Fachbereich Robotik

im BVMed

Progress report

Robotic assistance systems in surgery

From the BVMed division "Robotics in Medical Care"

Publisher

The progress report was compiled on behalf of the Robotics in Medical Care division of the BVMed - Bundesverband Medizintechnologie e.V. and produced in collaboration with the Healthcare Heads GmbH. The following content and requests reflect the opinion of the division.

BVMed's Robotics in Medical Care division is committed to improving patient care by establishing robotic assistance systems in standard medical care. The goal of the division is to inform the professional public about robotics in medical care and to promote patient access to modern technologies.

Note on gendering: For better legibility, personal designations and pronouns apply equally to all genders.

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Executive Summary

What are robotic assistance systems in surgery?

Robotic assistance systems support surgeons during an operation. They are not "robots" in the common sense of the word and operating “on their own”, but help surgeons to perform operations safely, precisely, and effectively. The degree of automation varies depending on the area of application and the assistance system. In general, medicine differentiates between active and semi-active systems. The potential applications of robotic assistance systems in surgical procedures have expanded considerably in recent years. These include procedures on the heart, vessels, oesophagus, stomach, liver, pancreas, intestine, lung, prostate, uterus, knee or hip, spine, female breast, abdominal wall, brain, throat and tongue etc.

What is the value of robotic assistance systems in healthcare?

Robotic assistance systems can help to overcome the healthcare sector’s challenges of a changing demographic and lack of available personnel. Current studies show a number of positive clinical and health economic effects across all indications: Patients benefit from speedier post-operative recovery, less pain and a reduced rate of complication (quality of outcome or treatment); doctors benefit by process optimization like customized staff deployment or data-supported decision-making, a better ergonomics, and patient-specific OR scheduling. The use of robotics in surgery opens entirely new training opportunities for junior staff.

How are robotically assisted procedures financed within German hospitals?

The costs of robotic assistance systems - like medical technology in general - are financed by operating and investment cost contributions. The operating costs for robotically assisted surgery are not yet separately reimbursed in the G-DRG system. Together with the costs of traditional surgical methods they are part of a reimbursement based on average cost. The use of a robotic assistance system is coded with a supplementary OPS code established in 2017 so that the increased use and the associated added value can be reflected within the system. The investment costs for robotic assistance systems as medical technology assets are generally financed by the federal states as part of the German dual hospital financing system. Thus, robotic assistance systems have also suffered from the inadequate investments of the federal states for years. For this reason, funding programs play an important role. The Hospital Future Fund promoted robotic assistance systems (funding item 9) in hospitals. However, for all patients to benefit from technical progress, a coordinated framework and adequate financing for the use of robotic assistance systems are required in the long term.

1. Introduction

Robotically assisted surgical procedures have been part of medical care for many years. While more than 1 million (mill.) patients worldwide are operated on with robotic assistance systems every year (Menon, 2020), the use of such systems in Germany still falls short of expectations (Bühren et al., 2023).

Robotically assistance systems in surgery are digital platforms. They are used by doctors to operate modern instruments with digital and sometimes novel functionalities otherwise not available. Increased precision, reproducibility and standardization (Tejedor, Sagias, & Khan, 2020) of surgical procedures are some of the advantages of robotically assisted surgical procedures. As a result, the individual skill of the operating surgeon is improved and patients benefit from the fact that even complex procedures can be performed more easily as minimally invasive surgery and with better results using robotic assistance (Tejedor, Sagias, Flashman, et al., 2020).

This can lead for some indications to faster postoperative recovery, less pain, and a reduced complication rate (Spinoglio et al., 2016; Stoffels et al., 2020; Feng et al., 2022, Christoffersen et al., 2023). In addition, the technology enables process optimization, for example through customized deployment of personnel (Auschra et al., 2023) and new training opportunities for junior staff. Robotic assistance systems can be a suitable solution and an important component of future patient care, particularly in the context of the financial, structural, demographic, and personnel challenges in the healthcare sector. The use of this technology must therefore not create economic deficits.

This brochure provides information on how robotic assistance systems in surgery can be part of the solution to the challenges our healthcare system is facing and can improve patient care and the results of surgical treatment. It is important to note that the use of robotic assistance systems in care is only established in some indications and is still in its infancy in others. This brochure summarizes the current evidence that supports the use of robotically assisted surgical procedures in medical care in the various medical areas. The aim is to provide a basis for a discussion about the successful, needs-based and sustainable integration of robotically assisted surgery into the German healthcare system.

