Project Orion
Independent Industry Report of Surgical Robots

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Frost & Sullivan
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Overview and Classification of Medical Robots (1/3)

- Medical robots are robots that are utilized in medical settings such as hospitals, clinics, and rehabilitation facilities to provide medical therapy or aid with medical care. It can help doctors diagnose and treat patients more effectively, thanks to improved clinical adaption and interactivity. Medical robots are high-end medical equipment with high technical hurdles, entrance thresholds, and added value, among other characteristics.

Classification of medical robots

- Surgical robots, rehabilitation robots, services robots, and auxiliary robots are the four categories according to the International Federation of Robots Classification.
- Characteristics of different medical robots
  Surgical robot: By using minimally invasive approaches, implementing complex surgical procedures, physicians can remote precise minimally invasive procedure.
  Rehabilitation robot: Assisting the human to complete limb movements for use in neuromotor rehabilitation training.
  Auxiliary robots: Medical equipments that can assist in the medical process and improve the quality of medical care.
  Services Robot: It can reduce the repetitive labor and improve the work efficiency of medical personnel

Surgical Robots

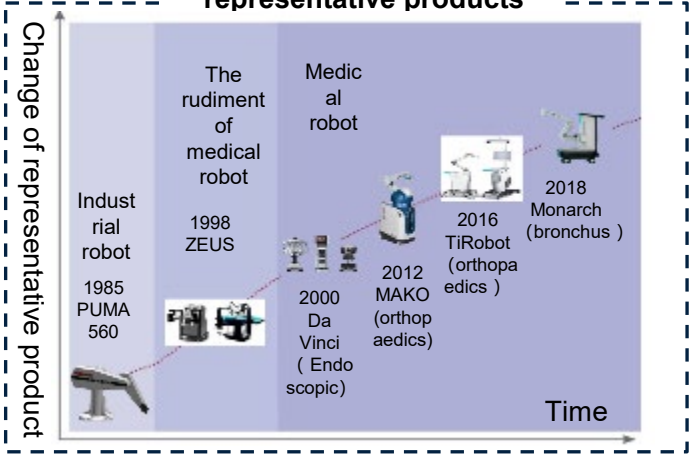
- Surgical robots are a subcategory of medical robots. A surgical robot refers to a smart service robot that assists the surgeon with performing minimally invasive surgery by enabling the surgeon to remotely control precise micro-movements of surgical instruments that are placed inside the patient's body through small incisions.
- Surgical Robots is a novel and interdisciplinary area that encompasses medicine, biomechanics, mechanology, machinery mechanics, hylology, computer graphics, computer vision, mathematical analysis, and robotics.

Surgical robot	Rehabilitation robot	Auxiliary robot	Services robot
			
Surgical robots, radiotherapy robots, endoscope robots, etc	Hang rehabilitation robots, nursing robots, etc	Capsule robot, dispensing robot, diagnostic robot, etc	Medical logistics robots, patients transfer, etc

Surgical robot specific advantages

- Resolving hand flutter by physician
- Providing a three-dimensional view of refined reading
- Overcoming human joint limitations and improving flexibility
- Reducing the number of shots when using X-ray positioning and fatigue of the procedure
- Automation, high accuracy may reduce personal technical reliance on physicians
- Scaling down the number of surgical doctors and nurses, and time of patient in hospital
- ...

Change of surgical robot representative products



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Source: Frost & Sullivan Analysis

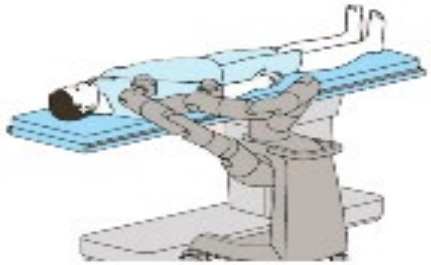
Overview and Classification of Surgical Robots (2/3)

- Surgical robots may overcome human physiological constraints and are employed as minimally invasive treatments with high precision requirements with their great operational accuracy, repeatability, and operational stability, resulting in considerable clinical advantages for patients. Surgical robots, in contrast to traditional surgery, provide ultra-high definition visual systems in narrow and confined surgical spaces via high-resolution 3D stereopsis and device freedom, possess positional navigation, flexible movement, and precision operation capabilities, and can expand panvascular interventional indications and improve surgical outcomes.
- Surgical robots are divided into endoscopic surgical robots, natural orifice surgical robots and other robots such as orthopedic robots, panvascular surgical robots, percutaneous surgical robots, etc.

Endoscopic Surgical Robots

- **Functional characteristics**： The procedure is performed by doctors assisted by a computer console, a robotic arm systems, and a high-definition camera systems. It has excellent potential prospects for use in urology, gynaecology, general surgery, etc.
- **Representative products home and abroad**: Intuitive Surgical(Da Vinci surgical robot), MedBot (Toumai operation robot), and Kangduo (minimally invasive Surgery robot)

Natural Orifice Surgical Robots



- **Functional characteristics**： Easy and convenient techniques for applying robotic Systems to Single hole hands as well as surgical access, and techniques for narrow spaces, Natural Orifice Surgery .
- **Representative products home and abroad**： Intuitive Surgical（Bronchoscopic robot）、 Johnson & Johnson （Bronchoscopic robot）

Source: NBS, Frost & Sullivan analysis

Overview and Classification of Surgical Robots (3/3)

No Robot assisted Surgery

Advantages:

- Low cost
- **Experienced physicians in complex case**

Limitations:

- Long time waiting for patients
- **Workload**
- **Insufficient accuracy**
- **Radiation during operation**
- **Larger wound, harmful for rehabilitation**

Robot assisted Surgery

Advantages:

- **Precious and clear image**
- **Flexible position and location**
- **Sufficient accuracy**
- **Small wound**
- **Long-term cost-effectiveness**

Limitations:

- Short-term elative higher cost
- **Conflict for experienced physicians**

Direction 1
Physician finish main body of operation with robot assisted

Direction 2
Robot finish main body of operation, physicians provide guidance

The key supportive technology

Accurate position:

- Remote operation by physicians could be implemented through effective image delivery and targeting function, so that the physicians could obtain the information of the patients in real-time.

3-D Image:

- 3-D image technology enables the physicians to implement the Surgery with no space and position confine. Additionally, the Percutaneous operation with 3-D image cause smaller wound.

The key supportive technology

Robotic Arm:
Percutaneous Surgery imposes requirement in terms of accurate operating, especially the physicians without perfect physical or emotional condition. The multi-dimension robotic arm with 5-7 degree of freedom assist in the sufficient accurate operation.

AI Algorithm:
Base on the 3-D Image technology, computer vision (CV) algorithm should be focused to analyze the information and provide instant feedback to the Robotic arm.

Source: Literature research, Frost & Sullivan Analysis

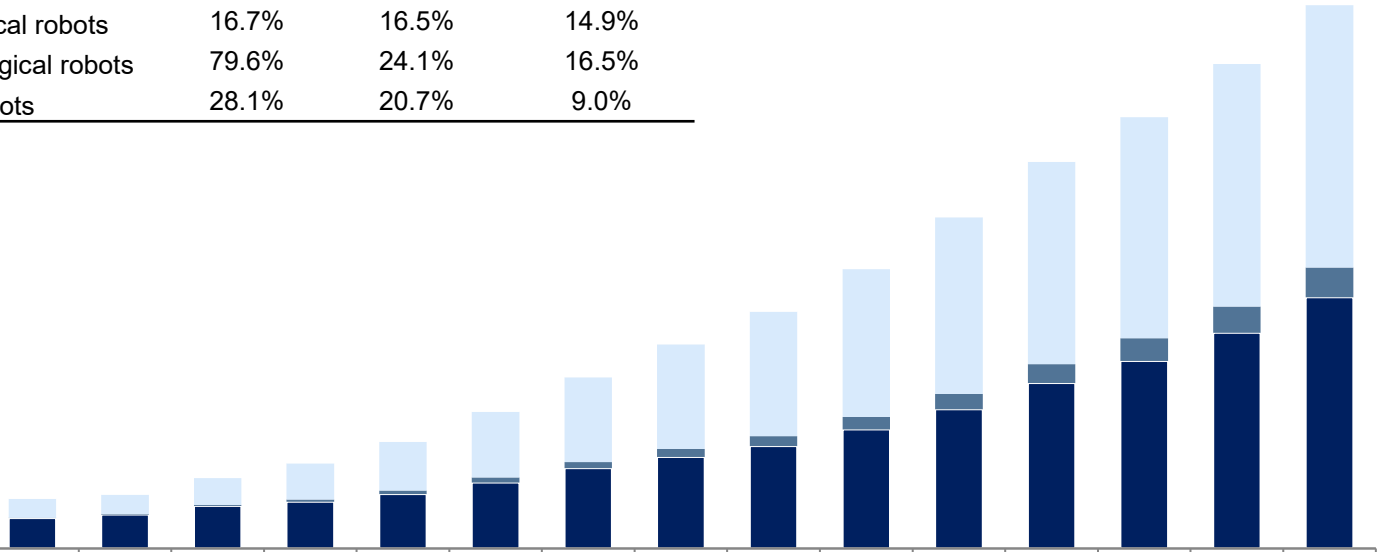
Historical and Forecast Global Market Size of Surgical Robots, 2019-2033E

- Driven by the increasing demand for accurate treatment and breakthrough in key technologies, the global market size of surgical robot has grown rapidly. From 2019-2024, the overall global market size of surgical robots increased from USD 7,709.1 million to USD 21,167.2 million, with a CAGR of 22.4%. By the year 2033E, the global surgical robots market will remain at a relatively high rate and is expected to reach USD 84,187.8 million, indicating a promising market potential.

Historical and Forecast Global Market Size of Surgical Robots, 2019-2033E

CAGR	2019-2024	2024-2030E	2030E-2033E
Overall market size of surgical robots	22.4%	18.9%	12.0%
Market size of endoscopic surgical robots	16.7%	16.5%	14.9%
Market size of natural orifice surgical robots	79.6%	24.1%	16.5%
Market size of other surgical robots	28.1%	20.7%	9.0%

Unit: Million USD
By ex-factory price



	2019	2020	2021	2022	2023	2024	2025E	2026E	2027E	2028E	2029E	2030E	2031E	2032E	2033E
Overall market size	7709.1	8322.4	10910.0	13181.1	16507.4	21167.2	26501.7	31642.8	36672.5	43281.6	51321.2	59900.0	66845.2	75047.9	84187.8
Market Size of Other Surgical Robot	2,943.0	2,991.0	4,145.4	5,600.8	7,529.4	10,144.9	13,114.8	16,236.2	19,277.1	22,907.5	27,363.2	31,351.4	34,285.7	37,575.8	40,645.2
Market size of natural orifice surgical robots	42.9	76.6	191.8	331.9	528.9	801.9	937.1	1215.9	1552.4	1951.8	2412.7	2933.1	3484.8	4043.5	4641.9
Market size of endoscopic surgical robots	4723.2	5254.8	6572.8	7248.4	8449.0	10220.4	12449.8	14190.7	15843.0	18422.3	21545.3	25615.6	29074.7	33428.6	38900.8

Source: Frost & Sullivan Analysis

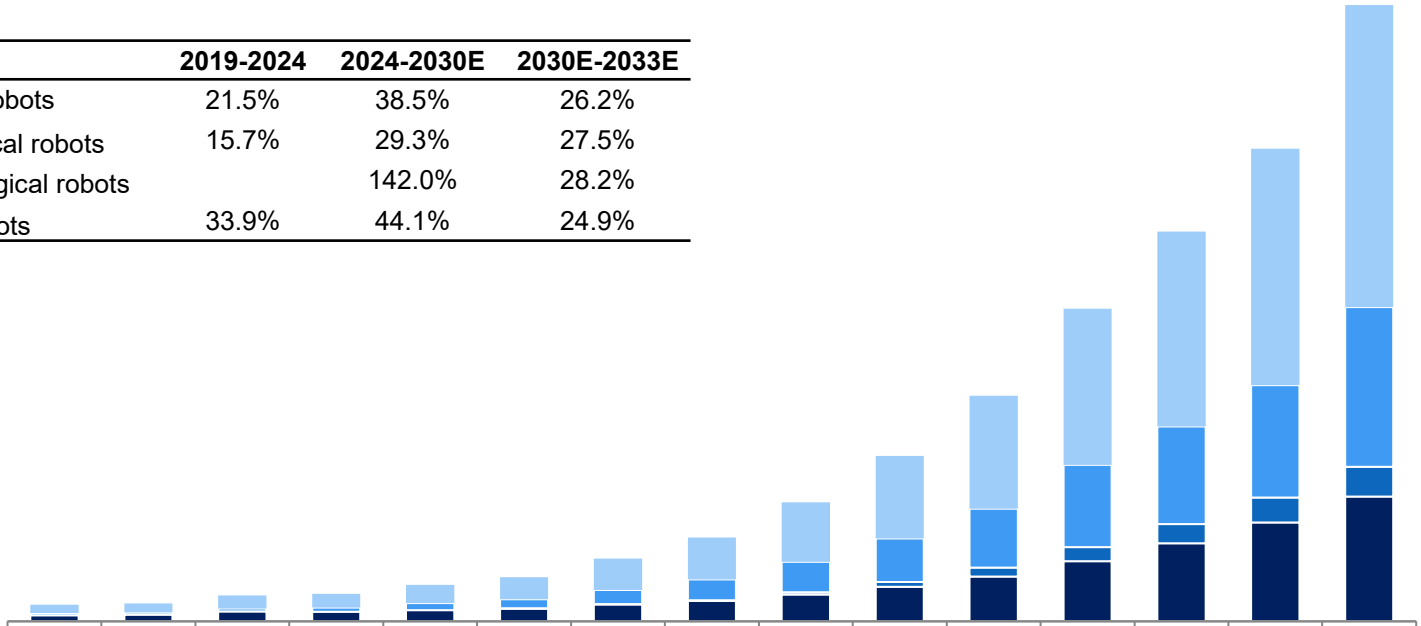
Historical and Forecast Market Size of Surgical Robots in China, 2019-2033E

- Driven by the aging population, the government's strong support for the medical field, and the upcoming domestic replacement in the future, the size of the surgical robot market in China has grown rapidly. By the year 2033E, the Chinese surgical robot market will remain at a relatively high growth rate and is expected to reach RMB 102,018.7 million.

Historical and Forecast Market Size of Surgical Robots in China, 2019-2033E

CAGR	2019-2024	2024-2030E	2030E-2033E
Overall market size of surgical robots	21.5%	38.5%	26.2%
Market size of endoscopic surgical robots	15.7%	29.3%	27.5%
Market size of natural orifice surgical robots		142.0%	28.2%
Market size of other surgical robots	33.9%	44.1%	24.9%

Unit: Million RMB
By ex-factory price

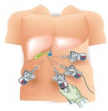
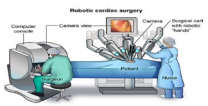


	2019	2020	2021	2022	2023	2024	2025E	2026E	2027E	2028E	2029E	2030E	2031E	2032E	2033E
Overall market size	2714.9	2934.5	4192.5	4473.4	5931.7	7184.2	10185.3	13594.4	19311.8	26866.4	36595.7	50750.3	63260.4	76688.5	102018.7
Market size of other surgical robots	692.3	716.5	951.2	1355.7	2268.8	2976.0	4594.2	6718.0	9850.7	14039.9	19122.6	26643.4	31631.6	36534.9	51876.5
Market size of natural orifice surgical robots						22.7	49.2	183.8	776.3	1654.0	2920.3	4555.2	6289.8	8028.0	9599.4
Market size of endoscopic surgical robots	2022.6	2218.0	3241.3	3117.7	3662.9	4185.5	5541.9	6692.7	8684.8	11172.6	14552.8	19551.7	25339.1	32125.5	40542.9

Note: 1.The CAGR for Market size of natural orifice surgical robots is from 2024 to 2033

Source: Frost & Sullivan Analysis

Comparison among Open Surgery, Conventional MIS and Robot-assisted Surgery

		Open Surgery	Conventional MIS	Robot-assisted Surgery
Surgery	Schematic Diagram			
Technology Features	Operating Flexibility	• High flexibility in hand manipulation	• Simple instruments with limited flexibility	• Robotic instruments can turn wrist, high flexibility
	Operating Accuracy	• Unable to eliminate surgeons' hand tremors • Strongly dependent on surgeons' skills	• Operation by a lever with low precision • Unable to eliminate physician hand tremors	• Eliminates hand tremors through algorithms • Proportionally controlled with higher precision
	Observation Mode	• Naked eye	• 2D images	• 3D images • 4K resolution
	Available Surgeries	• Coverage of a wide range of surgeries • Capable to perform complex surgeries	• Challenging to perform complex surgeries	• Capable to perform complex surgeries
Patient Value	Surgical Trauma	• Large incisions with large trauma	• Several smaller incisions with less trauma	• Several small incisions or only one small incision with minimal trauma
	Intraoperative Safety	• Excessive amount of blood loss • Long operation time • More intraoperative complications	• Large amount of blood loss • Long operation time Difficult to complete precise and complex operations	• Less amount of blood loss • Short operation time • Capable to perform precise and complex surgeries with high safety
	Postoperative Recovery	• More postoperative complications • Obvious postoperative pain and scarring	• More postoperative complications • Less postoperative pain	• Faster recovery, least trauma and postoperative pain • Less postoperative complications
Surgeon Value	Learning Curve	• Largest operation area and easiest to operate • Short learning curve	• High demand on surgeon skills • Long learning curve	• Short learning curve • Faster for surgeons to learn complex surgical operations
	Workload	• Long operation time Easy to fatigue	• High demand for surgeon skills and physical strength • Easy to cause fatigue	• Ergonomically beneficial design • Less fatigue caused in a sitting position
	Career	• Highly dependent on surgeon's physical strength and surgical skills	• Highly dependent on surgeon physical strength and surgical skills	• Reducing the demand on physical strength and surgical skill and extending surgeons' careers
Hospital & Social Value	Efficiency	• Easily accessed and widely available in primary, secondary and tertiary hospitals.	• Reduce patient hospitalization time and increase bed turnover rate	• Increase quality of care for patients • Further Reducing patient hospitalization time and increasing bed turnover rate • Improve the efficiency of healthcare service use • Alleviate the uneven distribution of medical resources and address medical staff shortage

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Global Competitive Landscape of Endoscopic Surgical Robots

- As of latest practicable date, only Intuitive Surgical have both multiport and single-port endoscopic surgical robots have undergone pivotal clinical trials and approved by regulatory authorities in the world. Based on public information, Edge Medical is the first company in China that has completed the pivotal clinical trials of both multi-port and single-port endoscopic surgical robots.

