parameters including time to complete task, scope and instrument trauma and the number of attempts to insert a guidewire were analysed. Performance on the VR simulator was compared to performance on a high fidelity ureteroscopy bench model.

**RESULTS:** Senior residents (n = 8) scored significantly higher on their global rating scale ( $29.4 \pm 2.5$  vs  $20.8 \pm 0.9$ ,  $P = 0.005$ ), checklist ( $19.1 \pm 1.1$  vs  $15.2 \pm 0.9$ ,  $P = 0.02$ ), pass/fail rating ( $X^2 = 7.3$ ,  $P = 0.007$ ) and required less time to complete the task ( $352.9 \pm 55.7$  s vs  $576.8 \pm 67.4$  s.,  $P = 0.02$ ) than the junior residents (n = 8) on the VR simulator. Junior residents also had a significantly higher incidence of scope trauma (4 vs 0.6,  $P = 0.02$ ). No significant differences were noted in instrument trauma and the number of attempts to insert the guidewire. Global rating scale performance on the VR simulator correlated well to performance on the high fidelity ureteroscopy bench model ( $r = 0.7$ ,  $P = 0.002$ ) as did time to complete task ( $r = 0.7$ ,  $P = 0.004$ ).

**CONCLUSIONS:** The Uro Mentor VR Ureteroscopy Simulator is a useful tool in assessing resident endourological skills. Performance on the VR simulator is comparable to a validated high fidelity ureteroscopy bench model. Future studies will assess the utility of VR simulators in surgical skills training.

## **ASSESSMENT OF BASIC HUMAN PERFORMANCE RESOURCES PREDICTS PERFORMANCE OF URETERORENOSCOPY**

*Matsumoto ED, Kondraske GV, Jacomides L, Wilhelm DM, Ogan K, Pearle MS, Cadeddu JA*

**PURPOSE:** To predict endoscopic performance in a cadaver model using basic performance resources (BPRs) measurements.

**SUBJECTS AND METHODS:** Medical students (n = 16) underwent intense ureteroscopic training on a virtual reality ureteroscopy trainer and were rated on performing ureteroscopy on a cadaver. The medical students also underwent 13 validated BPR measurements. Urology residents also performed cadaveric ureteroscopy and BPRs. A predictive model built from urology residents' (n = 16) BPRs and performance assessment was used to predict medical student cadaveric ureteroscopy performance based on their BPRs alone.

**RESULTS:** The predictive model built with urology residents predicted the ureteroscopic performance of 10 of 16 medical students within 15% of their rated ureteroscopic performance on the cadaver.

**CONCLUSIONS:** A predictive model built with urology residents can moderately predict the ureteroscopic performance of medical students from BPRs. Additional in vivo evaluation is required.

## **TEACHING LAPAROSCOPIC RADICAL PROSTATECTOMY IN ACADEMIC AND PRIVATE HOSPITALS: THE MENTORED APPROACH**

*Matsumoto ED, Webster TM, Blew B, Watterson J, Preiner J, Luke P, Kapoor A, VandenEykel R, Whelan JP*

**INTRODUCTION:** We developed a novel teaching and mentoring method called “block” surgery to simplify and improve time efficiency and safety while maintaining acceptable oncological and functional outcomes during the learning curve of laparoscopic radical prostatectomy (LRP).

**METHODS:** Videos of a LRP were analyzed and broken down into 10 key “blocks” assigned different levels of difficulty. Mentorees progressed gradually through each “block”. We compared the clinical outcomes when the mentoree did <50% of the case (group I), >50% of the case (group II), 100% of the case (group III) and when the mentor did the case alone ( $\pm$  fellow or resident) (group IV). This was a multi-center study.

**RESULTS:** Prior to the study all mentorees had at least 100 laparoscopic cases completed and the mentor had completed 62 LRPs. A total of 230 cases (Group I – 32 cases, Group II – 26 cases, Group III – 38 cases, Group – 134 cases) were completed. There were no significant demographic differences between the 4 groups and no differences were noted between group I, II, III and IV with respect to the following parameters: median blood loss (225, 300, 350, 200 mL), mean morphine use post-op (3.14, 1.55, 0.18, 0.5 mg), length of stay (36, 48, 24, 42 hrs), conversion rate (0 in all groups), complications, staging and positive margins. A difference was noted in the mean operative time (219, 232, 213, 180\*,  $p<0.05$ ). At 6 months, 129 subjects were available for continence and erectile functional assessment. For continence 80% were using no pads and 20% were using 1-2 pads. For erectile function, return of erections were similar in all 4 groups.

