# Dialogues in Pediatric Urology

*An official publication of the Society for Pediatric Urology*

*Richard M. Ehrlich, M.D., Founding Editor / William J. Miller, Founding Publisher*

Volume 33, Number 5
August, 2012



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# Update and Controversies in Laparoscopic Paediatric Urology - Part I

## *Application of Minimally Invasive Techniques to Pediatric Urology: Doing, Teaching and Pushing Envelopes*

## FROM THE GUEST EDITORS

**Pedro Jose-Lopez, MD**
**Francisco Reed, MD**

It is well known that minimally invasive surgery (MIS) has gained ground and respect in almost all aspects in paediatrics, especially in urology. MIS includes laparoscopy, video-assisted surgery, robot-assisted surgery and endosurgery; therefore the spectrum is huge. Nowadays almost all procedures in paediatric urology can be performed by minimally invasive surgery, even though in some cases, is still not the preferred route or gold standard.

The 3 coming editions congregate worldwide experts in paediatric urological laparoscopy & robotic surgery, with one aim and one aim only: to expose all their secrets of "how they do it". As editors we also asked them to show their own experience and to go through pros & cons, confronting different point of views. Consequently, reading these editions you will find expert opinions, no recipes. Despite the fact endourological procedures are being performed worldwide, this series does not include them, as this series would be even longer.

We truly hope that these editions of Dialogues In Paediatric Urology would be a helpful instrument for those who would like to develop MIS in paediatric urology from the very beginning and to those who would like to improve their own surgical skills solving day-to-day problems that we all experience during "chop-stick" surgery.

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## FROM THE EDITOR

**Elizabeth B. Yerkes, MD**

Welcome to the first edition of *Application of Minimally Invasive Techniques to Pediatric Urology*. As a confirmed maximally-invasive surgeon who recently found a seat on the MIS bus, I enjoyed the contributions of all of the authors in the series. It is humbling indeed to be the learner again, but it has been an interesting challenge for the learner and the teachers. It is not too late for the "Old Dogs" out there!

Understanding more about the challenges for MIS surgeons in developing countries also puts things into perspective. Even for those not smitten by MIS, there are very interesting perspectives on surgical education in this edition. Simulations to augment the time spent in the operating room and for overall surgical preparation are certainly a hot topic for training in the era of the 80 hour work week. The concept of Critical Thinking also rings true as we evaluate ourselves and will be the subject of increasing institutional and federal oversight and pressures.

There is something relevant to every practice, minimally- or maximally-invasive, in this edition. You will "do and teach" with new insight. I congratulate Drs. Lopez and Reed and all of the contributors on this comprehensive and accessible series for *Dialogues in Pediatric Urology*. Look for Parts II and III, each with procedure-specific opinions and pearls, in your Inbox soon.

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**500 Cummings Center, Suite 4550 / Beverly, MA 01915 / (978) 927-8330**
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# FROM THE GUEST EDITORS

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This is why the complete series "**Update and Controversies in Laparoscopic Paediatric Urology"** was divided in 3 editions. Many of us would like to perform big reconstructive surgeries in minimally invasive paediatric urology however as everything in life you should learn to "cradle" first, then "take some steps", when you feel confortable, "you walk" and at the end you can finally "run"… hopefully with some style.

This first issue that you have in your hands, gathers up information on how to start in minimal invasive surgery. It was designed to get involved from the beginning of MIS in Paediatric Urology. Thus, there are beautiful articles regarding history in both laparoscopic and robotic surgery. Then you can learn in two great papers how you can get and also give some training in these techniques in any part of the world; either a developed or a developing country. Finally it tackles a very common matter in most of paediatric urology: can you teach new tricks to an "old dog", and on the other hand, how can you transfer your surgical experience to the "new guy in town". We sincerely wish you enjoy this edition.

Afterwards, the second edition will come with information about the more common MIS in our field, like orchidopexy, resective surgery and pyeloplasty, with articles exposing different approaches and points of view.

The last edition of this series will cover the more difficult and controversial topics like MIS and its role in VUR and bladder augmentation, what can MIS give us in incontinence and also how it can help in DSD.

The invitation has been made; so please, sit comfortable and enjoy your first issue of the series "**Application of Minimally Invasive Techniques to Pediatric Urology."**

## Update and Controversies in Laparoscopic Paediatric Urology - Part I
### *Application of Minimally Invasive Techniques to Pediatric Urology: Doing, Teaching and Pushing Envelopes*



## Coming in Part II - Update and Controversies in Laparoscopic Paediatric Urology
### *Orchiopexy and Upper Tract*

# Laparoscopic Pediatric Urology

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Laparoscopy was first utilized in pediatric urology 35 years ago, for management of cryptorchidism. During the 1990s, applications for laparoscopy in pediatric urology expanded. Nephrectomy and partial nephrectomy were reported for ablative procedures. Reconstructive procedures were also reported, including the first pediatric laparoscopic pyeloplasty in 1995. Other reconstructive procedures included gastrocystoplasty, intravesical and extravesical approaches for vesicoureteral reflux, and continent catheterizable channels. The 2000s saw the introduction of robotic assisted laparoscopy into pediatric urology. During the past decade, reports of minimally invasive surgery in pediatric urology have proliferated. Multiple factors contribute to a surgeon's choice of surgical approach in the current era. The availability of robotic surgical systems to assist surgeons has not obviated the utilization of standard laparoscopy. Robotic assistance may be of most benefit for reconstructive procedures, if it is available to be utilized.

*During the past decade, reports of minimally invasive surgery in pediatric urology have proliferated. Multiple factors contribute to a surgeon's choice of surgical approach in the current era.*

### Cryptorchidism

Laparoscopic orchidopexy (LO) is now a standard operation for intra-abdominal testes. The outcomes are comparable, if not better, to the historical experience with traditional open approaches for high non-palpable testes. The skill set needed to effectively perform LO is transferrable and readily attainable. At this point in time, LO should not be considered a complex laparoscopic procedure for pediatric urologists. Robotic assistance is not needed to facilitate surgery to treat an intra-abdominal testis. During the past year, I have transitioned to a single umbilical incision, or LaparoEndoscopic Single Site (LESS) surgery, to perform LO without compromise in operative time, technique, or outcomes.