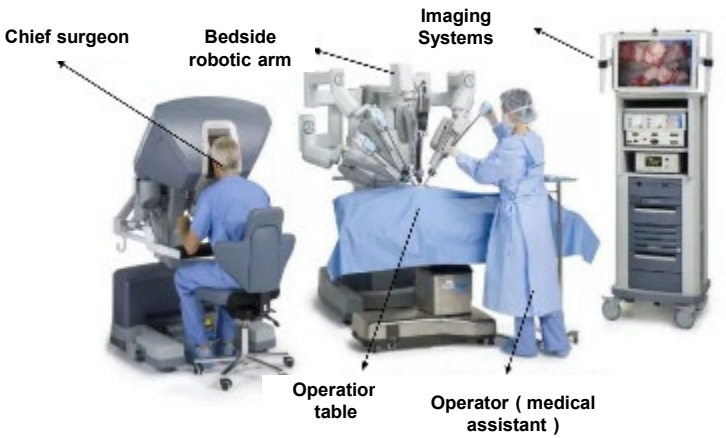
Manufacturer		
	Intuitive Surgical	**Edge Medical**
Multi-port Endoscopic Product	da Vinci Xi, da Vinci 5	MP1000, MP2000/Power/Apex
Approved Regions	CE (1999), FDA (2000), NMPA (2006), Japan(2009), etc.	NMPA (2022)
Single-port Endoscopic Product	da Vinci SP	SP1000
Approved Regions	FDA(2014), CE(2024), South Korea (2018)	NMPA (2023)

Source: Company official website, NMPA website, Frost & Sullivan Analysis

Definition and Overview of Endoscopic Surgical Robots

Introduction of Endoscopic surgical Robots

- At present Endoscopic surgical Robots have been widely used in clinical practice, mainly to complete urology Surgery , general Surgery (gastroenterohepatobiliary), cardiothoracic Surgery , gynecology Surgery and other related minimally invasive procedures.
- Robot assisted Endoscopic Surgery overcomes most of the limitations of conventional Endoscopic procedures and has many advantages, such as high operation accuracy, flexibility, reproducibility, and unaffected by human physiological factors such as fatigue and mood, which are of great importance to solve the problems faced by traditional minimally invasive Surgery , improve the quality of Surgery , and shorten the operation time, and effectively expand the surgical capability of physicians power.
- The deviation in robot-assisted surgeries could be controlled within 1 degree, while 3 degree deviation could only be obtained by experienced physicians as a ceiling for human capability (3-7 degree deviation)



Construction of Endoscopic surgical Robots

 **Computer console**	Control center for the operating surgeon
 **Robotic arm**	Arm mechanical shifting fixation point: having 3-4 arms that follow the surgeon's actions, Instead of surgical assistance work, greatly reducing human costs
 **Robotic instrument**	Interactive robotic arm: can accomplish a task with a specific precision much higher than human, such as ratcheting up, cutting, clotting, dissecting, suturing, and manipulating tissues.
 **Imaging Systems**	Equipped with 3D endoscopes and high-definition 3D analog image processing technology to provide anatomically realistic images of patients, allowing surgeons a wide and realistic view during Surgery

Source: Frost & Sullivan analysis

Development of Endoscopic Surgical Robots (take Da Vinci as benchmark)

- The Da Vinci robot of Intuitive Surgical was the first Endoscopic surgical Robots in history. Taking the Da Vinci robot as an example, Intuitive Surgical has focused its efforts on issues of reliability and the expansion of production and sales teams in the 4 years since the first robot was sold. The product has also been improving after the first robot was sold.
- The prototype instrument designed by the SRI in 1995 has 4 device degrees of freedom (with end on closures), uses a Single main operant hand to visually control the movement of the device ends, and the mechanical comparison between the main hand and the from hand is similar, thus simplifying the calculation of the main and from control. Later, another 3 generations of prototype machine were developed in 3 years based on this generation of prototype, and finally the Da Vinci Systems was developed and marketed.
- Around 2018, Da Vinci like surgical robotic products gradually appeared on the market, which operated in a similar manner to Da Vinci, but made improvements and updates in specific surgical assistance concepts and functions. CMR Surgical and TransEnterix are two representative companies.

INTUITIVE SURGICAL®

1996 da Vinci

Da Vinci first generation Systems

- The first generation Systems robotic arm belongs to the **engineering arm, which is bulky with exteriorized lines, and the operating table is bulky.**
- In 2000, Da Vinci surgical robots were officially approved by FDA to be put into Services and become the first surgical robot available worldwide that can be used in abdominal Surgery .

2006 Da Vinci S

Da Vinci second generation Systems

- The second-generation robotic arm **is significantly reduced to become an embracing arm and can be used in cardiothoracic Surgery .**
- The fourth arm was also better fused to the design. The operating table is also redesigned to be more lightweight and flexible. The distributed power supply and control Systems design greatly reduces the length of the wireforms 720p was essentially achieved by the visual Systems and was adapted to the Endoscopic Systems.

2009 Da Vinci Si

Da Vinci third generation Systems

- On the basis of the previous generation in 2009, the third generation of surgical robots have **added double consoles and reduced consoles to facilitate urological operations.**
- Additional functions: Da Vinci operation simulator, intraoperative fluorescence imaging technology, Single-hole operation equipment, BK cavity-specific ultrasonic assistant technology, etc., further introduced the third generation of Da Vinci Si Systems.
- A Single-hole technique has been added to allow all procedures to be performed by making a keyhole-like hole in the patient.

2014 Da Vinci X/Xi/SP

Da Vinci fourth generation Systems

- Introduced in 2014, the fourth-generation Da Vinci Xi Systems has been **upgraded from the embracing arm to the suspension arm**, making the operating robot suitable for more complex surgical procedures. In addition to this, the fourth-generation operating robot has developed **a remote observation and guidance Systems.**
- At present, it is widely used in general Surgery , urology, cardiovascular Surgery , thoracic Surgery , gynecology, facial and pediatric Surgery , etc.
- Beginning in 2018, as the first patents for Da Vinci surgical robots expired, many types of Da Vinci surgical robots were also developing products similar to Da Vinci, such as Versius in CMR Surgical and Snenhancer in TransEnterix.

Source: Research report, Frost & Sullivan Analysis

Major Competitive Landscape of Global Multiport Endoscopic Surgical Robots Market (1/3)

- Due to the cost and holding of patents, the number of surgical robotic Systems on the market is limited and slow to develop. The number of new surgical robotic Systems is increasing as the patent's expiration is nearing. Several Systems have been CE certified and are also available in the EU. The marketing of new products will intensify the competition of robots, and the overall cost price of surgical robots will further decrease. Robot assisted Surgery will be more common than manual Panvascular interventional Surgery in the near future.

Manufacturer	Intuitive Surgical			
product	Da Vinci Si Systems	Da Vinci Xi Systems (IS4000)	Da Vinci X Systems	Da Vinci 5 Systems (IS5000)
First approval time	2009 (FDA) 2009 (CE))	2014 (FDA) 2014 (CE)	2017 (FDA) 2017 (CE)	2024 (FDA)
Approved Indications in US	Mainly used for maintenance and upgrades, some countries have stopped selling new systems	• Urologic surgical • General thoracoscopic surgical • General and Gynecologic laparoscopic surgical		• Urologic surgical • General thoracoscopic surgical • General and Gynecologic laparoscopic surgical
Numbers of Robotic Arms	4	4	4	4
Degrees of freedom of Single robotic arm	12	12	12	12
Key features	4 robotic arms, 12 degrees of free EndoWrist surgical Systems Shock preventable	intraoperative fluorescence visualization, Single hole surgical equipment, endoluminal specific ultrasound assistance	Most of the features are the same as Da Vinci Si, but it is not suitable for multi-quadrant surgery and does not have integrated table motion	Da Vinci 5 is a modification to Da Vinci Xi with the same core features, with an additional set of force feedback instruments designed specifically
Ex-factory Price / USD	0.5million-2.5 million			
Cumulative installed base in 2024	9,629			
New Installed base in 2024	1,430			
Revenue in 2024/ USD	858.8million			

Source: Literature research, Company Website, Frost & Sullivan Analysis

Major Competitive Landscape of Global Multiport Endoscopic Surgical Robots Market (2/3)

- Due to the cost and holding of patents, the number of surgical robotic Systems on the market is limited and slow to develop. The number of new surgical robotic Systems is increasing as the patent's expiration is nearing. Several Systems have been CE certified and are also available in the EU. The marketing of new products will intensify the competition of robots, and the overall cost price of surgical robots will further decrease. Robot assisted Surgery will be more common than manual Panvascular interventional Surgery in the near future.

Manufacturer	Medtronic	Asensus	CMR Surgical
product	Hugo	Senhance	Versius surgical robot
First approval time	2021 (CE) 2022（Ministry of Health, Labour and Welfare of Japan） 2022（Health Canada）	2012（CE） 2017（FDA） 2019（Ministry of Health, Japan PMDA） 2020（Russian Federation）	2019（CE） 2024（FDA）
Approved Indications in US	X	• General and gynecological laparoscopy surgery • Urologic and Pediatric Urology	Cholecystectomy
Numbers of Robotic Arms	4	3/4 (Adaptive mode)	5
Degrees of freedom of Single robotic arm	7	7	7
Key features	Modular design empowers surgeons to choose the surgical approach for each patient Turns the surgeon console into a 3D HD simulated environment, enabling surgeons to learn and practice Wristed instruments provides versatility and quality	• Open remote control station • Ocular tracking software • Free standing cart • High precision tactile feedback Systems • Shock preventable	• Stand operation console • Free standing and small size • Tactile feedback Systems
Ex-factory Price / USD	ND[3]	~ 0.82 million [7]	~ 1.30 million [8]
Cumulative installed base in 2024	70+	-	186
New Installed base in 2024	NA	-	23
Revenue in 2024/ USD	NA	-	38.2 million

Note:
3. ND=Not Publicly Disclosed
7. The ex-factory price is calculated as the sum of product and service revenue divided by the number of robots placed in 2023

Source: Literature research, Company Website, Frost & Sullivan Analysis

Major Competitive Landscape of Global Multiport Endoscopic Surgical Robots Market (3/3)

- Due to the cost and holding of patents, the number of surgical robotic Systems on the market is limited and slow to develop. The number of new surgical robotic Systems is increasing as the patent's expiration is nearing. Several Systems have been CE certified and are also available in the EU. The marketing of new products will intensify the competition of robots, and the overall cost price of surgical robots will further decrease. Robot assisted Surgery will be more common than manual Panvascular interventional Surgery in the near future.

manufacturer	Meere company	Avatera Medical	Medicaroid	Moon Surgical	SS Innovations	Riverfield
product	Revo-I Systems	Avatera Systems	Hinotori robot Systems	Maestro Systems	Mantra/Mantra 3	Saroa
First approval time	2017（Korean FDA）	2019（CE）	2020（Japanese sales allowance）	2024(FDA)	2022（CDSCO）	x
Approved Indications in US	x	x	x	Laparoscopic surgical	x	x
Numbers of Robotic Arms	4	4	4	2	3-5	3
Degrees of freedom of Single robotic arm	7	7	8	-	-	-
Key features	Tactile feedback Systems The reusable instrument section can be reused 20 times	Minimal noise The extremely small size QXGA resolution Tactile feedback Systems	Four arm surgical Systems Suspension surgical arm The first listed surgical robot in Japan	Stable retraction and camera fixing function Simple structure and small size	Professional design open console Ergonomic design advanced vision system	Real-time control and feedback of forces are possible
Trial Locations	South Korea	EU	Japan	EU, US	India，Philippines，Ukraine etc.	Japan
Ex-factory Price / USD	ND [3]	ND [3]	ND [3]	ND [3]	ND [3]	ND [3]
Cumulative installed base in 2024	NA	NA	NA	NA	64	NA
New Installed base in 2024	NA	NA	NA	NA	41	NA
Revenue in 2024/ USD	NA	NA	NA	NA	20.6million	NA

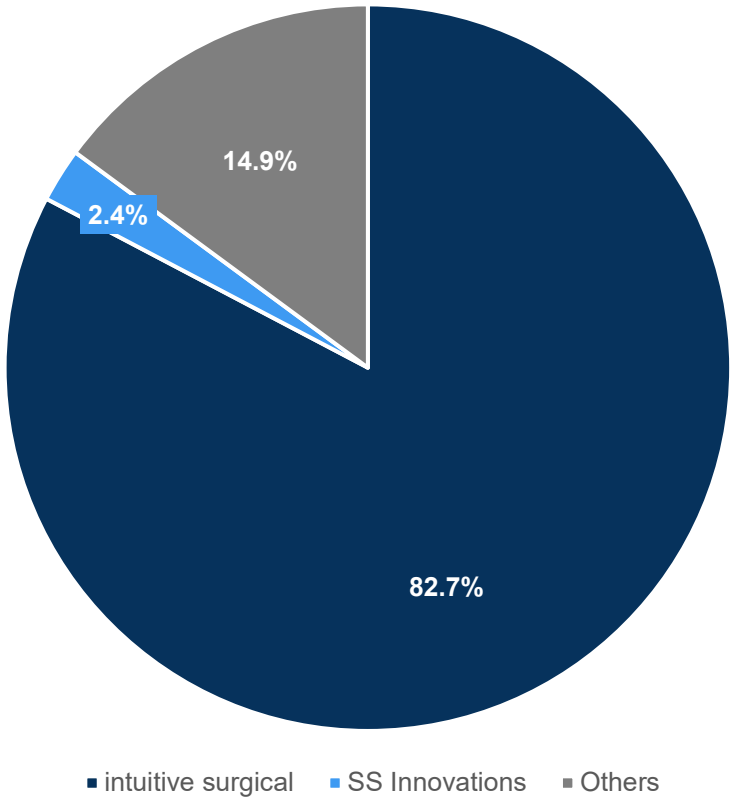
Note:
3. ND=Not publicly disclosed

Source: Literature research, Company Website, Frost & Sullivan Analysis

Analysis of Multi-port Endoscopic Surgical Robot Market in 2024

- In 2024, 1,726 multi-port Endoscopic Surgical Robots were newly placed globally. Intuitive Surgical placed 1,430 robots which contributed to the most majority of the market share, followed by SS Innovations (41 robots) and other brands.

Breakdown of Global Multi-port Endoscopic Surgical Robot Market by new placement, 2024



Major Competitive Landscape of Multiport Endoscopic Surgical Robots Market in China (1/4)

- Although the product-based R&D of Endoscopic surgical Robots started relatively late in China, there has been a rich accumulation of research on key technologies and core components. Among them, Edge Medical's multi-porous laparoscopic surgical robot is the only domestic brand that has gone through three generations. In August 2024, company released the new generation of multi-porous laparoscopic surgical robot MP2000, which has high performance and high stability. In terms of the Edge Cloud remote surgery system, Edge Medical performed the first remote human surgery in 2023, an intercontinental remote human surgery in 2024, and completed the world's first ultra-remote human surgery live broadcast. In 2024, in terms of revenue, Edge Medical rank the first among domestic manufacturers in the Chinese laparoscopic robot market.

Manufacturer	Intuitive Surgical		Edge Medical
Product	Da Vinci Si Systems	Da Vinci Xi Systems	Edge Medical Multi-Port Endoscopic Surgical Robotic System (MP1000, MP2000, MP2000 Power, MP2000 Apex)[6]
NMPA Approval Obtained	2011	2018 2023[16] 2024[17]	2022[7] 2023[18] 2024[19]
NMPA Approved Indications	Urologic, General, Gynecologic, Thoracic surgeries, Thorascopic assisted cardiotomy, Coronary anastomosis combined with mediastinotomy in cardiac revascularization		• December 2022: Urologic Surgery • August 2023: Gynecologic, General, and Thoracic Surgery
Green Path Obtained	/	/	√
Bidding Price / RMB	/	~ 22 million[5]	~15 million
Numbers of Robotic Arms[1]	4	4	4
Fluorescence imaging mode types	2	2	3
Degrees of Freedom of a single arm	12	12	12
Degrees of freedom of a single instrument connected to robot	7	7	7
Application in RALRP[2]	√	√	√
Application in T4 Cancer (the Late stage) in Urologic Surgery[3]	√	√	√
Application in radical hysterectomy with lymph node dissection[4]	√	√	√
Trial Locations	Global	Global	CN
Image transmission delay	<80ms	<80ms	40ms
High-resolution images	NA	NA	> 1,920×1,080 Pixel
Weight of Lightweight endoscope	NA	NA	338.5 g
Ex-factory price / RMB [9]	15~16 million		7~8 million

Note:
1:The surgical robots can process more complex surgeries with more arms
2:RALRP is the abbreviate of Robotic-Assisted Laparoscopic Radical Prostatectomy. RALRP is the gold standard for the surgical treatment of prostate cancer in developed countries, and is currently the most used robotic surgery worldwide.
3: According to National Cancer Institute, in the TNM system, T refers to the size and extent of the main/primary tumor. T4 is highest level representing the largest size of the main/primary tumor
4: Radical hysterectomy with lymph node dissection is a common procedure in robotic-assisted endoscopic gynecological surgery. Laparoscopic lymph node dissection is a difficult point in laparoscopic surgery, which requires a high degree of technical difficulty and precision.
5: According to Intuitive Surgical annual report and website, industry expert, interview and China Government Procurement (中国政府采购网), da Vinci Si system is no longer sold in China since 2019, the average price of da Vinci Xi system is about RMB 23 million
6: Edge Medical's MP1000 is a 4-arm endoscopic surgical robot, and the more surgical arms suggest a higher flexibility.
7. In December 2022, NMPA approved the use of MP-1000 for urologic surgery among adults
9. The ex-factory price was not publicly disclosed, please do not disclose in the prospectus
16. The domestic version of da Vinci Xi (IS4000CN) system has been approved in June 2023, whose registration certificate holder is Intuitive Fosun, a joint venture of Intuitive Surgical and Fosun.
17. Intuitive Medical updated its new registration certificate (2024) in May 2024, separating the host and the device for registration, and changing the product name to: "da Vinci Xi Surgical System" and Instruments for da Vinci Xi Surgical System
18. In August 2023, NMPA approved the use of MP1000 for Gynecologic, General, and Thoracic Surgery among adults
19. In July 2024, NMPA approved the use of MP2000, MP2000 Power, MP2000 Apex for among adults.

Source: Company Website, Expert Interview, Frost & Sullivan Analysis

Major Competitive Landscape of Multiport Endoscopic Surgical Robots Market in China (2/4)

- Although the product-based R&D of Endoscopic surgical Robots started relatively late in China, there has been a rich accumulation of research on key technologies and core components. Among them, Edge Medical's multi-porous laparoscopic surgical robot is the only domestic brand that has gone through three generations. In August 2024, company released the new generation of multi-porous laparoscopic surgical robot MP2000, which has high performance and high stability. In terms of the Edge Cloud remote surgery system, Edge Medical performed the first remote human surgery in 2023, an intercontinental remote human surgery in 2024, and completed the world's first ultra-remote human surgery live broadcast. In 2024, in terms of revenue, Edge Medical rank the first among domestic manufacturers in the Chinese laparoscopic robot market.

Manufacturer	Wego	Sagebot		
Product	MicroHand	Kangduo (KD-SR-01)	Kangduo (SR-1500)	Kangduo (SR-2000)
NMPA Approval Obtained	October 2021	June 2022	April 2024	July 2024
NMPA Approved Indications	Cholecystectomy, inguinal hernia surgery, repair of esophageal hiatal hernia and stomach fundoplication, window creation for liver cysts, appendectomy, and sleeve gastrectomy.	KD-SR-01:Urology Surgery, Gyneologic, General surgery, Thoracic Surgery; SR-1500:Urology SR-2000:Urology, gynecology, general surgery, thoracic surgery		
Green Path Obtained	√	√		
Clinical Trial Status	• Initiated: Urologic, Gynecologic Surgery	-	-	-
Bidding Price / RMB	Not Publicly Available	5.4~9.9 million[11]		
Numbers of Robotic Arms[1]	3	3	3	4
Fluorescence imaging mode types	NA	NA	NA	NA
Degrees of Freedom of a single arm	7	12	12	12
Degrees of freedom of a single instrument connected to robot	7	4	4	4
Application in RALRP[2]	√	√	√	√
Application in T4 Cancer (the Late stage) in Urologic Surgery[3]	x	x	x	x
Application in radical hysterectomy with lymph node dissection[4]	x	x	x	x
Trial Locations	CN	CN	CN	CN
Image transmission delay	NA	NA	NA	NA
High-resolution images	3D	NA	NA	NA
Weight of Lightweight endoscope	NA	NA	NA	NA
Ex-factory Price / RMB [9]	NA	3.5~9 million		

Note:

9. The ex-factory price was not publicly disclosed, please do not disclose in the prospectus

11. According to the public announcement of China Government Procurement (中国政府采购网), the First Affiliated Hospital of Heilongjiang University of Chinese Medicine purchased a set of Med Robot from Kangduo with a bidding price of RMB 5.4 million and Qinhuangdao First Hospital purchased another robot with a budget of RMB 9.9 million.

