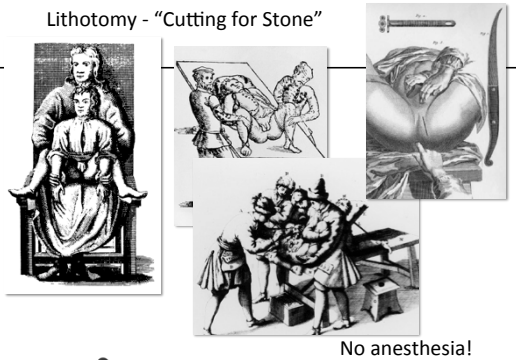
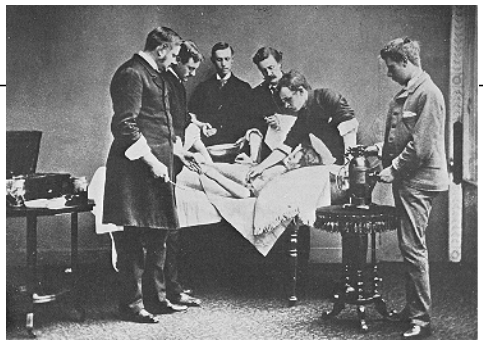
Lithotomy - "Cutting for Stone"



No anesthesia!

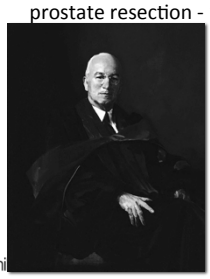
October 16, 1846 MGH Boston
First demonstration of ether anesthesia

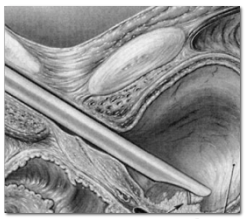


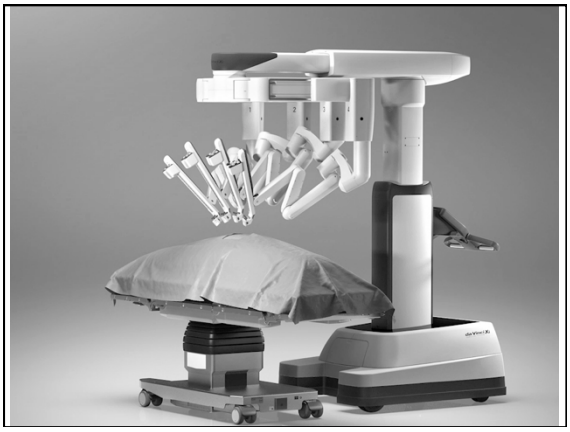
Lister's introduction of surgical antisepsis: 1867

Early MIS

- Hugh Young - Johns Hopkins Hospital
- Developed instrument for transurethral prostate resection - 1906







Controversy about Robotic Surgery

Robotic Surgery: How We Got Here and Where We Are Going

Craig A. Peters, MD
Chief, Pediatric Urology
Children's Medical Center
University of Texas Southwestern
Dallas, TX

Pediatric Laparoscopic Pyeloplasty - 1995

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PEDIATRIC LAPAROSCOPIC DISMEMBERED PYELOPLASTY

CRAIG A. PETERS, RICHARD N. SCHLUSSEL AND ALAN B. RETIK
From the Division of Urology, Department of Surgery, Children's Hospital and Harvard Medical School, Boston, Massachusetts