### Inguinal Hernias

Many techniques have not been described to treat pediatric indirect inguinal hernias with MIS. A standard laparoscopic approach, with or without dissection of the peritoneum of the internal inguinal ring, is expeditiously performed. Newer approaches included percutaneous closure with laparoscopic guidance. A laparoscopic approach may be of particular advantage in premature babies with very large inguinal / inguinoscrotal hernias, where the defect can be closed without a sometimes challenging groin dissection. Outcomes from these various procedures are similar. There are very limited direct comparisons and robust outcomes assessment, such as postoperative pain, analgesic use, convalescence, cosmesis, patient / family satisfaction, impact of parents time off from work, and long-term complications. Robotic assistance can certainly be utilized, but is not likely a cost effective treatment and has no significant role for surgical treatment of pediatric inguinal hernias.

### Varicoceles

Laparoscopic varicocele ligation is another application that may be commonly utilized. There is a long history of its use with well reported outcomes. Refinements to the technique are being reported to minimize potential complications, such as hydrocele formation. A laparoscopic Palomo varicoceletomy [Ed: high ligation of gonadal wessel packet] is readily performed with a brief operative time. Operative times are expected to be shorter than for open microsurgical procedures. Again, robotic assistance has essentially no role in the management of varicoceles.

### Ablative Kidney Surgery for Benign Disease

Laparoscopic and robotic assisted laparoscopic nephrectomy / nephroureterectomy and partial nephrectomy have been well described. Both approaches are effective and safe in the pediatric population. There are no direct comparisons between the two techniques. Simple nephrectomy is a fairly uncomplicated procedure in the majority of cases, with limited benefit expected by using robotic assistance. Experienced laparoscopists are very comfortable performing partial nephrectomy with a standard laparoscopic approach, in a reasonably short amount of time. For upper urinary tract duplication, a partial nephrectomy can be routinely performed in less than an hour. Early control of the diseased moiety's vessels expedites the procedure. With the development of LESS surgery, I have transitioned to this approach with an even better cosmetic outcome than a standard laparoscopic approach or robotic assisted approach. This can be achieved as an outpatient procedure with limited need for narcotic analgesia, in appropriately selected patients. Robotic assistance may facilitate a minimally invasive approach for partial nephrectomy when surgeons have less experience.

### Anti-reflux

There has been a long history of various techniques to perform a minimally invasive procedure instead of a traditional incision, when reconstruction of an anti-reflux mechanism is chosen, instead of endoscopic injection. The learning curve for an extravesical approach may be long with standard laparoscopy. An intravesical approach may be even more technically challenging due to limited working space for a pneumovesicoscopic procedure. Some experienced laparoscopists have reported a long learning curve for an intravesical cross trigonal ureteral reimplantation. Robotic assisted pelvic surgery is a good application of the benefits of wristed instrumentation. But, it may be limited to fairly large bladders in the pediatric population due to the working space required to effectively utilize the wristed instrumentation.

### Upper Urinary Tract Reconstruction

Pyeloplasty may be the most well reported procedure for MIS. Again, both laparoscopic and robotic approaches have been widely utilized. Suturing is undeniably facilitated by robotic assistance. But, this technology is expensive, currently with only one commercially available system. Due to prohibitive costs, the technology is not universally available. Although early experience with laparoscopic

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## Laparoscopic Pediatric Urology

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pyeloplasty in small patients was not equivalent to outcomes for a traditional open pyeloplasty, contemporary reports with standard laparoscopic pyeloplasty has been clearly shown to be safe and highly effective with limited morbidity in infants and toddlers. This is still in question for robotic pyeloplasty in infants. All of the benefits of robotic surgery may be difficult to validate, but its application for this patient population has not been well established. Advances in MIS have let to early reports demonstrating good results with LESS pyeloplasty, which conceptually is very technically demanding. Other procedures including ipsilateral ureteroureterostomy and transureteroureterostomy have been reported. Reports of direct comparison between standard LP and RALP have been limited.

### Complex Lower Urinary Tract Reconstruction

Complete intra-corporeal gastrointestinal augmentation cystoplasty has been safely and effectively performed in the pediatric population. Again, robotic assistance is not requisite to perform this type of reconstruction. There are limited reports for either approach. If a robotic system is available, it may be preferable to use it due to extensive suturing that is expected. This may also limit some of the mental fatigue that may ensue during prolonged laparoscopic procedures, which may be complicated by the physical strain on a surgeon for long or technically demanding laparoscopic procedures. A laparoscopic assisted approach for these reconstructions may be the best marriage of MIS and traditional reconstruction, especially in patients where cosmesis is of less concern or patients who are not sensate below the umbilicus.

### Continent Catheterizable Channels

Appendicovesicostomy and appendicocestomy have been well described. Due to the continence mechanism that needs to be constructed, suturing may be facilitated by robotic assistance. Experience for robotic assisted appendicovesicostomy may be more robust, but this may be due to surgeons' preference or lack of experience with these procedures using standard laparoscopy. There are simplified techniques for continent channels for antegrade enemas, included a laparoscopic assisted approach. This again, may be a great option, if no other urological reconstruction is needed or expected. If a formal continence mechanism is constructed, this can be readily achieved in-situ or by delivering the appendix at the umbilical incision.

### Genitourinary Malignancy

Application of MIS is limited in genitourinary malignancy. Both nephrectomy and partial nephrectomy are technically feasible. Lymph node dissections have been described as well in the pediatric population. The size of tumor and working space may preclude utilization of a robotic system more often than would be expected for a standard laparoscopic approach.

### Other

Mullerian remnants, seminal vesical cysts, anorectal malformations can all be approached with MIS. Experience, costs, availability, cosmesis, working space may all be factors that predispose a surgeon to choose a specific approach.

Essentially any open procedure can be or has been performed with MIS. In many cases, robotic assistance may be more beneficial to the surgeon rather than the patient, when performing laparoscopy in the pediatric population. Despite the advances in technology, laparoscopy without robotic assistance still has a major role in the surgical management of many conditions we treat as pediatric urologists. Pediatric surgeons have been slow or reluctant to implement robotics into their practices, even for reconstructive procedures. As technology continues to advance further, robotics may become more prevalent in surgery, but that will likely be in a different form than we currently have at our disposal.