12. The approved general surgeries of Wego MicroHand include Cholecystectomy, inguinal hernia surgery, hiatal hernia repair and fundoplication, hepatic cyst fenestration, appendectomy and sleeve gastrectomy

14. Updated till August 17. 2023.

15. The approved model of Intuitive Fosun is IS4000CN, which is the domestic version of Da Vinci Xi

Source: Company Website, Frost & Sullivan Analysis

Major Competitive Landscape of Multiport Endoscopic Surgical Robots Market in China (3/4)

- Although the product-based R&D of Endoscopic surgical Robots started relatively late in China, there has been a rich accumulation of research on key technologies and core components. Among them, Edge Medical's multi-porous laparoscopic surgical robot is the only domestic brand that has gone through three generations. In August 2024, company released the new generation of multi-porous laparoscopic surgical robot MP2000, which has high performance and high stability. In terms of the Edge Cloud remote surgery system, Edge Medical performed the first remote human surgery in 2023, an intercontinental remote human surgery in 2024, and completed the world's first ultra-remote human surgery live broadcast. In 2024, in terms of revenue, Edge Medical rank the first among domestic manufacturers in the Chinese laparoscopic robot market.

Manufacturer	MedBot	Cornerstone	AGIBOT
Product	Toumai surgical robot	Sentire(C1000)	AGIBOT(AM1000)
NMPA Approval Obtained	January 2022[6]	Sep 2024	Mar 2025
NMPA Approved Indications	Urologic Surgery, Gyneologic, General surgery, Thoracic Surgery[13]	Urology, general surgery	Urologic Surgery, Hepatobiliary Surgery, Gastrointestinal Surgery, Colorectal Surgery, Gynecology, Thoracic Surgery, General surgery
Green Path Obtained	√	Unknown	Unknown
Clinical Trial Status	-	-	-
Bidding Price / RMB	~ 15 million[10]	Not Publicly Available	Not Publicly Available
Numbers of Robotic Arms	4	4	Unknown
Fluorescence imaging mode types	NA	NA	NA
Degrees of Freedom of a single arm	11	Unknown	Unknown
Degrees of freedom of a single instrument connected to robot	7	Unknown	Unknown
Application in RALRP	√	√	√
Application in T4 Cancer (the Late stage) in Urologic Surgery	x	x	Unknown[20]
Application in radical hysterectomy with lymph node dissection	x	x	Unknown[21]
Trial Locations	CN	CN	CN
Image transmission delay	NA	NA	NA
High-resolution images	3D	3D	3D
Weight of Lightweight endoscope	NA	NA	NA
Ex-factory Price / RMB	~8.5 million	NA	NA

Note: 10. Wuwei Cancer Hospital of Gansu Province has announced a single-source bidding to MedBot for its Toumai surgical robot with a bid price of RMB 15 million.
13. Toumai has already submitted its application of multi-department expansion in 2025 H1 according to the annual report.
20. AGIBOT has been used in high-difficulty urological tumor surgeries (such as radical nephrectomy + vena cava tumor thrombus removal), but it is not clear whether it covers T4 stage cancer (late stage). Further clinical verification is needed.
21. AGIBOT supports gynecological surgeries (such as radical hysterectomy), but the specific data of lymph node dissection are not detailed in the clinical trial report.

Source: Company Website, Frost & Sullivan Analysis

Major Competitive Landscape of Multiport Endoscopic Surgical Robots Market in China (4/4)

- Although the product-based R&D of Endoscopic surgical Robots started relatively late in China, there has been a rich accumulation of research on key technologies and core components. Among them, Edge Medical's multi-porous laparoscopic surgical robot is the only domestic brand that has gone through three generations. In August 2024, company released the new generation of multi-porous laparoscopic surgical robot MP2000, which has high performance and high stability. In terms of the Edge Cloud remote surgery system, Edge Medical performed the first remote human surgery in 2023, an intercontinental remote human surgery in 2024, and completed the world's first ultra-remote human surgery live broadcast. In 2024, in terms of revenue, Edge Medical rank the first among domestic manufacturers in the Chinese laparoscopic robot market.

Manufacturer	Ronovo Surgical	Kangji Medical	Tuodao Medical
Product	Haisan-I Laparoscopic Surgical Robot System	Kangji Precision Clarity SR01-200	Tuoling Laparoscopic Surgical Robot
NMPA Approval Obtained	Mar 2025	Aprr 2025	Jul 2025
NMPA Approved Indications	Urologic Surgery, Gyneologic, General surgery, Thoracic Surgery	Urology, Gynecology, General Surgery	Urology, General Surgery, and Gynecology
Green Path Obtained	/	/	/
Clinical Trial Status	-	-	-
Bidding Price / RMB	Not Publicly Available	Not Publicly Available	Not Publicly Available
Numbers of Robotic Arms	3	4	4
Fluorescence imaging mode types	NA	NA	NA
Degrees of Freedom of a single arm	Unknown	7	13
Degrees of freedom of a single instrument connected to robot	4	Unknown	Unknown
Application in RALRP	√	√	√
Application in T4 Cancer (the Late stage) in Urologic Surgery	Unknown	Unknown	Unknown
Application in radical hysterectomy with lymph node dissection	Unknown	Unknown	√
Trial Locations	CN	CN	CN
Image transmission delay	NA	NA	NA
High-resolution images	3D	3D	3D
Weight of Lightweight endoscope	NA	NA	NA
Ex-factory Price / RMB	NA	NA	NA

Source: Company Website, Frost & Sullivan Analysis

Major Competitive Landscape of Multiport Endoscopic Surgical Robots Market in China (4/4)

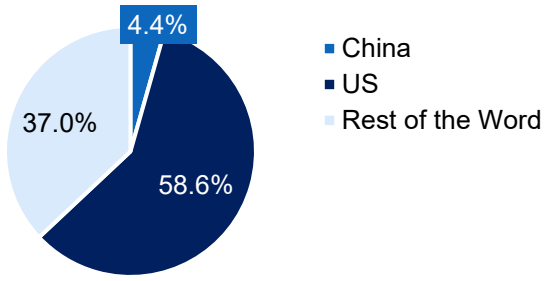
- Although the product-based R&D of Endoscopic surgical Robots started relatively late in China, there has been a rich accumulation of research on key technologies and core components. Among them, Edge Medical's multi-porous laparoscopic surgical robot is the only domestic brand that has gone through three generations. In August 2024, company released the new generation of multi-porous laparoscopic surgical robot MP2000, which has high performance and high stability. In terms of the Edge Cloud remote surgery system, Edge Medical performed the first remote human surgery in 2023, an intercontinental remote human surgery in 2024, and completed the world's first ultra-remote human surgery live broadcast. In 2024, in terms of revenue, Edge Medical rank the first among domestic manufacturers in the Chinese laparoscopic robot market.

Manufacturer	Vicen Healthcare	AIBOWIN Medical	BORNS
Product	Surgical endoscopic robotics system	PAI3000 Endoscopic Surgery Robot	Simphoni Ruxi Endoscopic Surgery Robot
NMPA Approval Obtained	/	/	/
NMPA Approved Indications	/	/	/
Green Path Obtained	/	/	√
Clinical Trial Status	The full performance testing and animal experiments have been completed	The phase-specific animal testing has been completed, and plans are underway to initiate a type testing and multi-indication clinical trial	The clinical trial has been completed.
Bidding Price / RMB	-	-	-
Numbers of Robotic Arms	4	2	4
Fluorescence imaging mode types	NA	NA	NA
Degrees of Freedom of a single arm	Unknown	Unknown	Unknown
Degrees of freedom of a single instrument connected to robot	Unknown	Unknown	Unknown
Application in RALRP	-	-	-
Application in T4 Cancer (the Late stage) in Urologic Surgery	-	-	-
Application in radical hysterectomy with lymph node dissection	-	-	-
Trial Locations	-	-	Global
Image transmission delay	NA	NA	NA
High-resolution images	3D	NA	3D
Weight of Lightweight endoscope	NA	NA	NA
Ex-factory Price / RMB	-	-	-

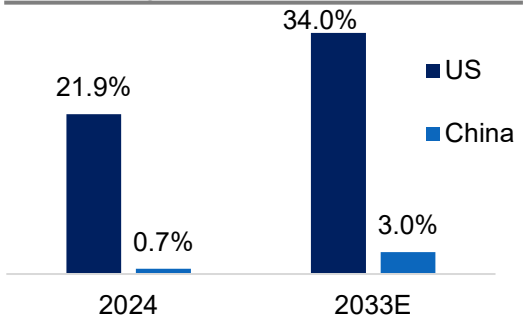
Source: Company Website, Frost & Sullivan Analysis

Market of Endoscopic Surgical Robot, China vs US

Distribution of Installed Base of da Vinci Surgical Systems by Regions as of December 31, 2024



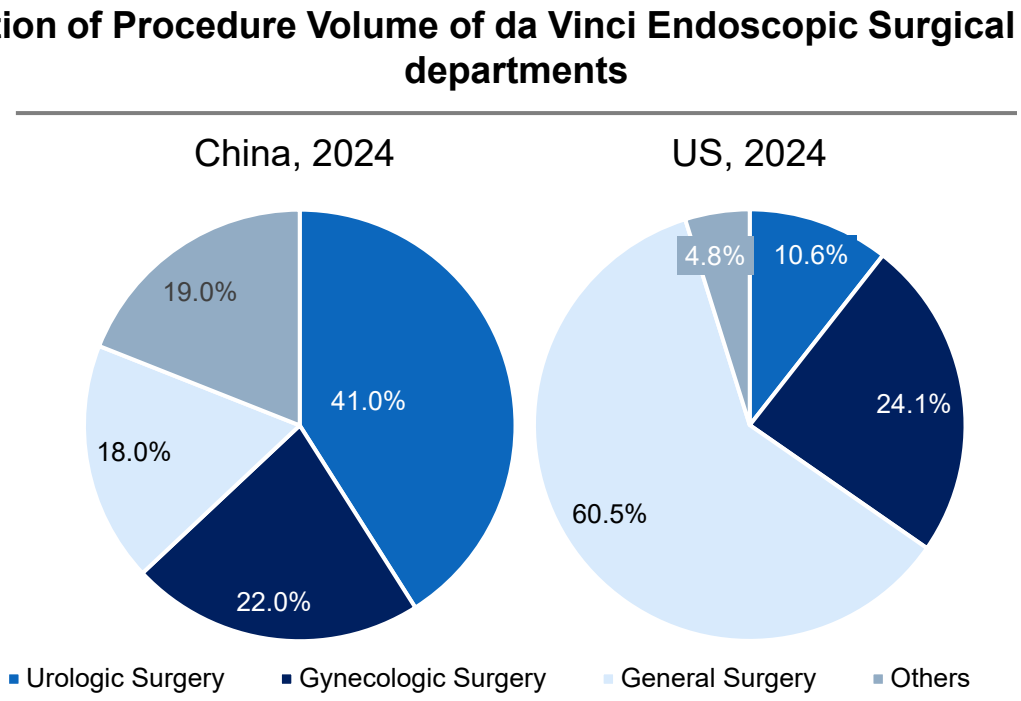
Comparison of Penetration Rate of Robot-Assisted Endoscopic Surgeries, China vs U.S.



Note: Penetration rate = volume of robot-assisted endoscopic surgeries/total volume of endoscopic surgeries

Source: Intuitive Surgical Annual Report, Frost & Sullivan Analysis

Distribution of Procedure Volume of da Vinci Endoscopic Surgical Robot by Departments，2024



Source: Intuitive Surgical Annual Report, Frost & Sullivan Analysis

Distribution of Procedure Volume of da Vinci Endoscopic Surgical Robot by departments, 2022

	da Vinci Multi-port Surgical System	da Vinci SP Surgical System
Urology	25.9%	7.7%
Gynecology	22.7%	40.1%
General Surgery	46.3%	20.4%
Others	5.0%	31.8%

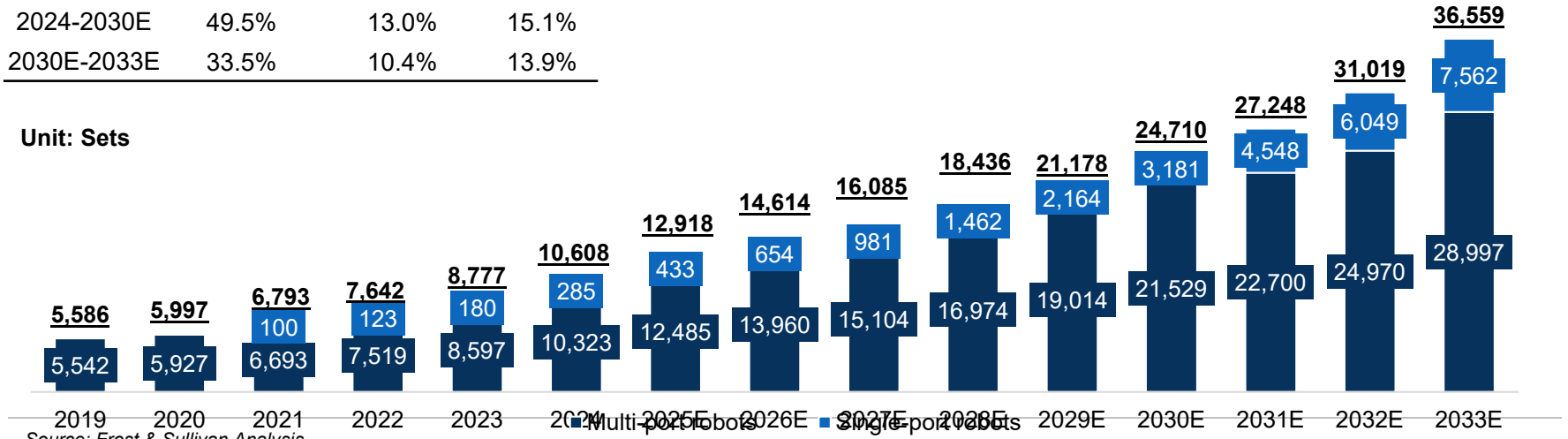
Source: Expert Interview, Frost & Sullivan Analysis

Historical and Forecast Global Installed Base of Multi-Port and Single-Port Endoscopic Surgical Robots, 2019-2033E

- The endoscopic single-port surgical robot has the advantages of low surgical space requirements, less trauma and faster postoperative recovery. In 2019, the global number of single-port endoscopic surgical robots was 44 sets and reaching 285 sets by 2024. It is expected to reach a number of 7,562 sets by 2033 at a forecasted CAGR of 33.5% from 2030 to 2033.
- In 2019, the global number of endoscopic multiport surgical robots was 5,542 sets and increased to 10,323 sets by 2024 with a CAGR of 13.2%. Driven by factors such as the aging population and the strong support of the government on the medical field, the global number size of endoscopic multiport surgical robots will grow rapidly, reaching 28,997 sets in 2033, with a CAGR of 10.4% from 2030 to 2033.
- By 2024, the cumulative number of da Vinci Surgical System in the U.S. was 5,807, the global cumulative number of da Vinci Surgical System was 9,902. The total global number of single-port and multiport surgical robots grew from 5,586 sets in 2019 to 10,608 sets in 2024 with a CAGR of 13.7%. By 2033, it is projected to be 36,559.

Historical and Forecast Global Installed Base of Multi-Port and Single-Port Endoscopic Surgical Robots, 2019-2033E

Period	CAGR		
	Single-port Robot	Multiport Robot	Total
2019-2024	45.3%	13.2%	13.7%
2024-2030E	49.5%	13.0%	15.1%
2030E-2033E	33.5%	10.4%	13.9%



Source: Frost & Sullivan Analysis

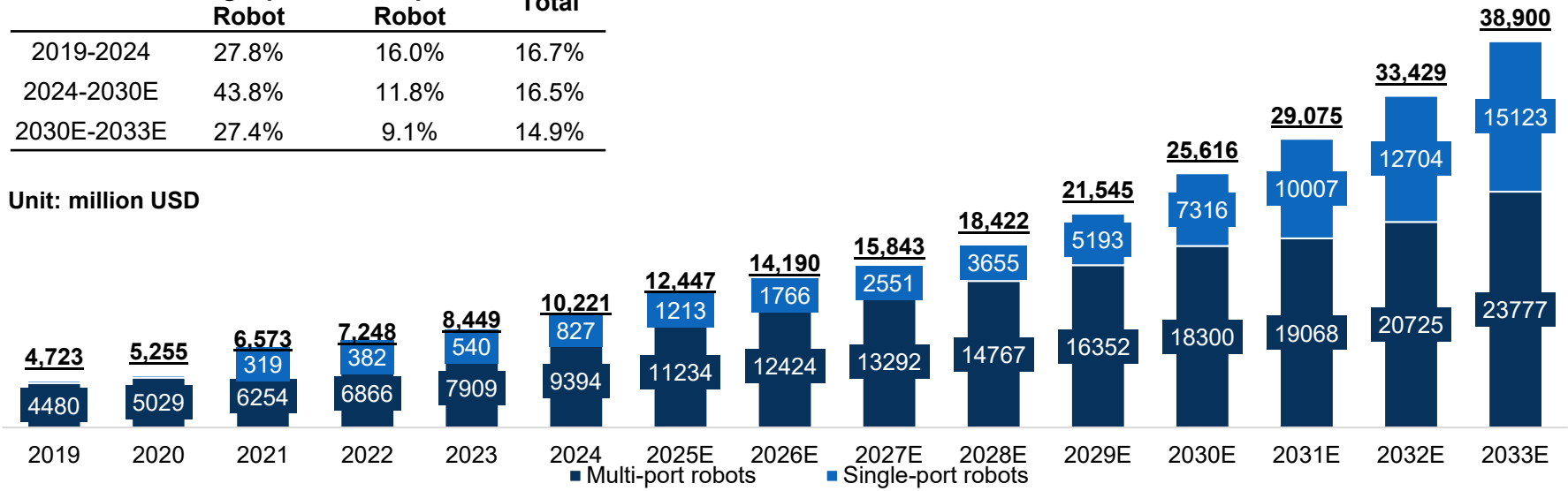
Historical and Forecast Global Market Size of Multi-Port and Single-Port Endoscopic Surgical Robots, 2019-2033E

- The global market size of single-port endoscopic surgical robots was USD 243 million in 2019. By the year 2033, the global market size of single-port endoscopic surgical robots will remain at a relatively high rate and is expected to reach USD 15,123 million, with a CAGR of 27.4% from 2030o 2033, indicating a promising market potential.
- From 2019 to 2024, the overall global market size of multiport surgical robots increased from USD 4,480 million to USD 9,394 million , with a CAGR of 16.0%. The global market size of multiport endoscopic surgical robots is expected to grow increasingly to reach USD 23,777 million in 2033, with CAGR of 9.1% from 2030 to 2033.
- The total market size of both multi-port and single-port endoscopic surgical robots grew from USD 4,723 million in 2019 to USD 10,221 million in 2024 with a CAGR of 16.7%. By 2033, it is projected to be USD 38,900 million.

