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Review

Precision surgery—The introduction of the da Vinci Robotic Surgical System in Hungary

Domonkos Tinka[1,*], Zsolt Jenő Szepesváry[2]

[1] Doctoral School of Economic and Regional Sciences, Széchenyi István University, H-9026 Győr, Hungary
[2] Faculty of Health and Sport Sciences, Széchenyi István University, H-9026 Győr, Hungary
*** Corresponding author:** Domonkos Tinka, tinka.domonkos@sze.hu

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Abstract: Surgical robots have been utilized for approximately three decades, primarily in high-income countries. In this paper, we focus on the experiences surrounding the introduction in Hungary of a specific robotic system originating from the United States, the da Vinci Surgical System. Manufactured and distributed by the American company Intuitive since 1995, this surgical system has been used globally in over ten million surgical procedures, with around 60,000 specialists trained to operate it. In Hungary, the robot system is distributed by the Sofmedica healthcare group. Besides Hungary, the company also operates in Romania, Greece, Bulgaria, and Cyprus. In Hungary, the company has eight active robot projects. Robot-assisted surgical interventions began in Hungary in 2022, with some healthcare facilities receiving the da Vinci System in 2023. Accordingly, the number of completed surgeries currently stands at a few thousand. During our review of the literature, we found that publications concerning robotic systems focus on three main areas: the development of robotic technology, comparisons of laparoscopic and robot-assisted surgery outcomes and advantages, and cost-benefit analyses of robot acquisition. Based on the available information, we present our findings from the past two years of Hungarian experiences, specifically those of the University Teaching Hospital in Győr-Moson-Sopron County.

Keywords: robot-assisted surgeries; global-European-Hungarian comparison; surgical specialties; urology; gynaecology; general surgery; costs; funding background

1. Introduction

In our study on surgeries assisted by da Vinci Robots, we address three main topics. First, we provide a literature review on the global, European, and Central-Eastern European applications of robotic technology. We discuss the most commonly used regional and surgical specialties where the robot is applied; however, due to space limitations, we do not delve into the evolution of robotic technology or the specific types of equipment.

Some of the publications on the medical application of da Vinci Robots focus on the technology's limitations, malfunctions, and the feedback from surgical teams to the manufacturer, which has led to further development of the equipment. We will not cover this topic or review the related literature at this time.

Following the global and European (regional) overview, we will discuss the surgical robotic systems introduced in Hungary in chronological order of their acquisition. We will then share the experiences of urological surgeries performed with the assistance of the da Vinci Robot at the Petz Aladár University Teaching Hospital in Győr-Moson-Sopron County between September 2023 and May 2024.

In subsequent publications, we will examine the return on investment and cost-benefit analysis of the da Vinci Robot Systems. Additionally, we will provide an overview of the funding background for the eight robotic systems currently operational in Hungary.

In conclusion, we will offer policy development recommendations to support the future application of these devices in Hungary.

2. Literature review

The U.S. Food and Drug Administration (FDA) approved the first version of the da Vinci Surgical System for clinical use in 2000 (Science Daily, 2000). Leung and Vyas (2014) note that "the vast majority of robot-assisted surgeries are urological, gynecological, or gastrointestinal procedures." In their article, they cite a 2010 publication by the system's manufacturer, Intuitive Surgical, which states that 70% of the surgeries performed up to that point were either prostatectomies (prostate removal) or hysterectomies (uterus removal). They highlight that, in the case of radical prostatectomy, robot-assisted surgery has become the preferred method for treating prostate cancer. Regarding gynecological interventions, it was estimated that 60% of minimally invasive hysterectomies, required for uterine cancer, were performed with robotic assistance. Several reasons explain why urologists and gynecologists are the most frequent users of robot-assisted methods: one being the frequent use of endoscopic and/or laparoscopic surgeries in these fields. Another factor is the limited availability of adequate instruments for performing surgeries in anatomically complex regions. When weighing options between open surgery, minimally invasive techniques, and robot-assisted interventions, robot-assisted surgery often stands out as offering the highest precision. Robot-assisted techniques can also be applied to other surgical procedures, such as coronary artery bypass surgeries in cardiothoracic surgery. In general oncological surgeries, they can be used for oesophageal cancer, gastric cancer, colorectal cancer, and thymic cancer.

In pediatric surgery, robot-assisted procedures can be employed for congenital heart defects, gastroesophageal reflux disease, and congenital kidney or urethral stricture. However, these applications are considerably less common than the aforementioned procedures."

Azizian et al. (2018), employees of Intuitive Surgical, were given the opportunity to share the company's accumulated experience with the da Vinci Surgical System up until 2017 in the first chapter of the first volume on Minimally Invasive Surgical Robots of the four-volume *Encyclopedia of Medical Robotics*. By 2017, approximately five million surgeries had been performed in 60 countries worldwide. The data on procedures across various specialties were compiled up to 2016, revealing that 20% of the surgeries were urological, 48% gynecological, and 28% related to general surgery (**Figure 1**). It was also evident at that time that more than 4000 of the 11,000 medical publications related to the da Vinci Surgical System between 2011 and 2016 were focused on the field of urology (**Figure 2**).