Laparoscopy, traditional and LESS, is a better option for non-reconstructive procedures of the genitourinary tract. It is a great option for reconstructive procedures, although there is no question robotics allows suturing to be easily accomplished by novices. Traditional laparoscopy is far more readily available technology for patient care. The outcomes from pediatric urological laparoscopic procedures are excellent. Robotic surgery is very expensive and not available in many parts of the world for pediatric application.

Under those circumstances, reconstructive procedures should be part of the armamentarium for contemporary pediatric urologists. Robotics has greater potential for mechanical failure. It has greater potential for simple problems, like human error of not having good maintenance. Robotic instruments have a set number of uses, 10 – 20 lives. If all of the lives are used, a simple oversight by operating room staff may lead to a replacement not being available, ordered, or stocked. This is a problem I have personally experienced. Robotic surgery may not confer a reduction in pain compared to standard laparoscopy or may be more painful than standard laparoscopy.

With advances in instrumentation and technology, I have transitioned to LESS and essentially discontinued performing traditional laparoscopic procedures, with better cosmesis than multi-incision laparoscopy or robotics. Robotic LESS may not be applicable to all pediatric patients in its current platform. Proficiency with MIS without robotic assistance is an invaluable skill set. It should be taught, learned, maintained, and utilized, until robotics is universally available and even better than its current iteration.

### Recommended Articles


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# Robotic Surgery in Pediatric Urology: The First Decade

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The DaVinci Surgical System® has been used in pediatric urology for ten years, and its role, while firmly established, remains to be defined clearly. In some ways, this is quite appropriate for a technology that is still truly in its infancy. This issue of the Dialogues is a fitting place to reflect on where the technology has come from and where it might be going.

In 2002, pediatric laparoscopic reconstruction was limited to a few centers and surgeons with limited outcome data and no consensus as to its potential value. While conventional laparoscopy was advancing steadily in adult applications, the progression in pediatric urology was limited. Several factors contributed to this, including perhaps a natural caution among pediatric practitioners. Changing from a procedure with a high level of success in children who may be perceived as both at risk for any deviation from accepted, but also able to rapidly recover from even long complex procedures, reduced the impetus to modify our techniques. The learning curve for reconstructive laparoscopy is slow and tedious, requiring significant investments in time and effort, not always available to a busy practitioner. Further, the typical pediatric urologist performs multiple very distinct different operations, ranging from pyeloplasty to hypospadias, and only a fraction may be performed laparoscopically. This limits, therefore, the ability to develop the necessary experience to be able to efficiently perform complex reconstructive laparoscopic procedures in a reasonable time. As the initial efforts to develop pediatric urological laparoscopy emerged, the ability to objectively demonstrate a clear improvement in outcomes was limited. The differential between open and laparoscopic procedures is small in many operations, and the functional outcomes, so often excellent in open surgery, can only be matched by laparoscopic applications. The drive to adopt laparoscopic techniques, often the case in adult uses, was rarely expressed from the patient/family perspective either. Pediatric laparoscopic and generally minimally invasive techniques, therefore, evolved more slowly in comparison to adult uses.

The emergence of the DaVinci ® system in 2001 offered an attractive option to obtain the benefits of laparoscopy without its limitations. While laparoscopic reconstruction is feasible in the small child, the level of precision and control remained limited and frustrating to those of us initially trained in open surgery where precision and delicacy were the foundation of successful surgery. At one point, my mentor, Dr. W. H. Hendren inquired while observing a laparoscopic pyeloplasty, "what nice operation are you making difficult today?" While perhaps spoken in jest, the message could not be denied. At its best, conventional laparoscopy was challenged by multiple limitations, including paradoxical movement, limited haptic feedback, two-dimensional imaging, clumsy tools, and non-articulating instruments that demanded the tissue to be brought to the tool rather than bringing the tool to the tissue. The overly vigorous handling of the tissues was completely against all that we had been taught in terms of pediatric reconstructive surgery. The potential to have the minimally invasive access capabilities of laparoscopy but with the high degree of manipulative dexterity and agility of the DaVinci system made its appeal obvious. The initial cases included simpler reconstructive procedures such as pyeloplasty, uretero-ureterostomies, ureteral reimplantation, and more complex ablative procedures such as partial nephrectomy and Müllerian remnant excisions.[1,3,4] The ability to access difficult anatomical areas with limited access morbidity and still perform a delicate operation was clearly appealing. Since then we have progressed to performing continent diversions, augmentation cystoplasty, bladder neck slings and complex ureteral reconstructions.[2] While the data remain limited, efficacy is clearly demonstrated. Although it is difficult to prove less morbidity in infants; it is clearly present in the older child.

The technology of the DaVinci® system has not fundamentally changed yet remains robust in current applications. The current version of the DaVinci system, the S*i*, is enhanced from the original system in terms of user interface, surgical arm configuration, and ease of use and method of laparoscopic port engagement. The images are enhanced by HD technology. The ability to include a real-time ultrasound image as a picture-in-picture within the surgical console is useful. The enhancements are beneficial, yet are incremental and not markedly different from the original version. Several other new technologies are being added, however, including single port access (albeit without articulation of the instruments), smaller binocular scopes (8 mm), a tissue sealing and cutting instrument, the capacity for directing an intracorporeal ultrasound probe, and the availability of a fluorescent dye imaging system to assess perfusion. These features are useful in specific situations, yet have little added value for pediatrics. There remains a significant need for more delicate instruments, size specific instruments, as well as ultimately moving towards more safety-focused technologies including restriction of movement algorithms. The current DaVinci® has been incrementally enhanced within a very solid, yet relatively rigid platform that is not well adapted to pediatric applications.

> ***While conventional laparoscopy was advancing steadily in adult applications, the progression in pediatric urology was limited. Several factors contributed to this, including perhaps a natural caution among pediatric practitioners.***

The ideal robotic procedure is probably pyeloplasty, where the morbidity of access is more than that of the procedure. From a clinical application perspective, the current system is easily used, and pyeloplasty is probably the most robust application in pediatric urology. The combination of morbid access through a flank incision, and the critical need for delicate tissue manipulation and suturing, makes this an ideal application for this new technology. There is no question that the dexterity of the DaVinci® system far surpasses that of conventional laparoscopy and in shorter times. The question remains as to the benefit relative to open surgery, and while shorter hospital stays and reduced narcotic use have been reported[3],no validated criteria for a more objective comparison are currently available.