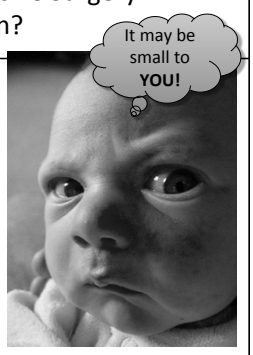
ABSTRACT

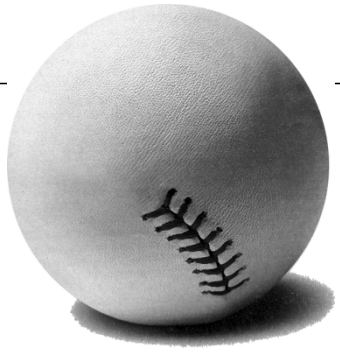
We performed laparoscopic dismembered pyeloplasty in a boy with right ureteropelvic junction obstruction using 4 cannula sites, and a dismembering and reanastomosis technique identical to that used in open pyeloplasty. Interrupted sutures were placed and tied intracorporeally. A nephrostomy tube was placed under direct vision for drainage but no ureteral stent was used. Total operating time was 5 hours. The patient was discharged home 36 hours after the procedure. The nephrostomy tube was removed 10 days postoperatively after radiographic demonstration of patency and 24 hours of clamping without pain. Followup excretory urography at 6 weeks showed much less hydronephrosis and a widely patent anastomosis. Our case illustrates the technical features and feasibility of laparoscopic pyeloplasty in children, and should encourage further development of pediatric urological reconstructive laparoscopic techniques.

KEY WORDS: kidney, peritoneoscopy, hydronephrosis

Why Minimally Invasive Surgery in Children?

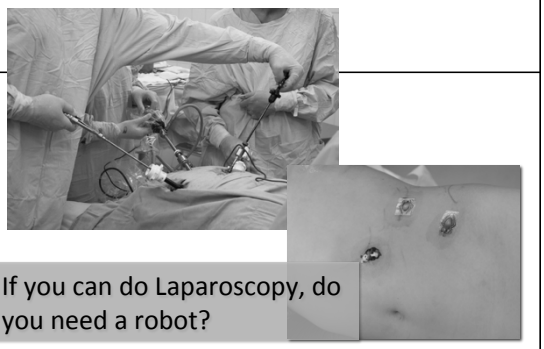
"Children recover quickly from any incision, and my incision is small"





Simply reducing the number of stitches or the length of the incision is NOT the goal of minimally invasive surgery - surgical morbidity is a complex combination of tissue trauma, metabolic changes, inflammatory effects, and patient perception

Minimally invasive sports surgery - Mt Sinai Hospital, NY



If you can do Laparoscopy, do you need a robot?

- If an operation is difficult, you are not doing it properly

Robert Gross, MD

"Father" of American Pediatric Surgery

- What nice operation are you making difficult today?

W. Hardy Hendren, MD

Robert Gross Professor of Surgery,
Harvard Medical School

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Conventional Laparoscopy:

Pirate Surgery

- Ergonomically challenging: like running with a peg-leg
- Operating with a hook at times
- Working with one eye covered

Idea stolen from John Meehan, MD

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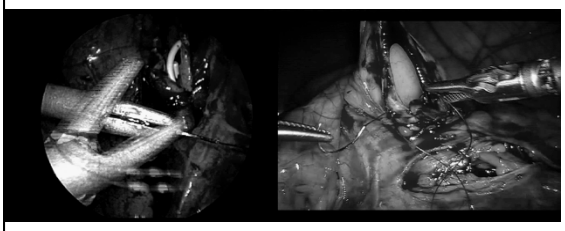
Conventional Laparoscopic vs. Robotic Pyeloplasty



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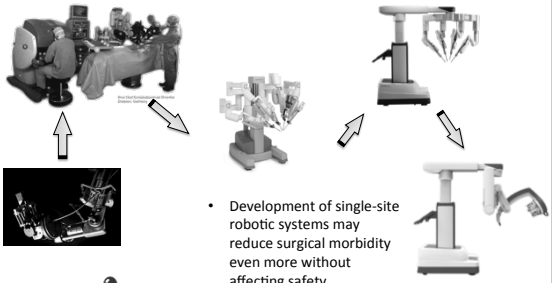
Evolution of a Technology



- Development of single-site robotic systems may reduce surgical morbidity even more without affecting safety

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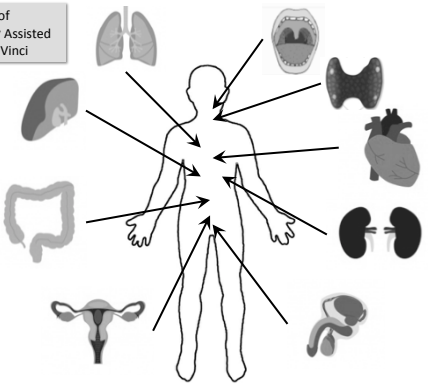
Emergence of Robotically Assisted Surgery - DaVinci



Robotic Surgery - Challenge

- Is this simply an expensive technology that has reduced morbidity for a few?
- Another example of "Technology-push" innovation that will ultimately have limited real value?
- …or, a truly valuable, paradigm-shifting technology that will re-define the surgical experience?

