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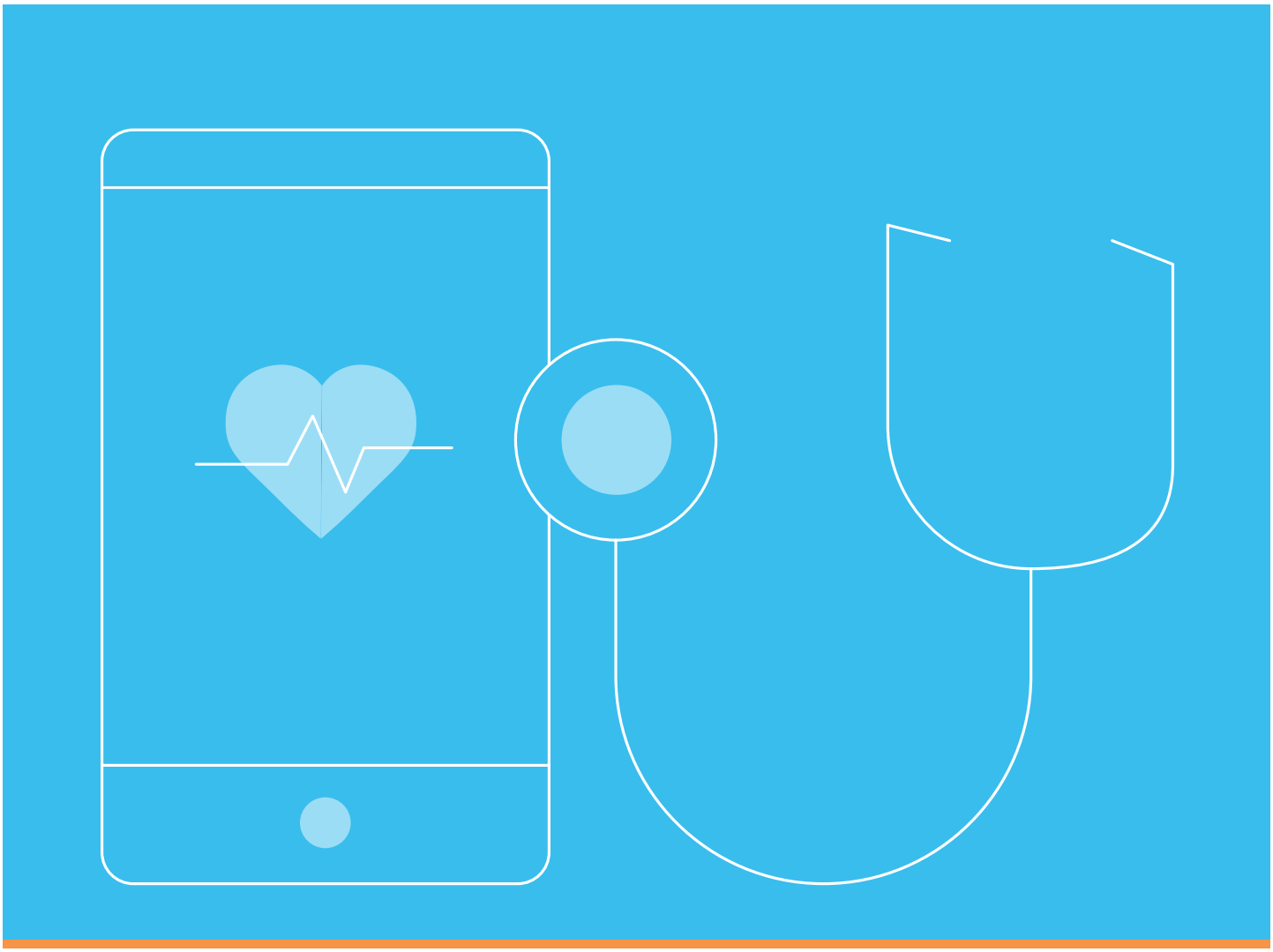
An economic view



Robotic assisted spine surgery[1]

An economic view

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Abstract
The retrospective comparison of clinical and process data of a German spine center before and after the introduction of a robotic surgery program shows a positive effect on operating costs. Both cost drivers length of stay and surgical process, but also complications were synergistically influenced in such a way that the case mix and case mix index could be increased at reduced operating costs. Thus, it could be shown for the first time in Germany that robotically assisted spine surgery can be associated with economic advantages.

Keywords: OP-Management, Investment, Patient Safety

Literature lies with the authors

1 Re. translator: Translation of the article „Robotisch assistierte Wirbelsäulenchirurgie; Eine ökonomische Betrachtung, KU Gesundheitsmanagement 10/2022, S. Sauermann, S. Habetha, PD Klassen.

