# Computer Assisted Surgeries & Simulation Technology in Healthcare.

**By:** EMeRG

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**Excerpts from MedSim 2019: DBT-IISc Bioengineering and Biodesign Initiative (BBI2) Workshop on Medical Simulation**
**By Krishanu Bhattacharjee, Founder & CEO, EMeRG.**

# THE NEED FOR COMPUTER ASSISTED SURGICAL SIMULATION.

1

## Surgical Errors

$17 BN In Yearly Losses

100,000 Deaths Globally

2

## Access to Care

4.8 Billion People with No Access to Surgery

95% Do Not Have Access in South Asia & Africa

3

## Skillset

>7,000 Deficit of Surgeons in the US

30% US Counties Do not Have a Surgeon

**3%** Incidence Rate of AE Among Patients Undergoing Surgery.

**<0.5%** of the World's Surgeons Have Access to Simulation.

**Subjectivity** due to years of experience is a growing concern.

**54%** of All Adverse Events Towards Surgery Are Preventable.

**400MN** People Globally May Have Rare Disease.

Surgical Simulation Allows Room For Error, And Helps Learn Consequences of Error.

Surgical Simulation Helps Mimic Rare Conditions and Builds Confidence in Surgeon.

Surgical Simulation Provides Safe, Standardized and Risk Free Objectivity Training.

# SPECIFICALLY FOR INDIA...

**URBAN-RURAL DIVIDE**

- **2 Lac Surgeons in Urban India.**
- **82.5% Shortage of Surgeons in Rural India.**

**LIMITED SPECIALISTS**

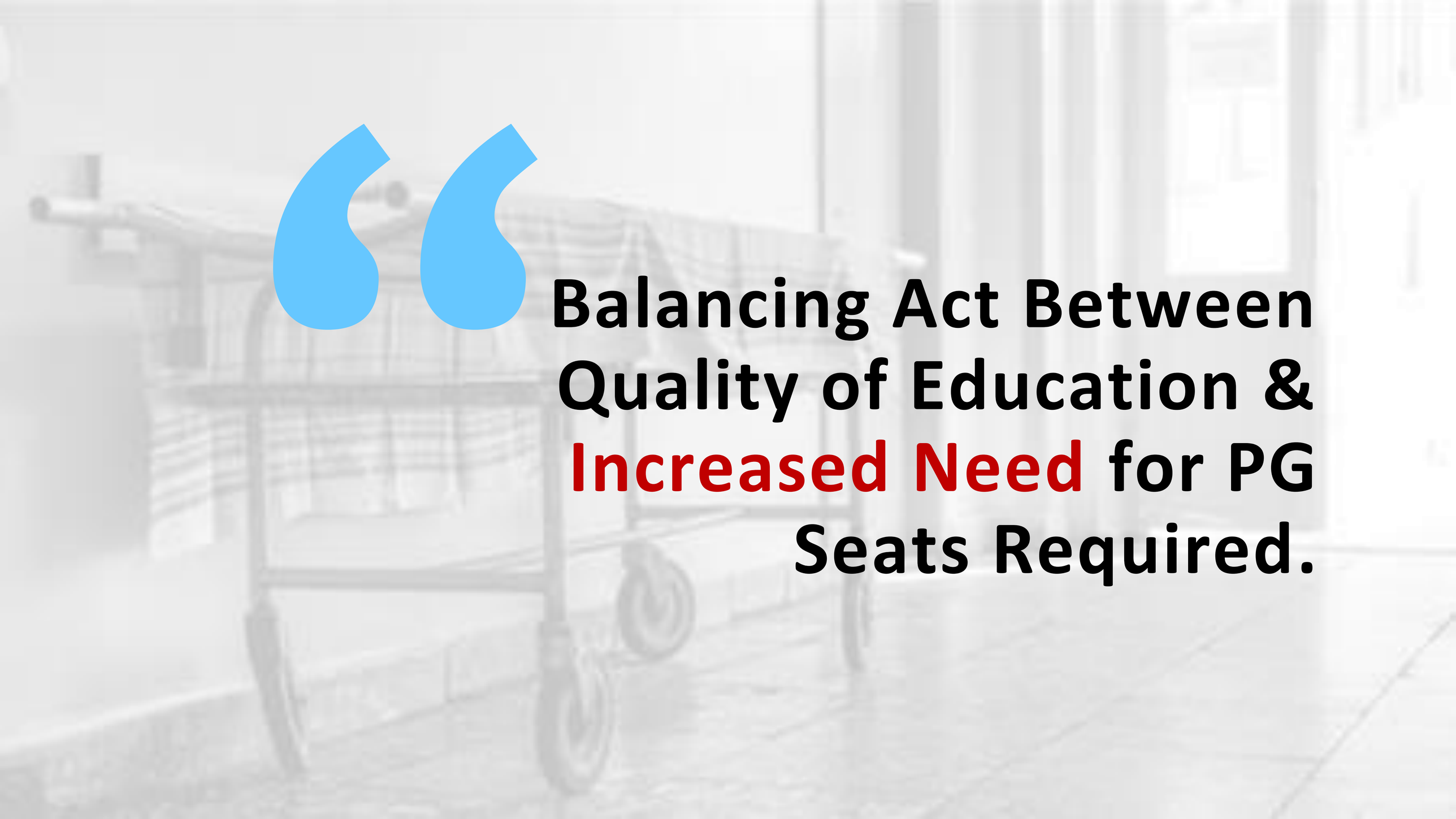
- **<50,000 Paediatricians.**
- **4,000 Cardiologists vs. 88,000 Requirement**