Historical and Forecast Global Market Size of Multi-Port and Single-Port Endoscopic Surgical Robots, 2019-2033E

Period	CAGR		
	Single-port Robot	Multiport Robot	Total
2019-2024	27.8%	16.0%	16.7%
2024-2030E	43.8%	11.8%	16.5%
2030E-2033E	27.4%	9.1%	14.9%

Unit: million USD



Note: The market size of endoscopic surgical robots includes equipment sales revenue, consumables sales revenue, maintenance and service revenue

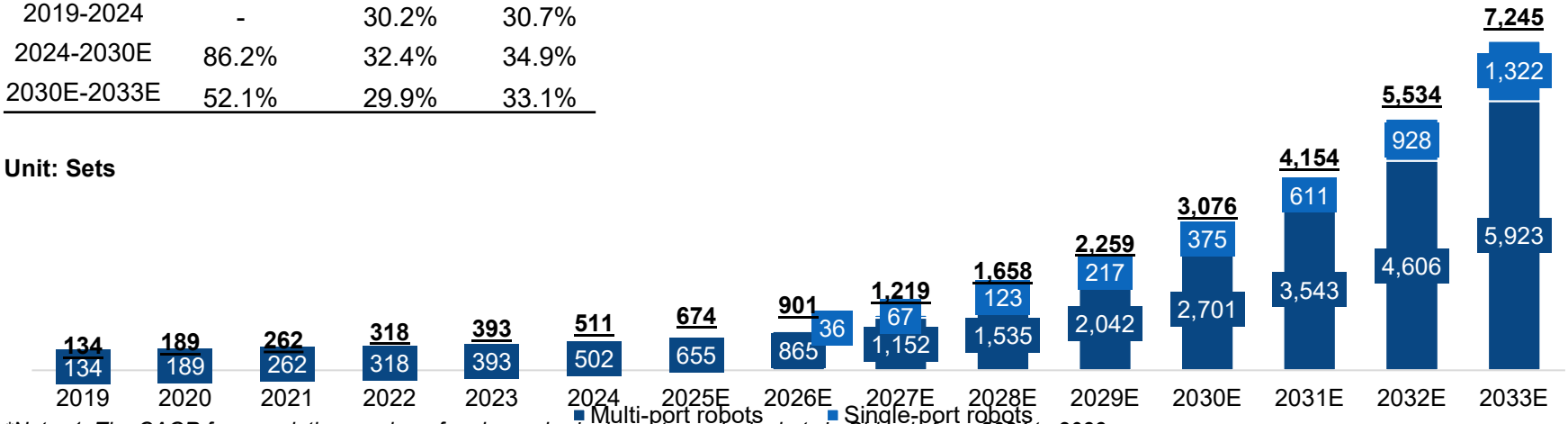
Source: Frost & Sullivan Analysis

Historical and Forecast Installed Base of Multi-Port and Single-Port Endoscopic Surgical Robots in China, 2019-2033E

- As the single-port surgical robots developed later than multiport surgical robots, it is barely no sign of single-port surgical robots in market before 2024. However, due to its advantages of single incision and less scar, its popularity is expected to be higher among the patients in future. Therefore, the number of cumulative endoscopic single-port surgical robots in China will be growing rapidly beginning from 2024. The cumulative number of single-port endoscopic surgical robots is projected to increase from 9 sets in 2024 to 1,322 sets in 2033.
- The cumulative number of endoscopic multi-port surgical robots in China grew steadily from 134 sets in 2019 to 502 sets in 2024 with a CAGR of 30.2%. From 2024 to 2033, its number of cumulative endoscopic multiport surgical robots is expected to reach 5,923 in 2033.
- The total number of both multi-port and single-port endoscopic surgical robots installed in 2024 was 511, and this number is expected to reach 7,245 by 2033.

Historical and Forecast Installed Base of Multi-Port and Single-Port Endoscopic Surgical Robots in China, 2019-2033E

Period	CAGR		
	Single-port Robot	Multiport Robot	Total
2019-2024	-	30.2%	30.7%
2024-2030E	86.2%	32.4%	34.9%
2030E-2033E	52.1%	29.9%	33.1%



**Note: 1. The CAGR for cumulative number of endoscopic single-port surgical robots in China is from 2024 to 2033.*

Source: Frost & Sullivan Analysis

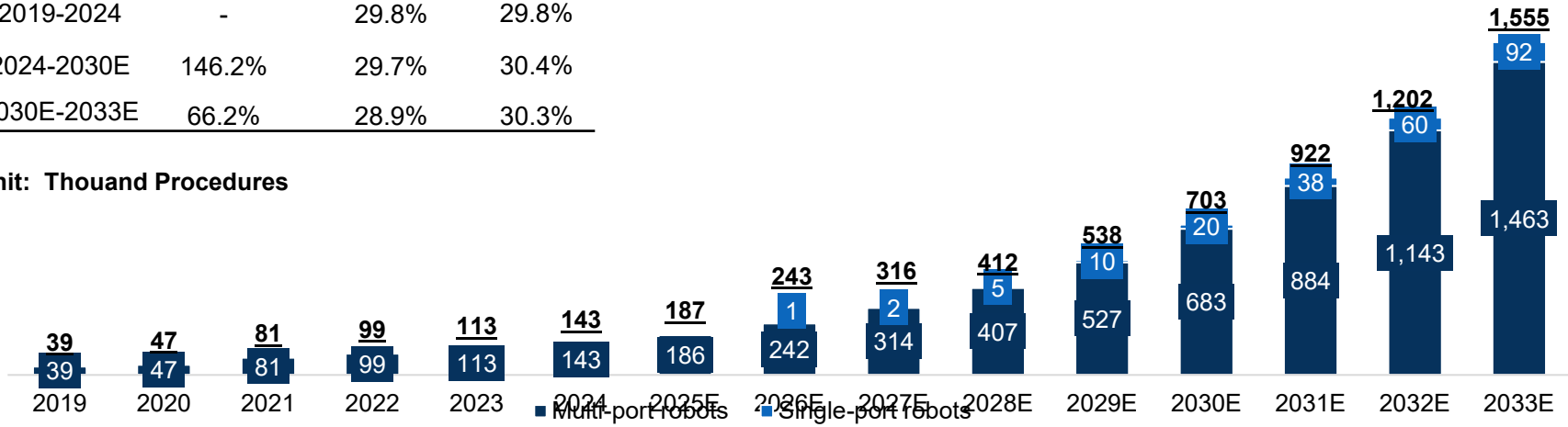
Historical and Forecast Volume of Multi-Port and Single-Port Robot-Assisted Endoscopic Surgery in China, 2019-2033E

- As the single-port surgical robots developed later than multiport surgical robots, it is barely no sign of single-port surgical robots assisted surgery presented before 2024. However, due to its advantages of single incision and less scar, its popularity is expected to be higher among the patients in future. Therefore, the volume of endoscopic single-port surgical robots assisted surgery in China will be growing rapidly beginning from 2024. The volume of single-port surgical robots is projected to increase from 0.1 thouand procedures in 2024 to 92.1 thouand procedures in 2033.
- The volume of multi-port endoscopic surgical robots assisted surgery in China grew steadily from 39 thouand procedures in 2019 to 143 thouand procedures in 2024 with a CAGR of 29.8%. From 2024 to 2033, the volume of multiport surgical endoscopic robots assisted surgery in China is expected to reach 1,463 thouand procedures in 2033.
- The volume of single-port and multiport surgical robots assisted surgery in China grew from 39 thouand procedures in 2019 to 143 thouand procedures in 2024 with a CAGR of 29.8%. By 2033, it is projected to be 1555 thouand procedures.

Historical and Forecast Volume of Multi-Port and Single-Port Robot-Assisted Endoscopic Surgery in China, 2019-2033E

Period	CAGR		
	Single-port Robot	Multiport Robot	Total
2019-2024	-	29.8%	29.8%
2024-2030E	146.2%	29.7%	30.4%
2030E-2033E	66.2%	28.9%	30.3%

Unit: Thouand Procedures



Note: 1. The CAGR for the volume number of endoscopic single-port surgical robots assisted surgery in China is from 2024 to 2033.

Source: Frost & Sullivan Analysis

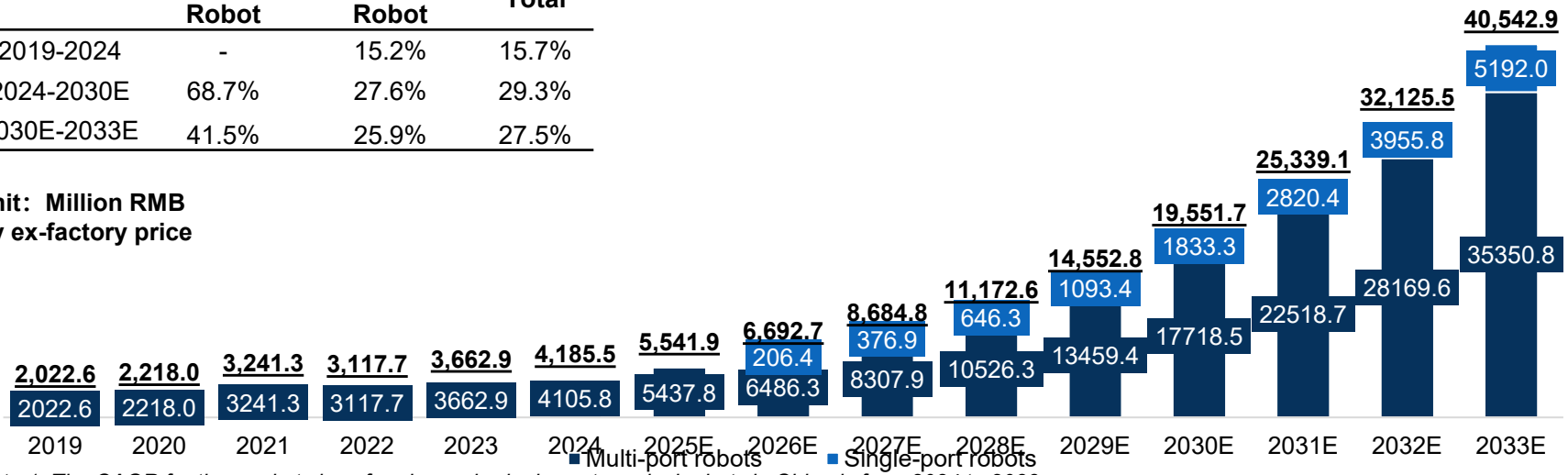
Historical and Forecast Market Size of Multi-Port and Single-Port Endoscopic Surgical Robots in China, 2019-2033E

- Due to its advantages of single incision and less scar, popularity of single-port surgical robots is expected to be higher among the patients in future. Therefore, the market size of endoscopic single-port surgical robots in China will be growing rapidly beginning from 2024. The market size of single-port surgical robots is projected to increase from 79.7 million RMB in 2024 to 5,192.0 million RMB in 2033.
- The market size of endoscopic multiport surgical robots in China grew steadily from 2,022.6 million RMB in 2019 to 4,105.8 million RMB in 2024 with a CAGR of 15.2%. From 2024 to 2033, the market size of endoscopic multiport surgical robots in China is expected to reach 35,350.8 million RMB in 2033.
- The market size of single-port and multi-port surgical robots in China grew from 2,022.6 million RMB in 2019 to 4,185.5 million RMB in 2024 with a CAGR of 15.7%. By 2033, it is projected to be 40,542.9 million RMB.

Historical and Forecast Market Size of Multi-Port and Single-Port Endoscopic Surgical Robots in China, 2019-2033E

Period	CAGR		
	Single-port Robot	Multiport Robot	Total
2019-2024	-	15.2%	15.7%
2024-2030E	68.7%	27.6%	29.3%
2030E-2033E	41.5%	25.9%	27.5%

Unit: Million RMB
By ex-factory price



Note:1. The CAGR for the market size of endoscopic single-port surgical robots in China is from 2024 to 2033.
2. The market size of endoscopic surgical robots includes equipment sales revenue, consumables sales revenue, maintenance and service revenue

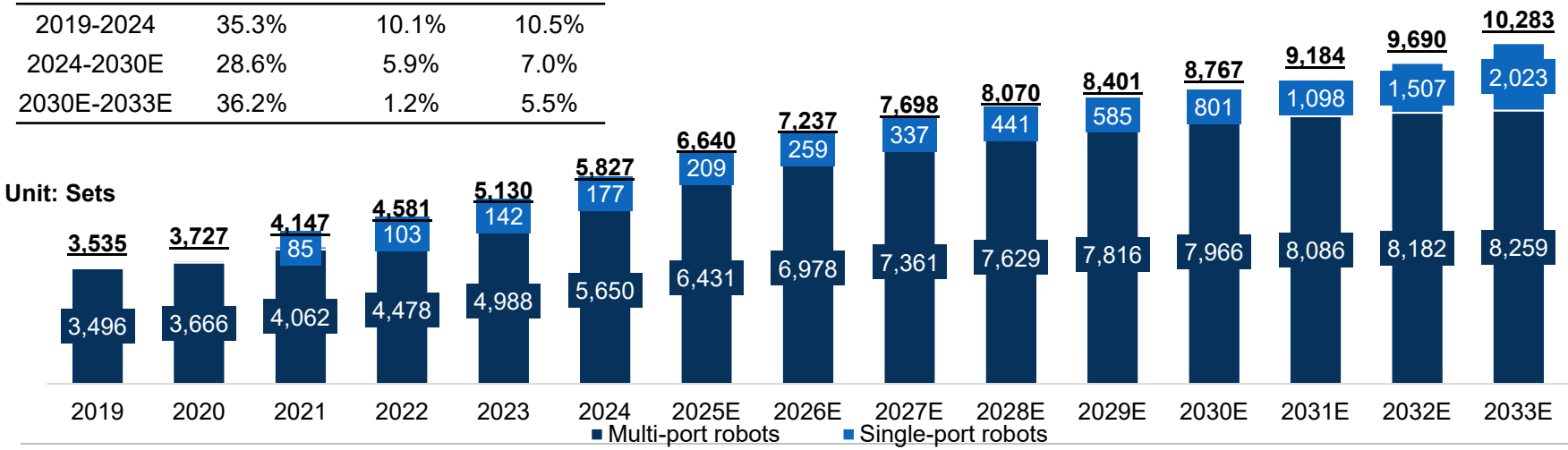
Source: Frost & Sullivan Analysis

Historical and Forecast Installed Base of Multi-Port and Single-Port Endoscopic Surgical Robots in U.S., 2019-2033E

- The cumulative number of endoscopic single-port surgical robots in U.S. grew from 39 sets in 2019 to 177 sets in 2024. The single-port surgical robots developed later than multiport surgical robots, but due to the advantages of single incision and less scar, its popularity is expected to be higher among the patients in future and the number of cumulative endoscopic single-port surgical robots in U.S. will be growing rapidly. The cumulative single-port endoscopic is projected to increase from 177 sets in 2024 to 2,023 sets in 2033.
- The cumulative number of endoscopic multiport surgical robots in U.S. grew steadily from 3,496 sets in 2019 to 5,650 sets in 2024 with a CAGR of 10.1%. From 2024 to 2033, its number of cumulative endoscopic multiport surgical robots is expected to increase from 5,650 sets in 2024 to 8,259 in 2033.
- The total cumulative number of single-port and multiport surgical robots in U.S. grew from 3,535 sets in 2019 to 5,827 sets in 2024 with a CAGR of 10.5%. By 2033, it is projected to be 10,283 sets.

Historical and Forecast Installed Base of Multi-Port and Single-Port Endoscopic Surgical Robots in U.S., 2019-2033E

Period	CAGR		
	Single-port Robot	Multiport Robot	Total
2019-2024	35.3%	10.1%	10.5%
2024-2030E	28.6%	5.9%	7.0%
2030E-2033E	36.2%	1.2%	5.5%



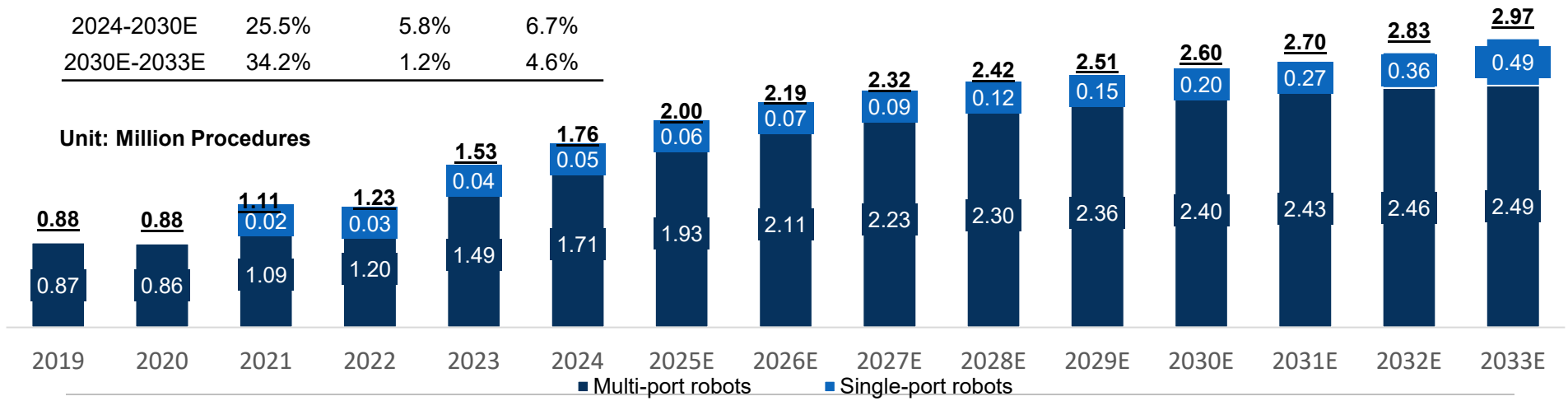
Source: Frost & Sullivan Analysis

Historical and Forecast Volume of Multi-Port and Single-Port Robot-Assisted Endoscopic Surgery in U.S., 2019-2033E

- The volume of endoscopic single-port surgical robots assisted surgery in U.S. grew from 0.01 million procedures in 2019 to 0.05 million procedures in 2024. From 2024 to 2033, the volume of endoscopic single-port surgical robots assisted surgery in U.S. is projected to increase from 0.05 million procedures in 2024 to 0.49 million procedures in 2033.
- The volume of endoscopic multiport surgical robots assisted surgery in U.S. grew steadily from 1.09 million procedures in 2019 to 1.71 million procedures in 2024 with a CAGR of 14.3%. From 2024 to 2033, the volume of endoscopic multiport surgical robots assisted surgery in U.S. is projected to increase from 1.71 million procedures in 2024 to 2.49 million procedures in 2033.
- The volume of single-port and multiport surgical robots assisted surgery in U.S. grew from 0.88 milion procedures in 2019 to 1.76 million procedures in 2024 with a CAGR of 14.7%. By 2033, it is projected to be 2.97 million procedures.

Historical and Forecast Volume of Multi-Port and Single-Port Robot-Assisted Endoscopic Surgery in U.S., 2019-2033E

Period	CAGR		
	Single-port Robot	Multiport Robot	Total
2019-2024	37.0%	14.3%	14.7%
2024-2030E	25.5%	5.8%	6.7%
2030E-2033E	34.2%	1.2%	4.6%



Source: Frost & Sullivan Analysis

Procurement Policy for Endoscopic Surgical Robots in China（1/2）

- China implements strict configuration management for large medical device, and requires a government-issued configuration certificate to purchase large medical device.
- The endoscopic surgery robot belongs to large medical device, and public hospitals need to follow the configuration plan set by the National Health Commission to purchase.

Date	Government	Policies	Comments
March 2018	National Health Commission	Large medical device configuration permit management directory (2018) 《大型医用设备配置许可管理目录（2018 年）》	• Large medical device is divided into Class A and Class B, which endoscopic surgical instrument control system (surgical robot) belongs to Class B equipment, and the provincial health and family commission is responsible for configuration management.
May 2018	National Health Commission	Large medical device configuration and use management (Trial) 《大型医用设备配置与使用管理办法（试行）》	• The state in accordance with the directory of large medical device to implement hierarchical classification of configuration planning and configuration license management. • Large medical equipment configuration management directory is divided into A, B two categories. The provincial health and health administrative departments are responsible for the configuration of management and issuance of configuration licenses of class B large medical device. • Institutions, applying for the allocation of class B large medical device, need to apply to the provincial health administrative departments
July 2020	National Health Commission	National Health Commission on the adjustment of the 2018-2020 large medical device configuration planning notice 《国家卫生健康委关于调整2018-2020年大型医用设备配置规划的通知》	• By the end of 2020, endoscopic surgical robots are planned to be configured 268 units, of which 225 units are planned for 2018-2020
March 2023	National Health Commission	Notice of the National Health Commission on Issuing the Large medical device configuration permit management directory（2023） 《国家卫生健康委关于发布大型医用设备配置许可管理目录（2023年）的通知》	• Endoscopic surgical robots are remained to be divided into class B large medical device .
June 2023	National Health Commission	Notice of the National Health Commission on the Release of the "14th Five-Year Plan" Large-scale Medical Equipment Configuration Plan 《国家卫生健康委关于发布“十四五”大型医用设备配置规划的通知》	• By the end of 2025, endoscopic surgical robots are planned to be configured 819 units, of which 559 units are planned for 2020-2025.

