THE ROBOT WILL SEE YOU NOW

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In a world where the number of people who need healthcare is growing faster than the number of people who can provide their care, the adoption of new technology is more imperative than ever. This bodes well for the robotic-assisted surgery (RAS) industry, which remains largely underpenetrated, with significant investment upside.

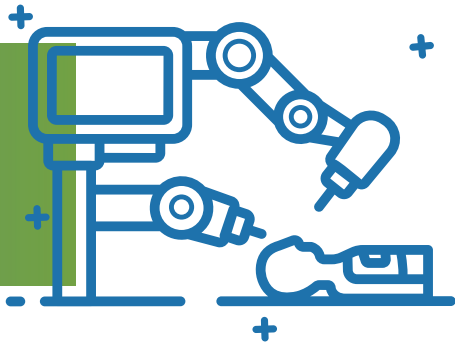
While global market leaders Intuitive Surgical and Stryker are well-positioned for this trend, the vast market opportunity is attracting new and innovative companies that will further advance surgery. Investors can capture the value of this theme through both the ROBO Global Robotics & Automation Index (ticker: ROBO) and ROBO Global Healthcare Technology & Innovation Index (ticker: HTEC). In this report, we segment the market by different indications and highlight the companies to watch.

WELCOME TO THE NEW FRONTIER OF SURGERY

Contrary to its name, robotic surgery is actually still performed by a surgeon, who uses a computer to control a robotic arm as it operates on a patient. The robot's arms are steadier and narrower than human hands and can, therefore, help surgeons access areas of the body that are very difficult to reach, and without tremor. They can also make smaller incisions than humans, which drives lower recovery times for patients. Using machine intelligence, RAS is driving efficiency and extreme surgical precision, resulting in improved patient outcomes, increased healthcare worker safety, and reduced surgeon burnout.

Surgical robots are used in a wide range of surgical indications, from prostate cancer to spine to endovascular procedures, and they comprise an $11 billion market.

Given only 3% of surgeries are done with robotics, we think further adoption will expand the market to over $30 billion by the end of this decade.

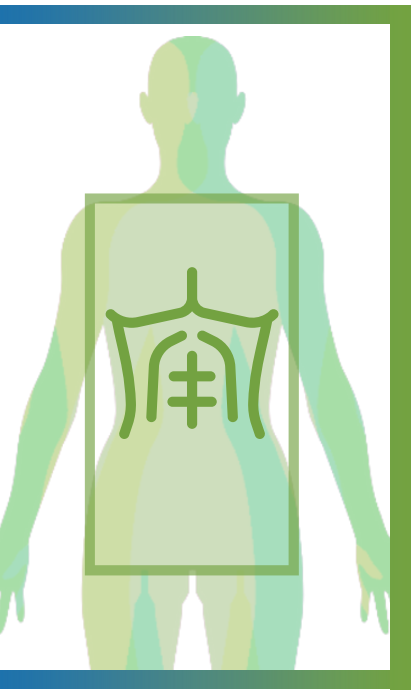


This will be driven by companies expanding use cases to more indications while enhancing robotic features, and by the growing geriatric population.

Surgical robot providers largely operate on a razor/razor blade model, whereby revenue is generated through sales of the actual robotic system, as well as the subsequent attachments and consumables for each procedure performed (like implants), as well as services such as training and maintenance. The companies who stand out as leaders in this space are the ones who not only sell the robot system but also offer a strong-enough value proposition to drive utilization of the system over time. Companies who fail to prove their value may see their robot sitting in an OR collecting dust and won't achieve the meaningful tail of consumables revenue.

THE HISTORY OF ROBOTIC SURGERY

1985	2000	2004	2013	2015	2018	2021
First Robot used on human to perform a neuro-biopsy	FDA Approval for 1st Gen Da Vinci Surgical Robot	Natural Office Transluminal Endoscopic Surgery (NOTES) Introduced	Over 500k Surgeries with Da Vinci Robots	Stryker Receives 510k Clearance for Mako	Da Vinci Single Port Robot Receives FDA Clearance	Medtronic Hugo Receives CE Mark in Europe (Soft Tissue)