2. What are robotic assistance systems in surgery?

Contrary to what the linguistic origin of the word "robot" might suggest, robotic assistance systems in surgery are characterized by the fact that the surgeon is still always responsible for the performed activities and the "surgical robots" themselves do not carry out any independent procedures.

Robotic assistance systems in surgery are characterized by the fact that they "assist" during surgeries. This means that they provide technical support for the operating doctors. The degree of used automation depends on the area of application and the respective assistance system.

Robotic assistance systems can be divided into active and semi-active systems in surgery (Lane, 2018). Active robotic assistance systems essentially provide support autonomously, but under the constant control of the surgeon, e.g. by actively operating a foot switch. Semi-active systems perform and complement pre-programmed tasks through the actions and activities of the surgeon (Lane, 2018). Active systems are mainly used in orthopaedics/endoprosthetics, trauma surgery (skeletal system), and neurosurgery (Feußner et al., 2018), while semi-active systems are primarily used for minimally invasive operations in the mostly preformed body cavities (Lane, 2018).

The supporting or "assisting" function of the systems is created by the digital integration of numerous technical features, including various software components and the functionality of the instruments. This includes for example, surgical planning, navigation, optical display, and the function of special instruments.

Robotic assistance systems in surgical procedures can be compared in part to the safety systems of a modern vehicle. Navigation systems, "lane assistants" or "brake and distance assistants" are also intended to make the surgery safer and more precise. This means that instruments and implants can be placed in precisely planned positions using previously planned paths and without tremor. Some robotic assistance systems can alert surgeons to problems during the procedure (e.g. through resistance or automatic stopping of the instruments) and/or provide additional functions and thereby contribute to the precision of the operation. This supports the surgeons' manual skills, improves the quality of treatment and avoids complications and re-operations.

3. How have robotic assistance systems developed in surgery?

Robotic assistance systems within the minimally invasive surgery

The introduction of minimally invasive surgery allowed patients for the first time to receive a gentler operation than with open surgery (Marescaux & Rubino, 2003). Only the instruments and a camera are inserted through small incisions in the skin. Surgeons control the procedure exclusively via the camera image without direct view or access to the surgical site. In conventional endoscopic surgery, doctors guide the camera and instruments directly with their hands. For this intensive training is required to compensate for the loss of direct vision and immediate access. The high demands on the doctors' dexterity and other technical challenges limit the use of this surgical technique, especially in complex operations (Marescaux & Rubino, 2003).

The modern era of robotic assistance systems began in the 1980s with a concept of the NASA (Schreuder & Verheijen, 2008). The first systems were used to hold the camera and as guidance systems during operations (Marescaux & Rubino, 2003). The commercial use of robotic assistance systems in surgery began with the realization that robotic assistance could overcome the technical challenges of conventional endoscopic surgery, especially in complex operations (Marescaux & Rubino, 2003). In the 1990s, the concept of the master-slave tele-manipulation system was developed, where the computer translates the surgeon’s movements to the instruments in the patient, similar to remote control (Marescaux & Rubino, 2003).

Robotic assistance systems use modern navigation technologies

Navigation has become a core component of active robotic assistance systems (Bäthis et al., 2003). Navigation supports precise orientation and instrument guidance by displaying instruments and implants in real time based on pre- and intraoperative imaging, and can reduce radiation exposure. Physicians can track the exact position of their instruments and implants in relation to the anatomical structures on the monitor in real time and precisely execute patient-specific, pre-operative surgical plans and, where necessary, adjust them intraoperatively.

4. What are the operations robotic assistance systems in surgery can be used for?

The robotic assistance systems currently available in Germany are already used to treat various diseases in multiple organs or areas of the body. The individual robotic technologies have been especially developed for their respective area of application. The possible applications include, for example, operations on internal organs such as the heart and blood vessels, oesophagus, stomach, liver, pancreas, intestines, lungs, prostate or uterus, or on the skeletal system with operations on the knee or hip (joint replacement) as well as operations on the spine, the female breast, the abdominal wall, on or in the brain or in the area of the throat and tongue. All procedures have in common that the instruments can reach the targeted anatomical structures gently and with increased precision. Many procedures are also characterized by a high degree of reconstructive surgery, as the surgical steps are supported and supplemented in both more complex and less complex operations. An exemplary overview of the body’s areas in which robotically assisted surgery is used shows figure 4-1.