**FEWER SEATS**

- **315 Cardiology PG Seats Vs 3,375 Required.**
- **78 in Endocrinology.**

**MASS EXODUS**

- **9% of Doctors in the UK are Indian Trained**



# Balancing Act Between Quality of Education & Increased Need for PG Seats Required.

## Wellness & Prevention

- Improve patient experience
- Use of VR to minimize anxiety
- Improve adherence and lifestyle

## Diagnosis

- Real-Time, anatomically accurate VR simulations to visualize medical diagnosis
- Digital Twins
- Interaction with Virtual Patients

## Surgical Planning

- Virtual surgical planning
- VR simulations used to illustrate the impact of procedures and treatment
- VR to create training scenarios which replicate common surgical procedures.

## Surgery & Treatment

- Surgical Navigation
- Surgical Robotics

## Condition Management

- VR Based immersive events that create breakthrough empathy for stigmatized or misunderstood conditions
- VR for Pain Management

# THE ROLE OF SIMULATION IN THE PATIENT JOURNEY.

As the daily digital eco-system continues to become commonplace, the patient and the physician of the future will slowly begin to demand for unobtrusive, naturally embedded digital interventions in the care lifecycle.

# THE KEY MARKET SEGMENTS IN CA SURGERY.

Three major segments that encompass clinical decision support, training and CME.

1 **Surgical Robots**
$3.5BN.

Hip & Knee Laparoendoscopy

2 **Surgical Navigation Systems**
$0.6BN.

Adoption of Intraoperative Imaging

3 **Simulators & Planners**
$0.3BN.

AR VR Adoption
Growing Clinical Applications & Investments

*Source: EMeRG estimates based on primary research with global surgical navigation, robotics and simulation manufacturers*

# SURGICAL SIMULATION: TRENDS.

## Key Examples:

**Inovus Medical** – World's most affordable 'take-home' laparoscopic simulators

**VirtaMed**– World's first virtual reality simulator for ankle arthroscopy

**Chai3D** – world's first MRI-compatible, image-guided, computer-assisted robotic device for neurosurgery.

### Laparoscopy

- Risk-Free Laparoscopic simulators – Laparoscopic appendectomy, kidney complications (complete nephrectomy), enteroenterostomy anastomosis
- Suturing, knot-tying and loop ligation;
- **E.g. - MEDICAL-X, CAE Healthcare, 3D Systems**

### Arthroscopy

- Virtual Arthroscopic Simulator– meniscal tears and perform meniscectomy
- Basic Skills - triangulation, loose body removal, guided meniscectomy
- **E.g. - VirtaMed, 3D Systems**