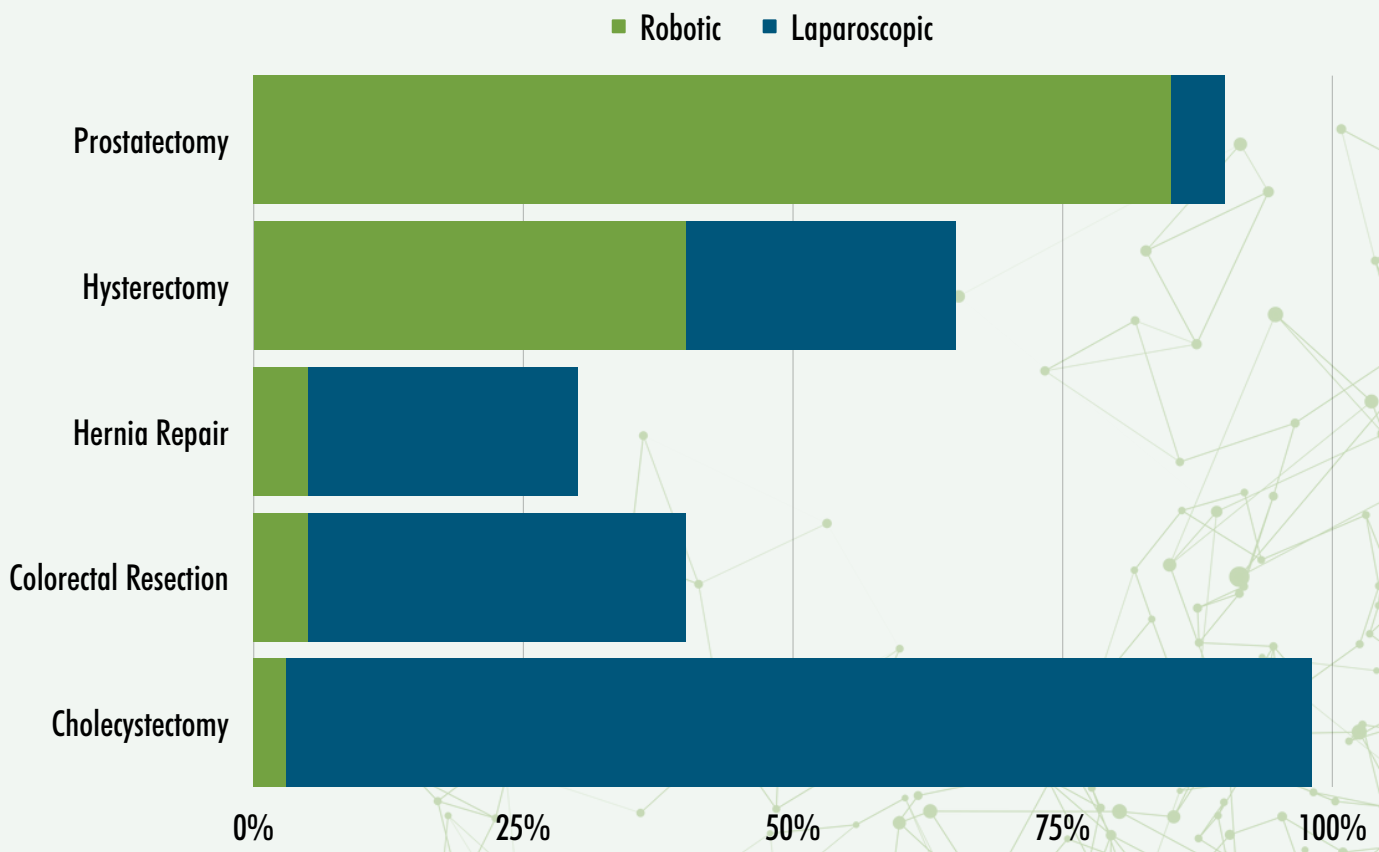


GENERAL SURGERY

Of the 310 million total surgeries[1] conducted annually, we believe that around 50 million are currently addressable by robots for soft tissue (general surgery, cardiovascular, and oncology as a few examples). Robotic surgery has gone from a novelty to being the status quo for several surgeries, especially in soft tissue covering hysterectomies, prostatectomies, colorectal, gastrointestinal.