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Pediatric Applications of the DaVinci System

Urology	General Surgery
Pyeloplasty (primary / secondary)	Nissen fundoplication
Partial nephrectomy	Cholecystectomy
Pyeloureterostomy	Diaphragmatic hernia
Ureterocalicostomy	Choledochal cyst
Ureteral reimplantation	Neuroblastoma resection
Megaureter	Ladd's procedure
Ureterocele repair	Bronchogenic cyst
Bladder neck reconstruction	Mediastinal tumor resection
Continent catheterizable stoma	Kasai portoenterostomy
Enterocystoplasty	Duodenal atresia
Antegrade continence enema	Tracheo-esophageal fistula
Mullerian remnant excision	Pulmonary resection
Orchiopexy	Ano-rectal reconstruction
Cardiac Surgery	**Otolaryngology**
Aortic ring repair	Laryngeal cleft repair
Patent ductus arteriosus	

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Progressive Capability

- Mastery of simple procedures laid the foundation for more complex ones
- Nephrectomy facilitated pyeloplasty
- Pyeloplasty facilitated partial nephrectomy and ureteroureterostomy
- Reimplants facilitated excisional megaureter repair, continent catheterizable channels and cystoplasty…

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Innovative Robotic Surgery

- HIDES technique pyeloplasty for kidney obstruction: all incisions below waist line
- Augmentation cystoplasty
- Continent catheterizable stomas for bladder abnormalities
- Bladder neck reconstruction for incontinence
- Radical cystectomy in children
- Retroperitoneal lymph node dissection for testis cancer

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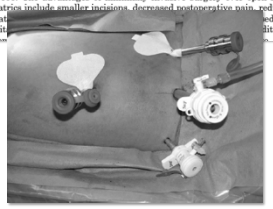
Hidden Incision Endoscopic Surgery: Description of Technique, Parental Satisfaction and Applications

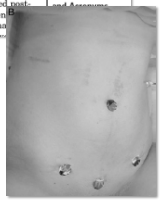
Patricio C. Gargollo

From the Department of Urology, Division of Pediatric Urology, Children's Medical Center Dallas and University of Texas Southwestern Medical School, Dallas, Texas

Purpose: The advantages of minimally invasive surgery over open surgery in pediatrics include smaller incisions, decreased postoperative pain, reduced post-

Abbreviations





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Vol. 185, 1425-1431, April 2011
Printed in U.S.A.
DOI:10.1016/j.juro.2010.11.054

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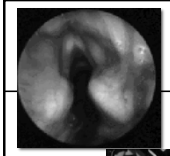
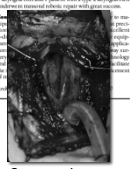
Laryngeal cleft repair



ORIGINAL ARTICLE

Robotic Surgery in the Pediatric Airway

Application and Safety



Robotic set-up

Open repair

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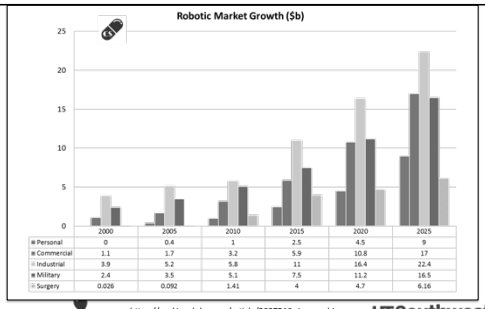
Reza Rehbar, DMD, MD Children's Hospital Boston

Pediatric Urology Robotic Surgery - State of the Art 2017

- Pyeloplasty *(primary and reoperative)*
- Ureteral reimplantation
- Partial Nephrectomy
- Pelvic Surgery
- *Bladder augmentation, continent urinary diversion (emerging)*