Assessing the value of the current application of the DaVinci ®system is difficult and probably premature at this point. In the early devel-

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opment of any new technology, premature assessment may be inappropriately harmful, as there is a need to develop efficiencies of use, better understanding of suitable applications, and clinical algorithms for effective use.[5] A recent assessment reported safety and efficacy, but cost-efficiency was not able to be demonstrable and no advantage was apparent.[8] This probably represented a premature judgment, and should be given limited weight.[7] Eventually, however, more rigorous assessment will be critically important. This is particularly true as the system evolves, as only by robust assessment can the direction of evolution be defined.[6]

It may be best to view the current DaVinci System® as a "Proof of Principle" technology that offers a glimpse at what may be the future of surgery. The key elements of the DaVinci® system speak to the potential for robotically assisted surgery. These include: 1) filtered and scaled movement in a digital platform; 2) high fidelity visualization with excellent illumination and 3-dimensional images; 3) point of action articulation; 4) access to small spaces that are anatomically difficult to reach. Each of these elements can be further developed within the digital platform and potentially integrated with other technologies, such as augmented reality combining endoscopic and real-time ultrasound images. Digital movement can permit controlled positioning, movement limitations for safety, and even automated movement for selected procedures. These elements offer the future possible advantages of surgery within a digital platform.

Robotically assisted surgery is here to stay. The current version, the DaVinci Surgical System®, is an excellent blending of technologies in a robust platform that has permitted performance of a wide variety of pediatric urological procedures safely and effectively. Much remains to be developed in the arena of robotic surgery to improve its real value. These areas include cost-efficiency, multi-tasking, effective integration with imaging, surgical navigation, safety controls, and educational paradigms. Child-friendly robotic systems will need to incorporate these elements to truly realize the potential of surgery in the digital age.

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# Minimally Invasive Surgery: Surgical Training in Developing Countries

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In the last two decades, laparoscopic and minimally invasive surgery (MIS) have placed themselves in a unique position in the pediatric urology surgical armamentarium. Laparoscopic and endoscopic procedures have replaced many traditional operations. A dramatic change in the way we train surgeons came with the application of these new technologies.[1] Developing countries (DC) bring additional challenges in terms of both clinical application and associated training process.[2] Although, MIS may be feasible and well done in urban areas and main cities of developing countries, there is a big disparity with large underdeveloped areas where is very difficult to permit adaptation and feasibility of MIS.[3] In addition, in most developing countries, there is a big difference in the way medicine is done and taught in Private Hospitals versus in Public Hospitals (free or at a very low cost for patients). There is still a major gap in the implementation of laparoscopic surgical methods in under-resourced settings, often due to restricted availability or access of the equipment and lack of laparoscopic training. Even with all of these potential problems, many skillful excellently trained surgeons are working and teaching MIS in many developing countries. Recognizing that all countries and education system have different problems, the goal of this article is not to compare training between different countries, but to note some of the difficulties that can be encountered.

Minimally invasive surgery is associated with high technology equipment and therefore comes with several additional limitations when training in developing countries. It is necessary to have a lot of innovation and ingenuity to achieve the goal of performing and teaching MIS techniques in developing countries at minimal cost. While many instruments are disposable in developed countries, this is usually not the case in developing countries. Most hospitals reuse instruments that have been designed for a single use. Although this practice is usually without any significant problem, it can potentially lead to higher rates of mechanical failures, infections, conversion to open procedures or injury to the patients. Also parts and repair availability of MIS equipment is extremely costly and difficult. In many developing countries, hospitals' biomedical support is lacking and service facilities are non-existent. Also, complex laparoscopic/robotic surgery is very much a team activity, and training of the operative room staff is of maximum importance. It is well known that competence and familiarity with new technology can be achieved with adequate training. Teaching the staff basic and advanced laparoscopic skills outside the operating room is effective but also costly. Besides, due to shortage of staff, it is difficult to work repeatedly with the same team so that the staff get the adequate experience. Because of these challenges, there is an additional pressure for surgeons working in developing nations to evaluate and decide which laparoscopic procedures give real benefit to their patients, as compared to open procedures, in terms of safety, efficacy, applicability and cost-effectiveness. It can be very difficult for a laparoscopic surgeon in a developing country at the beginning of his career. He will be compared all the time with traditional open surgeons who have been doing the surgery for many years with good success, low cost and minimal complication rate.

> ***The fast introduction of minimally invasive surgery has accelerated the development of new training methods to help residents and surgeons with these new technologies.***

The classic model for surgical training takes place in the operating room under the coordination and supervision of a senior surgeon. With minimally invasive surgery, this classic approach is difficult to reproduce and the skills needed are difficult to obtain due to ethical, medicolegal and economic considerations.[4] Even though Pediatric Urology does not have a single frequently performed laparoscopic operation, there are several good, classic operations that can be nicely performed laparoscopically, such as nephrectomy, heminephrectomy, pyeloplasty, intra-abdominal orchiodopexy, etc. Achieving proficiency in such procedures is often associated with a prolonged learning curve and a higher rate of complications. Training has no basis of uniformity or standardization and varies from centre to centre and country to country.[5]

Laparoscopic surgery brought new issues to the learning process: eye-hand coordination, surgical field visualization through a 2-D screen, adaptation to new instruments, and surgery without a full tactile sensation. The accepted principle in training for laparoscopy is that the trainee is familiar with the instrumentation in use, has attained an acceptable level of hand-eye coordination and is comfortable with a video camera attached where it is used.[6] Most of the early training in the developing countries was in the form of workshops done in developed countries lasting for two to five days. These early workshops were intensive, over eight to twelve hours a day. The problem is that many surgeons, upon returning to their own countries, encountered multiple problems adapting their learning experience to their reality and often cannot adapt to simplified procedures. It is well known that a qualified teaching faculty is one of the first steps in the training process. Many surgeons teaching MIS were not exposed during residency and were not fellowship-trained in MIS.[7] Unlike the training in conventional surgery, many surgeons have been trained in minimally invasive surgery while in active practice. Either they have developed their skill themselves or they have just learned laparoscopic surgery on their patients. The problem is also that teaching is not well paid, and surgeons who were trained in this way sometimes do not have adequate time or resources to teach. They teach more for personal motivation and satisfaction than for any other reasons. The fast introduction of minimally invasive surgery has accelerated the development of new training methods to help residents and surgeons with these new technologies. Several types of simulators have been developed for this purpose.[8-9] Some simulators are based on phantoms (e.g. plastic structures) while others are virtual reality computer based simulators. A third group is represented by the hybrid simulators, where the two components are inte-