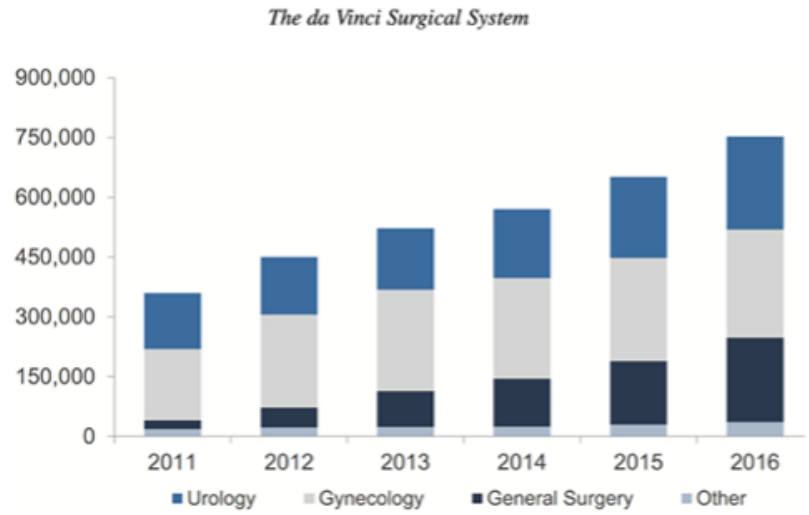

Figure 1. Worldwide da Vinci procedure growth from 2011 to 2016 (Azizian et al., 2018).

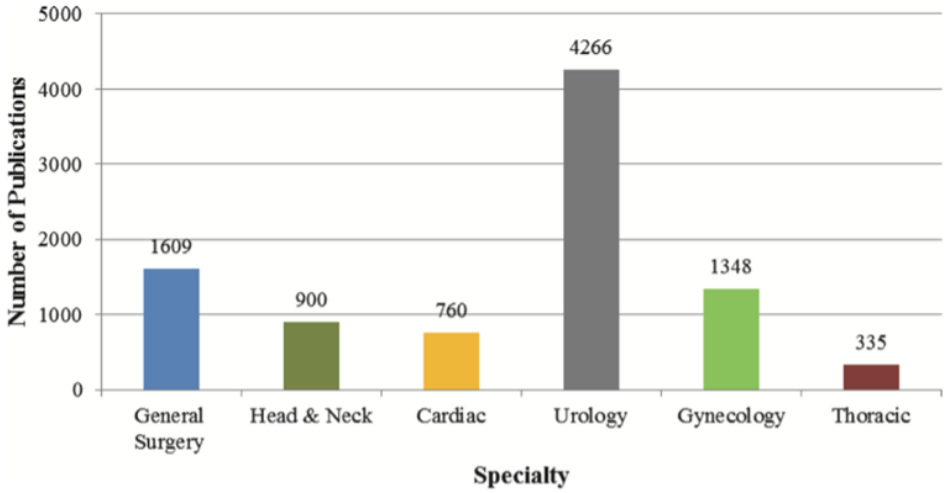

Figure 2. Publications on da Vinci technology from 1998 to 2015 by surgical specialty (Azizian et al., 2018).

Wu and Li (2017), specialists at the Faculty of Medicine of Shanghai Jiaotong University, affiliated with the Department of Thoracic Surgery at Shanghai Ruijin Hospital, described their experiences with da Vinci Robot-assisted surgeries conducted between 2006 and 2016. They found that the robotic system was primarily used for the surgical removal of cancerous lesions in the lungs, oesophagus, and mediastinum. They proposed future studies to investigate the applicability of the robotic system in pediatric surgeries, noting that da Vinci enjoys a monopoly in the field of minimally invasive robot-assisted surgical procedures. The authors emphasized that operations performed by the robotic system resulted in less tissue damage, fewer post-operative complications, and shorter recovery times compared to traditional camera-assisted thoracoscopic surgeries. Additionally, they pointed out the high cost of the robotic system and the need for further technological advancements. Both of these challenges, they suggested, could be mitigated over time through economies of scale and ongoing technical improvements.

Chen et al. (2017), specialists from the Hepatobiliary Surgery Department of Chongqing Medical University, expressed high expectations and confidence in future developments for da Vinci-assisted procedures in hepatobiliary surgery (involving the bile, liver, pancreas, gallbladder, and bile ducts). They acknowledged that the number of procedures performed in this specialty (particularly within China) remains relatively low, and for the time being, laparotomy and/or laparoscopic methods cannot be entirely replaced by da Vinci Robot-assisted surgeries. However, they noted that in anatomically complex regions, the da Vinci system has provided a clear breakthrough compared to laparoscopic techniques. Additionally, they suggested that the da Vinci system is expected to serve as the foundation for telemedicine in the future.

Koh et al. (2018) drew their conclusions based on the experiences from 10,267 procedures performed using the da Vinci Surgical System at Severance Hospital (Yonsei University Health System) in Seoul between July 2005 and December 2013. Their research focused on evaluating the effectiveness and safety of robot-assisted surgeries. The study included 47 surgeons from seven hospital departments within the institution. The majority of the surgeries performed were general surgical procedures, totaling 5641 cases (54.9%). This category included endocrine surgeries (38.0%), upper gastrointestinal tract surgeries (7.7%), lower gastrointestinal tract surgeries (7.5%), liver-biliary, as well as pancreas (1.2%) as well as pediatric procedures (0.6%). The second most frequently performed category was urological surgeries (33.0%), followed by otorhinolaryngological (7.0%), obstetric-gynecological (3.2%), thoracic (1.5%), cardiac (0.3%), and neurosurgical (0.1%) procedures. Thyroid surgeries (40.8%) and prostate surgeries (27.4%) accounted for more than half of the procedures, followed by abdominal surgeries (7.6%), colorectal surgeries (7.5%), kidney and urethra surgeries (5.1%), as well as head and neck surgeries (4.0%), uterine surgeries (3.2%), thoracic surgeries (1.5%), and other surgeries (2.9%). Almost all procedures (94.5%) were indicated due to malignant lesions. After 2005, the number of general and urological procedures saw a sudden increase, while the number of surgeries in other listed areas grew gradually. After 2007, there was a significant rise in the number of thyroid and prostate surgeries. The number of procedures performed due to benign lesions was minimal, although this number showed a continuous increase. The robotic system malfunctioned in 185 cases, representing 1.8% of the surgeries. The number of deaths attributed to procedures performed by the robotic system was 12 (0.12%). The institution regards the da Vinci Robot-Assisted System as effective and safe.