Source: NHC, Frost & Sullivan Analysis

Procurement Policy for Endoscopic Surgical Robots in China（2/2）

Date	Government	Policies	Comments
June 2023	National Medical Products Administration	Key Points of Technical Review of Lactic Endoscope Surgery System (Revised Version in 2023) 《腹腔内窥镜手术系统技术审评要点（2023年修订版）》	• To further standardize the management of laparoscopic surgical systems, the general requirements for laparoscopic surgical system products were issued. The registration applicants were guided in the preparation and writing of registration application materials for laparoscopic surgical system products, and the registration application materials were also provided as a reference for the technical review department to review the registration application materials.
Apr 2025	Beijing Municipal Medical Security Bureau	Several Measures to Support the High-Quality Development of Innovative Medicine in Beijing (2025) 《北京市支持创新医药高质量发展若干措施（2025年）》	• Establish innovation centers for surgical robot technologies, encouraging collaborative R&D efforts between medical institutions and enterprises to tackle key technological challenges, with a focus on applications in complex surgical procedures. • Build high-value medical equipment leasing platforms to accelerate the hospital adoption and iterative innovation of surgical robots, while reducing the financial burden on medical institutions when introducing new equipment. • Develop training and application demonstration centers for medical devices to enhance healthcare professionals' operational skills and promote the clinical adoption of new technologies. • Include the use of innovative medical devices such as surgical robots in the performance evaluation system of public hospitals, encouraging institutions to actively adopt new technologies and improve the quality of medical services. • Designated medical institutions may apply, in accordance with regulations, for DRG payment exclusions for innovative devices such as surgical robots, ensuring appropriate use and reimbursement of new technologies.
Apr 2025	National Medical Department of the State Food and Drug Administration	Measures on Optimizing Full Life Cycle Supervision and Supporting the Innovative Development of High-end Medical Devices (Draft for Comments) 《关于优化全生命周期监管 支持高端医疗器械创新发展的举措（征求意见稿）》	• Improve the review and approval mechanism, strengthen the supervision of the entire life cycle, fully support major innovations in high-end medical devices, and promote the application of more new technologies, new materials, new processes and new methods in the field of medical and health, publicly solicit opinions from the public.

Source: NHC, Frost & Sullivan Analysis

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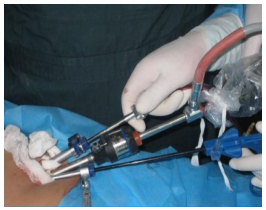
Comparison of Single-port and Multiport Endoscopic Surgery and Surgical Robots

	Multiport Endoscopic Surgery	Single-port Endoscopic Surgery
Key Features	• Relatively mature technology • Relatively larger operating fields • Easier operability of instruments for surgeons • Reduced operation time 	• Minimal incision and less scarring • Reduced postoperative pain and less use of analgetic medication • Relatively faster recovery and shorter hospital stay • Improved patient's satisfaction with better cosmesis, especially in use of gynecology surgeries 
Surgical Robot	Multi-port endoscopic surgical robot	Multi-port endoscopic surgical robot + single-site multi-channel access platform Single-port endoscopic surgical robot

	Multi-port Endoscopic Surgical Robot	Single-port Endoscopic Surgical Robot
Current Application	• Extensive clinical application • Occupying the majority of market share in the surgical robot market	• Approved indications: Gynecologic Surgery, Urology, General Surgery • Currently only one single-port surgical robot has been approved by NMPA for urologic surgeries
Key Features	• Wide surgical field and convenient operation with multiple incisions • Adaption to a wide range of surgical types with great advantages in highly demanding and complex surgeries • Application in general surgery, urologic surgery, gynecologic surgery, thoracic surgery, etc.	• Less trauma and fast recovery with only one incision • A complement to multi-port surgical robots due to less invasiveness • More advantages in the surgery which is performed in a highly-focus narrow space, such as prostate surgery, cystectomy, ovariectomy, segmental ureterectomy, etc.. • Faster postoperative recovery and suitable for younger patients with high aesthetic requirements
Future Trends	• Continuing steady growth in the market size due to advantages including a wide range of application in different procedure types, convenient operation and ability to perform complex surgery	• Higher patient acceptance and expected significant growth in the clinical application due to less trauma, shorter postoperative recovery time and better aesthetic outcome

No significant difference in postoperative complications between single- and multi-port endoscopic surgery robots, both of which reduce the complications of conventional MIS

Source: Literature research, Frost & Sullivan analysis

Frequency of Upgrades of Single-port and Multiport Endoscopic Surgical Robots

- The da Vinci surgical systems, developed by Intuitive Surgical Inc. (“Intuitive Surgical”), are the most widely used surgical robots in the world. Demonstrate the update frequency of multi-port and single-port laparoscopic surgical robots with reference to the update frequency of da Vinci surgical robots. On average, the da Vinci surgical robot system is updated every 5 years.

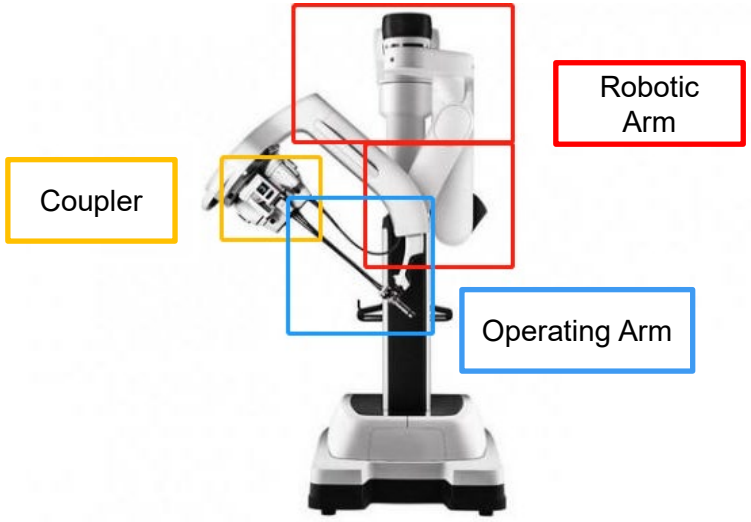
Year	Generation	System	Features	Type
2000	• First	• da Vinci Surgical Robot	• The first ever integrated endoscopic surgical robot, which was approved by the FDA	• Multiport Endoscopic Surgical Robot
2006	• Second	• da Vinci S	• Offered improved robotic arm movements, console displays, and simpler set up	• Multiport Endoscopic Surgical Robot
2009	• Third	• da Vinci Si	• Offered dual consoles, analog controllers, and intraoperative fluoroscopic imaging technology	• Multiport Endoscopic Surgical Robot
2014	• Fourth	• da Vinci Xi	• Improvements in flexibility, precision, and imaging clarity	• Multiport Endoscopic Surgical Robot
2017	• Fourth	• da Vinci X	• Adding new features such as an acoustic system, a laser guidance system, and a lightweight endoscope, and a smaller robotic arm, maintaining the basic features of da Vinci Xi at a more affordable price	• Multiport Endoscopic Surgical Robot
2018	• Fourth	• da Vinci SP	• The single-hole laparoscopic surgical robot, received FDA approval for urology procedures	• Single-port Endoscopic Surgical Robot

Source: Literature research, Company Website, Frost & Sullivan analysis

Overview of Single-port Endoscopic Surgical Robot

- In general, there is no significant difference between these single-port and multi-port endoscopic surgical robot in terms of clinical treatment effect. To choose which approach usually depends on both patients' requirements and surgeons' preference.
- The single-port endoscopic surgical robot is designed specifically for single-port endoscopic surgery, such as da Vinci SP(Intuitive Surgical). For single-port endoscopic surgery, issues such as instrument clashing, inability to achieve effective triangulation for dissection and difficulties with intracorporeal suturing are improved by use of robotics.

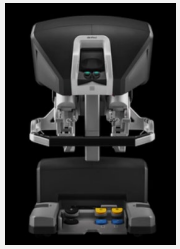
Construction of Single-port Endoscopic Surgical Robot



Patient Cart

Equipped with articulating arms which hold the instruments that are inserted into the patient.

Surgeon Console



Control center for the operating surgeon.

Vision Cart

Equipped with endoscopes and image processing technology to provide anatomically realistic images,

Technical Difficulties of Single-port Endoscopic Surgical Robot

- One endoscopic arm and 2-3 operating arms need to insert the abdominal cavity through a single sheath.
- The vision arm needs to have the function of lighting. The operating arms needs to have sufficient strength and working space.
- Also, the diameter of the endoscope need to be small in order to facilitate moving, operating and avoid instrument clashing.

Source: Frost & Sullivan analysis

Development of Surgical Robotic Systems

Case Study: Intuitive Surgical

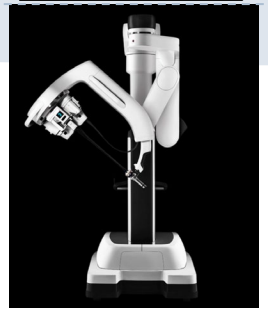
Development of Surgical Robotic Systems

2009 — Multi-port da Vinci Si

da Vinci Si and X/Xi are versatile and flexible, with setup automation and guidance that promotes OR efficiency. They provide multi-quadrant access and are used for a variety of complex procedures.

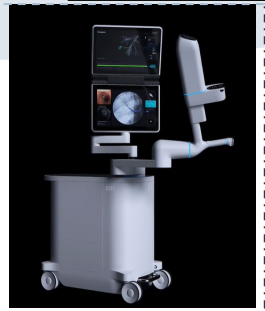
2014 — Multi-port da Vinci X/Xi

2014 — Single-port da Vinci SP



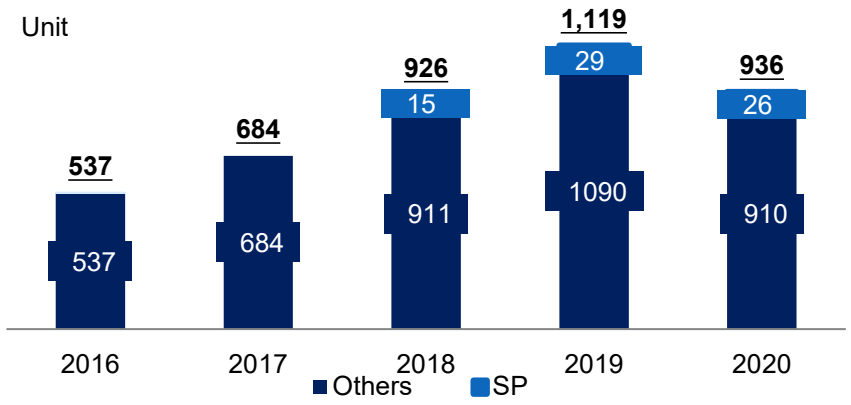
da Vinci SP offers three multi-articulated instruments and a full wrist 3DHD camera that can be seen and controlled in tight surgical spaces with one single arm. Simplified setup, multiple control modes and dynamic information display are all included.

2019 — Ion Endoluminal System



Ion system features an ultra-thin, ultra-maneuverable catheter that allows navigation far into the peripheral lung, and stability enables the precision needed for biopsy.

Volume of Da Vinci System Shipments from 2016-2020



Note: Others is the multi-port robotic system (da Vinci Si, X and Xi system).

- The da Vinci surgical system, developed by Intuitive Surgical, currently occupies a major market share in the endoscopic surgical robots market. The product portfolio of Intuitive Surgical consists of the multi-port robotic systems (such as da Vinci Si, X and Xi system), the single-port robot SP and the robotic bronchoscopy platform Ion.
- With the advantages of being more minimally invasive and less scarring, da Vinci SP system was commercially launched in 2018 and is especially favored by female patients.

Source: Intuitive Surgical website, Frost & Sullivan Analysis

Major Competitive Landscape of Global Single-port Endoscopic Surgical Robot

Manufacturer	Intuitive Surgical	Asensus Surgical/ Great Belief Inter-national Limited(GBIL)	Virtual Incision
Product	da Vinci SP	Surgibot	MIVR
First Approved Time / Current Status	2018 (FDA) 2022 (Japan)	2011 (CE)[4]	2023 (FDA) Pivotal trial ongoing in US[5]
Number of Endoscopic Camera Arm + Number of Instrumental Arm	1+3	1+2	1+2
Degrees of Freedom of Instruments	7	6	6
Degrees of Freedom of the Endoscope	4	Unknown	Unknown
Immersive Vision[1]	√	Not publicly available	Not publicly available
Trial Locations	US, South Korea, France	EU	US
Ex-factory Price / USD	~3.92 million [3]	ND[2]	NA
Cumulative installed base in 2024	270+	NA	NA
New installed base in 2024	95+	NA	NA

**Note:*
1. "Immersive vision" refers that the surgical robot being equipped with a 3D-HD vision system.
2. ND=Not Publicly Disclosed
3. The ex-factory price of Intuitive surgical is the average ex-factory price of single-port surgical robots, da Vinci multi-port surgical robots, and ION, which was calculated as the sum of product and service revenue divided by the number of surgical robots placed in 2024
4. The CE-approved version of Surgibot was so-called "Spider" in 2011, and Surgibot is the improved version of it that is still under development and whose ownership has been transferred to GBIL in 2021.
5. FDA has authorised the marketing of Virtual Incision's MIRA Surgical System for adult colectomy procedures.

Source: Company official website, NMPA website, Frost & Sullivan Analysis

Major Competitive Landscape of Single-port Endoscopic Surgical Robot in China

Manufacturer	Intuitive Surgical	Edge Medical	MedBot	Surgerii	Vicarious Surgical
Product	da Vinci SP Surgical System	Edge Medical Single-Port Endoscopic Surgical Robotic System (SP1000)	Toumai Single-Port Laparoscopic Surgical Robot	Surgerii Modular Endoscopic Surgery Robot[1]	Vicarious Surgical System
NMPA Approval	×	November,2023	February,2025	June, 2023	×
Single-armed Single Port or not	√	√	×	×	×
NMPA Approved Indications/Clinical Trial in China	• Patient Enrolling: Urologic, otorhinolaryngologic, Gynecologic and General surgery (Mainland) • Trial Initiated: Otorhinolaryngology, Head and Neck, Urologic, Colorectal surgery (Hong Kong)	• Approved: Gynecologic Surgery, Urology, General Surgery	• Approved:Cholecystectomy, liver cyst fenestration, sleeve gastrectomy, fundoplication, hiatal hernia repair, inguinal hernia surgery, appendectomy, laparoscopic surgery of upper urinary tract in urology (except malignant lesions), gynecology (except malignant lesions)	• Approved: Urology, gynecology, general surgery, Thoracic surgery(lungs)	×
Green Path Obtained	×	√	√	√	×
Device Price	NA	NA	NA	NA	NA
Number of Endoscopic Camera(s) + Number of Instruments	1+3	1+3	1+3	1+3	1+2
Degrees of Freedom of the Endoscope	4	5	4	Unknown	4
Degrees of Freedom of Instruments	7	7	7	7	13
Application in Total Hysterectomy[2]	×	√	×	√	×
Trial Locations	CN	CN	CN	CN	Global

Note:
1. Surgerii Modular Endoscopic Surgery Robot performs single-port surgery adopting a structure of four robotic arms.
2. Total hysterectomy is the surgery to remove the entire uterus, including the cervix. According to the Levels of Gynaecological Laparoscopic Surgery (HKCOG), total hysterectomy is a level 4 major surgery. Surgery is divided into four levels according to its technical difficulty, complexity and risk: the higher the level, the more complicated the operation and the higher the difficulty.

Source: Company official website, NMPA website, Frost & Sullivan Analysis

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Overview of Natural Orifice Surgical Robots

- Natural orifice transluminal endoscopic surgery (“NOTES”) is the Surgery of the human oral cavity, anus, vagina, urethra and other natural cavity, in the process of solving the patient's disease, no incision is left on the human surface, which alleviates the surgical trauma. It mainly includes procedures by laparoscopy, enteroscopy, gastroscopy, colposcopy and urethroscopy. But such procedures are 2D imaging, lack of flexibility of surgical instruments, and their soft fiberoptic scopes lack a firm and stable operating platform and are not suitable for complex procedures.
- Robot-assisted NOTES is an emerging surgery technology and refers to NOTES performed with assistance of natural orifice surgical robots. The natural orifice surgical robot refers to a surgical robot that can perform diagnosis and surgery through placing controllable flexible endoscopes through one of the bodies’ natural orifices such as the digestive tract and respiratory tract. Currently used in gynecology, urology, etc.

Representative products

Johnson & Johnson AURIS

In March 2018, the Monarch Surgical Robot, developed by Auris Health, is FDA certified for use in diagnostic and therapeutic bronchoscopic procedures. Auris was acquired by Johnson & Johnson in 2019 at more than US$5.7 billion.

Monarch bronchoscopic Robots

INTUITIVE SURGICAL®

In 2019, the Ion robotic arm assisted navigational bronchoscope Systems was approved by the FDA, and it expanded the minimally invasive platform of Intuitive Surgical to include tools that enable biopsy of the lung periphery.

Ion bronchoscopic Robots

Technical barriers and development directions

Limitations of the force contact feedback Systems	Since transluminal Surgery has a certain potential damage to the tissue of natural cavity, through the improvement of Laparoscopic instruments, the operator can be provided with more appropriate force to the robotic arm and perceive different properties of the tissue, thus improving the surgical safety.
The surgical robotic Systems is bulky	The development of microsurgical robots could allow technologies to be better applied to endoluminal Surgery .
Surgical Robots versatility	The intelligent surgical robot of developing multifunctional sensors can detect various physiological indicators in the abdominal cavity intraoperatively.

Highlighting strengths and clinical implications

- Application of the surgical robotic Systems in Natural Orifice S urgery enables 3D imaging, facilitating surgical manipulation b y physicians.
- The surgical robotic arm is stable and provides a firm operatin g platform. The robotic arm joints were multiple, and the range of motion was wide and flexible.
- Patients have less postoperative pain and small surgical incisi ons, which can lead to more difficult and complex procedures i n the clinic.

Source: Literature Research, Frost & Sullivan analysis

Major Competitive Landscape of Natural Orifice Surgical Robots Global Market (1/2)

- Currently, there are five FDA-approved natural orifice surgical robots. The development of natural orifice surgical robots in China is in its early stages, with only two companies approved: LungHealth Medical and Edge Medical.

Manufacturer	Edge Medical	MedBot	Intuitive Surgical
Product	Edge Medical Robotic Bronchoscope System	Trans-bronchial Surgical Robot	Ion Platform
FDA	NA	NA	2019
CE Mark	NA	NA	NA
NMPA	2025	NA	2024
Device Price	N/A	N/A	~ USD 600,000
Numbers of Robotic Arms*	2	1	1
Trans-natural Cavity	Bronchus	Bronchus	Bronchus
Surgical Applications	• Diagnostic and therapeutic bronchoscopic procedures	• Lung biopsy	• Lung biopsy
Key Features	• Integration of diagnosis with treatment • Advanced navigation systems for precise positioning • Maneuverability of the catheter to articulate 180° in all directions • Access to most segments of the lung	• Mature slim conduit structure and control technology • First clinical trial of bronchoscope robot for lung diagnosis and treatment in China • Precise end positioning and control	• Accurate shape and position of the conduit can be obtained displayed in real time • Ultra-thin articulated robot guide allows 180 degrees in all directions • Compatible with multiple imaging modes: Intra-bronchial ultrasound, fluoroscopy and cone beam CT scanner
Cumulative installed base in 2024	NA	NA	800+
New installed base in 2024	NA	NA	270+
Revenue in 2024/ USD	NA	NA	NA

**Note: For trans-bronchoscopic surgical robots, the bronchoscope/catheter complex has a different structure and is operated with different numbers of robotic arms.*

Source: Company Website, FDA, Frost & Sullivan analysis

Major Competitive Landscape of Natural Orifice Surgical Robots Global Market (2/2)

- Currently, there are five FDA-approved natural orifice surgical robots. The development of natural orifice surgical robots in China is in its early stages, with only two companies approved: LungHealth Medical and Edge Medical.

