Robotics in Medicine
The *da Vinci*® Surgical System

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Device Technologies
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Evolution of Surgery

- Open surgery: mid-19th C
- Minimally invasive surgery: late 1980’s
- Robotic (Intuitive) surgery with daVinci: 1999
Minimally Invasive Surgery

- Reduced blood loss
- Fewer complications
- Shorter LOS
- Faster recovery
- Less scarring

Click image to view video
da Vinci® Surgical System

Surgeon Console    Surgical Cart    Vision Cart
Eliminates
• Counter-intuitive motion
• Instrument tremor

Provides
• Improved ergonomics
• Hand / eye alignment

Transforms
• 2-D vision to true 3-D
• 5 DOF instruments to 7 DOF (greater endoscopic dexterity)
• Comfortable ergonomic surgeon position
• Natural intuitive movements
• Hand to eye alignment
• Allows both instrument and endoscope movement
3-D vision

Superior 3-D image

Stereoscopic design with two 3-chip cameras

‘Open’ surgery orientation
EndoWrist instruments

- Modeled after the human wrist
- Full range of motion with 7 degrees of freedom
- Instrument tips replicate finger movements
• Eliminates tremor
• Enables ambidexterity
• Provides motion scaling from 2:1 to 5:1
• Accelerated learning curve
Hence the uptake per specialty: decreases with complexity of procedures
...and the potential for da Vinci surgery to fill the gaps
Improves Urology Patient Outcomes - Radical Prostatectomy

- Nerve sparing and continent
- Less blood loss & incidence of transfusions
- Shorter hospital stay, 2-3 day reduction
- Shorter recovery time, 2-4 week reduction
- Less scarring

**da Vinci® System Laparoscopic Radical Prostatectomy Post-op Patient**

**Conventional Open Surgery Radical Prostatectomy Post-op Patient**
Surgical Example - Dorsal Venous Complex Stitch
Value = Efficacy ÷ Invasiveness\(^2\)
Improves Cardiac Patient Outcomes

- Reduces surgical incisions
- Reduces blood loss
- Reduces recovery time and post-op length of stay
- Reduces costs
Surgical Example - Mitral Valve Repair
Value = Efficacy ÷ Invasiveness$^2$
Surgical Example - TECAB - Beating Heart
Dexterity for complex dissections (endometrial cancer, endometriosis, etc)

Vaginal cuff suture closure with ease

Improved visualization and access around cervix for colpotomy

Video courtesy of Javier F. Magrina, M.D.
TORS - Trans Oral Robotic Surgery - ENT
More than 1170 systems worldwide
130,000 procedures performed worldwide in 2008
da Vinci® European Installed Base 1999 - 2009
Robotic Milestones in Australia and New Zealand

- **1st daVinci installed – Aug 2003**
- **10 systems in ANZ**
  - Epworth Hospital – Richmond – VIC - 2003
  - Royal Adelaide Hospital – SA - 2004
  - Epworth Eastern Hospital – Box Hill – VIC - 2005
  - St Vincents Hospital – Syd – NSW -2006
  - Ascot Hospital – Auckland NZ - 2007
  - Grace Hospital – Tauranga NZ - 2007
  - SJOG – Subiaco – WA - 2007
  - Greenslopes Private Hospital – Brisbane – QLD -2008
  - Royal Brisbane Hospital – Brisbane – QLD - 2008
  - Christchurch – NZ - 2009

- **Currently > 4300 procedures performed in Australia**
History - Experiments with Enhanced Telesurgery

Photo courtesy Hank Morgan
Medical Robotics - The Second Wave

Computer-enhanced surgical dexterity through telemanipulation

Illustration courtesy: Dr. Akhil Madhani
Early telesurgery concept from SRI
FREFLEX Force-Reflecting Exoskeletal Arm Master (1994)
Early da Vinci® Components

Early Electronics Chassis

First Robotic Console
Early telesurgery concept from SRI
Master Tool Manipulator - (MTM)

- Receives input from the surgeon and transfers that motion to the patient side manipulators via the system servo loop.

- Controls both the ECM and PSMs.
Patient Side Manipulator - (PSM)

- The PSMs hold the surgical instruments and provide accurate, smooth and safe translation of surgeon inputs on the MTMs.

- Utilize remote center concept to provide accuracy.
Vision System

- Vision System is used to provide a high quality, three-dimensional (3D) view of the surgical site.
- Two 3-chip Cameras are mounted on a custom 3D endoscope with separate optical channels.
- Headquarters in Sunnyvale, Ca
- >1000 employees
- Global company
- ISRG (NASDAQ) June 2000
- Founded in 1995 by Fred Moll, M.D. & Robert Younge
- Pentagon funded a robotics project at Stanford -> origin of da Vinci system
da Vinci® Surgical System - 1999
Latest - da Vinci® Si system - April 2009
The Robotic OR of the Future?
Augmented Reality

Real time data fusion

Courtesy: CBYON
Advanced Software: Planning

- Optimal path planning/port selection
- Identification of landmarks/measurements
- Registration between models and robot

Courtesy: Karlsruhe

Courtesy: GMD, Bonn
Advanced Software - Simulation

- Offers a way to train surgeons in a consistent environment
- Offers promise of objective surgical assessment
- Offers promise of significant cost reduction for training
High Definition Vision - Multiple Inputs

Ready. Place head in View Port to operate.
An Information Rich Surgical Environment

- Integration, registration, & utilization of preoperative and real-time information:
  - Training
  - Pre-op plans
  - Setup
  - Navigation
  - Constraint
  - Collaboration
Thank You