In relation to the Korean institution, it can be concluded that the vast majority of procedures, approximately 40% and 30%, involved thyroid and prostate surgeries. However, Lőrincz et al. (2019**)** highlights that in Korea, thyroid surgeries performed with the da Vinci Robot are not primarily justified by the effectiveness of the procedure but by aesthetic considerations driven by cultural factors. He notes that: The trans-axillary approach, originating from an axillary skin incision, allows for the removal of the thyroid and parathyroid glands without leaving a visible neck scar, as well as the selective dissection of the cervical soft tissues, typically targeting lymph node regions II–III–IV and VI–VII, via a supra-pectoral approach using long, thin robotic instruments with fully articulating ends. Due to the absence of a visible neck scar, this method offers primarily cosmetic/aesthetic advantages. In addition, when

approaching the thyroid laterally with the robot, the recurrent laryngeal nerve and the parathyroid glands that need to be preserved are visualized much earlier compared to conventional surgical techniques. However, because of the extensive supra-pectoral dissection, this method cannot be considered minimally invasive; rather, it is maximally aesthetic. In the United States and Europe, this surgery is typically performed for benign thyroid conditions, such as nodular goiter or Graves' disease, while in Southeast Asia, particularly in South Korea, primarily due to cultural reasons, a vast amount of experience has accumulated in robot-assisted surgeries for well-differentiated thyroid cancers, specifically papillary micro-carcinomas."

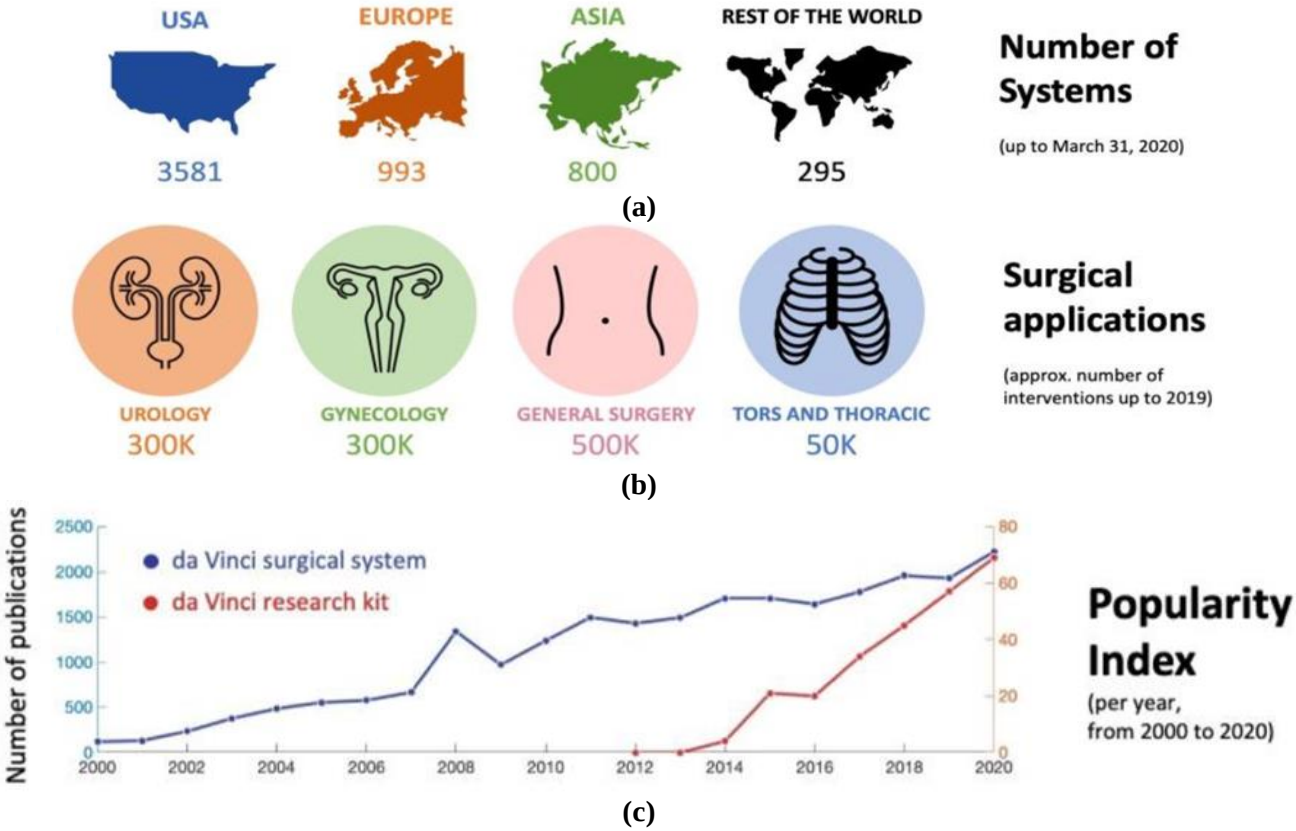

Figure 3. Number of systems, surgical application, popularity index of da Vici Robotic Systems (D'Ettorre et al., 2021).