For most indications, procedures continue to be non-robotic as shown in the chart below. The main barriers to further adoption are financial costs, extra operative time, and training. That said, we believe the benefits of robotics, such as faster recovery times, cleaner incisions, and better overall patient outcomes will further drive reimbursement, financial justification, and overall adoption rates.

Robotics Procedure Penetration, U.S. 2016

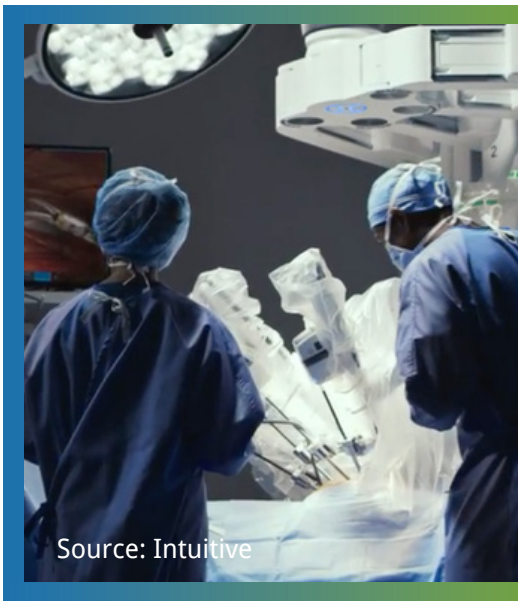


Source: Decision Resources Group

The lion's share of the market is currently held by Intuitive Surgical, with an estimated 90% share of the soft tissue market. Since its initial launch in 2000, the company is now on its fourth generation robot, Da Vinci Xi, with two additional core products, the SP (Single Port) and the Ion (minimally invasive lung biopsy). The company has over 6,700 instruments placed globally, with which 1.5 million procedures were conducted and $5.7 billion in revenue was generated in 2021.

Intuitive has a rich R&D pipeline, and is currently working on getting FDA approval for more indications, including colorectal and thoracic procedures. Once approved, the company expects the new indications to expand its addressable market to $20 billion.

Intuitive Surgical's market position has provided them with a strong moat. Its customer base is sticky, and many existing customers continue to buy more systems. In Q4 2021, the number of hospitals that owned at least seven Intuitive systems in one building grew by 50%. The company continues to work with the world's leading surgeons to conduct more studies, develop more proof sources, and further penetrate the general surgery market.


Source: Intuitive

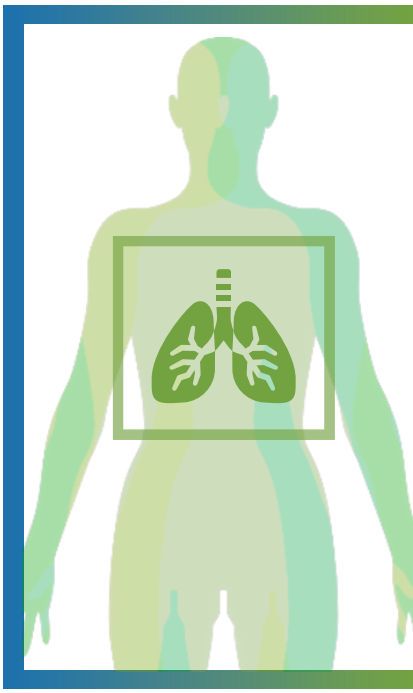
While we have high conviction that Intuitive will maintain its market leadership for the long term, the vast market opportunity makes the industry attractive for new entrants, and there is plenty of room for other companies to compete.


Source: Intuitive

Fresh off a SPAC merger, ROBO index member Vicarious Surgical is aiming to design, produce, and launch the world's smallest form-factor single-port robot with an incision the size of a dime. This technology seeks to reduce bleeding and post-operation scarring, while offering faster recovery time, lower costs, and easier controls.