### Cath Labs

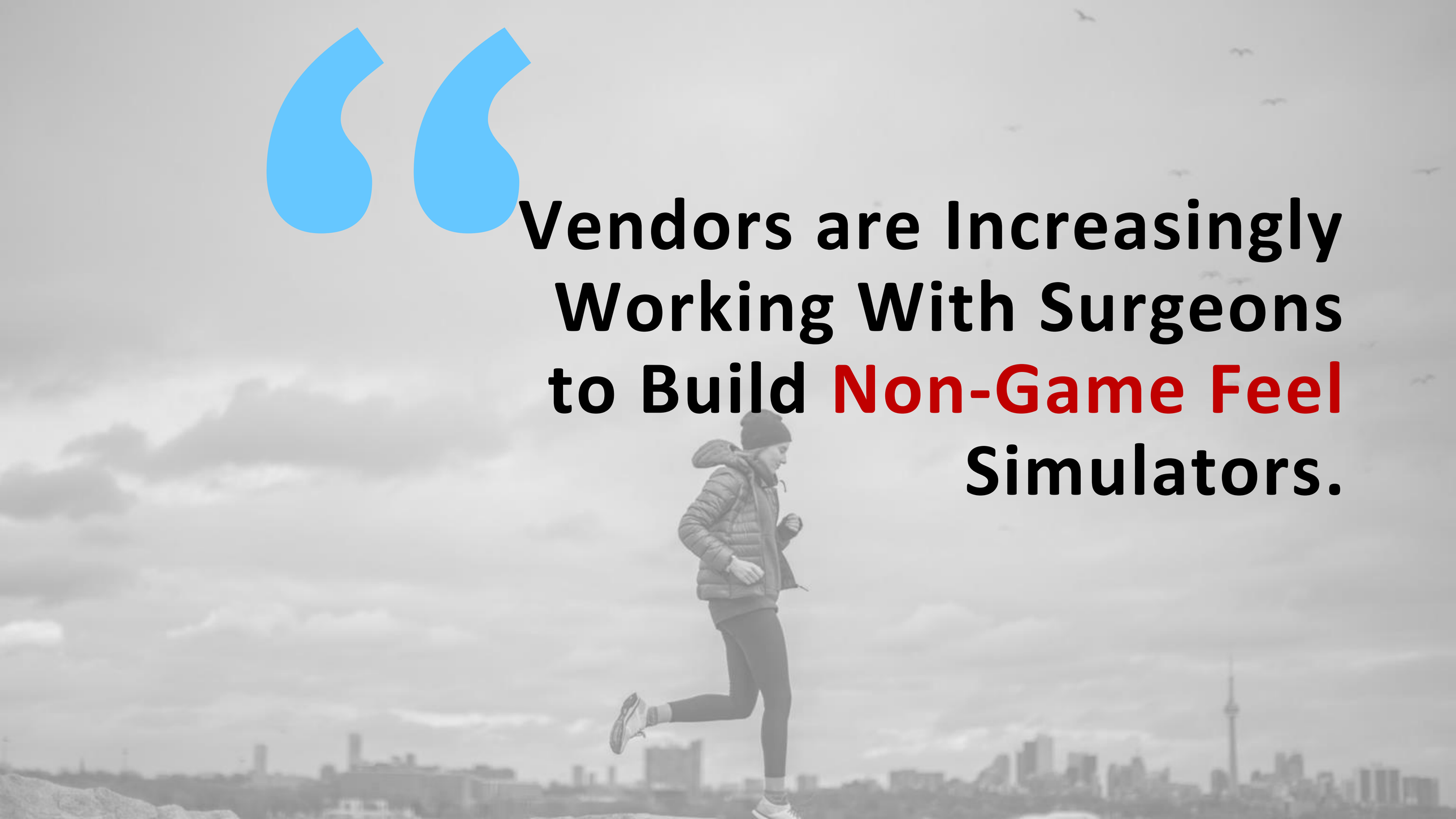
- Immersive cath lab simulators – complex structural interventions (ASD closure, TAVI); CRTD implants
- Part-task training (PTT) – arterial and venous access and closure
- **E.g. - 3D Systems, CAE Healthcare**

### OBS/GYN

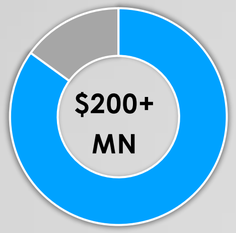
- Ectopic Pregnancy & Oophorectomy, breech birth conditions
- **E.g. - 3D Systems, EON Reality**

### Neuro

- Brain aneurysms and arteriovenous malformations (AVMs), Skull base meningioma
- Microsurgery – Meningioma, Glioma
- **E.g. - CAE Healthcare, Surgical Theater, LLC.**



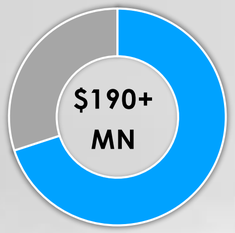
“Vendors are Increasingly Working With Surgeons to Build Non-Game Feel Simulators.