Manufacturer	Johnson & Johnson	MedRobotics	Momentis[5]	Noah Medical
Product	Monarch Platform	Medrobotics Flex Robotic System	Anovo (Hominis) surgical robotics platform[5]	Galaxy System
FDA	2018	2017	2021	2023
CE Mark	NA	2014	NA	2021
NMPA	2023	NA	NA	2025
Device Price[1]	~ USD 500,000	~ USD 1,000,000	Unknown	Unknown
Numbers of Robotic Arms[2]	2 (up to 3)[3]	1	2	1
Trans-natural Cavity	• Bronchus • Urinary tract	• Mouth and throat • Gastrointestinal tract	• Vagina	• Bronchus
Surgical Applications	• Diagnostic and therapeutic bronchoscopic procedures • Diagnostic and therapeutic procedures in the urinary tract	• Transoral procedures in the mouth and throat • Colorectal procedures	• Benign (non-cancerous) transvaginal surgical procedures[4]	• Bronchoscopic visualization • Diagnostic and therapeutic procedures
Key Features	• Integral soft mirror supports sheath • The platform integrates software, data analysis, robots and visual imaging	• For Colorectal operation • 3D HD display • Freely twisted arm to nearly 180 degrees • Fast, flexible and easy to use	• The first soft tissue surgical robot platform • Approved for natural orifice endoscopic-assisted transvaginal gynecologic procedures • Miniature humanoid-shaped arms, providing human level dexterity and 360-degree articulation	• C-arm fluoroscopy which provides real-time navigation and lesion updates • Single-used bronchoscope and accessories for providing faster turnaround, less cleaning, and reduced risk for cross-contamination
Cumulative installed base in 2024	NA	NA	NA	NA
New installed base in 2024	NA	NA	NA	NA
Revenue in 2024/ USD	NA	NA	NA	NA

Note: 1: Device prices are derived from via multi-channel sources, including literature researches, secondary industry report, enterprise sales data and expert interview.
2: For trans-bronchoscopic surgical robots, the bronchoscope/catheter complex has a different structure and is operated with different numbers of robotic arms.
3: The platform of Monarch cart is designed with extensible architecture, which can install up to three robotic arms approved by FDA in 2020, to seek clearance for more indications in new specialties
4: Hominis Surgical System are indicated for the following benign (non-cancerous) procedures: Total Benign Hysterectomy with Salpingo-Oophorectomy, Total Benign Hysterectomy with Salpingectomy, Total Benign Hysterectomy, Salpingectomy, Oophorectomy, Adnexectomy, Ovarian cyst removal.
5: Momentis Surgical (Used name: Memic Innovative Surgery) announced to rebrand their surgical robotic platform from "Hominis Surgical System" into "Anovo Surgical System" in July 2022

Source: Literature researches, Company Website, FDA, NMPA, Frost & Sullivan analysis

Major Competitive Landscape of Natural Orifice Surgical Robots Market in China (1/2)

- Currently, there are five FDA-approved natural orifice surgical robots. The development of natural orifice surgical robots in China is in its early stages, with only two companies approved: LungHealth Medical and Edge Medical. Edge Medical's bronchoscope robot CP1000 was approved for marketing in China in January 2025. It is the first domestically produced dual-arm bronchoscope robot product.

Manufacturer	Intuitive Surgical	Johnson & Johnson	Edge Medical	MedBot	YuanhuaTech	Tuodao Medical
Product	Ion Platform	Monarch Platform	Edge Medical Robotic Bronchoscope System	Trans-bronchial Surgical Robot	Natural Orifice Surgical Robots	Natural Orifice Surgical Robots
FDA	2019	2018	NA	NA	NA	NA
NMPA	2024	2023	2025	NA	NA	NA
Double-armed, Double-Catheter Configuration	x	√	√	x	Unknown	Unknown
Live Image Navigation Technology	√	√	√	Unknown	Unknown	Unknown
Key features	• Fiber optic shapesensing technology provides stability • Enable accurate biopsy	• Experience Vision During Peripheral Biopsy • Bronchoscope and magnet Navigation Integration	• Integrating diagnosis with treatment and advanced navigation systems provide precise positioning • Maneuverability of the catheter to articulate 180° in all directions • Access to most segments of the lung	• Mature slim conduit structure and control technology • First clinical trial of bronchoscope robot for lung diagnosis and treatment in China • Precise end positioning and control	• Unknown	• Unknown

Source: Literature researches, Company Website, FDA, NMPA, Frost & Sullivan analysis

Major Competitive Landscape of Natural Orifice Surgical Robots Market in China (2/2)

- Currently, there are five FDA-approved natural orifice surgical robots. The development of natural orifice surgical robots in China is in its early stages, with only two companies approved: LungHealth Medical and Edge Medical. Edge Medical's bronchoscope robot CP1000 was approved for marketing in China in January 2025. It is the first domestically produced dual-arm bronchoscope robot product.

Manufacturer	Kemaigy	LungHealth Medical	Microinvasive surgical Robot[1]	Broncus Medical	Aopeng Medical		Ultimage
Product	Natural orifice surgical robot	Polaris Bronchoscope Navigation Robot	Natural orifice surgical robot	Natural orifice surgical robot	Natural orifice transluminal ESD surgery robot	Natural orifice transluminal ERCP surgery robot	HEROS natural cavity diagnosis and treatment robot
FDA	NA	NA	NA	NA	NA	NA	NA
NMPA	NA	2024	NA	NA	NA	NA	NA
Double-armed, Double-Catheter Configuration	x	x	Unknown	Unknown	x	Unknown	Unknown
Live Image Navigation Technology	√	√	Unknown	√	√	√	√
Key features	• Unknown	• Seven-axis collaborative robotic arm	• Real-time human-computer interaction with tactile and visual information	• Possess a full-lung arrival navigation system	• Possesses an endoscope pushing unit with the resistance sensing function	• Unknown	• Combined with AI technology

Note: 1. Abbreviation of Tianjin University Microinvasive surgical Robot team

Source: Literature researches, Company Website, FDA, NMPA, Frost & Sullivan analysis

Major Competitive Landscape of Trans-bronchial Surgical Robots Global Market

- Currently, there are five FDA-approved natural orifice surgical robots. The development of natural orifice surgical robots in China is in its early stages, with only two companies approved: LungHealth Medical and Edge Medical.

Manufacturer	Edge Medical	MedBot	Intuitive Surgical	Johnson & Johnson	Noah Medical
Product	Edge Medical Robotic Bronchoscope System	Trans-bronchial Surgical Robot	Ion Platform	Monarch Platform	Galaxy System
FDA	NA	NA	2019	2018	2023
CE Mark	NA	NA	NA	NA	2021
NMPA	2025	NA	2024	2023	NA
Double-armed, Double-Catheter Configuration	√	x	x	√	x
Live Image Navigation Technology	√	Unknown	√	√	√
Key features	• Integration of diagnosis with treatment • Advanced navigation systems for precise positioning • Maneuverability of the catheter to articulate 180° in all directions • Access to most segments of the lung	• Mature slim conduit structure and control technology • First clinical trial of bronchoscope robot for lung diagnosis and treatment in China • Precise end positioning and control	• • Fiber optic shapesensing technology provides stability • Enable accurate Biopsy	• Experience Vision During Peripheral Biopsy • Bronchoscope and magnet Navigation Integration	• C-arm fluoroscopy which provides real-time navigation and lesion updates • Single-used bronchoscope and accessories for providing faster turnaround, less cleaning, and reduced risk for cross-contamination

Source: Company Website, FDA, Frost & Sullivan analysis

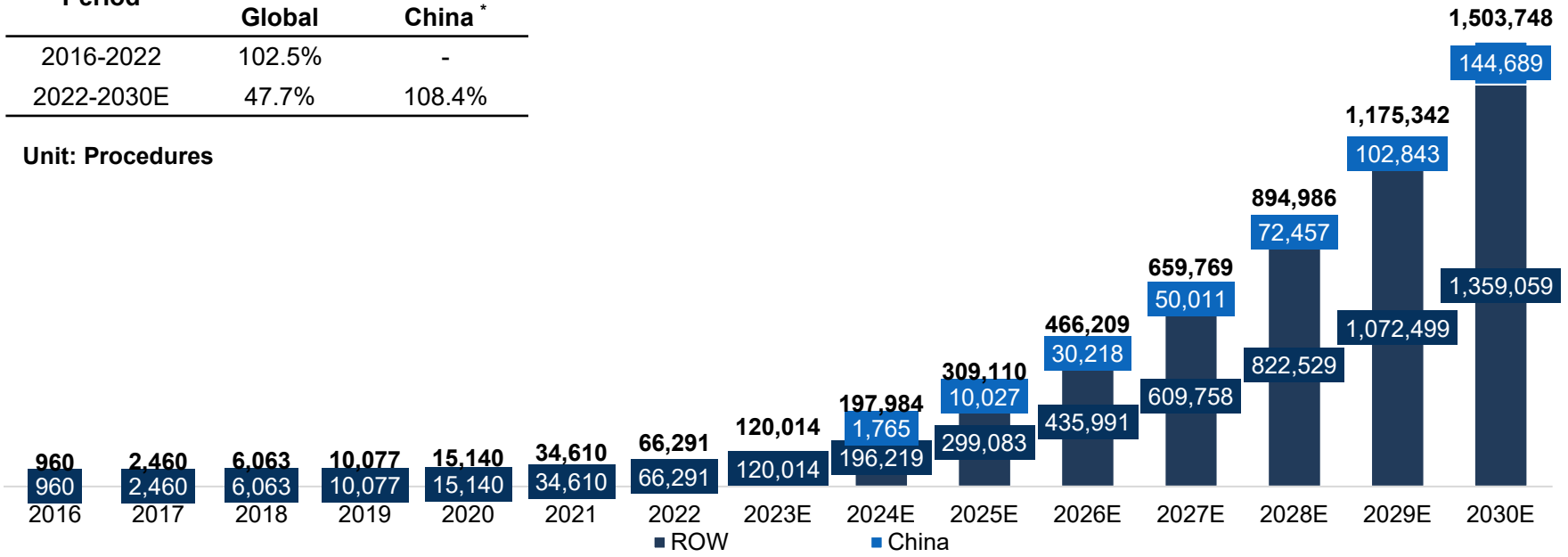
Historical and Forecast Procedure Volume of Robot-Assisted NOTES, Global vs China, 2016-2030E

- Robot-assisted natural orifice transluminal endoscopic surgery is performed by entering the abdominal cavity through the natural cavity (mouth, anus, vagina, etc.) for various diagnosis and treatment, or by Laparoscopic through the natural cavity into the thorax and other body cavities. Mainly including Laparoscopic, enteroscopy, gastroscopy, colposcopy and urethroscopy. In 2016, the global number of Natural Orifice Surgical surgeries was 960, and increased to 66.3 thousand by 2022 with a CAGR of 102.5%. It is expected to reach a number of 1,503.7 thousand by 2030E at a forecasted CAGR of 47.7%.
- With the enhanced awareness of minimally invasive surgery and the continuous breakthrough of technology, the volume of robotic-assisted Natural Orifice surgery in China is expected to grow rapidly from 1,765 procedures to 144.7 thousand procedures with a CAGR of 108.4% from 2024 to 2030E.

Historical and Forecast Procedure Volume of Robot-Assisted NOTES, Global vs China, 2016-2030E

Period	CAGR	
	Global	China *
2016-2022	102.5%	-
2022-2030E	47.7%	108.4%

Unit: Procedures



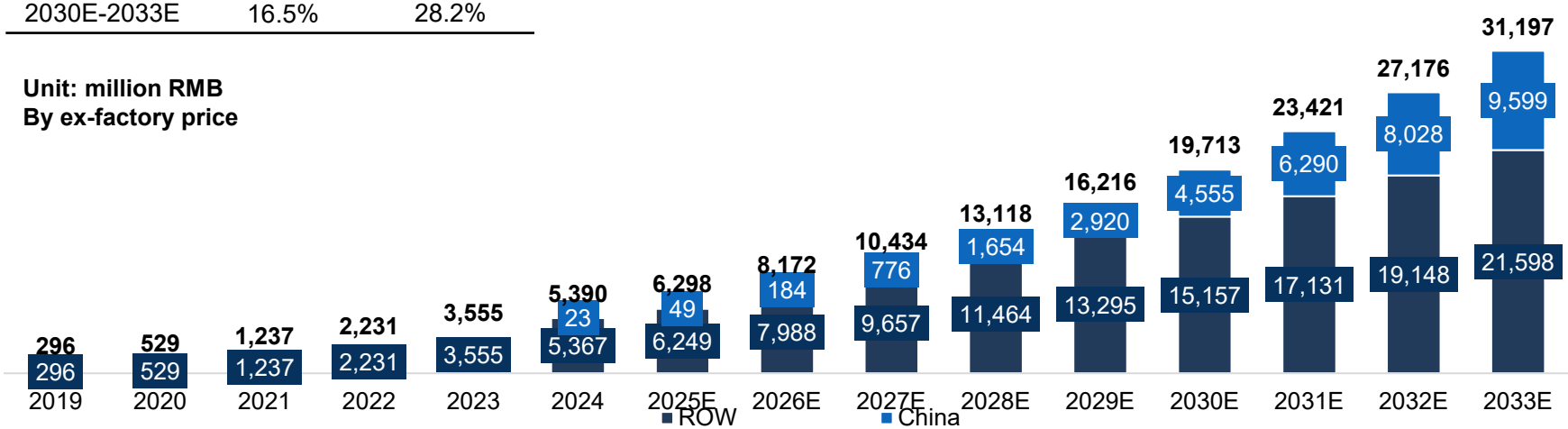
Note: The CAGR for the volume of robotic-assisted Natural Orifice surgery in China is from 2024 to 2030.

Historical and Forecast Market Size of Natural Orifice Surgical Robots, Global vs China, 2019-2033E

- The global market size of Natural Orifice Surgical Robots has maintained a rapid growth in recent years, from 296.4 million RMB in 2019 to 5,389.5 million RMB in 2024, with a CAGR of 78.6%. The global market size of Natural Orifice Surgical Robots is expected to reach RMB 31,197.0 million by 2033.
- The overall market size of Chinese Natural Orifice Surgical Robots in 2024 has reached to 22.7 million RMB; from 2024 to 2033, the Chinese Natural Orifice Surgical Robots market will remain continuously growing at a high rate and is expected to reach RMB 9,599.4 million by 2033E.

Historical and Forecast Market Size of Natural Orifice Surgical Robots, Global vs China, 2019-2033E

Period	CAGR	
	Global	China
2019-2024	78.6%	-
2024-2030E	24.1%	142.0%
2030E-2033E	16.5%	28.2%



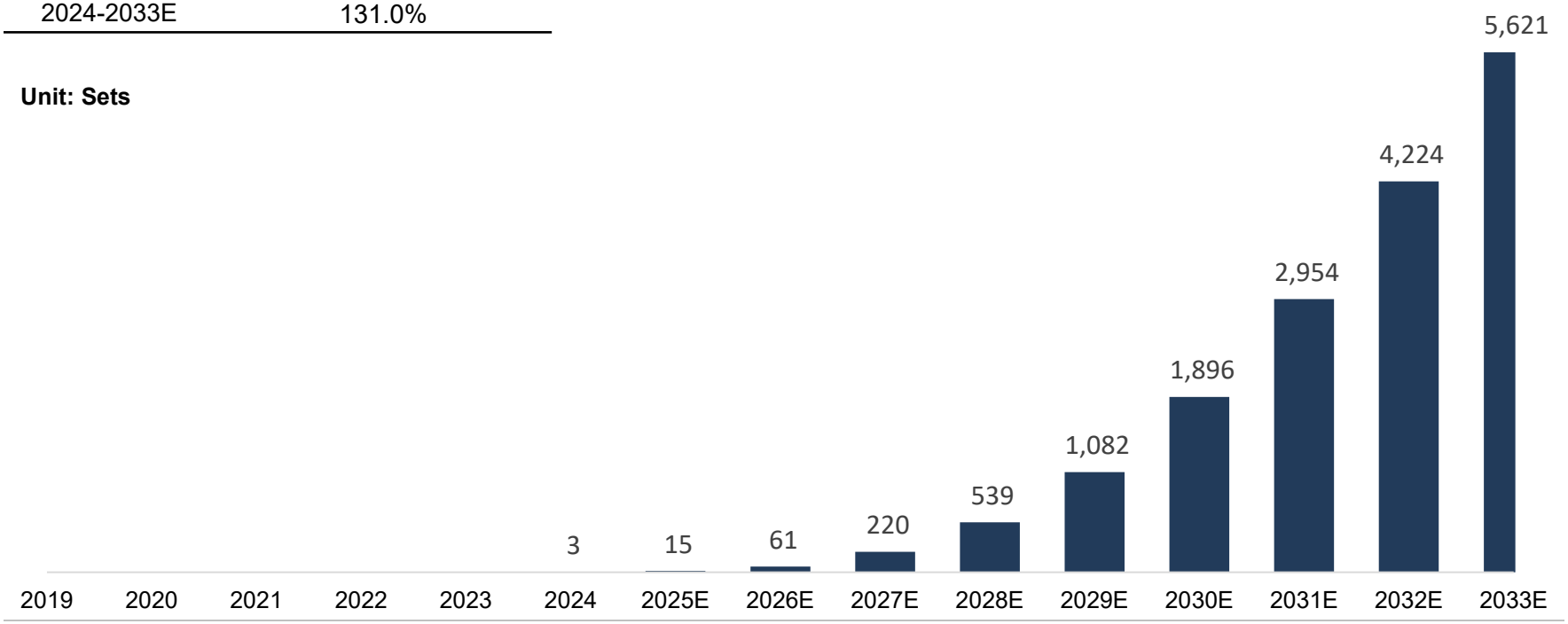
Note: The CAGR for the market size of robotic-assisted Natural Orifice surgery in China is from 2024 to 2033.

Historical and Forecast Installed Base of Natural Orifice Surgical Robots in China, 2019-2033E

- Currently, natural orifice surgical robots in China is under development. However, as people become more health conscious and demand for robotic surgery increases, the cumulative number of natural orifice surgical robots in China will grow rapidly in future. Starting from 3 sets in 2024 and reach 5,621 sets in 2033, with a CAGR of 131.0%.

Historical and Forecast Installed Base of Natural Orifice Surgical Robots in China, 2019-2033E

Period	CAGR
2019-2024	-
2024-2033E	131.0%



Source: Frost & Sullivan Analysis

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Overview of 3D Medical Endoscope

- When using 2D and low-resolution images, the drawback is the loss of depth perception. Therefore, it is necessary to adopt high-precision display technologies such as 3D and 4K to achieve a realistic visual effect. Regarding the application of imaging technology in the field of surgical endoscopy, there are mainly two major trends. One is the development of 3D and high-definition endoscopes, and the other is the development of imaging processing devices. The sense of reality of image processing 3D products cannot be compared to real 3D endoscopes, and can only be used as a supplement.
- 3D imaging technology enables surgeons to close wounds more precisely, especially in gastrointestinal and gynecological surgical procedures. When performing endoscopic surgery, if 3D images are used, it is easier to grasp the positional relationship at the time of suture, etc., so it can speed up the operation and reduce the burden on the surgeon.

2D Endoscope

- In the last century, people invented 2D endoscope, which is known as a major breakthrough in the surgical field. Surgeons do not need to perform operations through large incisions. They only need to make a small incision of 1-2 cm on the surface of the human body and insert endoscopes into the chest cavity of the patient, then they can complete the operation while watching "TV".