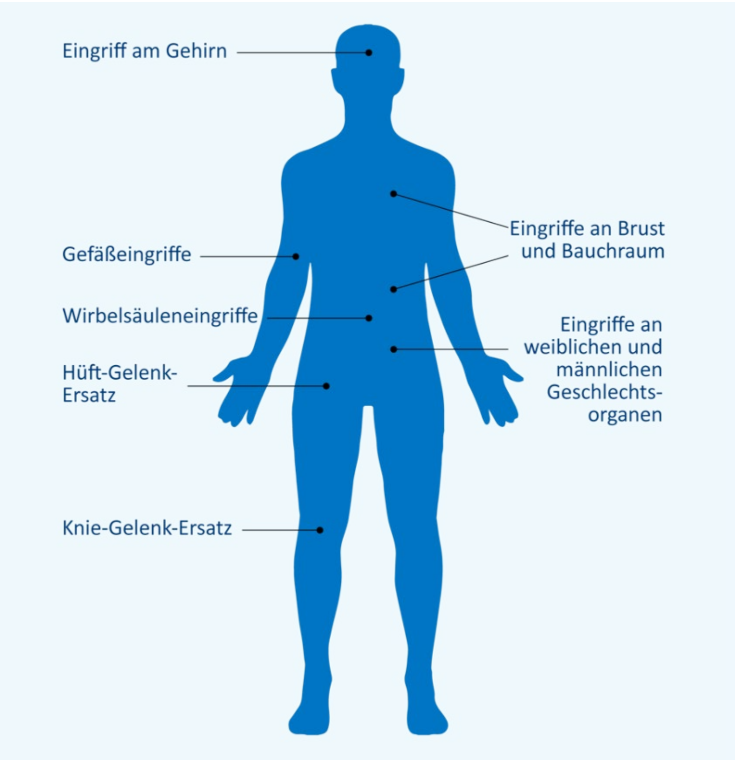

Figure 4-1 : Exemplary overview of areas of application for robotic assistance systems in surgery

5. Robotic procedures and hospital billing

DRG-based hospital billing requires coding of inpatient procedures with OPS codes from the German procedure classification "Operationen- und Prozedurenschlüssel" (OPS).

For already over 20 years, the use of a robotic assistance system can be identified by an OPS code. This OPS code is coded as "supplementary information" in addition to the primary procedure (e.g. knee joint replacement, removal of the prostate). Within the section for the use of a surgical robot "Anwendung eines OP-Roboters" (OPS code section 5-987) there are currently four OPS codes available to differentiate between the different types of robotic assistance systems ("Complex surgical robot", "Robotic arm", "Miniature robot", "Other").

The treatment cases can be identified in the hospital billing data via the OPS code. This makes it possible to evaluate the use of robotic assistance systems in Germany. Figure 5-1 shows how often an OPS code for robotically assisted surgery was coded between 2006 and 2023.