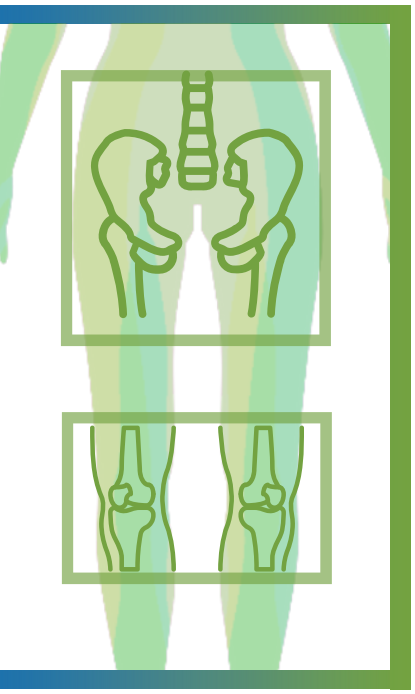
With more than 15% of men over age 40 with benign prostate hyperplasia (BPH), and over 150k transurethral resection of the prostate (TURP) procedures annually in the United States to address this condition, Procept Biorobotics is offering a new RAS approach to this market. Aquablation uses water pulse jets to reduce prostate size while significantly lowering the risk of side effects.

BRONCHOSCOPY



Moving up the anatomy to bronchoscopy, Intuitive Surgical further demonstrates its technology leadership as it revolutionizes lung cancer diagnosis. Today, lung cancer has a five-year survival rate of 18%. In comparison, for prostate cancer, the five-year survival rate is 98%. Early and definitive diagnosis can help close this gap and improve the survival rate for lung cancer, but therein lies the challenge. It is very difficult to biopsy tissue from a lung and obtain the correct sample tissue for an accurate cancer diagnosis. Intuitive's new bronchoscopy platform Ion uses computer vision, shape-sensing, and ultra-thin maneuverable catheters to enable navigation into the hardest-to-reach places of the lung.

The company is currently conducting a large multi-center study, and early evidence shows that using Ion for biopsy results in an 83% likelihood of providing clinicians with enough information to establish a diagnosis. This is game-changing for lung cancer, and the company plans to release final results of this study in 2022.



ORTHOPEDIC SURGERY

With more than a million hip and knee replacements done annually in the United States alone, as well as over 1.6 million spinal surgeries[2], the orthopedics and spine markets represent a $36 billion market opportunity[3]. This number is expected to double over the next decade, driven by growing global geriatric population, increasing willingness for robotic procedures, and new implant technology, such as stem-cell cartilage implants to support millions with arthritis or injuries to the knee and hand.

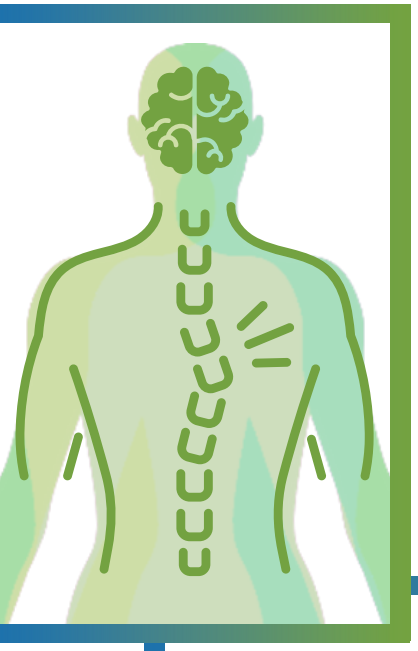
Unlike general surgery, RAS in orthopedics has been slower in uptake due to the complexities associated with operating on bones and inserting implants, like vibration. It also takes longer to complete robotic procedures vs. manual methods because of the few minutes required at the beginning of the procedure to train the robot on the size and dimension of the bone. That said, once this information is registered with the robot, the procedure can be done with greater precision, leading to better overall outcomes and lower hospital costs. A recent study published by the American Journal of Managed Care (AJMC) shows a $4K reduction[4] in per-patient costs when using robotic systems. Additionally, 90-day hospital readmissions were cut in half among patients for whom robotics were used.

HTEC member Stryker has made significant strides with its surgical robot, Mako, which it acquired in 2013. The strong surgeon preference for Mako over other orthopedic robotic platforms stems from Mako's ease of use. Essentially, the robot reduces the chance of making mistakes. The image-based platform is very precise, but its main limitation is that, compared with a non-robotic procedure, it takes longer to do a surgery using this platform. That said, it's still the market-leading option. The company now has more than 1,500 Mako installations around the world, which have been used to conduct 300,000 procedures. The company is also seeing strong momentum in Europe and Asia, and since Mako has only recently been approved in China, Brazil, and Turkey, enormous market opportunity remains.