### Ortho - Surgery

- TKR, THR, Shoulder Reconstruction
- 1.5 MN Knee Replacements / Year
- Increased Procedure Time

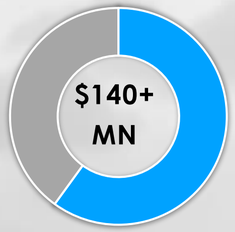
**Stryker, Medtronic, B.Braun, BrainLab**




### Neurosurgery

- Craniotomy, stereotactic biopsy
- EM tracking vs. IR
- Need for intra-operative MRI

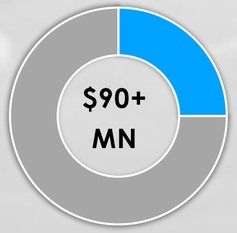
**Stryker, Medtronic, BrainLab**




### Spine Surgery

- Significant increase in spinal fusion
- Reduction in nerve injury rates, misplaced screws and revision surgeries

**Stryker, Medtronic, BrainLab**




### ENT

- Visualization of fragile anatomy such as the optic nerves, blood vessels and brain tissue
- ENT in ambulatory surgery centres

**Stryker, Medtronic, BrainLab**

# SURGICAL NAVIGATION SYSTEMS: TRENDS

**Key Examples:**

**7D Surgical** – First and only machine-vision IGS allowing patient registration in 20 secs.

**Compass International** – First portable frameless stereotactic system for neuro.

**Scopis (Stryker)** – AR in FESS.

# CHALLENGES TO BE COUNTERED – AS DESCRIBED BY PHYSICIANS

- Physical footprint of cameras is large
- With surgical assistants in the sterile field, the line of sight to the arrays are hard to keep open
- The workflows with several current offerings are not customizable
- With the UI being outside of the sterile field, a company representative or nurse may be required to operate the system.
- The arrays may need additional pins, sometimes outside of the incision.
- The reflective spheres invariably demonstrate downtime when there's spillage of blood on them or when someone gets in between the array and the camera.
- Registration takes too long.

## Robotically Assisted Micromanipulation

- Master-slave system
- Most surgical robots belong to this class
- Ex. da Vinci surgical robot

### Pre-Programmed Robots

- Can perform specific tasks with limited / no human intervention
- Largely for ortho applications; ROBODOC

### Steady – Hand Systems

- Microsurgical procedures
- Decouples surgeon's hands from instrument
- Largely Experimental (The Johns Hopkins University)

### Microbots

- Complex in-vivo surgeries
- Cardiac, Neuro, Ophthal
- Proteus / Given Imaging

# SURGICAL ROBOTS: TRENDS

**Key Companies**

- Intuitive Surgical
- **Mazor Robotics (Medtronic)**
- Verb Surgical (Google + J&J)
- **Stryker**
- Think Surgical

# INNOVATION IN SURGICAL ROBOTS:

**A new and potent combination of data fluidity, processing speeds, deep learning and engineering advances is beginning to shape the future of medical robotics.**

1

### VIRTUAL INCISION

Developing a first-of-its-kind, miniaturized robot for general surgery abdominal procedures – colon resection.

2

### MONARCH-BY AURIS

Robotics, micro-instrumentation, endoscope design, sensing, data science on one platform – for lung cancer.

3

### AXSIS-BY CAMBRIDGE CONSULTANTS

Developing a miniaturized, compact surgical robot for cataract lens replacement and potentially for natural orifice, cancer and GI applications .

4

### J&J–GOOGLE (VERB SURGICAL)

Developing a first-of-its-kind, miniaturized robot for general surgery abdominal procedures utilizing advanced analytics.

5

### PRECEYES SURGICAL SYSTEM

High precision robotic surgery for vitreoretinal surgeries.

# INNOVATIONS IN GI AND LAPAROSCOPIC SURGERY.

## Simulator Control System

### Levita Magnetic Surgical System

- Magnetic surgical system for laparoscopic cholecystectomy procedures
- Better visualization of surgical site by the ability to grasp and retract the gallbladder

## Simulation Solutions & Systems

### High Fidelity Training Box

- By SAGES
- The total cost for one simulator unit is $2,150 USD.
- Most surgeons, 97.5%, found that the simulator had high fidelity

## Robotic Surgical System

### Versius Surgical Robotic System

- By CMR surgical
- Cost effective surgical robotic system for laparoscopy
- Focus on benefits for surgeons: Ergonomic working positions, reduced stress and fatigue
- Portable

**Need of the hour**

**Affordable / cost-effective simulation | High Fidelity | Software as service**

**Integration of VR in inexpensive ways**

# THE M&A LANDSCAPE IS DYNAMIC.

**Acquisitions by traditional medical device and healthcare companies are noticeably skewed towards digital, data based, small companies that invest in the areas of visualization and robotics.**