The most comprehensive evaluation of surgeries performed using the da Vinci Robotic System is provided by D'Ettorre et al. (2021). In their article, they state that the da Vinci Robotic System, marketed by Intuitive Surgical, is the most successful and widely adopted minimally invasive surgical system in the world. Over the 20 years leading up to the publication of their study, approximately 7 million procedures had been performed using around 5000 operational da Vinci systems. The authors conclude that robot-assisted surgical techniques are most commonly applied in the fields of urology, gynaecology, and general surgery, but robotic solutions are also being utilized in other specialties, such as thoracic and oral surgery (**Figure 3**). The authors also highlight the remarkable volume of peer-reviewed scientific publications related to the da Vinci Robotic System, which is estimated to be around 25,000. This vast number of publications can be attributed to the fact that researchers from both

medical and technical sciences are investigating the system. From the medical perspective, research focuses on the effectiveness of robot-assisted minimally invasive surgery and its development for new or specialized applications. On the technical side, publications center on the system's technological advancements. A major boost to these technical developments came in 2014 when the manufacturer of the robotic system partnered with Johns Hopkins University and the Worcester Polytechnic Institute to establish a joint platform called the da Vinci Research Kit (dVRK). This initiative provided open access to the hardware of the system for the research community, which has led to unparalleled technological progress, including integration with other technologies.

Goh and Ali (2022), researchers at the Faculty of Medicine at the University of Queensland, highlight that further growth in the application of the da Vinci Surgical System is expected in cardiothoracic surgery, general surgery, head and neck surgery, orthopedic surgery, as well as urological and gynecological surgeries. They anticipate this spread due to the fact that, while retaining all the benefits of laparoscopic procedures, robot-assisted surgery offers surgeons significantly improved visibility, dexterity, freedom, precision, maneuvrability, and delayed fatigue. They note, however, that acquiring and maintaining the system is extremely costly, and they expect these costs to decrease with technological advancements, shorter operating times gained through experience, the appropriate selection of surgical procedures based on experience, and improved clinical outcomes.

Gkegkes et al. (2017) sought to estimate the costs of da Vinci Robot-assisted general surgical procedures by reviewing publications in the PubMed and Scopus databases. They identified 31 studies that covered a wide range of surgical procedures. The average cost for robot-assisted, open, and laparoscopic surgeries varied within the following ranges: €2539–€57,002, €7888–€16,851, and €1799–€50,408, respectively. Additional non-surgical costs ranged between €900–€48,796, €8347–€8800, and €870–€42,055 for the three categories. The conversion rate from laparoscopic to open surgery was 34/18,620 (0.18%), while the rate of conversion for robotic surgery was 22/1488 (1.5%). The duration of robot-assisted, open, and laparoscopic surgeries ranged from 54.6 to 328.7 minutes, 129 to 234 minutes, and 50.2 to 260 minutes, respectively. The authors conclude that the primary drawback of robot-assisted surgeries noted in the literature is the high acquisition and maintenance cost of the equipment. Nevertheless, they also suggest that, particularly in hospitals specialized in these procedures, increasing case numbers, technological advancements, and the integration of the technology in medical training could make the investment financially viable.

This study does not aim to analyze the cost structure of da Vinci Robot-assisted surgical procedures or to draw significant conclusions by comparing them to other surgical methods (such as laparotomy or laparoscopy). Our sole intention is to highlight that the most commonly documented "disadvantage" of this method, according to various authors, is its cost. McBride et al. (2021) emphasize the importance of examining the costs of robot-assisted surgeries by cost category when estimating their total expenses. They advocate for itemizing costs by category because, for example, operating room usage represents a common cost across all disease types

and surgical methods. However, for robot-assisted surgeries, it is generally true that 17–60% of the total cost can be attributed to the technology itself.

3. da Vinci Robots in Europe and Central-Eastern Europe

According to the publication of Intuitive Surgical (2019), by 2019, 150 da Vinci systems had been deployed in Germany, where 150,000 surgeries had been performed by 220 specialists and healthcare professionals trained to use the robotic system. They noted that, in 2019, a total of 600 console surgeons and healthcare professionals trained in robotic surgery were active across Europe. Alcimed (2021) reported that in France, 180 surgical robots were in use by 2021, primarily in urology, gynaecology and general surgery. Mayor et al. (2022) observed that out of the approximately 1000 da Vinci Surgical Systems operating in Europe, 115 were deployed in the United Kingdom. Their research indicates that while the robotic system is most commonly used globally in general surgery and gynaecology, in the UK, it is predominantly applied in urology. This trend can be attributed to the frequent use of the robot for radical prostatectomies, where the system's enhanced surgical visibility and precision offer significant advantages. They also noted that urological robotic systems used in surgeries cost approximately £1.7 million (800 million HUF). Robotic surgery has become so widespread in British urological practice that by 2019, 92% of radical prostatectomies were performed with robotic assistance.