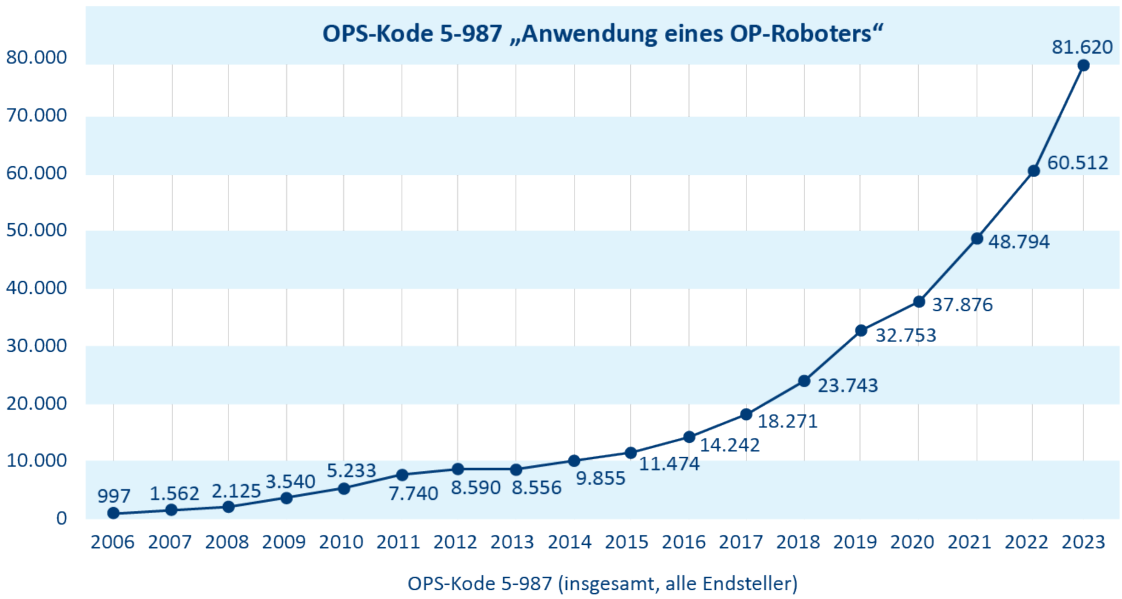

Figure 5-2 : Use of robotic assistance systems in Germany 2006 to 2023 (Sources: DeStatis: 2006-2021, InEK DatenBrowser: 2023).

Currently, OPS codes for robotically assisted surgery are not relevant when assigning a treatment case to a DRG within the G-DRG system. This means that a hospital charges the identical flat-rate amount for a case - regardless of whether the operation was performed with or without the use of a robotic assistance system.

If patients are discharged earlier because of a robotically assisted operation compared to another surgical technique, this can even lead to a reduction in reimbursement. This DRG system mechanism does not take into account that the advantage of the earlier discharge of patients was only achieved through an additional technical effort.

The introduction of robotic assistance systems in hospitals needs to not only take into account the DRG-based billing of such treatments with the health insurances, but also the investment of the acquisition. Within the dual hospital financing system medical technology assets like robotic assistance systems are not financed via the G-DRG system, but are the responsibility of the federal states. Harmonizing the framework conditions of investment and operating cost financing is therefore a prerequisite for the successful introduction of robotically assisted surgery in Germany. The planned pre-reimbursement as part of the hospital reform is not suitable to improve the situation, as the pre-reimbursement only relates to the DRG-relevant operating costs.

6. Robotic assistance systems are an important component of digitalization in the healthcare sector

Today the development and improvement of interventional medicine is no longer exclusively initiated by doctors, but requires improved and innovative medical products and procedures (Feußner et al., 2018). Terms like "digitalization", "high-tech-surgery", "surgery 4.0", "big data", "miniaturization", "virtual reality", "navigation", "simulation", and "artificial intelligence", are closely related to this topic (Anthuber, 2018; Feußner et al., 2018). The increased use of robotic assistance systems indicates the increasing digitalization of surgery (Feußner et al., 2018).

The surgery of the future will be characterized by the use of many additional intelligent and interconnected systems mounting in a communication and information network (Manzei-Gorsky, Schubert, 2022).

In modern healthcare, for example, designing more effective processes will create improvement with tangible solutions for the needs-based, local, and quality-oriented treatment of patients (van Alst, 2020). Therefore, the digitalization of medicine and surgery in particular, creates high expectations for the relief of individual suffering, as well as overcoming of epidemiological challenges (Manzei-Gorsky, Schubert, 2022). Computer-based robotic assistance systems in surgery can support the implementation of digitalization in healthcare in multiple ways.

Digitalization is seen as the most important challenge in maintaining the highest level of healthcare for patients in Germany in the future (Manzei-Gorsky, Schubert, 2022). The challenges for customized and modern healthcare are even greater if no solution is found for the long-term sustainable financing of digitalization and the associated investments.

With the Hospital Future Act (KHZG) of 2020 the federal and state governments jointly provided EUR 4.3 billion to fund digitalization in the healthcare sector. The relevance of robotic assistance systems in surgery for digitalization and, above all, patient benefit had already been recognized and the technology was included in the funding guidelines. However, digitalization in the healthcare sector requires a long-term funding perspective due to the hospitals' great need for development and the constantly evolving technologies.