About 25 percent of the population complains of back pain. If they cannot be controlled with medication and general measures, spinal surgery may become necessary. Here, posterior (dorsal) fusion of vertebral segments (approx. 28,000 surgeries in Germany each year) and stabilization by a screw-rod construction is the current gold standard for treatment. Studies have shown that screw malpositions can occur in 1.8 to 40 percent of treated cases depending on the surgeon and the used technology. This can lead to a loss of stability of up to 71 percent, on the one hand, and nerve injuries, on the other. Robotic assisted spine surgery (RASS) represents the latest technological advancement for precise and safe screw placement in minimally invasive spine surgery. RASS promises improved outcome and process quality, which has already been demonstrated in a variety of surgical applications. In Germany, the first rollout of RASS for routine use occurred in 2018. Although there is increasing evidence on the accuracy and reliability of screw placement, the economic impact of the outcome and process benefits for hospitals has not been studied, yet. This paper investigates the economic impact of the implementation of RASS technology in a spine center (certified DWG center level II) in Germany, which used image guided surgery (IGS) exclusively for screw implantation until 2017 and RASS exclusively since 2019. Based on clinical and process data, the economic effects of introducing the robotic surgery program will be assessed using the InEK[2] benchmark.

Study Design

The study was conducted in two steps:

1. The retrospective, comparative, monocentric analysis in a level II DWG center compares all screw-rod stabilizations in 2017 (using IGS) with the corresponding treatments in 2019 (using RASS). A univariate analysis of case number, length of stay (LOS), case mix (CM), case mix index (CMI), and duration of the surgical intervention ("Schnitt-Naht-Zeit") was performed. The economic evaluation of the outcome parameters was based on the data of the DRG-system published by the German Institute for Reimbursement in Hospitals (InEK). The analyzed cases of the years 2017 and 2019 were grouped uniformly with the DRG-system 2020 in order to exclude distortions of e.g. CM or CMI due to changes in the DRG-system over the years and to enable a more realistic assessment with regard to nursing costs (these are no longer part of the DRG reimbursement since 2020). The year 2018 was completely excluded from the study because the RASS technology was implemented around the middle of the year. This meant that, on the one hand, there were no uniform conditions for the cases of the year 2018 and, on the other hand, the initial, strong effects of the learning curve could therefore be excluded for the RASS cases.

2. The German Spine Registry (DWG[3] Registry) collects data on surgeries performed at DWG-certified spine centers in Germany. A retrospective comparison of RASS cases from a DWG level II center with cases from the other hospitals in the DWG registry was performed using a query in the DWG registry. Since it is not possible to distinguish between IGS and RASS in the registry, a preliminary analysis was performed using the quality data of the G-BA. This verified that only the center under study performed robotically assisted spine surgery in 2019, allowing comparison of these cases with the other cases in the registry. With the aim of making the two groups of cases as homogeneous as possible, the query of the DWG registry for 2019 was performed with the criteria age 40 - 70 years, surgery TLIF monosegmental L1 - S1, specialist standard, intraoperative 3D imaging RASS/navigation. A comparison of LOS, blood loss and blood transfusions, intraoperative and postoperative complications and postoperative interventions was performed. The results were economically evaluated using cost data from InEK's benchmark.

2 Re. translator: InEK is the acronym for the German Institute for Reimbursement in Hospitals (Institut für das Entgeltsystem im Krankenhaus) that calculates the in-patient reimbursement in the form of the DRG-system in an annual process based on published costs data.