**CONCLUSION:** LRP surgery minimizes some of the morbidity associated with open surgery but it’s complex and requires advanced laparoscopic skill sets. Participation in our “block” surgery mentorship programme has diminished the learning curve and has allowed safe implementation of a LRP programme with acceptable oncological and functional outcomes.

## **TEACHING AND MENTORING: A MULTI-CENTER LAPAROSCOPIC RADICAL PROSTATECTOMY EXPERIENCE**

*Wong JA, Webster T, Blew B, Watterson J, Preiner J, Luke P, Kawakami J, Beiko D, Kapoor A, Whelan JP, Matsumoto ED*

**INTRODUCTION AND OBJECTIVE:** We developed a novel teaching and mentoring method called “block” surgery to simplify and improve time efficiency and safety while maintaining acceptable oncological and functional outcomes during the learning curve of laparoscopic radical prostatectomy (LRP).

**METHODS:** Videos of a LRP were analyzed and broken down into 10 key “blocks” assigned different levels of difficulty. Urologists were recruited from multiple centers. Mentorees gradually progressed through each “block”. We compared the clinical outcomes when the mentoree did <50% of the case (group I), >50% of the case (group II), 100% of the case (group III) and when the mentor did the case alone ( $\pm$  fellow or resident) (group IV). We compared preoperative demographic data, perioperative data and postoperative oncological and functional data. Erectile and continence data was captured using the IIEF and UCLA Prostate Cancer Index (PCI).

**RESULTS:** Prior to the study all mentorees had at least 100 laparoscopic cases completed. A total of 8 urologists were mentored from 4 academic and 2 private centers. A total of 303 cases (Group I – 34 cases, Group II – 27 cases, Group III – 55 cases, Group IV – 187 cases) were completed between 11-24-2004 to 06-07-2007. There were no significant demographic differences between the 4 groups and no differences were noted between group I, II, III and IV with respect to the following parameters: median blood loss (225, 300, 400, 200 mL), mean morphine use post-op (3.14, 1.68, 0.21, 0.6 mg), length of stay (36, 48, 48, 36 hrs), conversion rate (1 in group III and 1 in group IV), complications, stage, positive margins and PSA at 6 months. A difference was noted in the mean operative time (215, 235, 210, 178\*,  $p < 0.05$ ). At 6 months, group III had a higher incontinence rate (via UCLA PI score) compared to the other 3 groups ( $p < 0.05$ ) For erectile function, decline in erectile functions (IIEF) were similar in all 4 groups. The median number of cases mentored cases need to perform LRP independently for our highly select group of urologist was 8 (range 2-26)

**CONCLUSIONS:** We report the first multi-center LRP mentorship experience. LRP surgery minimizes some of the morbidity associated with open surgery but it is complex and requires advanced laparoscopic skill sets. For centers without a robot but extensive laparoscopic experience, our mentorship programme can diminish the learning curve and has allowed safe implementation of a LRP programme with acceptable oncological and functional outcomes.

## **ASSESSING THE SURGICAL DECISION-MAKING ABILITY OF NOVICE AND PROFICIENT UROLOGISTS**

*Chatterjee S, Ng J, Matsumoto ED*

**INTRODUCTION AND OBJECTIVE:** This study was designed to examine whether the Surgical Decision-Making Rating scale (SDM-RS) can measure a difference in surgical judgment between urologists at various levels of training.

**METHODS:** Medical students, urology residents and staff urologists (n=23) viewed clips from eight selected urological procedures and verbalized their thought processes. The clips were ordered in increasing complexity from lower level tasks (catheterization, cystoscopy) to more advanced procedures (laser lithotripsy, open and laparoscopic prostatectomy and nephrectomy). Performance was transcribed and blindly rated utilizing the previously validated SDM-RS. Subjects were also asked to evaluate their own performance using this scale.

**RESULTS:** Overall the SDM-RS was able to distinguish level of training across both knowledge domains (anatomy and management of the current task) and judgment domains (avoiding complications, higher reasoning and immediate surgical planning). Mean score across all levels of training was 104 out of 200 (range 45-140). Lower level tasks could not consistently discriminate level of training ( $p=0.10$ ). SDM-RS performance on higher level tasks showed a significant correlation to seniority ( $p=0.01$  –  $p=0.004$ ). Total score correlated with level of training ( $p<0.001$ ) and differences in score became more apparent as the tasks increased in complexity ( $p=0.01$ ). This trend persisted when performance was analyzed separately for knowledge domain ( $p<0.001$ ) and judgment domain elements ( $p<0.001$ ). Self-evaluation correlated well with blinded evaluation across all levels of training (coef=0.87,  $p=0.01$ ).