> Additional technical information on the use of surgical robots can be found here:
> https://www.bvmed.de/themen/robotik

7. Possible improvements in quality and efficiency through robotic assistance systems

The use of robotic assistance systems in surgery leads to various changes in healthcare. This directly affects patients and users, but also the design of care processes and the availability of data. These changes make robotically assisted surgery a valuable contribution to quality-oriented healthcare.

In 1966, Donabedian introduced the dimensions of structural quality, process quality, and outcome quality to describe quality in medical care. While structural and process quality influence the outcome quality, it is not possible to specify the exact extent of that influence (Donabedian, 2005). The parameters of outcome quality are therefore generally more relevant for patients.

The objective of supporting doctors in surgery with robotic assistance systems is to achieve better treatment outcomes and thus generate a direct benefit for patients (Flynn et al., 2022). Improved quality of outcome can be achieved, for example, by reducing complications or speeding up recovery after surgery. Robotic assistance systems in surgery can also support the more efficient use of resources, resulting, for example, for some indications in shorter hospital stays (Kayani et al., 2018; Dewulf et al., 2022; Strauss et al. 2022). The following section provides an overview of the clinical and economic added value of robotic assistance systems in surgery based on the selected scientific publications.

Additionally, computer-based systems can be integrated into an IT infrastructure and can make detailed and extensive treatment data available for documentation and analysis. Due to their supraregional relevance to healthcare, robotic assistance systems in surgery can also contribute to the quality-oriented restructuring of healthcare, e.g. through the creation of specialized centers and outpatient treatment.

8. Selected scientific evidence on robotic assistance systems in surgery

Scientific studies are the basis for an evidence-based evaluation of medical treatments. Studies on the use of robotic assistance systems in surgery have already been conducted worldwide.

Selected studies showing the potential benefits of robot-assisted surgery are listed below. Long-term studies including a 5- or 10-year follow-up are not yet available due to the novelty of the technology for some indications. However, they are necessary to evaluate the added value of the technology in the long term.

The listed literature gives an overview of the possible advantages of robotic assistance systems across indications and technologies for the health policy discussion.

Table 8-1 : Overview of selected study results on robotic assistance systems in surgery.

The value of robotically assisted surgery	**Relevant for**
Increased safety (e.g. fewer complications, revisions)	Patients, economic efficiency
Studies that contribute evidence to this value	
(Batailler et al., 2019, Improved implant position and lower revision rate with robotic-assisted unicompartmental knee arthroplasty); (Benech et al., 2020, Navigated robotic assistance results in improved screw accuracy and positive clinical outcomes: an evaluation of the first 54 cases);	

(Fu et al., 2021, Robot-assisted technique vs conventional freehand technique in spine surgery: A meta-analysis);
(Cacciamani et al., 2018, Impact of Surgical Factors on Robotic Partial Nephrectomy Outcomes: Comprehensive Systematic Review and Meta-Analysis);
(Huntsman et al., 2020, Robotic-assisted navigated minimally invasive pedicle screw placement in the first 100 cases at a single institution);
(Klassen et al., 2021, P47 Computer-assisted spinal surgery versus freehand navigation - DWG registry query for monosegmental TLIFs from 2019);
(Kleeblad et al., 2018, Midterm Survivorship and Patient Satisfaction of Robotic-Arm-Assisted Medial Unicompartmental Knee Arthroplasty: A Multicenter Study);
(Li et al., 2021, Comparison of accuracy and safety between robot-assisted and conventional fluoroscope assisted placement of pedicle screws in thoracolumbar spine A meta-analysis);
(Mergenthaler et al., 2021, Is robotic-assisted unicompartmental knee arthroplasty a safe procedure? A case control study);
(Mont et al., 2021, Health Care Utilization and Payer Cost Analysis of Robotic Arm Assisted Total Knee Arthroplasty at 30, 60, and 90 Days);
(Moschetti et al., 2016, Can Robot-Assisted Unicompartmental Knee Arthroplasty Be Cost-Effective? A Markov Decision Analysis);
(Pearle et al., 2017, Survivorship and patient satisfaction of robotic-assisted medial unicompartmental knee arthroplasty at a minimum two-year follow-up);
(Vardiman et al., 2020, Pedicle screw accuracy in clinical utilization of minimally invasive navigated robot-assisted spine surgery);
(Wallace et al., 2020, Navigated robotic assistance improves pedicle screw accuracy in minimally invasive surgery of the lumbosacral spine: 600 pedicle screws in a single institution);
(T. Wang et al., 2019, A meta-analysis of robot assisted laparoscopic radical prostatectomy versus laparoscopic radical prostatectomy);
(Yeroushalmi et al., 2022, Early Economic Analysis of Robotic-Assisted Unicondylar Knee Arthroplasty May Be Cost Effective in Patients with End-Stage Osteoarthritis)