3 Re. Translator: DWG is the acronym for the German Spine Association (Deutsche Wirbelsäulengesellschaft)

Results

The single-house analysis showed an increase in the number of cases from 203 surgeries in 2017 to 252 in 2019. The LOS of IGS cases was on average 1.5 days shorter per case compared to the InEK benchmark, and the LOS of RASS cases was 2.5 days shorter. According to the actual CM, the InEK benchmark thus yields a value of 190 Euros per day. This corresponds to an operating cost advantage for RASS of 475 Euros per case compared to the DRG reimbursement and approx. 120,000 Euros for the entire CM. CM increased from 586,792 in 2017 (IGS) to 737,609 in 2019 (RASS) and CMI rose from 2.89 (2.84 effective) to 2.93 (2.91 effective). Average duration of the surgical intervention remained nearly steady at 81 min (IGS) and 82 min (RASS) per case. The query of the DWG registry revealed 77 RASS cases from the DWG level II center and 274 cases from other hospitals. LOS averaged 7.04 days for RASS cases and 10.64 days for IGS cases. 90 percent of RASS surgeries were completed within 2 hours, compared with 20 percent of IGS surgeries completed within this time. Of 76 cases with blood loss data, 75 (98.7 percent) RASS cases had 500ml blood loss vs. 166 of 269 (61.7 percent) IGS cases. No blood transfusion was needed in 100 percent of RASS surgeries vs 88.3 percent of IGS procedures. In-patient stay was reported as "complication-free" in 100 percent of RASS cases, compared with "intensive care unit > 2 days" in 1 percent and "prolonged stay" in 9.9 percent of IGS cases. Intraoperative adverse events occurred with comparable frequency in both groups (dura injuries: RASS 4 (5.2 percent), IGS 13 (4.7 percent), with an additional 2 fractures and 1 "other" complication in IGS). No postoperative complications requiring treatment were documented for the RASS cases. For IGS cases, the following complications were found: epidural hematoma (12.3 percent), other hematoma (0.7 percent), radiculopathy, (1.4 percent), cerebrospinal fluid leak (0.7 percent), motor dysfunction (1.1 percent), sensory dysfunction (0.7 percent), superficial wound infection (0.5 percent), deep wound infection (1.1 percent), implant malposition (0.7 percent) and others (2.5 percent). Postoperative interventions to manage complications in IGS cases were reported as hematoma removal (6 percent), suture (6 percent), (fibrin) adhesive (6 percent), material reimplantation (6 percent), abscess drainage (3 percent), decompression (19 percent), and others (13 percent). The additional costs for the hospitals for these postoperative measures were estimated on the basis of the main service costs of the DRGs that would be affected if only this measure were performed. The result was an additional cost of approximately 75,655 Euros for complications requiring surgery in the 274 IGS cases.

Discussion

The introduction of a robotic surgical program has resulted in a measurable increase in effectiveness and efficiency as compared to IGS. More cases were operated on and the pre-existing LOS benefits were extended by almost one day, nearly double. This results in a potential revenue increase of 550,000 Euros, whereas the LOS-related operating cost advantage amounted to 475 Euros per case compared to the InEK benchmark (total of 120,000 Euros). With a simultaneous shortening of the LOS, the rise in case numbers and CM shows that additional cases can be treated, which can indicate an increase in revenue. An average 8.4 days LOS of RASS cases means that 75 additional cases with an average CMI of 2.93 are mathematically possible per year. Realizing a viable 15 percent of this per year would generate an additional revenue of approx. 120,000 Euros per year through RASS-related process optimization at the base case value of Lower Saxony 2020 (3,662.97 Euros) as used for this study. Combined with the cost benefits of a reduced length of stay and avoidance of complications requiring surgery, the total annual operating cost benefit from RASS vs. IGS amounts to ca. 260,000 Euros. The significant differences between IGS and RASS cases in terms of complications, blood loss and length of stay are in line with numerous international publications on robotic-assisted surgery and RASS. Comparable economic evaluations of the introduction of a robotic surgery program for hospitals in Germany have not been published yet. The evaluation of clinical and process data with cost data published by the InEK is a relatively simple method for estimating the extent of economic chan-

ges with a differential cost analysis.
Studies conducted in a controlled and prospective study design and including additional parameters (e.g., costs of intensive care) are necessary for a more accurate estimation of costs and savings.

Limitations and Assessment

The limitations mainly arise from the data basis available through the DWG register. The data are only available in aggregated form, so that a plausibility check based on the raw data was not feasible. The process of data cleaning in the registry is unclear as details have not been published. Some of the data fields in the registry are not described precisely and are probably not filled without doubt as a consequence. The case groups in the study center and DWG registry are not sufficiently matched to allow statistically valid comparison. Propensity score matching, e.g. using the Carlsson score, is desirable but could not be performed due to lack of data access. Furthermore, the analysis was performed exclusively for TLIF surgeries in one spinal segment, so that the results should be verified for other procedures. The evaluation of clinical differences with the InEK benchmark can only represent a rough estimate/approximation of actual costs. Nevertheless, the evaluated data allows reasonable conclusions about the basic economic effects of implementing RASS in a hospital.

Conclusion

The introduction of a robotic surgical program in a DWG Level II center has demonstrated economic advantages over freehand navigation. These result from a reduction in length of stay and avoidance of complications. Such improvements offer the possibility to treat additional cases, thus increasing revenue by raising the case mix and case mix index. The prospect of standardizing the surgical process and thereby allowing more reliable planning of surgical times, for example, seems particularly promising. Further studies are necessary to obtain a more accurate economic evaluation.

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