HTEC member Smith & Nephew offers a handheld robotic assist device called CORI, as well as a suite of personalized implants that improve outcomes. Unlike Mako, Cori is an image-less system, which has its own benefits, like lower cost, and it eliminates the need to use radiation.

We're also watching up-and-coming companies in this space, like Monogram Orthopedics, a new startup seeking to disrupt orthopedic surgery by making it more efficient. With Monogram, the surgeon can do advanced imaging and can custom-prepare the bone unique to the patient, and use 3D printing to allow the surgeon to make custom implants. The goal will be a less-invasive, better-fitting, and longer-lasting outcome for the patient. It also aims to reduce vibration seen with even the most elegant current robotics systems like Mako.

NEUROSURGERY AND SPINE REQUIRE A DIFFERENT SET OF TOOLS



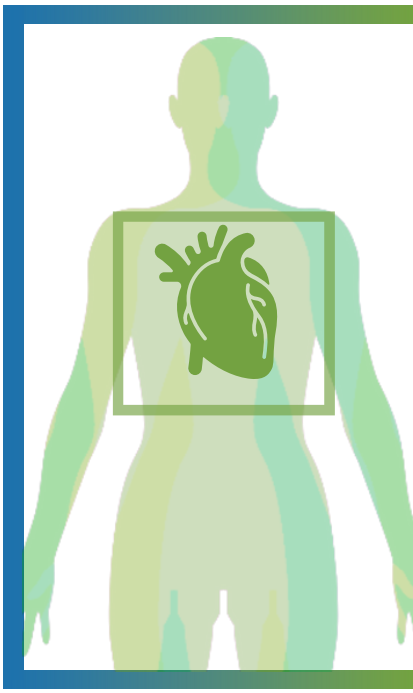
Neurosurgery requires extremely precise planning and movements. Globus Medical offers best-in-class, minimally invasive spine (MIS) solutions. Its ExcelsiusGPS robotic navigation platform has been clinically proven to improve screw placement accuracy and reduce radiation exposure compared with conventional fluoroscopic techniques. It has also significantly reduced the time it takes to insert a screw to 3.6 minutes per screw (v.s 7.7 minutes with the conventional MIS method). The company continues to innovate and has recently advanced the ExcelsiusGPS rigid robotic arm beyond screw placement to include retractor and port system trajectory alignment. The upgrade eliminates the need for a table-mounted system, and it maximizes retractor or port stability.

Source: Globus Medical

South Korea–based Koh Young, which specializes in 3D optical inspection for the semiconductor industry, launched the KYMERO Neurosurgery Robot to improve precision of biopsies and tumor removal. KYMERO is the world's first commercially approved brain surgery robot that can be attached to the operating table.

Source: Koh Young

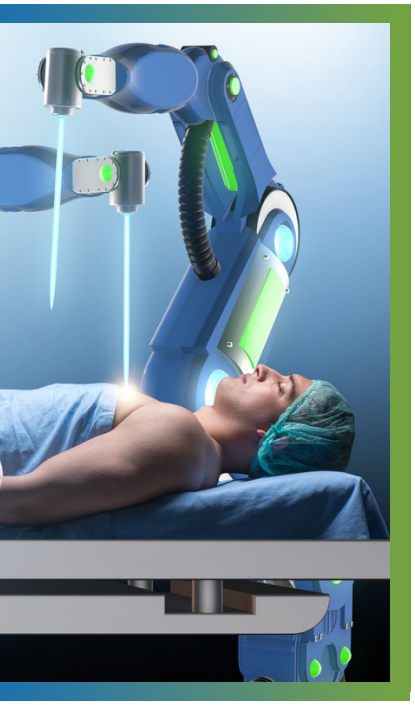
VASCULAR



Corindus, acquired by HTEC member Siemens Healthineers in 2019, offers CorPath, a robotic-assisted system for percutaneous coronary intervention (PCI), which is a minimally invasive procedure that opens clogged coronary arteries. CorPath has had success in over 10,000 cases worldwide and has even been used in a handful of remote RAS procedures in India. The implications of this advancement are literally far and wide because, over time and increasing 5G adoption, people in logistically challenged areas may gain access to procedures from surgeons in urban settings that they may not have previously been able to access.