According to Bonafide's (2024) research, robotic surgery in Italy is poised for significant expansion, with estimates predicting that by 2029, the total value of robots sold in Italy will reach $250 million, exceeding 90 billion HUF. In Italy, as in many other countries, robotic surgery is most commonly applied in urology, gynecology, and general surgery. As reported by Il Mattino (2024), there were 200 active da Vinci Surgical Systems in use across 168 of Italy's hospitals in 2024, of which 130 served the public healthcare system.

The European Commission's (2020) report highlighted that Poland had already allocated funds for acquiring da Vinci systems from the European Regional Development Fund for the 2014–2020 period. As a result, by 2020, three hospitals (Poznań, Wrocław, and Toruń) had acquired these robotic systems, with a total cost of €3.2 million, €2.7 million of which was financed through an operational program under the "Research, Technological Development, and Innovation" priority area.

According to Medexpress (2023), in 2023, the countries in Europe with the highest number of da Vinci Robots were France (340), Germany (330), the United Kingdom (200), Italy (195), and Spain (105), while Poland had deployed 34 systems.

In Poland, the robotic systems are distributed by Synektik, which announced in their 2021 publication that it would expand its exclusive distribution of surgical robots to Czechia and Slovakia starting in 2022. By 2022, a total of 16 systems had been sold across these two countries (Medical Robotics Report, 2022).

Table 1 provides an overview of the areas of application regarding the most frequently performed surgeries in the world.

Table 1. Applicational areas and types of surgeries most frequently performed worldwide (self-edited).

Applicational areas and types of surgeries most frequently performed worldwide	
Specialty	**Surgery**
General surgery	Colorectal surgeries
Urology	Prostatectomy
Gynecology	Hysterectomy
Thoracic surgery	Lung cancer surgeries
Head and neck	Trans oral tumor removal

4. da Vinci Robots in Hungary

The da Vinci Robots in Hungary are distributed by the Sofmedica group, specifically through the Life Saving Innovation division of the company. The group has been operating in Europe since 1994 in the following countries: Hungary, Romania, Greece, Bulgaria, Cyprus, and Croatia. According to the information provided on their website, the company distributes the da Vinci Surgical Robot System, manufactured by Intuitive Surgical, and runs eight robotic surgery programs in Hungary, fifteen in Romania, eleven in Bulgaria, seventeen in Greece, and three in Cyprus.

The company provides three essential pieces of equipment necessary for robotic surgical intervention: the patient cart, the surgical console, and the vision cart (Sofmedica, 2024).

According to the report from the National Hospital Directorate-General, the acquisition of da Vinci Robots in Hungary took place under the project titled "Introduction of Robotic Surgery in Hungary", EFOP-5.2.6-20-2020-00014 (OKFŐ, 2023). The first two systems were installed at the Jahn Ferenc South-Pest Hospital and Clinic in Budapest and at the National Institute of Oncology (OOI). The start of the Hungarian robotic surgery program was made possible through the Human Resources Development Operational Program, which provided 1.3 billion forints in funding in a consortium format to the two Hungarian institutions, allowing each to acquire a da Vinci X Robot. The first robot-assisted surgery was performed at the OOI at the end of January 2021, with a goal of conducting 200 procedures in each institution by mid-year. This target was surpassed, as 778 procedures were performed at the two institutions during the program period. Across the country, more than a thousand robot-assisted surgeries had been performed by this time, including those conducted with the two robots and the da Vinci devices at Semmelweis University and the University of Pécs.

According to a statement from the Hungarian Society of Clinical Oncology, by January 2023, 234 urological and two gynecological oncology surgeries had been performed with the da Vinci X Robot at Jahn Ferenc Hospital (MKOT, 2023). Since the start of the program, a total of 463 robot-assisted surgeries had been carried out at the two institutions. The majority of surgeries at Jahn Ferenc Hospital were urological, while the oncology center focused on gynecological tumour surgeries. At the same time, plans were made to acquire a second robot using funds from the Recovery and

Resilience Facility (RRF) program. This device was intended for use at the thoracic surgery center of the National Institute of Oncology. At the Cancer Surgery Center of the National Institute of Oncology, the robot was used primarily for gynecological oncology surgeries, particularly for early-stage endometrial and cervical cancer operations. Over the three months of the abdominal surgery program, forty procedures were performed, mostly involving the removal of colorectal tumours using the robot. Experts noted that robot-assisted surgeries allow for more precise definition of the surgical area, enable procedures in difficult-to-reach locations traditionally challenging with conventional or laparoscopic methods, and make surgeries on overweight patients relatively easier to perform.

In a March 2022 statement, the University of Debrecen reported that they planned to acquire a surgical robot using grant funds, with plans to carry out approximately 300 procedures annually. In line with international practice, the robot was intended for urological, gynecological, and general (mainly thoracic) surgeries. Specialists in all three fields emphasized the nerve-sparing nature of the technology, the faster recovery time for patients, and the reduction of physical strain on surgeons due to improved ergonomics. Consistent with international literature, the university highlighted the importance of using surgical robots in medical education. In October of the same year, the University of Debrecen issued another statement announcing that robot-assisted kidney stone removal had been successfully performed at the Clinical Center's Urology Clinic using the French-developed ILY robot. The university also reported receiving a high-frequency laser device from Olympus, which enables the rapid fragmentation of kidney stones during procedures.