**CONCLUSIONS:** The SDM-RS can reliably detect differences in knowledge and surgical judgment between medical students, urology residents and staff urologists. The differences between groups in judgment and knowledge become more apparent as task complexity increases. This tool has potential applications in evaluating trainees and determining subjects with “proficient” decision making abilities. It also shows significant correlation between self rated performance and blinded evaluation.

**TEACHING LAPAROSCOPIC RADICAL PROSTATECTOMY IN AN ACADEMIC AND COMMUNITY CENTRE:  
THE MCMASTER UNIVERSITY MENTORSHIP PROGRAMME**

*Matsumoto ED, Webster T, Kapoor A, VandenEykel R, Whelan JP*

**INTRODUCTION:** Radical prostatectomy remains the gold standard for the treatment of localized prostate cancers. Increasingly, a number of centres throughout North America have been developing a laparoscopic radical prostatectomy programme. However, widespread dissemination of the skills necessary to perform this procedure successfully has not occurred given the technically challenging nature of the surgery. We have developed a novel teaching and mentoring method called the “block” surgery in order to simplify and improve time efficiency and safety while maintaining acceptable oncological and functional outcomes during the learning curve.

**METHODS:** We analyzed videos of our laparoscopic radical prostatectomy and were able to break the procedure down into 10 key “blocks”. Each “block” was assigned a level of difficulty by the mentor. During the mentored cases, the mentor allowed the mentoree to start with the easiest “block” and gradually progress through all the key “blocks”. During the early stages, mentoree operating time was limited to approximately 20 minutes per “block” to minimize the anesthetic burden on the patient. We compared the clinical outcomes for the mentoree when he did <50% of the case (group I), >50% of the case (group II) and finally when the mentoree performed the case without the mentor (group III). This was compared to the cases completed by the mentor alone ( $\pm$  fellow or resident) (group IV). Patients completed IIEF and UCLA PCI pre-operatively and at their 6 week, 3, 6, 9 and 12 month follow-ups.

**RESULTS:** Both mentoree (TW and PW) had at least 100 laparoscopic cases completed prior to embarking on this programme. The mentor (EM) at inception of the study had completed 62 laparoscopic radical prostatectomies. A total of 92 cases were completed between November 28, 2004 and December 11, 2005. In group I there were 21 cases, group II 13 cases, group III 8 cases and group IV 50 cases. There were no significant demographic differences between the 4 groups. There were no differences noted between group I, II, III and IV with respect to the following parameters: operative time (191, 225, 233, 185 min. respectively), median blood loss (200, 200, 250, 200 mL, respectively), mean morphine use post-op (4.6, 3.1, 0, 1.3 mg, respectively), conversion rate (0%, 0%, 0%, 0%, respectively), complications, staging and positive margins. A difference was noted in the length of stay between group II and III (48hrs vs 24 hrs,  $p=0.02$ ). At 6 months 30 subjects were available for functional assessment. For continence 78% were using no pads and 22% using 1-2 pads. For erectile function, 5 of 15 with bilateral nerve sparing have had sex in the previous 4 weeks. None were on PD5 inhibitors.

**CONCLUSION:** Laparoscopic radical prostatectomy is an alternative surgical approach for prostate cancer which minimizes some of the morbidity associated with open surgery. However, this procedure is complex and requires advanced laparoscopic skill sets. For an experienced laparoscopic surgeon, participation in our “block” surgery mentorship programme has diminished the learning curve and has allowed safe implementation of a laparoscopic radical prostatectomy programme with acceptable oncological and functional outcomes. Plans are underway to expand this programme to other academic and community urological centres.

## **TRANSFER OF LAPAROSCOPIC RADICAL PROSTATECTOMY SKILLS FROM BENCH MODEL TO ANIMAL MODEL: A RANDOMIZED CONTROL STUDY**

*Sabbagh R, Chatterjee S, Kwan L, Wong JA, Kapoor A, Matsumoto ED*

**INTRODUCTION AND OBJECTIVES:** Laparoscopic radical prostatectomy (LRP) requires intracorporeal suturing and knot tying to complete the urethrovesical anastomosis. In order to acquire the surgical skills to properly and efficiently perform this crucial step, we developed a urethrovesical model (UVM) for use in a laparoscopic body trainer. We performed a randomized controlled study to compare task-specific training (i.e. urethrovesical anastomosis) on the UVM to basic laparoscopic bench model suture training and to assess transferability of skills to a higher fidelity live porcine model.