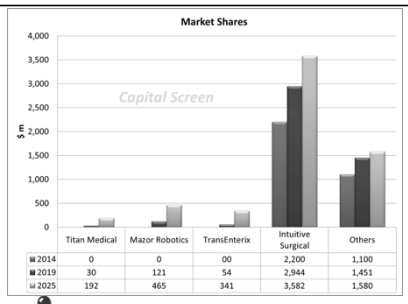
Growth of Robotics



	2000	2005	2010	2015	2020	2025
Personal	0	0.4	1	2.5	4.5	9
Commercial	1.1	1.7	3.2	5.9	10.8	17
Industrial	3.9	5.2	5.8	11	16.4	22.4
Military	2.4	3.5	5.1	7.5	11.2	16.5
Surgery	0.026	0.092	1.41	4	4.7	6.16

https://seekingalpha.com/article/3637516-rise-machines-makes-transenterix-titan-medical-strong-buys

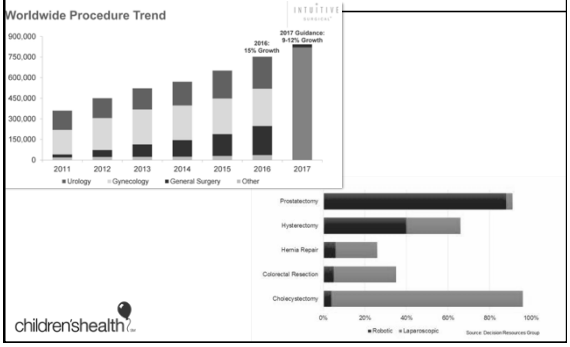
Robotic Surgery Market Share



	Titan Medical	Mazor Robotics	TransEnterix	Intuitive Surgical	Others
2014	0	0	00	2,200	1,100
2019	30	121	54	2,944	1,451
2025	192	465	341	3,582	1,580

https://seekingalpha.com/article/3637516-rise-machines-makes-transenterix-titan-medical-strong-buys

Robotic Surgery Growth



Robotic Surgery Development

M7 Surgical robot - SRI

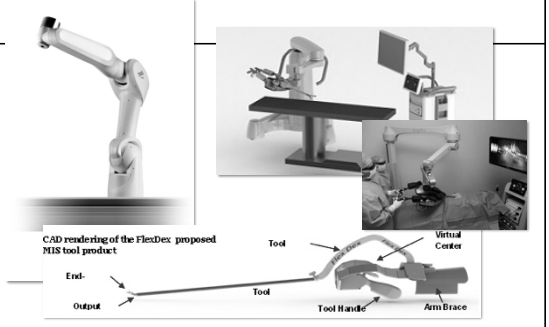
Amadeus System – Titan Medical, Canada

SOPHIE- Eindhoven Univ.

RAVEN- Univ. of Washington

MiroSurg-German Aerospace - Munich

Emerging Robotic systems



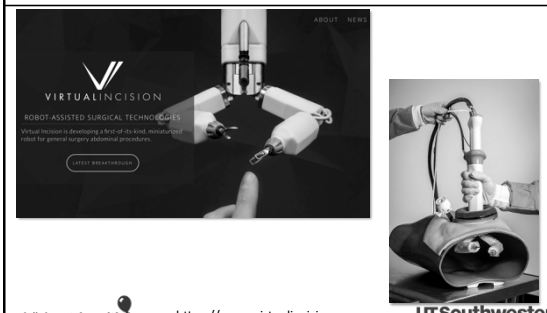
REVO-I - Korea

http://www.meerecompany.com

Titan Medical: SPORT™ Surgical System

http://www.titanmedicalinc.com

Virtual Incision Corp.

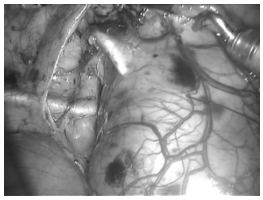


https://www.virtualincision.com

Did Halsted need a robot?