3D Endoscope

- In the past few years, 3D HD video technology was applied to endoscopy surgery. Doctors wearing auxiliary 3D glasses can see 3D images of the surgery on a 3D monitor.
- When the surgeon wears 3D glasses, the field of vision will be dark, and a endoscopic operation often lasts four or five hours, which can easily cause visual fatigue and dizziness, increase the risk of doctor's judgment.

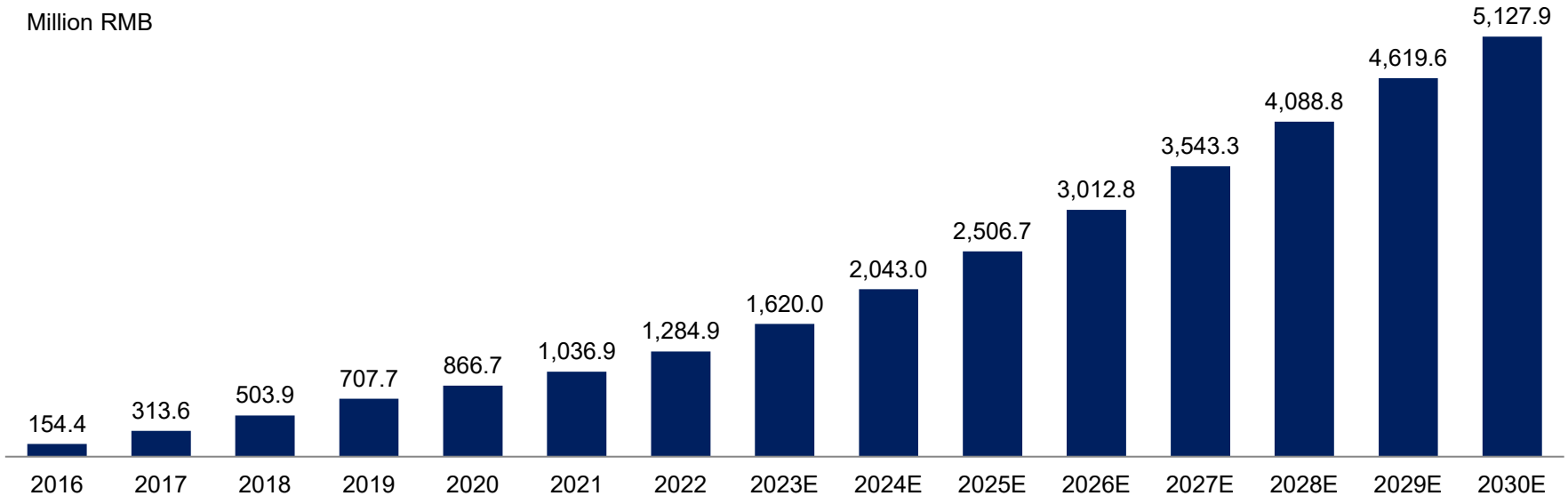
Source: Literature Review, Frost & Sullivan Analysis

Historical and Forecasted Market Size of 3D Endoscopy in China, 2016-2030E

- The market size of 3D endoscopy in China has maintained a rapid growth in recent years, from 154.4 million RMB in 2016 to 1,284.9 million RMB in 2022, with a CAGR of 42.4%. The market size will further expand, reaching 5,127.9 million RMB in 2030, with CAGR of 18.9% from 2022 to 2030.

Historical and Forecasted Market Size of 3D Endoscopes in China, 2016-2030E

Period	CAGR
2016-2022	42.4%
2022-2030E	18.9%



Source: Frost & Sullivan analysis

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Overview of Surgical Stapler

- Surgical stapler is a medical device that replaces manual suture. The main working principle is to use titanium nails to anastomose while the blade is cutting the tissue.

Application fields

- Has been applied in many clinical operations:
  - Cardiothoracic surgery
  - Gastrointestinal surgery
  - Hepatobiliary spleen and pancreatic surgery
  - General surgery
  - Urology, etc.

Standards

- Product technical requirements
  - *《Guiding Principles for the Preparation of Technical Requirements for Medical Device Products》*
- Product Standard
  - *YY/T 0245-2008: General specifications for stapler*
  - *YY 0875-2013: Linear stapler and cartridge*
  - *YY 0876-2013: Linear cutter stapler and cartridge*
  - *YY/T 1415-2016: Skin stapler*

Characteristics

- Compared with traditional manual suture, staplers have the following advantages:
  - Simple and convenient operation
  - Fast suture, which shortens the operation time
  - Few side effects and effectively reduces surgical complications.
  - Avoiding the defects of manual sutures and sewing tightly and moderately tightly
  - Enabling the removal of tumors that could not be removed in the past

Source: Frost & Sullivan Analysis

Application of Surgical Stapler

- Surgical staplers can be categorized according to shape and application field.

	Type	Usage	Application Scenarios
Open Stapler	Linear Stapler	Closure of tissue incision and closure of stump	Abdominal surgery, thoracic surgery and pediatric surgery
	Circular Stapler	Anastomosis of the end of the digestive tract such as esophagus and gastrointestinal tract and resection of anorectal hemorrhoids	Esophagus and gastrointestinal surgery
	Linear Cutting Stapler	Resection and anastomosis of tissues and organs	Gastrointestinal surgery, gynecology, thoracic surgery and pediatric surgery
	Purse-string Stapler	Purse-string suture, often used in conjunction with a circular stapler	Esophagus and gastrointestinal surgery
	Skin Stapler	Suture of longer skin incisions	General surgery, orthopedics, obstetrics and gynecology, burns, emergency, cardiothoracic surgery, neurosurgery and other operating rooms
Endo Stapler* & Smart Stapler		Resection, transection and suture of tissue	Oncology surgery, cardiothoracic surgery, gastrointestinal surgery, hepatobiliary spleen and pancreas surgery, general surgery, gynecology, pediatrics

**Note: Endo staplers only include manual endoscopic staplers.*

Source: Frost & Sullivan Analysis

Introduction of Smart Staplers

- After the popularization of endo staplers, the demand for convenience and efficiency has arisen.
- By pushing a few buttons, smart staplers are able to automatically complete complex movements, significantly reducing the workload of doctors during surgeries. Smart staplers are leading the future trends with multiple advantages.

	Smart Staplers
Advantages	• Providing precision and maneuverability with fully powered articulation, rotation, and clamping • Substituting traditional surgical suturing with faster speed, fewer side effects and reduced surgical complications • Easy to use without requiring proficient surgical suturing skills
Development Trends	• Changing different firing parameters for better anastomotic outcomes through chip recognition technologies • By detecting tissue thickness, prompting the surgeon whether the staples are within the effective stitching range, greatly reducing the malformation of the staples and human operation errors • Adjusting firing speed according to real-time feedback to ensure stapling effectiveness
Technical Barriers	• Reliability of stapling effects, including nail shape and leaking, etc. • Stability of the stapler during firing with more consistent compression of stapler onto tissue, optimizing the average compressive force on target tissue • Intelligent and automatic system

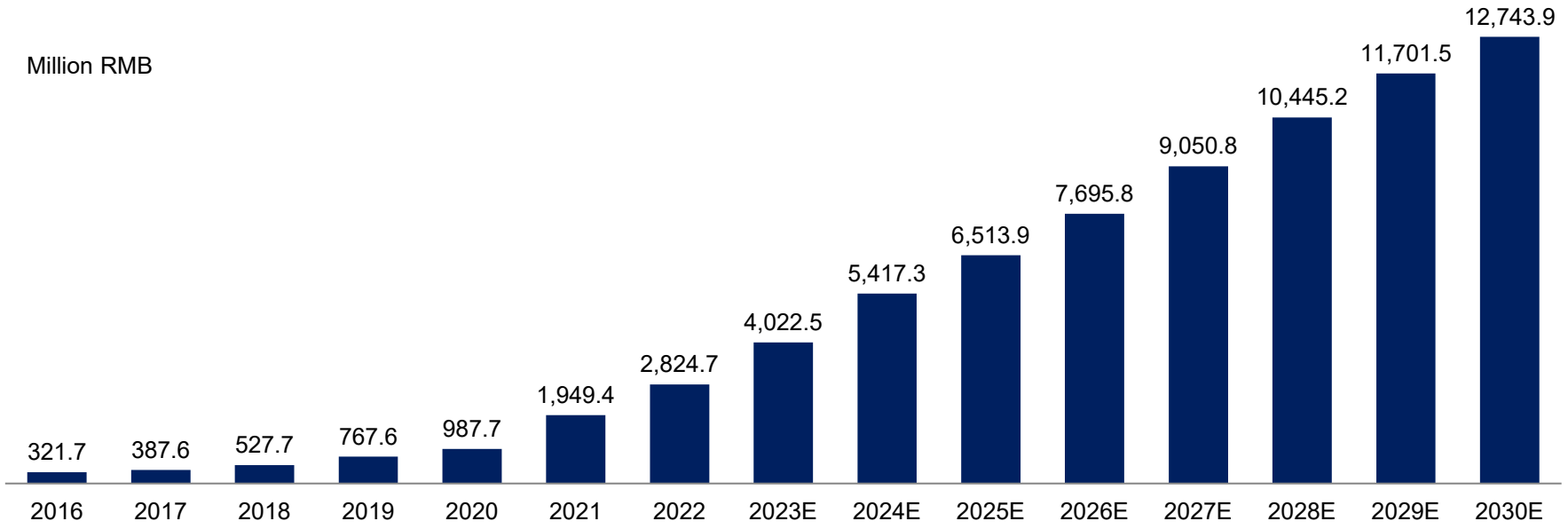
Source: Frost & Sullivan Analysis

Historical and Forecasted Market Size of Surgical Smart Stapler in China, 2016-2030E

- The market size of surgical smart stapler in China reveals a rising trend. It has increased from 321.7 million RMB in 2016 to 2,824.7 million RMB in 2022, representing a CAGR of 43.6%.
- With the development of novel technique, the surgical smart stapler market in China will expand rapidly, reaching 12,743.9 million RMB in 2030, with CAGR of 20.7% from 2022 to 2030.

Historical and Forecasted Market Size of Surgical Smart Stapler in China, 2016-2030E

Period	CAGR
2016-2022	43.6%
2022-2030E	20.7%



Source: Frost & Sullivan analysis

Confirmation

- Only less than 10% of all Class III Grade A hospitals in China had adopted da Vinci Surgical Systems as of the Latest Practicable Date.
- As disclosed by China National Intellectual Property Administration, Edge Medical rank the first among Chinese surgical robotics companies in terms of the number of Chinese patent grants and patent applications.
- Open surgery usually requires an incision of the patient's skin that is usually larger than 5 centimeters to complete the procedure. It typically involves greater damage to surrounding organs, more intraoperative bleeding, susceptibility to infection, more postoperative complications, longer hospitalization and recovery time and eventually increased hospitalization costs.
- Robot-assisted surgery is accomplished by the surgeon in front of a console of the robot with the control over the handle and remote maneuvers to manipulate the tips of robotic arms.
- A endoscopic surgical robot typically consists of a surgeon's console, a patient-side cart and a vision system. In the patient-side cart, surgical instruments attached to robotic arms are remotely controlled by surgeons to accomplish tasks, including ratcheting up, cutting, clotting, dissecting, suturing and manipulating tissues, with greater precision than human hands.
- The U.S. is currently the largest market for endoscopic surgical robots, and the da Vinci Surgical Systems are the major products that dominate the global market.
- Since robot-assisted surgery can provide increased precision in complex procedures and reduce the incidence of surgical complications, endoscopic surgical robots are suitable and widely used for urologic, general and gynecologic surgery in China.
- According to public information, Edge Medical is the only domestic company that is developing staplers for surgical robots as of the Latest Practicable Date.
- Robotic bronchoscopy can reach more than 90% of the lung segments covering the sixth and above order segmental bronchi and allows surgeons to perform real-time accurate biopsy or ablation procedures, thereby enabling earlier and more accurate diagnosis and treatment of lung nodules.
- Edge Medical initiated a clinical trial for SP1000 in gynecologic surgery in November 2021 and have received ethics committee approval from four clinical trial institutions, which makes SP1000 the first single-port surgical robot in China that has entered the clinical trial stage in gynecologic surgery.

Confirmation

- The timespan of Edge Medical's MP1000's clinical trial in urologic surgery is shorter than the average time for other Chinese surgical robotics companies to complete their pivotal clinical trials.
- The degrees of freedom in total of the robotic arm and instruments of Edge Medical's MP1000 represent the highest level in the endoscopic surgical robots industry globally.
- A surgeon at the First Affiliated Hospital of Zhengzhou University successfully performed a prostatectomy with Edge Medical's MP1000 on a patient who was diagnosed with a late-stage prostate cancer in only 111 minutes, which was shorter than the average time spent in open surgery
- Robotic bronchoscopes are a category of natural orifice surgical robots with great clinical and market value. Bronchoscopy is widely used for biopsy of pulmonary nodules. Simple procedures, such as ablation, can be performed during bronchoscopy. Because of the limitation on the control accuracy and flexibility of bronchoscopes, as well as the lack of navigation technology, conventional bronchoscopes can only access approximately 50% of the bronchial region and thus the diagnostic accuracy is relatively low.
- A surgeon at the Chinese PLA General Hospital successfully performed a retroperitoneal partial nephrectomy using Edge Medical's MP1000 on a patient with a right kidney tumor with only seven-minute warm ischemia, which was shorter than the average warm ischemia time of robot-assisted surgery.
- The degrees of freedom in total of the endoscope and the instruments of Edge Medical's SP1000 represent the highest level in the endoscopic surgical robots industry globally.
- Edge Medical's Edge Bronchoscope Robot conducted animal testing in January 2022, which was the first case of animal testing for two-arm bronchoscope robots in China.
- Da Vinci Surgical Systems are the most widely used multi-port surgical robots in the world.
- Edge Medical is the only Chinese company that included T4 late stage cancer in the pivotal clinical trial in urology conducted in China.

Confirmation

- There was no registration application by Class III medical device candidates admitted to the Green Path that was rejected due to objection received during public notification period
- Based on the analysis of public information released by the NMPA, the overall passage rate for Green Path applications is under 25% (352 out of over 1,600 applications as of December 31, 2021), and only 46 and 59 Class III medical device candidates were admitted to the Green Path in 2020 and 2021, respectively.
- Edge Medical's SP1000 was the first animal testing case performed using a single-port surgical robot in China.
- As of the Latest Practicable Date, 73 companies had obtained NMPA approval in China for their smart staplers.
- As of the Latest Practicable Date, 15 companies in total including six Chinese companies had obtained NMPA approval in China for their 3D endoscopes
- The upgraded features and newly added functions in each new generation of the da Vinci Surgical System have expanded its application to more surgical specialties and provided improved accuracy, operability, precision and dexterity to surgeons.
- The learning curve for minimally invasive surgery is longer than that for open surgery because the laparoscopic device changes the surgeon's sense of vision and touch in laparoscopic surgery, lacking depth of field and directional recognition, and the surgeon needs to find a visual reference to recognize the three-dimensional level when applying it. In addition, conventional minimally invasive surgery is operated with levers, which have low precision and unable to eliminate physician hand tremors. And the instruments are simple and have limited flexibility. In some complex surgeries, the operator often operates in an awkward position. Robot-assisted surgery allows surgeons to operate instruments intuitively and is able to simulate human hand movements, complemented by its own features of tremor filtering, 3D high-definition images, high degrees of freedom and high flexibility, which greatly shorten the learning curve for surgeons. With the support of VR technology, surgeons can perform multiple surgical simulations on the robot platform.
- Da Vinci Xi is an updated version of Da Vinci Si. Da Vinci Xi features upgrades in various functionalities from da Vinci Si (such as improved vision and dexterity) but they are not radically different products.

Confirmation

- In March 2018, the former national Health and Education Commission released the Notice on Issuing a Management Catalog (2018) for Licensing the Configuration of Large Medical Devices (大型醫用設備配置許可管理目錄（2018年)), the endoscopic surgical instrument control Systems (surgical robot) from the original category A was adjusted to category B, by the provincial health commission responsible for configuration management. This makes the approval of the configuration of surgical robots from the National Health Commission to the provincial health commissions, simplifying the approval process and shortening the approval cycle. The procurement of surgical robots has been changed from a unified bidding process (once a year) by the National Health Commission to a centralized procurement process at the end of each quarter or specific month by provincial health commissions, which takes only 2-3 months from application to approval, making it more convenient for medical institutions to apply for and eventually purchase surgical robots.
- An intelligent platform with continuous cross-fertilization of multiple intelligent technologies will become the future application trend. The integration of artificial intelligence, augmented reality technology, and surgical robots helps to achieve preoperative intelligent surgical planning. Intraoperative 3D holographic imaging and robot-assisted operation to improve the clarity of the surgeon's surgical field of vision and surgical precision. The integration of IoT, 5G, and mixed reality technologies with surgical robotics enables expert remote consultation and remote surgical treatment. It also expands the scope of application to cover a variety of surgical robots and multiple surgical specialties, forming a comprehensive platform covering a full range of surgical specialties and providing insight into surgeons' needs to develop customized solutions.
- The da Vinci surgical systems, developed by Intuitive Surgical Inc. (“Intuitive Surgical”), are the most widely used surgical robots in the world. Take, for example, the upgrade of the da Vinci Surgical Robot: In 2000, Intuitive Surgical released the first generation of the da Vinci Surgical Robot, the first ever integrated endoscopic surgical robot, which was approved by the FDA. The da Vinci S model came out in 2006 and offered improved robotic arm movements, console displays, and simpler set up. The da Vinci Si model came out in 2009 and offered dual consoles, analog controllers, and intraoperative fluoroscopic imaging technology. The 4th generation da Vinci Xi robot was released in 2014, with improvements in flexibility, precision, and imaging clarity. The fourth generation Da Vinci X system robot was released in 2017, adding new features such as an acoustic system, a laser guidance system, and a lightweight endoscope, and a smaller robotic arm, maintaining the basic features of da Vinci Xi at a more affordable price. In 2018, da Vinci SP, the single-hole laparoscopic surgical robot, received FDA approval for urology procedures.