The 2022 reports from the University of Debrecen did not provide information about the surgical use of the da Vinci Robot; however, in April 2023, a press release appeared on the Index.hu portal, quoting a representative from Sofmedica. The release announced that, in addition to the devices at the National Institute of Oncology, Jahn Ferenc Hospital, the University of Pécs, and Semmelweis University, a da Vinci robot would soon be arriving at the University of Szeged and the University of Debrecen.

According to an April 2023 statement from Széchenyi István University in Győr, specialists from the Petz Aladár University Teaching Hospital of Győr-Moson-Sopron County and Széchenyi István University demonstrated the da Vinci Robot. In line with practices reported in both international and domestic medical literature, the device will primarily be used for urological, gynecological, general, and thoracic surgeries, as well as complex, multi-disciplinary procedures. The demonstration was led by Dr. Zsolt Jenő Szepesváry, co-author of this article, Vice Dean for Development at the Faculty of Health and Sports Sciences at Széchenyi István University, Deputy Medical Director of the Petz Aladár University Teaching Hospital, and Head of the Urology Department, who, in connection with the introduction of the surgical robot, states that "innovative solutions are essential in practice-oriented education, helping our students acquire up-to-date knowledge. The teaching of robotic surgeries is important not only for doctors but also for healthcare professionals, as surgery is a team effort involving many participants."

The September 2023 issue of Egészségkalauz (Health Guide) reported the launch of Hungary's eighth da Vinci robot at Wáberer Medical Center. Initially, the robot will be used for urological surgeries, followed by gynecological and thoracic procedures.

The advantages of robot-assisted surgery compared to laparoscopic methods were summarized as follows:

- The robot's arms are narrower and can bend,
- They can move around three axes, making the surgical area more accessible,
- Its camera provides a 3D view of the surgical site with 10–12 x magnification.

HVG (2023) also reported on Wáberer Medical Center's investment in the da Vinci Surgical Robot, noting that with the 1 billion forint investment, they plan to perform 200 surgeries annually.

The difference between the areas of application used in Hungary and international practice stems from the fact that the use of the da Vinci robotic systems is considered a relatively newly introduced technology in Hungary. For this reason, it has primarily been adopted first by specialties with significant experience in minimally invasive technologies, specifically urology and gynecology specialists (**Table 2**). We have analyzed the available literature on the early stages of the Hungarian program. According to a report by a co-author of this article, to date more than 2000 surgeries have been performed in Hungary using da Vinci robotic systems to date. These case numbers mark an exceptionally successful start for the Hungarian robotic surgery program, as the annual number of surgeries performed per robotic system in Hungary exceeds international practice. While in other parts of the world approximately 150 surgeries are performed annually per da Vinci devices, in Hungary, this number is 200–300.

Further correlations will be examined later.

Table 2. Applicational areas in Hungary compared to world (self-edited).

Applicational areas in Hungary compared to world	
World	**Hungary**
General surgery	Urology
Urology	Gynecology
Gynecology	General surgery
Thoracic surgery	Thoracic surgery
Head and neck	Head and neck

5. Experiences with da Vinci Robot-assisted surgeries at Petz Aladár University Teaching Hospital (PAEOK) in Győr

Since 4 September 2023, the surgical team led by Dr. Zsolt Jenő Szepesváry—Vice Dean for Development at the Faculty of Health and Sports Sciences at Széchenyi István University, Deputy Medical Director of Petz Aladár University Teaching Hospital (PAEOK), and Head of the Urology Department—has performed 75 surgeries using the robot acquired through a strategic partnership between Széchenyi István University and PAEOK. Nearly all of these surgeries were oncological, with the exception of a few complex reconstructive procedures, primarily aimed at restoring function. These cases align with the planned usage of the robot, the pre-established surgical portfolio, and the international and domestic practices detailed in the first and second sections of this paper.

In line with international practices, the implementation of the robotic system in Győr began with urology, the specialty most affected by functional concerns and the highest volume of procedures. Following the completion of quality-assured training, other specialties have been gradually integrated into the robotic program. Currently, two urologists, one thoracic surgeon, and two gynecologists in Győr hold accredited console surgeon qualifications. Additionally, three assistant physicians with surgical team member qualifications are involved, bringing the total number of doctors participating in robot-assisted surgeries at the hospital to eight. PAEOK has ensured that the training of medical staff runs parallel to that of its doctors. Surgical assistants, operating room aides, and staff from departments supporting the handling of robotic surgical equipment, such as the Central Sterilization Unit, have all undergone training. Comprehensive training covering all specialties (surgery, thoracic surgery, gynecology, and urology) and the full composition of surgical teams is scheduled for September 2024 by the hospital.

The experiences of the robotic surgery team in Győr are also in line with international practices. They emphasize the significant advantages of avoiding open surgery, minimizing the size of incisions, and ensuring rapid healing. They have observed that the technology enhances surgical precision and significantly reduces blood loss. The robot allows for the extensive use of instruments with high degrees of freedom, even in narrow and confined spaces. Postoperative pain is notably lower compared to other minimally invasive techniques, such as laparoscopic surgeries. Patients can be discharged home sooner. Additionally, there has been a marked and measurable improvement in functional outcomes, particularly in early urinary continence following surgeries for prostate cancer. This is notable even though the Urology Department at PAEOK had already been at the forefront of both national and international standards in this regard with laparoscopic procedures.