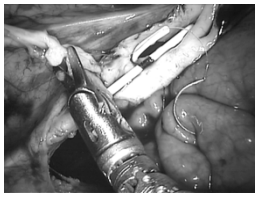
Surgical Needs

- Visualization



Surgical Needs

- Visualization
- Tissue handling



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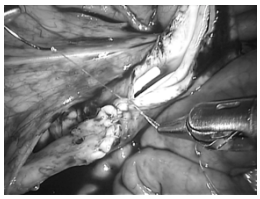
Surgical Needs

- Visualization
- Tissue handling
- Instrument control



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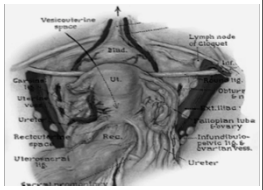
Surgical Needs

- Visualization
- Tissue handling
- Instrument control
- Situational knowledge



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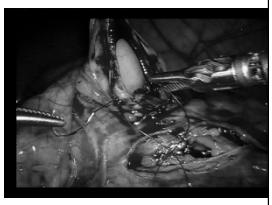
Surgical Needs

- Visualization
- Tissue handling
- Instrument control
- Situational knowledge
- Tissue joining



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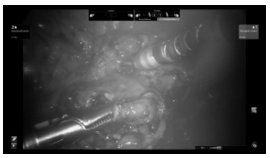
Surgical Needs

- Visualization
- Tissue handling
- Instrument control
- Situational knowledge
- Tissue joining
- Tissue removal



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Surgical Needs

- Visualization
- Tissue handling
- Instrument control
- Situational knowledge
- Tissue joining
- Tissue removal
- Safety

> The only way the defenseless patient can retaliate upon the incompetent surgeon is hemorrhage
>
> W.S. Halsted

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Pathways to the Future

- Control and Automation
- Image integration
- Navigation
- Haptics: physical and biological
- Novel Robotic Systems

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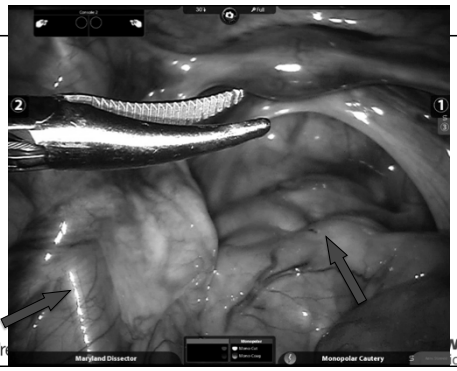
"No fly" zones



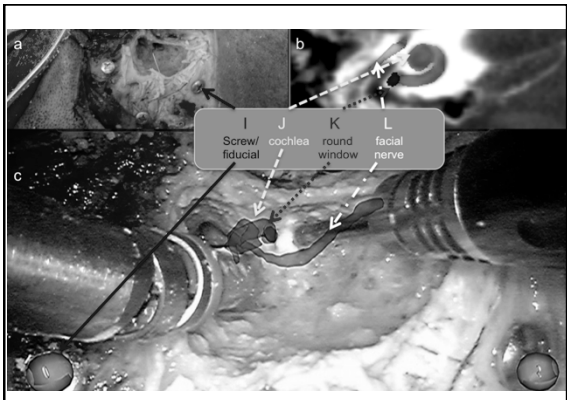
"No fly" zones

Semi-autonomous surgical robot

STAR – Children's National Health System

UTSouthwestern Medical Center

Augmented Reality *("Mixed reality")*



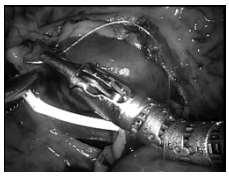
K. Cleary, D. Preciado

Haptics: Technology

- Visual
- Auditory
- Force-feedback
- Biologic

Haptic Needs

- Tissue texture – differentiate types of tissues and structures to identify location/anatomy
- Tool resistance when moving into a structure you may not want to touch
- Tension on suture or tissue

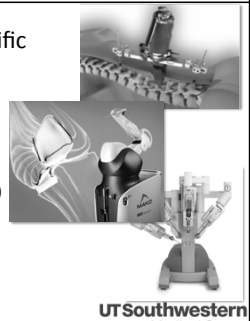


Pneumatic force sensors

David Geffen School of Medicine

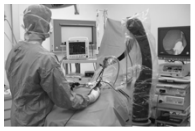
Procedure-specific Robotic Systems

- Procedure/Location-specific Systems
  - Mazor System: spine surgery
  - Mako Robotics: knee surgery
  - DaVinci: largely limited to abdominal and thoracic (chest) procedures