The value of robotically assisted surgery	**Relevant for**
High patient satisfaction with the treatment outcome	Patients
Studies that contribute evidence to this value	
(Coon et al., 2015, Short to mid term survivorship of robotically assisted UKA: a multicenter study); (Rossi & Benazzo, 2023, Individualized alignment and ligament balancing technique with the ROSA® robotic system for total knee arthroplasty); (Scott et al., 2010, Predicting dissatisfaction following total knee replacement A prospective study of 127 patients)	

The value of robotically assisted surgery	**Relevant for**
Patients experience a higher quality of life	Patients
Studies that contribute evidence to this value	
(Bhimani et al., 2020, Robotic-assisted total knee arthroplasty demonstrates decreased postoperative pain and opioid usage compared to conventional total knee arthroplasty);	

(Malkani et al., 2020, New Technology for Total Knee Arthroplasty Provides Excellent Patient-Reported Outcomes: A Minimum Two-Year Analysis); (Marchand et al., 2017, Patient Satisfaction Outcomes after Robotic Arm-Assisted Total Knee Arthroplasty: A Short-Term Evaluation); (Mulpur et al., 2022, Comparison of patient reported outcomes after robotic versus manual total knee arthroplasty in the same patient undergoing staged bilateral knee arthroplasty)

The value of robotically assisted surgery	**Relevant for**
Patients experience improved functionality	Patients
Studies that contribute evidence to this value	
(Eerens et al., 2022, Improved joint awareness two years after total knee arthroplasty with a handheld image-free robotic system); (Malkani et al., 2020, New Technology for Total Knee Arthroplasty Provides Excellent Patient-Reported Outcomes: A Minimum Two-Year Analysis	

The value of robotically assisted surgery	**Relevant for**
Patients report less pain	Patients
Studies that contribute evidence to this value	
(Bhimani et al., 2020, Robotic-assisted total knee arthroplasty demonstrates decreased postoperative pain and opioid usage compared to conventional total knee arthroplasty); (Malkani et al., 2020, New Technology for Total Knee Arthroplasty Provides Excellent Patient-Reported Outcomes: A Minimum Two-Year Analysis	

The value of robotically assisted surgery	**Relevant for**
Gentler performance of the operation (e.g. less blood loss, tissue damage or radiation exposure)	Patients, economic efficiency
Studies that contribute evidence to this value	
(Fu et al., 2021, Robot-assisted technique vs conventional freehand technique in spine surgery: A meta-analysis); (Jiang et al., 2020, Robot-Assisted versus Freehand Instrumentation in Short-Segment Lumbar Fusion: Experience with Real-Time Image-Guided Spinal Robot); (Khan et al., 2021, Blood loss and transfusion risk in robotic-assisted knee arthroplasty: A retrospective analysis); (Kayani et al., 2020, A prospective randomized controlled trial comparing biochemical, thermal, and macroscopic soft-tissue injury outcomes in conventional jig-based versus robotic total knee arthroplasty); (Klassen et al., 2021, P47 Computer-assisted spinal surgery versus freehand navigation - DWG registry query for monosegmental TLIFs from 2019); (Zhang et al., 2019, Comparison of Superior-Level Facet Joint Violations Between Robot-Assisted Percutaneous Pedicle Screw Placement and Conventional Open Fluoroscopic-Guided Pedicle Screw Placement)	