After analysing the results of the completed surgeries, both oncological and functional outcomes have been excellent, and surgery durations have significantly exceeded expectations. Dr. Zsolt Jenő Szepesváry has become Hungary’s second urology proctor (international console surgery instructor). The first proctor was Dr. Péter Tenke, a specialist at Jahn Ferenc Hospital and the National Institute of Oncology, who was involved in the training for the two robotic systems first introduced in Hungary, as detailed in the second section of this paper. The activities of the Győr center have now expanded to include international surgical training, with surgeons from Croatia, where Sofmedica distributes robotic systems, being trained at the Győr Urology Center. Dr. Szepesváry also plays a role as a proctor in launching the urology robotic surgery program at the University of Debrecen.

6. Summary

Surgical procedures performed using the da Vinci Robot System are considered the most advanced minimally invasive surgical technology worldwide, in Europe, and in Hungary. In cancer surgery, they offer significant precision, shorter hospital stays, and faster, more effective recovery. This has led both public hospitals and private clinics to compete in providing the most modern treatments, particularly for patients

with urological, gynecological, and general surgical conditions, helping them return to the workforce as quickly as possible.

The da Vinci robotic system is manufactured by Intuitive Surgical, a U.S.-based company, and its use is most widespread in the United States. In Europe, countries like France, Germany, the United Kingdom, Italy, and Spain lead in both absolute numbers of installed robots and per capita use, while Poland, Czechia and Slovakia also surpass Hungary in this regard.

Currently, da Vinci's continuously evolving systems dominate robotic surgery, appearing irreplaceable despite their high investment costs, which typically amount to approximately one billion HUF per system. These costs do not include maintenance, depreciation, or the operational costs associated with each surgery. However, according to the literature, these high expenses may be offset by the faster and more sustained recovery of patients, along with the system's potential for medical education and professional training in the medium and long term. Additionally, cost reductions may result from economies of scale as the use of these systems expands.

Based on this analysis, it is necessary to prepare for further acquisitions of such equipment. Among the Central and Eastern European countries, Poland and Hungary have followed similar procurement strategies. In Poland, funds for acquiring da Vinci robots were included in the 2014–2020 European Regional Development Fund (ERDF) cycle, leading to the installation of the first systems in three cities, partially funded by the European Union.

Of the eight da Vinci systems currently in operation in Hungary, six were also financed in part by EU funds. The first systems arrived under the Human Resources Development Operational Program, with funding provided by both the Hungarian government (14%) and the European Social Fund and European Regional Development Fund (86%) (EFOP, 2020). EFOP's primary aim was to improve the country's economic and social cohesion and competitiveness, with a particular focus on enhancing human capital and improving the social environment. Health development was a key intervention area of EFOP. Future procurement of such systems in Hungary may be supported by the Recovery and Resilience Facility (RRF) (2021–2026), which prioritizes healthcare development among its nine components, focusing on recovery and adaptation in the post-pandemic period.

The National Development and Spatial Development Concept, which sets priorities and goals until 2030, has aligned its development strategy with the EU's 2014–2020 program financing period (OFTK, 2014). The document addresses health preservation and restoration in several sections (1.3.4. Deterioration of health conditions, 1.3.11. Renewal of education and healthcare systems, 2.2.1. Healthy and renewing society, 2.2.2.1.2. Healing Hungary, healthy society, health, and sports economy). It is crucial that funding sources be planned until 2030, ensuring that the most advanced cancer surgery techniques can extend and improve the quality of life for affected Hungarian citizens.

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References

Alcimed (2021). Robots in surgery: the new must-have for surgeons. Available online: https://www.alcimed.com/en/insights/robots-in-surgery-the-new-must-have-for-surgeons/ (accessed on 05th April 2024.).

Bonafide (2024). Italy Surgical robots Market Overview, 2029. Available online: https://www.bonafideresearch.com/product/6401786312/italy-surgical-robots-market# (accessed on 3rd May 2024).

Chen, J., Li, Y., Gong, J. P., & Yakun, W. (2017). Application of da Vinci surgical robotic system in hepatobiliary surgery. Int. J. Surg. Med, 4(1), 22-27.

D'Ettorre et al (2021). Accelerating Surgical Robotics Research: A Review of 10 Years with the da Vinci Research Kit. IEEE Robotics & Automation Magazine, 28 (4), 56–78. doi: 10.1109/MRA.2021.3101646

Debreceni Egyetem (2022). Robot assisted surgeries at the Urology Clinic. Available online: https://hirek.unideb.hu/robotasszisztalt-mutetek-az-urologiai-klinikan (accessed on 5th March 2024).

Debreceni Egyetem (2022). Robotic surgery may start at the University of Debrecen Clinical Centre. Available online: https://hirek.unideb.hu/robotsebeszet-indulhat-debreceni-egyetem-klinikai-kozpontjaban (accessed on 5th March 2024).

EFOP (2014–2020). Available online: https://www.palyazat.gov.hu/programok/szechenyi-2020/efop (accessed on 5th March 2024).

Egészségkalauz (2023). First in private healthcare in Hungary: the highest quality in robotic surgery. Available online: https://www.egeszsegkalauz.hu/hirek/da-vinci-robotsebeszet-maganegeszsegugy-waberer/9g28d2v (accessed on 5th March 2024).

Európai Bizottság (2021). European recovery plan. Available online: https://hungary.representation.ec.europa.eu/strategia-es-prioritasok/europai-helyreallitasi-terv_hu (accessed on 5th March 2024).