Task-specific Robots

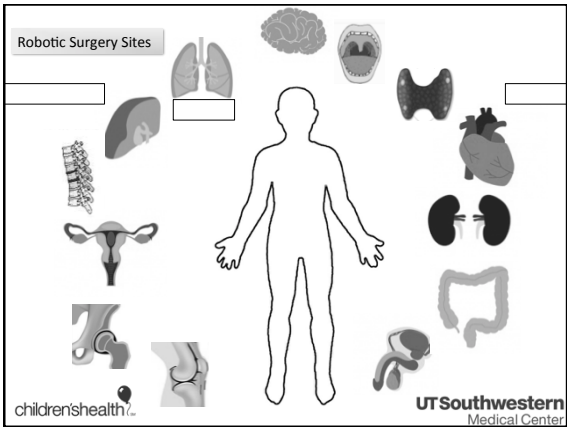
- Manage individual surgical tasks
  - ✓Cutting or sawing
  - ✓Suturing
  - ✓Anastomosis
  - ✓Endoscope control
  - ✓Needle biopsy



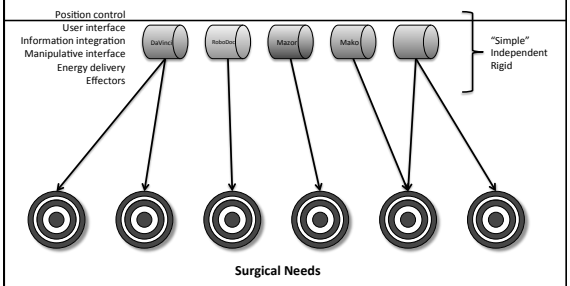
SOLOASSIST Aktive Kameraführung

ViKY Endo Control

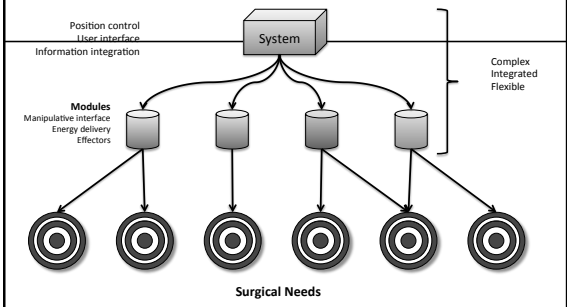
Robotic Surgery Sites



Procedure-specific Robotics



Modular Robotics

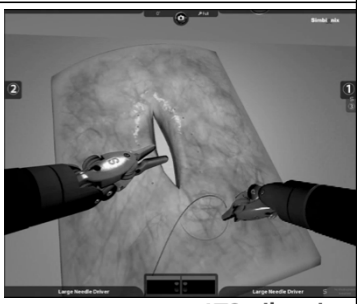


Tele-proctoring

- Use of real-time, remote access to DaVinci video stream to observe and guide the more advanced trainee.
- Secure link via Internet into the robotic OR

Robotic Simulation

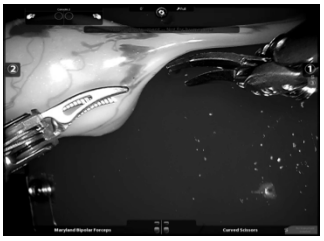
- Novel virtual reality simulator for robotic surgery with the DaVinci system
- MIMIC (Seattle, USA)



Da Vinci Virtual Reality Simulation

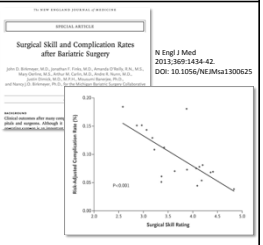
Robotic Simulation

- Development and Validation of an inexpensive procedure-specific simulation tool – Timberlake
- $2.50