**METHODS:** 28 participants enrolled in this prospective, single blinded randomized controlled study. All subjects were either senior residents, fellows or staff surgeons. Subjects watched a 15 minute video reviewing an actual LRP urethrovesical anastomosis. They were then randomized to a task-specific intervention arm that practiced urethrovesical anastomosis for 2-hours on the UVM or to a control group that practiced basic laparoscopic suturing on a foam model. After training, all participants had to perform a laparoscopic urethrovesical anastomosis on the UVM then on an anesthetized female pig to assess transferability of skills and effect of training models. A blinded expert scored their videotaped performance using a laparoscopic suturing checklist (CL), global rating score (GRS) and time, for both the UVM performance and the porcine urethrovesical anastomosis. End-product rating was used to assess the porcine urethrovesical anastomosis. Mann-Whitney Rank test was used to compare the two groups.

**RESULTS:** At baseline there were no differences in previous laparoscopic experience, distribution of surgical specialty and level of training between groups. There was no difference in urethrovesical anastomosis performance between the UVM and the live porcine model, supporting transferability of skills. On the porcine urethrovesical anastomosis, the UVM trained group had significantly higher checklist score ( $10.9 \pm 0.6$  vs  $8.1 \pm 0.9$ ,  $p=0.02$ ), GRS ( $29.6 \pm 1.7$  vs  $22.8 \pm 1.5$ ,  $p=0.005$ ) and end-product rating ( $20.9 \pm 1.4$  vs  $15.5 \pm 1.1$ ,  $p=0.04$ ) than the control group.

**CONCLUSIONS:** Laparoscopic urethrovesical anastomosis is one of the challenging steps during a LRP. We have demonstrated that the laparoscopic skills learned on the UVM are transferable to a higher fidelity porcine model and task-specific training on the UVM is superior to basic laparoscopic suturing practice. Future studies will evaluate the transferring of skills to the operating room as well as utility in robotic laparoscopic training.

## **TELE-SURGERY IN AN EXTREME ENVIRONMENT IN THE ABSENCE OF A LOCAL PHYSICIAN-THE NEEMO 7&9 MISSIONS**

*Anvari M, Williams D, Thirsk R, Morin L, McKinley C, Broderick T, Kapoor A, Sebjang H, Hall G, Adili A, Dobranowski*

**INTRODUCTION:** Telementoring, both with and without robotic assistance, can effectively facilitate transfer of knowledge from one surgeon to another during live surgery. Recent experience with robotic-assisted remote telepresence surgery (RARTS) has demonstrated that a surgeon can safely perform advanced procedures from a distance. The scientific goal of the NEEMO missions is to evaluate the potential for these technologies to enable provision of emergency surgical care in an extreme environment in the absence of a physician.

**METHOD:** Coordinated by NASA, the NEEMO missions utilize the Aquarius undersea habitat as a training analogue for space missions. During NEEMO 7 (Oct. 11-21, 2004), experts at the Centre for Minimal Access Surgery (CMAS) in Hamilton, ON, used telementoring with robotic assistance to guide Aquarius crewmembers through several simulated surgical procedures including lap cholecystectomy, arterial anastomosis, cystoscopy and removal of a renal stone. NEEMO 9 (Oct. 3-20, 2005) will investigate the use of tele-presence surgery using a portable two-arm robot to allow a remote surgeon to carry out emergency surgery with latencies ranging from 150 ms to 2 seconds. For both missions, the Aquarius crew includes 3 astronauts, 2 habitat technicians and one surgeon as a control.

**RESULTS:** NEEMO 7 demonstrated that with proper telementoring technique, non-physicians could successfully be guided through all of the simulated surgical procedures, although not as quickly or as efficiently as the surgeon control. The mentoring skills of the remote surgeon and the image quality provided by the telecommunications network were found to be critical to successful telementoring. Telerobotic assistance could not be properly evaluated during NEEMO 7 because the robotic platform was too bulky for the confines of Aquarius. A newly developed and more compact system will be evaluated during NEEMO 9 in October 2005.

**CONCLUSIONS:** The technologies evaluated during the NEEMO missions may play a significant role in providing emergency medical and surgical care in extreme environments in the absence of a local physician, such as field of battle or human space exploration, and also in remote regions around the globe.