### MEDTRONIC

..acquired **Mazor Robotics, Visualase**

### STRYKER

..partnered with **Synaptive, Ziehm & NeuroLogica**

### J&J

..acquired **Orthotaxy & Auris Health**

### TITAN

..collaborated with **Mimic Technologies..**

### AURIS SURGICAL

had **Hansen Medical before being acquired by J&J.**

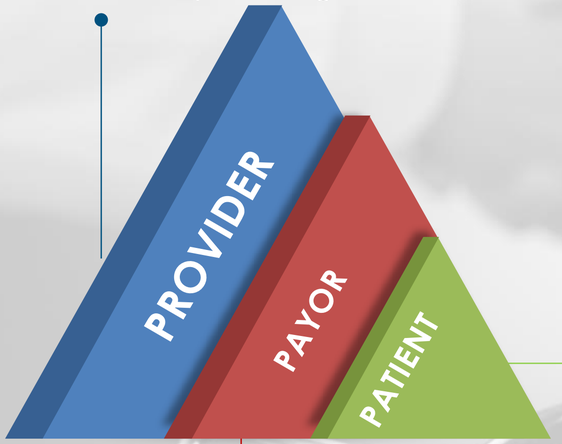
### SIEMENS

..acquired **XACT Robotics** to expand on interventional portfolio

# THE BIG PICTURE.

**More Randomized Clinical Trials Are a Need to establish the efficacy of computer aided surgical navigation systems!!**

- **95%** Accuracy is commonly reported with computer-aided surgery
- Fluoroscopically-assisted pedicle screw placement has been reported at **85% accuracy**
- Significant reduction in the amount of radiation delivered to operating room staff
- As per specific studies, the learning curve to master the robot **was >=10 robotic** procedures.
- Reduction in the operating room time; Decrease in fatigue



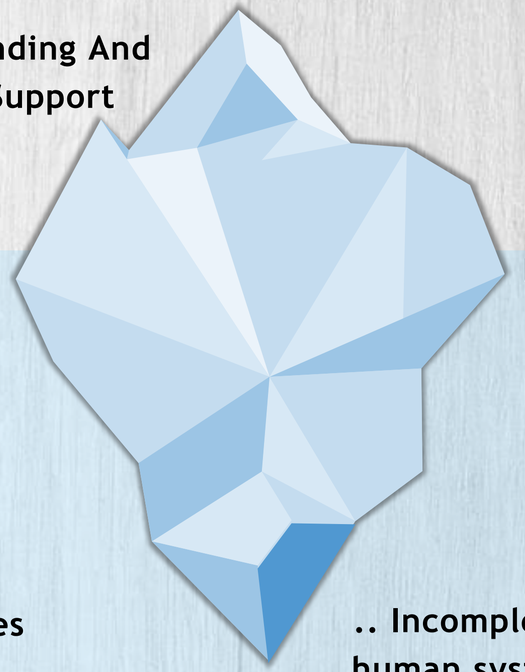

- Less postoperative imaging - Reduced cost and radiation exposure
- **100% Artificial joint: alignment within 3 degree**
- Shorter hospitalization

- **$200–300** - savings for residency program in Arthroscopy while using Computer assisted Surgical simulators
- **$600,000** - Saved by using Robotic Surgical Simulator for skill training
- An incremental cost-effectiveness ratio of **US$23,288** per reoperation avoided.

# THE WAY AHEAD.

## Issues around implementation of Surgical Simulators in Training and Clinical Workflows

…Lack of Funding And Financial Support



360-degree videos have variable levels of fidelity and offer limited ability for interaction and immersion.

.. Difficulty in incorporating simulations into existing curriculum..

.. Lack of outcomes measurement…

.. Incomplete mimicking of human systems due to high complexity..

46% of schools used basic simulation and only 23% used advanced procedure training with simulators.

Only 5% AR/VR Start-ups in India Raised Any Funding in Last 5 Years

**Disruptive technologies that address the need for ergonomic, intuitive and easy to use simulators while ensuring lower-costs would define the future adoption of such technologies. Some of the locally founded and incubated innovations presented at MedSim 2019 are likely to play a crucial role in widespread dissemination of such technologies:**

1. **EndoMimyk** – an immersive haptic simulator for endoscopy / colonoscopy
2. **Critica** – Advanced ICU simulation system
3. **Fetal Acoustic Simulator** for training of primary care nurses

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