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## Surgical Training in Developing Countries *(continued from previous page)*

grated. Simulators are accepted worldwide for laparoscopic surgical training and provide formative feedback that allows an improvement of the performances of the young surgeons.[9] In addition, training using animal models and virtual reality simulators offers the possibility to achieve not only skill and rule-based behavior but also knowledge-based behavior. Skill-based behavior simulators are needed for learning basic skills, such as use of instruments. Rule-based behavior and knowledge-based behavior training has to be developed using more sophisticated training methods, with an extensive range of educational features.[8-9] Models useful and applicable for developing countries need to be lower-cost equipment, similar to the earlier low-fidelity devices (box trainer Fig 1).[10] Computerized training devices are an excellent option, as long as the basic hardware and software to support it is available and affordable. Animal laboratories and surgical skills centers are very useful and are a large thrust of laparoscopic surgery training in developed nations. They have considerable value and benefit if integrated into an ongoing, comprehensive residency training program. Unfortunately, they are very expensive to develop and maintain, and serve a limited purpose in the developing world.

**_In developing countries, laparoscopy and minimally invasive surgery still face many challenges, from the availability and condition of the material used to the experience and skills of surgeons._**

Maintenance of skills is as difficult as acquisition of skills. A concern in some DC is that of the low patient volumes in some hospitals. This can contribute to a gradual loss of the skills in MIS. One of the goals in developing countries should be to focus in providing MIS in one or a few centers in each country. Also, in each of these hospitals one or two staff doctors should be in charge of MIS, so that the volume will be enough to maintain the skills and teach surgeons in MIS.

***Figure 1*** *Home made laparoscopic training box*

### Conclusions

In developing countries, laparoscopy and minimally invasive surgery still face many challenges, from the availability and condition of the material used to the experience and skills of surgeons. However, even with all of these potential problems, many excellent and skillful surgeons are working and training minimally invasive surgeons all around many developing countries. There is still a major gap in the implementation of MIS surgical methods in under-resourced settings, often due to restricted access and avail-ability of MIS equipment and lack of adequate MIS training. Providing comprehensive MIS training at all levels is very important, but the availability of reliable, low-cost and low-maintenance materials is of foremost importance. With a reduction in the cost of equipment, this trend will changed, and hopefully a prolonged exposure to laparoscopic surgery will be an integral part of surgical training in all teaching hospitals and a pre-requisite for graduation.

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# Best Training Methods In Developed Countries

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Training in laparoscopic pediatric surgery and notably in pediatric urology should make full use of the most up-to-date simulation tools, as well as mentoring.

Training should allow young surgeons to acquire skills that will enable them to gain full autonomy for the safe performance of surgical procedures.

## Training in Developed Countries

A question is implicitly raised by the title of this article: what are the differences between surgery in underdeveloped and developed countries? And as such, in what ways do these countries have such different training needs?

To answer this question, one should be able to identify the differences in healthcare, notably in the field of surgery, between a developed country and a developing country.

- Healthcare structural organization: a surgeon in an underdeveloped country must provide basic and general care.
- The abundance of operative equipment is different from one country to another.
- Laparoscopic surgery should be able to be done without expensive and sophisticated means that have not proven to be beneficial to the patient. For instance, the robot compensates for a lack of dexterity and allows access to deep and tricky anatomical regions in ideal operating environments, but the use of the robot represents an additional cost per patient.
- In underdeveloped countries, surgery should make up for potential technical downfalls (equipment, advanced electrocautery or assisted suturing devices). Surgeons should be able to make do with reduced available means while maintaining the quality of their work. Surgeons should be able to carry out simple laparoscopic hemostasis without using sophisticated instrumentation, which is sometimes not available, and they should also be able to perform hand-assisted sutures intracorporeally.
- The incidence of encountered pathologies is different depending on geographical and social-cultural parameters. Additionally, the stake of training in underdeveloped countries is often one of mass healthcare. The stake of surgical training in developed countries is rather one for increasing demands from cosmetic, ethical, and medicolegal standpoints. This is also true from an economic standpoint.

***Training in laparoscopic pediatric surgery and notably in pediatric urology should make full of use of the most up-to-date simulation tools, as well as mentoring. Training should allow young surgeons to acquire skills that will enable them to gain full autonomy for the safe performance of surgical procedures.***

## Training Cost

Training cost includes total time spent on simulators prior to any form of surgery, as well as the cost of tools used for simulation. Not only do simulators often make it possible to very simply develop basic skills, but they also use virtual reality from patient imaging data preoperatively. A behavioral and case simulation is the ultimate preoperative step, and as such it comes at a considerable cost. Trainees should indeed be trained in an operating room environment, which should be as close as possible to real-time surgery, with the usual staff (nurses, surgical team, and anesthesiologists). All operative steps shall be performed:

- technique management according to patient needs
- technique conversion without apprehension or difficulty
- use of an appropriate operative technique that will not cause subsequent disorders

The training cost should also be examined according to operative time that trainers and trainees have spent together. This is known as "patient" time [operative time], which is longer at the beginning of the learning curve. It includes the time spent by trainers to mentor trainees. Training cost also includes potential adverse effects with or without subsequent impact on the patient and the quality of the result.

As this training comes at a considerable cost, the training should focus on "best value" techniques, namely the ones that trainees will eventually have to perform most often. Learning needs should be structured.In a tertiary care center or teaching hospital environment, additional spare time will be secured in cases where trainees have to concentrate on highly-specialized activities. Some procedures may be point-less if trainees will not use those skills in the future.