European Commission (2020). Poland implements robotic surgical procedures for cancer treatment. Available online: https://ec.europa.eu/regional_policy/en/projects/Poland/poland-implements-robotic-surgical-procedures-for-cancer-treatment (accessed on 7th March 2024).

Gkegkes I. D. et al (2017). Robotics in general surgery: A systematic cost assessment. Journal of Minimal Access Surgery, 13(4), 243–255. doi: 10.4103/0972-9941.195565

Goh E. Z., Ali T. (2022). Robotic surgery: an evolution in practice. Journal of Surgical Protocols and Research Methodologies, 2022(1), 1–3. https://doi.org/10.1093/jsprm/snac003

HVG (2023). A first in Hungarian private healthcare: robotic surgery of the highest quality - Wáberer Medical Center upgrades its surgical department with a billion-euro investment. Available online: https://hvg.hu/pr_cikkek/20230927_Elsokent_a_hazai_maganegeszsegugyben_robotsebeszet_a_legmagasabb_minosegben__Egymilliardos_beruhazassal_fejleszti_sebeszeti_osztalyat_a_Waberer_Medical_Center (accessed on 7th March 2024).

Il Mattino (2024). Pascale Cancer Institute Becomes First in Italy to Use Latest Generation of Single-Port Surgical Robot. Available online: https://www.ilmattino.it/en/pascale_cancer_institute_becomes_first_in_italy_to_use_latest_generation_of_single_port_surgical_robot-8099788.html?refresh_ce (accessed on 7th March 2024).

Index (2023). Nearly a thousand surgeries performed by robots at home. Available online: https://index.hu/belfold/2023/04/04/robotsebeszet-da-vinci-orvostudomany-innovacio/ (accessed on 5th March 2024).

Intuitive (2019). Intuitive Opens New Commercial Center in Freiburg. Available online: https://isrg.intuitive.com/node/17316/pdf (accessed on 7th March 2024).

Leung, T., & Vyas, D. (2014). Robotic surgery: applications. American journal of robotic surgery, 1(1), 38-41.

Lőrincz, Balázs Bendegúz (2019). Applications of robot-assisted head and neck surgery, Medicalonline. Available online: https://medicalonline.hu/gyogyitas/cikk/a_robotasszisztalt_fej_nyak_sebeszet_alkalmazasi_teruletei (accessed on 7th March 2024).

Magyar Klinikai Onkológiai Társaság (2023). Robotic surgery for urological, gynaecological tumours. Available online: https://mkot.hu/robotsebeszet-az-urologiai-nogyogyaszati-daganatok-mutetjeinel/(accessed on 7th March 2024).

Magyar Közlöny (2014). National Development 2030 - National Development and Spatial Development Concept. 7–297. Available online: https://ngmszakmaiteruletek.kormany.hu/download/9/5f/d0000/MK14001.pdf (accessed on 7th March 2024).

Mahdi Azizian, May Liu, Iman Khalaji, and Simon DiMaio (2018). Chapter 1 THE DA VINCI SURGICAL SYSTEM. The Encyclopedia of Medical Robotics, Volume 1: Minimally Invasive Surgical Robotics. https://doi.org/10.1142/10770-vol1

Mayor et al (2022). Past, present and future of surgical robotics. Trends in Urology & Men's Health. https://doi.org/10.1002/tre.834open_in_new

McBride et al. (2021). Detailed cost of robotic-assisted surgery in the Australian public health sector: from implementation to a multi-specialty caseload, BMC Health Serv Res, (21)108, 1–8. https://doi.org/10.1186/s12913-021-06105-z

Medexpress (2023). Where will robotic evolution in medicine take us? Available online: https://www.medexpress.pl/en/events-campaigns/where-will-the-robotic-evolution-lead-us-in-medicine/ (accessed on 5th March 2024).

Medical Robortics Report (2022). Instrumenty EndoWrist® stosowane w systemie robotowym da Vinci. Available online: https://medicalrobots.eu/add/file/1400004375.pdf (accessed on 5th March 2024).

Országos Kórházi Főigazgatóság (2023). Revolutionary new Hungarian robotic surgery programme a success. Available online: https://okfo.gov.hu/Hirek/sikeres-az-uj-forradalmi-magyar-robotsebeszeti-program (accessed on 7th March 2024).

Science Daily (2000). FDA Approves New Robotic Surgery Device. Available online: https://www.sciencedaily.com/releases/2000/07/000717072719.htm (accessed on 5th March 2024).

Sofmedica (2024). Robotic surgery, setting new standards. Available online: https://sofmedica.com/hu/portfolio/robotsebeszet/ (acessed on 7th March 2024).

Széchenyi István Egyetem (2023). Experts from the Petz Hospital and Széchenyi University of Győr presented the surgical robot. Available online: https://www.uni.sze.hu/post/a-gy%C5%91ri-petz-k%C3%B3rh%C3%A1z-%C3%A9s-a-sz%C3%A9chenyi-egyetem-szakemberei-mutatt%C3%A1k-be-a-seb%C3%A9szeti-robotot (accessed on 5th March 2024).

Wu Han, Li Hecheng (2017). Application of the da Vinci in thoracic surgery. AMJ Medical Journal. doi: 10.21037/amj.2017.01.02a

Yonsei Med J. (2018). Efficacy and Safety of Robotic Procedures Performed Using the da Vinci Robotic Surgical System at a Single Institute in Korea: Experience with 10000 Cases. Yonsei Medical Journal, 59(8), 975–981. https://doi.org/10.3349/ymj.2018.59.8.975