The value of robotically assisted surgery	Relevant for
More precise surgical results	Quality of care
Studies that contribute evidence to this value	
(Batailler et al., 2019, Improved implant position and lower revision rate with robotic-assisted unicompartmental knee arthroplasty); (Bekelis et al., 2012, Frameless robotically targeted stereotactic brain biopsy: feasibility, diagnostic yield, and safety); (Benech et al., 2020, Navigated robotic assistance results in improved screw accuracy and positive clinical outcomes: an evaluation of the first 54 cases); (Carai et al., 2017, Robot-Assisted Stereotactic Biopsy of Diffuse Intrinsic Pontine Glioma: A Single-Center Experience); (Cardinale et al., 2016, Implantation of Stereoelectroencephalography Electrodes: A Systematic Review); (De Benedictis et al., 2017, Robot-assisted procedures in pediatric neurosurgery); (Domb et al., 2014, Comparison of Robotic-assisted and Conventional Acetabular Cup Placement in THA: A Matched-pair Controlled Study); (Fomenko & Serletis, 2018, Robotic Stereotaxy in Cranial Neurosurgery: A Qualitative Systematic Review) (Fu et al., 2021, Robot-assisted technique vs conventional freehand technique in spine surgery: A meta-analysis); (González-Martínez et al., 2016, Technique, Results, and Complications Related to Robot-Assisted Stereoelectroencephalography); (Gregori et al., 2014, Handheld precision sculpting tool for unicondylar knee arthroplasty. A clinical review); (Gupta et al., 2020, Robot-assisted stereotactic biopsy of pediatric brainstem and thalamic lesions); (Huntsman et al., 2020, Robotic-assisted navigated minimally invasive pedicle screw placement in the first 100 cases at a single institution) (Kaper & Villa, 2019, Accuracy and precision of a handheld robotic-guided distal femoral osteotomy in robotic-assisted total knee arthroplasty 41); (Kayani et al., 2020, A prospective randomized controlled trial comparing biochemical, thermal, and macroscopic soft-tissue injury outcomes in conventional jig-based versus robotic total knee arthroplasty); (Sharma et al., 2019, Accuracy of robot-assisted versus optical frameless navigated stereoelectroencephalography electrode placement in children); (Vardiman et al., 2020, Pedicle screw accuracy in clinical utilization of minimally invasive navigated robot-assisted spine surgery); (Wallace et al., 2020, Navigated robotic assistance improves pedicle screw accuracy in minimally invasive surgery of the lumbosacral spine: 600 pedicle screws in a single institution); (M. Wang et al., 2022, Frameless Robot-Assisted Stereotactic Biopsy is Superior to Microsurgical Biopsy for Pediatric Diffuse Intrinsic Pontine Gliomas)	

The value of robotically assisted surgery	Relevant for
Process optimization (e.g. standardization of operation duration and procedure)	Quality of care, economic efficiency
Studies that contribute evidence to this value	

(Cacciamani et al., 2018, Impact of Surgical Factors on Robotic Partial Nephrectomy Outcomes: Comprehensive Systematic Review and Meta-Analysis);
(Cardinale et al., 2016, Implantation of Stereoelectroencephalography Electrodes: A Systematic Review); (González-Martínez et al., 2016, Technique, Results, and Complications Related to Robot-Assisted Stereoelectroencephalography);
(Gupta et al., 2020, Robot-assisted stereotactic biopsy of pediatric brainstem and thalamic lesions);
(Kaper, 2020, Learning curve and time commitment assessment in the adoption of navio robotic-assisted total knee arthroplasty);
(Kayani et al., 2018, Robotic-arm assisted total knee arthroplasty has a learning curve of seven cases for integration into the surgical workflow but no learning curve effect for accuracy of implant positioning);
(Klassen et al., 2021, P47 Computer-assisted spinal surgery versus freehand navigation - DWG registry query for monosegmental TLIFs from 2019);
(Ma et al., 2019, Short-term outcomes of robotic-assisted right colectomy compared with laparoscopic surgery: A systematic review and meta-analysis);
(Sharma et al., 2019, Accuracy of robot-assisted versus optical frameless navigated stereoelectroencephalography electrode placement in children);
(Shearman et al., 2019, Robotic-assisted unicondylar knee arthroplasty is associated with earlier discharge from physiotherapy and reduced length of stay compared to conventional navigated techniques);
(Sires et al., 2021, Accuracy of Bone Resection in MAKO Total Knee Robotic-Assisted Surgery);
(Thilak et al., 2021, Accuracy in the Execution of Pre-operative Plan for Limb Alignment and Implant Positioning in Robotic-arm Assisted Total Knee Arthroplasty and Manual Total Knee Arthroplasty: A Prospective Observational Study);
(Vardiman et al., 2020, Does the accuracy of pedicle screw placement differ between the attending surgeon and resident in navigated robotic-assisted minimally invasive spine surgery?)
(M. Wang et al., 2022, Frameless Robot-Assisted Stereotactic Biopsy is Superior to Microsurgical Biopsy for Pediatric Diffuse Intrinsic Pontine Gliomas)