Likewise, training shall be directed toward the most relevant activities. However, it is helpful to know all potential approaches and have young trainees benefit from an operative technique range as wide as possible to allow for the adequate response to specific needs of patients.

## Training of Residents in Specific Surgical Specialties

The monitoring of patients in the operating room is still considered essential to the majority of trainees.[1,2]

Simulation in pediatric surgery is mandatory because of the low occurrence of some interventions, converging educational, ethical, medicolegal and economical considerations.[3.4]

Simulation includes three different aspects:

- Simulation for basic surgical skills allows one to learn and/or to improve surgical technique (dissection, knotting, etc.);
- Surgical preparation, thanks to virtual reality, allows one to outline a satisfactory surgical strategy for a given patient, once different possibilities have been tried.
- Behavioral simulation strengthens the import of a preoperative checklist and gives surgeons a good reason to make one. It allows for better handling of potential mishaps (complications, conversions).

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## Best Training Methods in Developed Countries *(continued from previous page)*

Even though laparoscopy has been an evident catalyst of simulation programs[5-10] it was never the only one. Medicolegal aspects of training have put junior and senior surgeons in the limelight. It soon became obvious that not only should one first proceed with basic surgical training prior to moving on to operating on human beings, but also that the operative strategy should be structured and that practicing surgical techniques that are more rarely used is paramount. Ethical data also support the idea that training is indispensable before shifting to proper surgery.

For economical reasons, one should not spend too much time in the operating room with an undertrained junior surgeon. It is mandatory that skills be acquired outside of the operating room and prior to stepping into the operating room.

A certain number of simulation devices have rapidly grown over the last few years, and as a result of their use of virtual reality and computer sciences, they have offered a more realistic rendering of operative procedures in the field ofsimulation.[11] Nevertheless, mere black boxes, which are an equivalent of the pelvitrainer devised by Kurt Semm, are truly inexpensive and easy-to-use instruments that seem to offer excellent results.

Simulation through surgical preparation using virtual reality, although indispensable to simulate basic surgical techniques (dissection, hemostasis, suturing, clip placement, etc.), is also compulsory to incite surgeons to prepare their intervention adequately.

***Surgery can only be carried out appropriately if it is seen as a whole, notwithstanding the interaction between the three following specialties: surgeon, anaesthesiologist, and scrub technician.***

Simulation should also be used in the management of behaviors and human exchange. After the development of individual skills and preparation to the intervention, comes this third indispensable simulation. Navy soldiers enrolled in three-month long submarine campaigns, underwater without ever coming up to the surface, have perfectly understood that one should be prepared for crisis management. They apply what they call "training platforms" in which theoretical and practical components are truly essential, as is human communication. Surgery can only be carried out appropriately if it is seen as a whole, requiring the interaction between the three following specialties: surgeon, anaesthesiologist, and scrub technician.[12, 13] These three specialties will indeed work together and develop combined and interdependent tasks.

Checklists elaborated prior to anaesthesia and surgery could already be considered a small part of behavioral simulation. However, operating room organization, patient installation, and the missions to be carried out by nursing, anaesthesiologist, and surgical instrumentation staff, should also be discussed. In addition, it is paramount to control the validity of the instrumentation, as well as its ergonomics (monitor, cables, electrocautery systems, suction and aspiration devices, etc.). In case of difficulty, conflicts should absolutely be avoided and leadership issues should be tackled.

In the 70s, anaesthesiologists in the resuscitation department described the "spaghetti syndrome"[14] in which anarchy takes over, resulting in major disorder in infusion line set up, syringe pushers and other monitoring cables; this situation may well jeopardize good functioning of care providing, caused by the complete material disarray.

Simulation helped to explore the role of specific disturbances during an intervention[15-20]: the impact of fatigue, lack of sleep, alcohol intake on the eve of an intervention, a phone ringing during the intervention, inappropriate or unusual questions concerning the patient during surgery, background music in the operating room. All of these stressful situations, plus the number of people in the room, language barriers (hands-on surgery sessions abroad), working in a new, unfamiliar operating room with new instruments, should be submitted to behavioral simulation tests.

It has been demonstrated that misunderstanding between anaesthesiologists, surgeons and scrub technicians and the lack of cross evaluation, may be responsible for incidents during surgical interventions. It is mandatory that these three groups should be able to communicate, exchange information, and attempt to resolve problems jointly in the operating room.

A question was raised regarding the benefit/cost equilibrium of simulation. In other words, does simulation actually "work" ? [21, 22, 23] It has been demonstrated that simulation practice results in improved performance in in-vivo surgery. But are all techniques reproduced during simulation immediately convertible in terms of surgical performance?[24] It has been demonstrated that each line of training contributes to skill enhancement as a whole. Yet, there is no efficacy transfer evidence of any type of simulator on real-life performance enhancement. As far as aviation is concerned, it has been established that a one-hour simulator training session equals to half-an-hour of free flight practice.[11] Simulation cost[24, 25] depends upon target population, the means used (black box or mere mirror, versus advanced simulator), and above all, upon the implementation of simulation within education as a whole. Simulation has a future if its cost remains acceptable and if benefits for the patient are evident. Return on investment should be considered. The same can be said about the accreditation process, which gives way to a reduction of professional insurance fees. [Meaningful] use of simulation should lead to similar results.

Simulation seems indispensable in pediatric surgery, in which extremely diverse and sometimes rare interventions take place. A training strategy for the entire residency period should be outlined. Seniors should use simulation from the point where they engage in a new or less common, more technically demanding procedure.

In summary, simulation is made up of three complementary aspects. Manual dexterity simulation allows for individual technical progress. The second aspect offers the possibility to prepare for the intervention using virtual reality and is specific for each patient. Finally, the performance of a surgical procedure brings together surgical professionals from different backgrounds. It is fundamental to articulate individual skills to achieve operative success.

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**ACKNOWLEDGEMENTS**

The authors wish to acknowledge that this article was translated from French to English by Christopher Burel and Guy Temporal, professional medical translators and editors.

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# Best Way of Training: How To Improve Learning Curve

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### Introduction

In the last years, the laparoscopy has revolutionized the current pediatric urology practice; the benefits for patients such as smaller incision with better cosmetic results, reduced morbidity, faster recovery, and shorter hospital length of stay[1], make laparoscopic surgery a fundamental part in the performance of pediatric urologists.