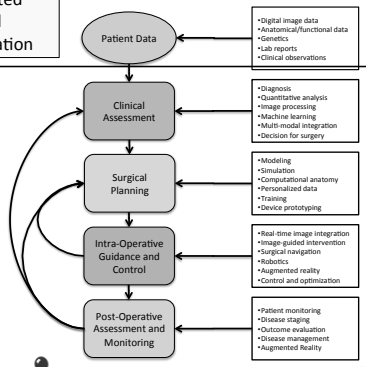


Robotic Skills Assessment

- Credentialing
- Maintenance of Certification
- Liability

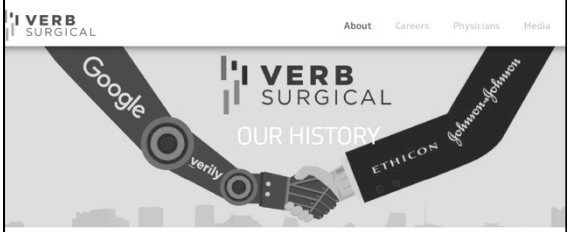


Integrated Surgical Information



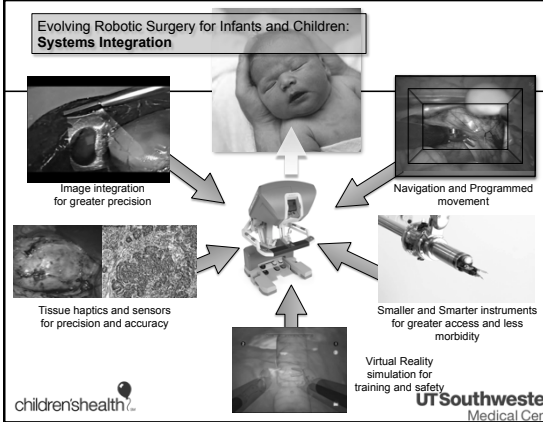
Novel Technology RFA response - 2014

Virtual Robotic Systems



- SRI Robotics is licensing technology directly to VERB
- Goal: "…advanced imaging, data analysis, and machine learning to remove variation, enable greater efficiency and provide better outcomes across the spectrum of surgery." (WSJ 2016)

Evolving Robotic Surgery for Infants and Children: **Systems Integration**

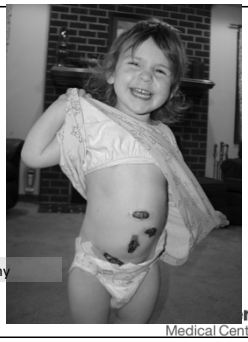


Paradigm Shift?

"I thought I felt a paradigm shift, but it was just my undershorts riding up."

The Patient Experience

- While difficult to measure or value, patient and family experience and perceptions are critically important
- What is "enough" reduction in morbidity?
- What is the value of a better cosmetic result?



2 days Post-op from partial nephrectomy

Impact on the Patient and Family

- Reducing morbidity and improving outcomes requires being able to measure them
- It is not the patient alone who is impacted by surgery, but the entire family
- Developing ways to capture how the patient and family are affected by the surgical experience is essential for us to really improve that experience

Surgical Robotics 2017

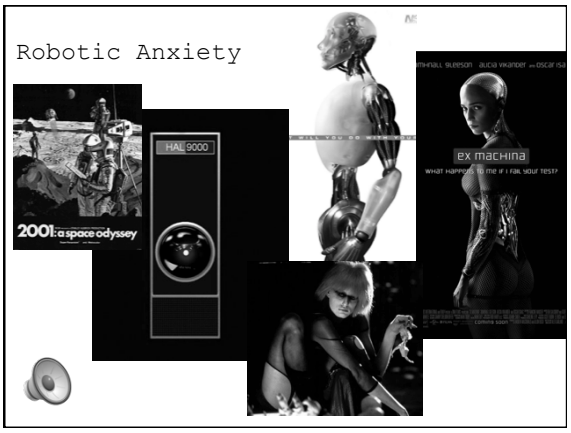
- There is an inherent dilemma within new medical technologies:
  - ✓The need to ensure value and safety
  - ✓The need to allow innovation to survive
- Robotic pediatric surgery has several clear "wins" – pyeloplasty in older children, retrovesical surgery, complex renal reconstruction – these may be seen as heralds of potential future "wins".

The ultimate in outpatient surgery?

The Future?

KEVIN KELLY GEAR 12.24.12 6:30 AM

BETTER THAN HUMAN: WHY ROBOTS WILL — AND MUST — TAKE OUR JOBS



Surgical Robotics 2017; *and beyond*

- Our job is to critically look at robotic procedures, their outcomes and impact on the patient and their family
- This requires a degree of equipoise – you have to be willing to be objective and self-critical
- If not, credibility goes out the door
- *Anticipate and Shape the future*

children's health

UT Southwestern Medical Center