The value of robotically assisted surgery	**Relevant for**
Shorter inpatient stay	Quality of care, economic efficiency

Studies that contribute evidence to this value

(Cool et al., 2019, Revision Analysis of Robotic Arm-Assisted and Manual Unicompartmental Knee Arthroplasty);
(Fu et al., 2021, Robot-assisted technique vs conventional freehand technique in spine surgery: A meta-analysis);
(Klassen et al., 2021, P47 Computer-assisted spinal surgery versus freehand navigation - DWG registry query for monosegmental TLIFs from 2019);
(Ma et al., 2019, Short-term outcomes of robotic-assisted right colectomy compared with laparoscopic surgery: A systematic review and meta-analysis);
(Pierce et al., 2020, Robotic Arm-Assisted Knee Surgery: An Economic Analysis);
(Sephton et al., 2020, Achieving discharge within 24 h of robotic unicompartmental knee arthroplasty may be possible with appropriate patient selection and a multi-disciplinary team approach);
(Shearman et al., 2019, Robotic-assisted unicondylar knee arthroplasty is associated with earlier discharge from physiotherapy and reduced length of stay compared to conventional navigated techniques)

9. Necessary adaptation of the framework conditions for robotic assistance systems in surgery

Robotic assistance systems in surgery can make a significant contribution to overcoming the current challenges in the German healthcare system (including care structures, demographics, digitalization, outpatient care). For this to succeed, it is necessary to change the framework conditions to support the implementation into clinical routine.

BVMed's robotics division sees the following points:

Harmonizing the separate financing of investments and operating costs

The implementation of robotic assistance systems in surgery requires an initial major investment by the hospitals. As part of the dual hospital financing system the federal states are responsible for financing such investments, but they are not honoring this obligation adequately.

Apart from this, operating costs of robotic assistance systems as well as the maintenance and repair costs are part of the DRG calculation. The economically sustainable implementation of robotic assistance systems in hospitals therefore requires both: sufficient funding for the initial investment and coordinated and adequate reimbursement of the operating costs.

Securing the financing of investment costs

As part of the hospital reform, changes to the financing of operating costs are planned, e.g. the addition of a pre-reimbursement to the DRG flat rate system. So far, however, no solution to the hospital investment backlog of around €50 billion has been identified. Due to decades of declining investment funding by the federal states, hospitals are now dependent on DRG-based reimbursement to mostly compensate the purchase of a robotic assistance system in surgery. The desired concentration of complex services in fewer hospitals must be accompanied by appropriate technical equipment and options for financing this equipment.

Including robotic assistance systems in surgery in the digitalization strategy for the healthcare sector

Robotic assistance systems in surgery are part of the digitalization in the healthcare sector in many ways. With the help of digital functions and the generation of extensive data, they support the efficient use of resources, e.g. through better process optimization and continuous analysis and optimization of treatment quality. As the use of robotic assistance systems also generates a continuous flow of data, the technology also enables the automated documentation of treatment cases, which can be incorporated into register studies or used for hospital billing. Robotic assistance systems in surgery therefore are an important building block for digital care strategies.

Procedures are planned and carried out digitally and the resulting data is evaluated for continuous improvement, creating databases with learning and illustrative material. Part of the digitalization strategy should also be to improve the framework conditions for such data processing in hospitals.

Better identification of robotic assistance systems in surgery in routine and registry data

For the healthcare research to be able to better examine the added value of robotic assistance systems in surgery for the German healthcare system, it needs to be possible to identify the patients of the respective treatment in routine data. Therefore, the identification must be improved both in hospital billing data (via primary OPS codes) and in register data (via mandatory entries). For example, the German Arthroplasty Registry currently considers to differentiate between surgical techniques (e.g. robot-assisted, navigated, patient-specific incision blocks, manual) in addition to the implants.

Improving quality of treatment by needs-based use of robotic assistance systems in surgery

The use of innovative instruments and robotic assistance system controlled digital techniques can improve treatment outcomes. This may enable patients to recover more quickly or reduce blood loss during surgery. For patients in Germany to benefit from the improved care quality, the framework conditions must allow the needs-based use of robotic assistance systems without economic disadvantages for the users.

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