Confirmation

- Edge Medical's SP1000 conducted the first case of radical operation for cervical cancer and level 4 surgery in China completed by a domestically developed single-port surgical robot
- Edge Medical's MP1000 the first case of radical operation for stage IV ovarian cancer in China completed by a domestically developed multi-port surgical robot
- Frost & Sullivan conducted a sample of hospitals to obtain the average daily endoscopic surgery volume (including laparoscopic and thoracoscopic procedures) for different levels of hospitals, and then combined this with the Chinese hospital classification and its volume in the Chinese Health Statistical Yearbook to obtain the overall endoscopic surgery volume in China, which was 8,824,160 in 2020 and is expected to grow to 36,171,627 by 2030. Frost & Sullivan also obtained the volume of robotic-assisted endoscopic procedures in China based on the global volume of procedures disclosed in the Intuitive Surgical Annual Report and interviews with relevant experts in the industry. Based on the overall endoscopic surgery volume in China and the robotic-assisted endoscopic surgery volume in China, the penetration rate of robotic-assisted endoscopic surgery volume in China was obtained with a growing trend. The penetration rate of robot-assisted endoscopic surgery will gradually increase, with a penetration rate of only 0.5% in 2020 and expected to reach 5.1% by 2030 in China.
- Based on the installed base of the da Vinci SP system in the U.S. and its future trends disclosed in Intuitive Surgical's annual report, combined with the in-process research of Chinese single-port endoscopic surgical robot manufacturers and interviews with experts in the industry, Frost & Sullivan obtained the expected future installed base of single-port endoscopic surgical robots in China. Frost & Sullivan predicts that single-port endoscopic surgical robot will be approved in 2022 in China, and the installed base of which will increase from 9 units in 2022 to 1,773 units in 2030.
- Endoscopic surgical robot currently in the design development phase and not yet in clinical trials are: Shenzhen konosteng Technology's multiport endoscopic surgical robot, B.J.ZH.F.Panther Medical's endoscopic surgical robot, BORNS's multiport endoscopic surgical robot, Easyaploon's endoscopic surgical robot, Jinshan Science and Technology's multiport endoscopic surgical robot and Shuchuang Robot's endoscopic surgical robot.
- In 2018, the FDA approved the da Vinci SP Surgical System for use in single-port urological surgical procedures for adults. In 2019, the FDA approved the da Vinci SP Surgical System for use in transoral otolaryngology surgical procedures in the oropharynx restricted to benign tumors and malignant tumors classified as T1 and T2 for adults.
- Da Vinci SP Surgical System is expected to be the first single-port endoscopic surgical robot commercialized in 2022

Confirmation

- Natural orifice surgical robots currently in the design development phase and not yet in clinical trials in China are: Natural orifice surgical robot of Yuanhua Tech (元化智能科技); Natural orifice surgical robot of Kemaiqy (科迈启元), applied in TUR (transurethral resection); Natural orifice surgical robot of Tuodao Medical (佗道医疗); transnatally flexible endoscopic surgery robot of Langhe Medical (朗合医疗), applied in lung cancer; Natural orifice surgical robot of Tianjin University Microinvasive surgical Robot team (天津大学妙手微创手术机器人团队), applied in gastrointestinal diseases; Natural orifice surgical robot of Kunbo Medical (堃博医疗), applied in lung diseases；Natural orifice transluminal ESD surgery robot and natural orifice transluminal ERCP surgery robot of Aopeng Medical (奥朋医疗) applied in gastrointestinal diseases; HEROS natural cavity diagnosis and treatment robot (ESD surgery robot) of Ultimage (中科华影)
- Founded in 2017, Edge Medical is an advanced surgical robot company in the medical device industry, dedicated to designing, developing and manufacturing surgical robots.
- Under the leadership of the founders of Edge Medical, Dr. Wang and Dr. Gao, who both have around 10 years of experience in surgical robot research and are the pioneers in China's surgical robot industry.
- In 2020, the number of gynecologic surgeries performed using da Vinci SP Surgical Systems accounted for approximately 42.0% of the procedure volume of da Vinci SP Surgical Systems in Korea, followed by head and neck surgery accounting for approximately 35.0%, general surgery, urology and others
- The frequency of preventive maintenance inspections for da Vinci Surgical Systems is typically one to four times per year; and the annual maintenance fee for da Vinci Surgical Systems in China ranges from RMB1.2 million to RMB3.0 million.
- Following a submission of correct/additional materials as required by the supplemental request notice from the CMDE, it typically takes less than six months for the NMPA to grant approval.
- There were five companies which had their multi-port endoscopic surgical robots approved in China, but no single-port endoscopic surgical robot had been approved in China, according to Frost & Sullivan.
- As there may be no single-port endoscopic robot commercialized in China until 2022, the procedure volume before 2022 is not available.
- Although currently there is no single-port endoscopic surgical robot approved in China, the single-port endoscopic surgical robots are expected to gradually gain popularity.

Confirmation

- In China, among the major international surgical robot companies, Intuitive Surgical's fourth generation da Vinci Xi Surgical System and third generation da Vinci Si Surgical System were the only products that had been approved by the NMPA.
- There was no single-port endoscopic surgical robots approved by the NMPA in China, and Surgerii and MedBot were the only other domestic companies than Edge Medical that were developing single-port endoscopic surgical robots in China.
- According to public information, Edge Medical was the only domestic company that is developing staplers for surgical robots.
- From 2018 to 2021, the da Vinci SP Surgical System was one of the only two single-port endoscopic surgical robot products approved and commercialized globally and was the product that dominated the market.
- Edge medical is first company in China having completed the pivotal clinical trials of both multi-port and single-port endoscopic surgical robots. The company has substantially completed the pivotal clinical trial of SP1000 and are now in the process of preparing the final clinical report.
- There are five companies which had their multi-port endoscopic surgical robots approved in China, but no single-port endoscopic surgical robot had been approved in China
- According to public information, Edge Medical was the only domestic company that is developing staplers for surgical robots
- Intuitive Surgical was the only company in the world that had completed the pivotal clinical trials and obtained approval from regulatory authorities for both multi-port and single-port endoscopic surgical robots, and Edge Medical was the first company in China having completed the patient enrollment in the pivotal clinical trials of both multi-port and single-port endoscopic surgical robots. The company has substantially completed the pivotal clinical trial of SP1000 and are now in the process of preparing the final clinical report.
- Shenzhen manufacturing center of Edge Medical is expected to be larger than all the existing surgical robot manufacturing facilities in China.
- Colon cancer is one of the most common cancers worldwide by incidence.

Confirmation

- Except for its da Vinci SP Surgical System which is a single-port endoscopic surgical robot, all of its da Vinci Surgical Systems are multi-port endoscopic surgical robots. In addition to the da Vinci Surgical Systems, as of the Latest Practicable Date, there were six other multi-port endoscopic surgical robots that were approved by the FDA or the Ministry of Health, Labor and Welfare of Japan or obtained CE Mark, including Asensus's Senhance, Avatera Medical' s A vatera, CMR Surgical' s V ersius, Meerecompany' s Revo-I, Medtronic' s Hugo and Medicaroid's Hinotori Surgical Robot System.
- In China, among the major international surgical robot companies, Intuitive Surgical's fourth generation da Vinci Xi Surgical System and third generation da Vinci Si Surgical System were the only products that had been approved by the NMPA.
- Globally, only two trans-bronchoscopic surgical robots are approved by the FDA, namely Intuitive Surgical's Ion Platform, with one robotic arm, and Johnson & Johnson's Monarch Platform, with two robotic arms.
- Globally, four natural orifice surgical robots were approved by the FDA or obtained CE Mark, including Intuitive Surgical's Ion Platform for peripheral lung nodule biopsy, Johnson & Johnson's Monarch Platform, Memic's Avono (Hominis) for transvaginal robotic surgery and MedRobotics' Flex for visualization of, and surgical site access to, the anus, rectum and distal colon, among which the first two products are bronchial surgical robots.
- In China, none of the existing natural orifice surgical robotic products launched in the U.S. or EU has received approval from the NMPA. Edge Medical and MedBot are the only two domestic companies that are developing natural orifice surgical robots. Edge Medical's bronchoscope surgical robot is for diagnostic and therapeutic bronchoscopic procedures, while MedBot's trans-bronchial surgical robot is for lung diagnosis and treatment and lung biopsy.
- The aggregate market size of multi-portendoscopic surgical robots, single-port endoscopic robots, natural orifice surgical robots, 3Dendoscopes and smart staplers in China is expected to grow to RMB 56,778.3 million by 2030.
- Ovarian cancer staging is the first domestic multi-port endoscopic surgical robot to perform a radical surgery for the treatment of stage IV advanced ovarian cancer.
- Gastric cancer is one of the top ten most common cancers in China by incidence.
- Lung cancer is one of the top three most common cancers in China by incidence.
- MP1000, Intuitive Surgical's da Vinci Surgical Robot and MedBot's Toumai Laparoscopic Surgical Robot are the only products with a four-arm structure approved in China.

Confirmation

- The main assumption of this prediction is that the market growth in China will mirror the trend in the number of newly installed Da Vinci SP Surgical System in the United States, which grew from 13 units per year in 2018 after its FDA approval to 24 units per year in 2021 at a CAGR of 22.7% and translates to a CAGR of 87.0% in terms of the growth in the number of cumulatively installed Da Vinci SP Surgical System.
- Ovarian cancer is one of the three most common malignant tumors in gynecology, and the operation involved in its removal is typically extensive and complicated.
- The total robotic distal gastrectomy surgery completed by MP1000 is the first total robotic distal gastrectomy procedure completed by a domestic multi-port endoscopic surgical robot.
- The radical left hemicolectomy surgery completed by MP1000 is the first radical left hemicolectomy procedure completed by a domestic multi-port endoscopic surgical robot.
- The radical cervical cancer surgery completed by SP1000 is the first single-port robot-assisted radical cervical cancer surgery in China, and the first domestic single-port surgical robot used in a level 4 surgery.
- Edge Medical's SP1000 is the first and the world's second single-armed single-port surgical robot to have completed registration clinical trials in China.
- Within the industry, "endoscopic surgical robots" and "laparoscopic surgical robots" both refer to a kind of robotic surgical system that uses a minimally invasive surgical approach to operate endoscopy procedures. Endoscopic surgical robots can be used to perform endoscopy, which generally includes laparoscopy and thoracoscopy. Laparoscopy refers to a procedure that permits visual examination of the abdominal cavity with an optical instrument called a laparoscope, which is inserted through a small incision made in the abdominal wall. Thoracoscopy refers to a procedure that permits visual examination of the lung surfaces and pleural space through a viewing tube called a thoracoscope.
- There will be significant growth potential for the penetration of robot-assisted endoscopic surgeries in China due to the rising end-user demand, technological progress, surgeons' improved skill in operation of robot-assisted surgeries and favorable government policies.

Confirmation

- From 2018 to 2021, the da Vinci SP Surgical System was one of the only two single-port endoscopic surgical robot products approved and commercialized globally and was the product that dominated the market. Due to the later approval time of single-port endoscopic surgical robots, the clinical trials for certain surgical specialties are still underway in some jurisdictions. Technological constraints of single-port endoscopic surgical robots also exist, such as the relatively concentrated instrument placement site within limited surgical area, the difficulty to form an operating triangle with all the instruments and the endoscope emerged through a single cannula, and the technical requirement of more synergies when controlling instruments. Such current limitations on applicable medical procedures and technological constraints of single-port endoscopic surgical robots have resulted in a significantly smaller market size of single-port endoscopic surgical robots than multi-port endoscopic surgical robots.
- A downward pricing trend due to predicted increasing competition as the market grows in the future has also been factored into the pricing projection. As more single-port endoscopic surgical systems are approved in China, in particular, domestically manufactured products which have lower production costs, the single-port endoscopic surgical robot market is expected to be more competitive which may drive down the price of such products in China. However, the expected increase in the installed base of single-port systems endoscopic and other surgical growth drivers mentioned above will offset the future price reduction and help the market to achieve fast growth overall.
- Compared to multi-port endoscopic surgical robots, single-port endoscopic surgical robots are more suitable for surgeries that require access to a narrow workspaces and further minimize wounds to patients, with fast postoperative recovery and high patient acceptance, specially for young patients with certain aesthetic requirements. Single-port endoscopic surgical robots are one of the major directions for the development of next generation surgical robots.
- In the United States robot-assisted surgery is covered by both commercial health insurance and national health insurance reimbursement.
- Intuitive Surgical adopts a similar fee model for its da Vinci Xi Surgical Systems and charges approximately 10% of the equipment retail price for subsequent maintenance each year starting from the second year after purchase.
- The general timeframe required from manufacturing, delivery to installation of MP1000 is approximately three to six months.
- Surgical robot is a sophisticated manipulating robot that assists the surgeon with performing minimally invasive surgery (the “MIS”) by enabling the surgeon to remotely control precise micromovements of surgical instruments that are placed inside the patient’s body through small incisions.

Confirmation

- It is also expected that more commercial insurance coverage will become available for robot-assisted surgeries in China as participants in the industry have been negotiating with insurance companies for their inclusion and given the fact that insurance companies have increasingly extended the coverage to expensive procedures. Although the penetration rate of single-port endoscopic surgical robots in China is not currently available because no single-port endoscopic surgical robot has been approved in China, Frost & Sullivan projected that the penetration rate in China will increase in the future mainly based on: (I) the rapid increase in the installed base andsurgical penetration rate of the da Vinci multi-port surgical systems when they were first launched in China, (2) the rapid increase in the installed base and surgical penetration rate of the da Vinci multiport surgical systems when they were first launched in the U.S. and (3) the increase in the installed base and surgical penetration rate of the da Vinci Sp Surgical System in the U.S. Based on the aforementioned advantages, trends and the predicted overall acceptance and penetration in Chinaand as single-port endoscopic surgical robots will be approved in China in the future, their surgicavolume and market size will grow rapidly in the future.
- In Shanghai, certain surgeries (namely radical prostatectomy, partial nephrectomy, total hysterectomy, and radical resection of rectal cancer) performed using endoscopic surgical robots are currently covered under the medical insurance reimbursement list, thus such surgeries performed with the approved products, namely da Vinci Surgical Systems and Toumai Laparoscopic Surgical Robots, are eligible for reimbursement.
- In April 2021, four clinical applications of robotic-assisted surgery (i.e. radical prostatectomy, partial nephrectomy, total hysterectomy, and radical resection of rectal cancer) were covered by the medical insurance reimbursement list in Shanghai, which demonstrated the recognition of the importance of endoscopic surgical robots and more clinical applications performed by robotic-assisted surgery are expected to be included in the medical insurance reimbursement list of more provinces and cities.
- The ex-factory price of MP1000 is approximately 50% lower than that of da Vinci Surgical Systems.
- While robotic-assisted MIS allows for a minimally invasive HKEX 3rd 1(vi) approach that may result in less post-operative pain, scarring, risk of infection and faster recovery time, the long-term effectiveness and safety of robotic-assisted MIS for cancer-related procedures have not been studied as adequately as traditional treatments. For example, there might be potential risks associated with the use of surgical robots for mastectomy or other procedures in the prevention or treatment cycle for patients who have breast cancer and further studies are needed to evaluate the long-term benefits and risks.

Confirmation

- Open surgery and conventional MIS accounted for 63.9% and 33.0% of the global surgical volume in 2021, respectively. In China, open surgery, conventional MIS and robotic-assisted MIS accounted for 85.7%, 14.2% and 0.1% of the surgical volume in 2021, respectively.
- Usually, domestic surgical robot companies normally recognize revenue when end-customer hospitals issue acceptance confirmations.
- Domestically manufactured MP1000 enjoys various cost advantages over da Vinci Surgical Systems, such as lower logistics costs and tariffs compared to international transportation costs and tariffs for imported products.
- MP1000 has a comprehensive indication coverage including urology, gynecology, general and thoracic surgeries and the registrational applications of all these indications have been accepted by the NMPA, presenting a lead over its domestic competitors. The appeal of MP1000 can be further demonstrated by its short approval-to bid-winning time that MP1000 achieved the first sales order in the same month as it received regulatory approval
- Edge Medical's MP1000 has broader application than other domestic brands such as being capable of using in T4 cancer in urologic surgery.
- Edge Medical's MP1000 has an additional robotic arm than other domestic brands developing three-armed endoscopic surgical robots, which offers a better flexibility and hence enhanced performance and better functionality.
- It is within industry norm that medical device companies may negotiate the prepayment percentage with distributors and such percentage may vary based on different commercialization strategies.
- A hospital normally issues acceptance confirmations after the product is installed by the medical device company and tested by the hospital.
- As of December 3l, 2022.the installed base of da Vinci Surgical Systems in the U.S. was 4,563 sets, representing 60.5% of the global installed base.
- The installed base of da Vinci Surgical Systems in China was only approximately 317 as of December 31, 2022, which represented 4.2% of the global installed base.
- The installed base of endoscopic surgical robots in China continues to grow, and the installed base of da Vinci Surgical Systems in China increased from 58 units in 2016 to 317 units in 2022.
- In 2018, the FDA approved the da Vinci SP Surgical System for use in single-port urological surgical procedures for adults. In 2019, the FDA approved the da Vinci SP Surgical System for use in transoral otolaryngology surgical procedures in the oropharynx restricted to benign tumors and malignant tumors classified as T1 and T2 for adults

Confirmation

- Approximately 289 hospitals, all of which are Class III Grade A hospitals, have installed endoscopic surgical robots as of the Latest Practicable Date, representing approximately 17% of the total number of Class III Grade A hospitals in China.
- The bidding price is relatively lower due to the generally lower pricing of 3-arm surgical robots compared to 4-arm surgical robots.
- In 2022, a total of 23 single-port endoscopic surgical robots were sold globally, all of which were da Vinci SP sold by Intuitive Surgical.
- There was no single-port endoscopic surgical robots approved by the NMPA in China as of the Latest Practicable Date, and Surgerii and MedBot were the only other domestic companies than Edge Medical that were developing single-port endoscopic surgical robots at clinical stage in China as of the Latest Practicable Date.
- Globally, five natural orifice surgical robots were approved by the FDA or obtained CE Mark as of the Latest Practicable Date, including Intuitive Surgical's Ion Platform for peripheral lung nodule biopsy, Johnson & Johnson's Monarch Platform, Momentis' Anovo for transvaginal robotic surgery, Noah Medical's Galaxy and MedRobotics' Flex for visualization of, and surgical site access to, the anus, rectum and distal colon, among which the first two products are bronchial surgical robots.
- As of the Latest Practicable Date, there were 15 major companies in total, including eight Chinese companies, that had obtained NMPA approval in China for their 3D endoscopes.
- As of the Latest Practicable Date, over 70 companies had obtained NMPA approval in China for their smart staplers.
- There are devices that can be synergistic with our surgical robots, such as 3D endoscopes, which can help the company develop devices applied for surgical robots, and there are target businesses available in the market that meet such criteria.
- Ongoing regulatory obligations and reviews are industry norm for medical device companies.
- Single-arm single-port structure requires all the instruments and the endoscope to emerge through a single cannula while at the same time ensuring that the instruments are properly triangulated around the target anatomy, more technologies and techniques are necessary to overcome the challenges related to the single-port surgery.
- There is no substitution relationship between multi-port endoscopic surgical robots and single-port endoscopic surgical robots as they are providing available options for surgeons when performing surgeries in different clinical departments according to their respective advantages.

Confirmation

- We conducted market research on both the demand side and the supply side on the relevant marketed or under-study single-port endoscopic surgical robot via multi-channel sources, including literature research, secondary industry reports, company annual reports, expert interviews, profiles of major and other competitors, and market trends. Based on these studies, we have collected the procedure volumes of marketed single-port endoscopic surgical robots and their revenues, and has estimated the market size of the single-port endoscopic surgical robots under research and relevant disclosure of global competitors to calculate the market size of single-port endoscopic surgical robots in China. Compared to multi-port endoscopic surgical robots, single-port endoscopic surgical robots are more suitable for surgeries that require access to a narrow working space and further reduce patient wounds with fast postoperative recovery and high patient acceptance, especially for young patients with certain aesthetic requirements. Single-port endoscopic surgical robots are one of the major directions for the development of next generation surgical robots. Based on the above advantages and trends, as the overall acceptance and penetration of robot-assisted endoscopic surgery in China increases, and as single-port endoscopic surgical robots are approved in China in the future, their surgical volume and market size will grow rapidly in the future.
- The general timeframe required from manufacturing, delivery to installation of multi-port surgical robots is approximately three to six months.
- The information regarding the useful life of da Vinci Surgical Systems and the pricing range of consumables is not publicly available.
- Even though the centralized procurement related rules in a few provinces, such as Anhui Province and Fujian Province, have included category B large medical devices which cover endoscopic surgical robots, in practice the centralized procurement has only been implemented on certain large medical devices such as CT and MRI equipment, and no centralized procurement of surgical robots and related consumables (including instruments and accessories for endoscopic surgical robots) has been implemented in China. Furthermore, the centralized procurement is typically applicable to medical devices that a large number of hospitals will purchase in bulk. Given the innovative nature of surgical robots and the limited number of surgical robots approved by the NMPA so far, the likelihood for surgical robots to be included in the centralized procurement scheme is low.
- it is subject to changes in the overall medical device industry in China and globally.
- We face potential competition from various sources, including major international and domestic companies which are also developing surgical robots and minimally invasive surgical instruments.

Confirmation

- According to Medical Waste Management Regulations (醫療廢物管理條例), the obsolete consumables of surgical robots should be regarded as medical wastes and unitedly disposed by medical waste centralized disposal departments, which indicates the industry norm that the obsolete consumables (including a variety of instruments and accessories) shall be discarded and cannot be recycled by manufacturers.