CorPath is now on its second-generation robot, CorPath GRX. The GRX offers increased control of a guide catheter and guidewire, and it positions stents exactly where you need them with 1 mm movements. This system has demonstrated 98% clinical success in complex cases and a 20% reduction in radiation administered to patients compared with procedures done with manual PCI. The platform has also reduced radiation exposure to physicians by over 95%.

LET'S NOT FORGET THE PICKS AND SHOVELS



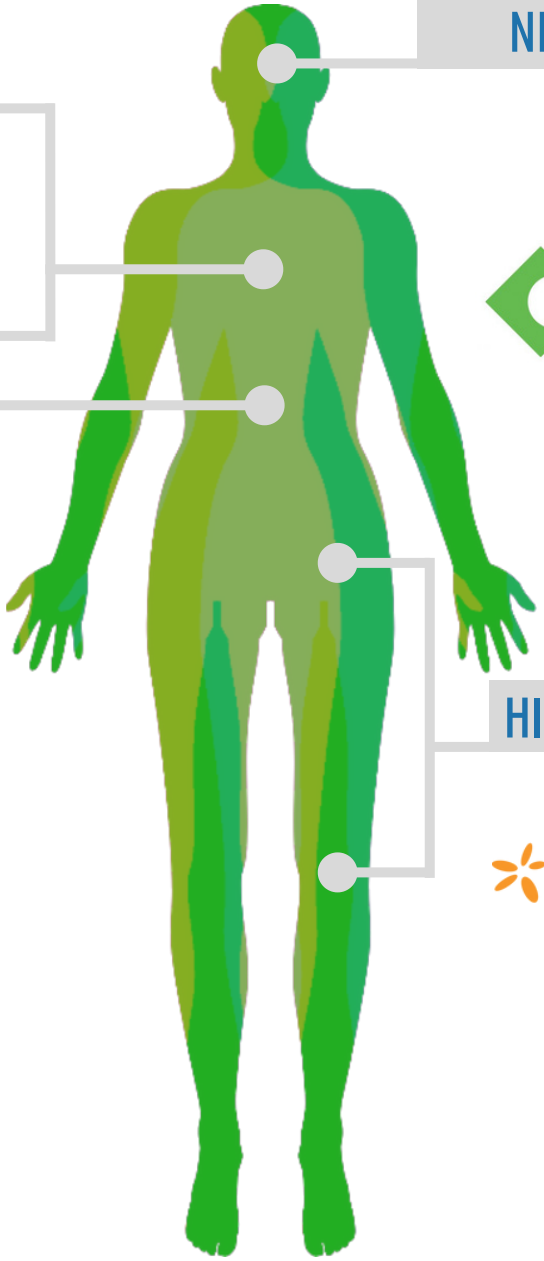
Novanta is the leading technology supplier for industrial and medical robotic surgery applications, and more than half of its revenue is derived from healthcare companies, including some of the most well-known medtech names. The company promises extreme accuracy and reliability in small form factors, such as position encoders, so surgeons can know where they are during the procedure; motion control drives, so surgeons can know where they're going; precision motors, enabling surgeons to move accurately; and force and torque sensors, to provide surgeons with a sense of touch. It is critical for all of these functions to operate in unison, and Novanta is the only supplier that offers all of these capabilities.

Incidentally, as of the beginning of 2022, Novanta currently stands with the highest bookings and backlog in the company's history. Given the strength in market positions among its client base, we believe this is a leading indicator of end-market demand, which bodes well for this industry in the long run.

The Anatomy of Surgical Robotics

ROBO Global provides exposure to this theme across two of its portfolios, ROBO and HTEC. Below is a summary of companies within the portfolios and where they fit in the industry, anatomically speaking.

ROBO Index Companies in the Robot Surgical Space:



LUNGS

INTUITIVE SURGICAL®

HEART

SIEMENS Healthineers

Corindus Vascular Robotics

Boston Scientific

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VICARIOUS SURGICAL

NEURO & SPINE

GLOBUS MEDICAL

KOH YOUNG TECHNOLOGY

HIP & KNEE JOINTS

stryker

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