Today, the problem is focused in how to achieve appropriate laparoscopic training, because the Halsteadian model of ''see one, do one, teach one,'' which has represented the primary method of teaching operative skills for decades, might not apply for laparoscopy. The main reason is that training in laparoscopic surgery is hard, because mind and skills have to be re-trained due to the spatial orientation in a two-dimensional environment, manipulation of longer instruments with reduced tactile feedback, and accommodating the pivot effect.[2]

Actually, there are various forms of laparoscopic training, like box trainers, virtual reality, and animal models, that in most of the cases are required prior to performing laparoscopic surgery in a human patient. Moreover there are different types of additional training, such as intensive short courses to one or two-year fellowship programs.

Fortunately, prior to pediatric urology training a program in pediatric surgery or urology should be completed. Nowadays during these training programs, laparoscopy must be learned and performed.

In this manuscript we reflect a kind of teaching/learning method that helps to reduce the learnng curve for difficult laparoscopic procedures in a pediatric urology-training program.

### Where did the idea came from? Background

After struggling with complex laparoscopic procedures, a prospective study was carried out in our unit in a 7-month period; where a step-by-step laparoscopic pyeloplasty surgical protocol was developed. Two-experienced laparoscopic pediatric urologists developed that protocol and explained it to all the surgical team, including surgical assistant (pediatric urology trainee), anesthetist, scrub nurses, nurses and technicians. The surgical protocol included port placement, the use of a fourth port for traction and stent introduction, kind and length of suture.

Twelve patients were included, separated in 2 groups (A and B)

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## Best Way of Training: How to Improve the Learning Curve *(continued from previous page)*

because some changes were made in the surgical protocol, like changing from PDS to monocryl and standardization of the number and length of sutures from 10 cm to 12 cm. The pediatric urology staff members performed all procedures alternately. Surgical time from incision to closure was measured.

A reduction in surgical time from 171.2 (120-200) minutes in group A to 141.7 (90-210) minutes in group B was achieved; demonstrating that surgical time optimization is attributable both to improving coordination of the team as well as refinements and standardization to the protocol.

There was a perception that if a 30 minute reduction was achieved with that step-by-step protocol, then the surgical time in laparoscopic pyeloplasties performed by a pediatric urology (PU) fellow, with previous pediatric laparoscopic basic training, should be at least as good as group A's surgical time.Therefore, after assisting during group A and B pyeloplasties, and following the exact same surgical protocol, the pediatric urology fellow operated on 6 new patients enrolled as group C.Group C included four males with mean age 9.5 years (8 mo – 11 y)and mean weight 28 kg (9 – 56 kg). Only one was right-sided.Mean surgical time was 160.8 min (125 – 180 min). Compared with surgical time in Group A (171.2), there was a 10 minute reduction. Considering that Group A was done by two experienced laparoscopic pediatric urologists, this time reduction of Group C could be attributed to the protocol by itself, and not only to surgeon's skills.

### Discussion

Laparoscopy is gaining ground rapidly in pediatric urology. For that reason a well established laparoscopic training program should be delivered to all pediatric urology fellows.

Standardized programs on box trainers can be used to assess baseline laparoscopic skills and to track fellow's improvement over time. The McGill Inanimate System for Training and Evaluation of Laparoscopic Skills (MISTELS) consists of five laparoscopic exercises performed in an endotrainer box, which includes cutting, ligating loop, suturing with extra- and intracorporeal knots.[3]

For most of pediatric urology fellowship programs at least a 3-year prior surgical training is required (urology or pediatric surgery) where basic laparoscopic procedures, like appendectomies, cholecystectomy or other simple exploration procedures, have been performed. Before starting with advanced laparoscopic procedures, simple pediatric urology procedures such as abdominal exploration for undescended testes, varicocele, renal biopsy, nephrectomy, etc. should be supervised by the mentor. The mentor looks after the fellow progression and the right time for doing complex procedures. During this period, the trainee should assist in as many laparoscopic procedures as possible, especially in reconstructive ones, like pyeloplasty.

> ***Laparoscopy is gaining field rapidly in pediatric urology. For that reason a well established laparoscopic training program should be delivered to all pediatric urology fellows.***

Since 1993 when Schuessler et al. described the first laparoscopic pyeloplasty, it has rapidly advanced and gain acceptance in pediatric patients even though it is a very difficult laparoscopic procedure because it requires surturing and tying ability in addition to dissection.

Many have proposed training models for laparoscopic pyeloplasty, including a renal pelvis configured from chicken skin (Ooi et al), crop and esophagus of a chicken (Ramachandran et al), and a porcine model (McDougall et al).[4, 5, 6] Even with these kind of training, pyeloplasty is still a difficult and demanding laparoscopic procedure.

In our study the mean surgical time in group C is shorter than the one in group A (161 vs 171); and this can be translated as a success in this learning method; because it should be expected that surgical time for the PU fellow surgical group to be longer than that of the staff members. Therefore, after assisting the staffs in their procedures, and knowing exactly the step-by-step protocol, surgeries performed by PU fellow were easy-going.

In our unit, we think that besides box-training, animal training (when possible), and laparoscopic courses, pediatric urology residents should be mentored first by assisting in as many procedures as possible. They then perform surgical procedures from easy to hard-ones. Then come reconstructive surgeries, always assisted by a mentor in order to guide, consult, help and correct the fellow.

Making a step-by-step surgical protocol for each laparoscopic procedure, which should be interiorized by the fellow, could shorten the learning curve and bringing confidence to the resident in her/his future career. With this surgical protocol, a kind of repeated "brain surgery" is taken in every procedure (assisted or performed), helping in the step-by-step of the surgery.

Besides being only a one-center experience, we are confident that with a previous lab-training, the terrible and fearing suturing learning curve will be shorter as long as all the surgical team understands and incorporates the surgical protocol.

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# Best Way of Training New Tricks For an Old Dog

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## Introduction

Minimally invasive techniques in paediatric urology have come a long way over the last two decades. While endourological procedures (such as cystoscopy) have been around for some time, it is only since the early nineties that laparoscopy and laparoscopic therapeutic procedures took hold and flourished to the current era of robotically assisted urology. Advances in technology also meant that more and more procedures could be performed by minimally invasive techniques rather than by the conventional route.

However, in my experience, any new technique has its own learning curve and certainly during my training, while I would embrace the minimally invasive aspect of paediatric urological procedures, this was not often the case with some senior paediatric urologists at the time. This article therefore focuses on the background behind the willingness or unwillingness to learn new 'tricks' and how to get acceptance of an 'old dog' to learn new tricks. This will not deal with specific procedures but a more general approach to learning and critical thinking that forms the basis of change in training.

## Single Loop and Double Loop Learning

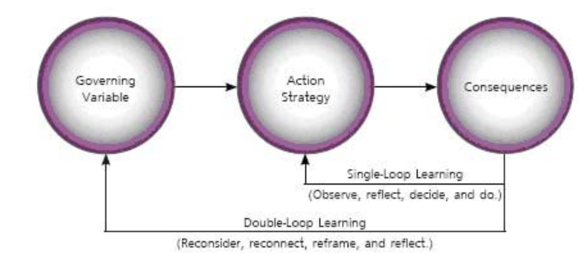
Argyris and Schon[1] in 1974 put forward the theories of single and double loop learning, which has stood the test of time.

## Single Loop Learning

In single loop learning, the organization (in this case the paediatric urologist) performs a task to achieve a specific objective (in our case let's say surgery for UPJ obstruction). The surgeon has performed this procedure by the open technique many times so much so that it can be performed without a second thought repetitively. In this situation, there is very little in the way of learning involved. Experts assert that most organizations operate according to single-loop learning – members establish rigid strategies, policies and procedures and then spend their time detecting and correcting deviations from the "rules." In our scenario this would mean that the surgeon is concerned with performing the pyeloplasty with this fixed rigid technique in mind with minor variations of the technique to suit the case.

## Double Loop Learning

Double loop learning is mainly 'thinking outside the box'. This may involve thinking in different ways of achieving the set goal, which might be better for the patient. It may involve changing the way the surgeon works along with change in the working practices of the entire team. This ability to think outside the box is termed double loop learning. In the case of performing the pyeloplasty, the surgeon may feel and think that it is worthwhile challenging the traditional open technique for minimally invasive technique and start performing this technique with constant reevaluation (double loop learning) and improving the technique.




Source: Adapted from Chris Argyris and Donald Schon. 1978. *Organizational Learning: A Theory of Action Perspective*. Reading, Mass: Addison-Wesley.

A schematic representation of these modes of learning is shown below (bottom left):

Governing variables is a fancy term for those things that heavily influence your desired outcome and certain limitations on how you can accomplish it. Governing variables also reflect your values. Put in the context of our surgeon and the pyeloplasty, the governing variables would be:

1. The child requires a pyeloplasty for the UPJ obstruction
2. This needs to be done by an open operation

In this scenario, in single loop thinking, the surgeon will invariably do whatever is necessary to accomplish the desired governing variables. However in double loop thinking, these governing variables will be challenged and may be:

1. Does this child require a pyeloplasty for the UPJ obstruction
2. Does it need to be done by an open operation
3. What other ways may I do the procedure

This therefore allows the surgeon to actively seek alternative ways of doing things and challenging the main assumptions and thereby modifying the action strategy.

## Critical Thinking

Having mentioned the theories of learning, it is easy to see why some individuals who are single loop learners are very reluctant to change as compared to their counterparts who are double loop learners. However single loop or double loop learning is not all that promotes training. The concept of critical thinking is very important in this aspect and is discussed below.

Critical thinking has been defined in different terms by different individuals. The Delphi report[2] defined critical thinking and a critical thinker as: We understand critical thinking to be purposeful, self-regulatory judgment which results in interpretation, analysis, evaluation, and inference, as well as explanation of the evidential, conceptual, methodological, criteriological, or contextual considerations upon which that judgment is based. CT is essential as a tool of inquiry. As such, CT is a liberating force in education and a powerful resource in one's personal and civic life. While not synonymous with good thinking, CT is a pervasive and self-rectifying human phenomenon. The ideal critical thinker is habitually inquisitive, well-informed, trustful of reason, open-minded, flexible, fairminded in evaluation, honest in facing personal biases, prudent in making judgments, willing to recon-

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## Best Way of Training New Tricks for an Old Dog *(continued from previous page)*

sider, clear about issues, orderly in complex matters, diligent in seeking relevant information, reasonable in the selection of criteria, focused in inquiry, and persistent in seeking results which are as precise as the subject and the circumstances of inquiry permit. Thus, educating good critical thinkers means working toward this ideal. It combines developing CT skills with nurturing those dispositions which consistently yield useful insights and which are the basis of a rational and democratic society.

So what does this mean for our surgeon? Assuming our surgeon is in the double loop learning camp, one would assume that the following critical thinking would apply in terms of the pyeloplasty.

1. Does the child require a pyleoplasty? What is the evidence? Has all the evidence been considered?
2. If the answer for the pyeloplasty is still 'yes', the next set of questions could be – is an open operation the best operation? What is the evidence? What are the outcomes? What is the morbidity, duration of the procedure etc.
3. What are the other options? Laparoscopic transperitoneal, retroperitoeoscopic, robotic, laparoscopic assisted
4. How do the other options compare with the open technique?
5. What training do I need? What is the learning curve for this procedure?

Once these questions are analysed, options considered, our surgeon may make a decision to learn and try a new technique but constantly re-evaluate the situation and be open to change based on new evidence or advice given as long as it goes through the same critical thinking process.

### So how does one train an old dog new tricks?

One of my trainers- a paediatric surgeon since retired never took to minimally invasive surgery on the grounds that "the open technique has served me well for many years with excellent outcomes so I am not going to change." A typical single loop learner and non critical thinker! However another trainer would constantly challenge us on different approaches to the same 'governing variables' and was in fact one of the first in our institution to learn and then train myself and peers in minimally invasive techniques.

So while the actual training is not difficult, it is getting the horse to the water that is the challenge. Instilling the critical thinking beliefs and double loop learning behaviour is, I would suggest, the only way of getting old dogs to learn new tricks.

### References

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