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BACKGROUND

- Robotic surgical systems (RSS) have become commonplace in several medical areas.¹
- RSS are used in laparoscopic procedures, spine and neurosurgery, orthopedics, and vascular surgeries.^{1,2}
- In prostatectomy RSS are state of the art and paved the way for other robotic urological procedures.²
- Diversification and technological advances may spur the application of RSS in different medical areas.^{1,2}
- Under §17b of the KFG (Krankenhausfinanzierungsgesetz/Hospital Financing Act), German hospitals have a uniform remuneration system for billing inpatient services. In accordance with §21 KHEntgG, the InEK (Institut für das Entgeltsystem im Krankenhaus/Institute for the Hospital Remuneration System) makes data on charges for inpatient services available.³

OBJECTIVES

- To investigate the utilization of robotic-assisted surgery (RAS) from 2005 to 2020 in Germany.
- To evaluate age and sex-specific trends in the utilization of RAS.
- To evaluate indications and medical specialties associated with RAS and associated trends throughout the years.

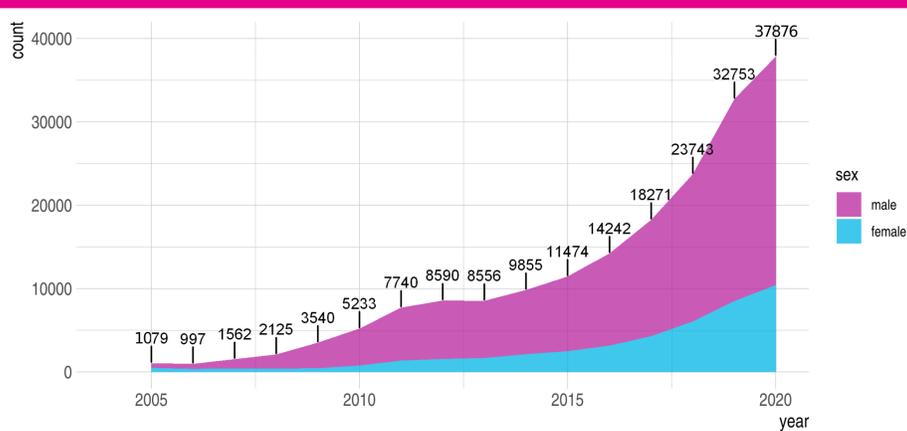
METHODS

- We conducted a retrospective data analysis using German §21 KHEntgG hospital data of the Federal Statistical Office of Germany (DESTATIS) and the InEK.^{3,4}
- RAS was identified by OPS codes 5-987.0, 5-987.1, 5-987.x from 2005 to 2020.
- Age and sex-specific trends in RAS were investigated using compound annual growth rates (CAGR) and sex-ratios.
- Predominant indications, German Diagnosis Related Groups (G-DRG), and medical specialties associated with RAS were identified by DRG and ICD-10-GM codes. Results are presented as numbers and percentages.

RESULTS

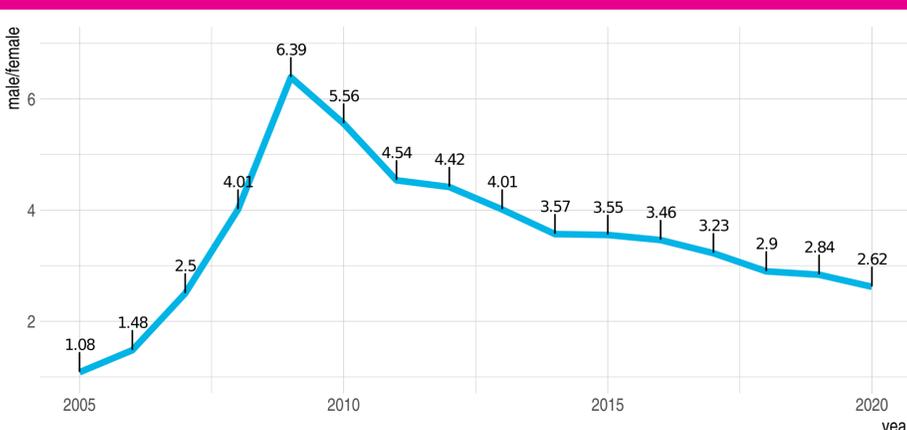
- 1079 (561 male, 518 female) RAS were performed in 2005 in German hospitals. By 2020, the number had increased to 37,876 (27,415 male, 10,461 female), resulting in a CAGR of 26.8% (29.6% male, 22.2% female) (see **Figure 1**).

Figure 1. Number of robot-assisted surgeries (5-987.-) in Germany from 2005 to 2020



- With a sex ratio of 1.08:1, RAS was performed with similar frequency in males and females in 2005. Differences steeply increased until 2009 (sex ratio: 6.39:1), before steadily declining to a sex ratio of 2.62:1 by 2020 (see **Figure 2**).

Figure 2. Sex-ratio in robot-assisted surgeries (5-987.-) in Germany from 2005 to 2020



- Across all evaluated years, RAS was performed most frequently on individuals between 65 to 70 years of age (19.8%) (see **Figure 3**).
- 87.4% of RAS were performed on individuals 50 years or older.
- Few RAS take place among men under the age of 50. They show a peak between 65 to 70.
- Females show higher age variability in the use of RAS. They also peaked around 65 to 70 years (12.21%) in 2020 but showed highest values at around 45 to 50 years in previous years (13.18% in 2009) (see **Figure 4**).
- In 2020, the medical specialty in which RAS was conducted most often was urology (66.7%), with the most common indication being malignant prostate neoplasms (41.8% of all indications). Other relevant specialties were gastroenterology (10.1%), orthopedics (9.2%), and gynecology (6.0%). 74.6% of robot-assisted surgeries were performed in connection with tumor indications (malignant neoplasms: 69.7%, benign neoplasms: 4.9%).

RESULTS (CONTINUED)

Figure 3. Percent of robot-assisted surgeries (5-987.-) in Germany by age

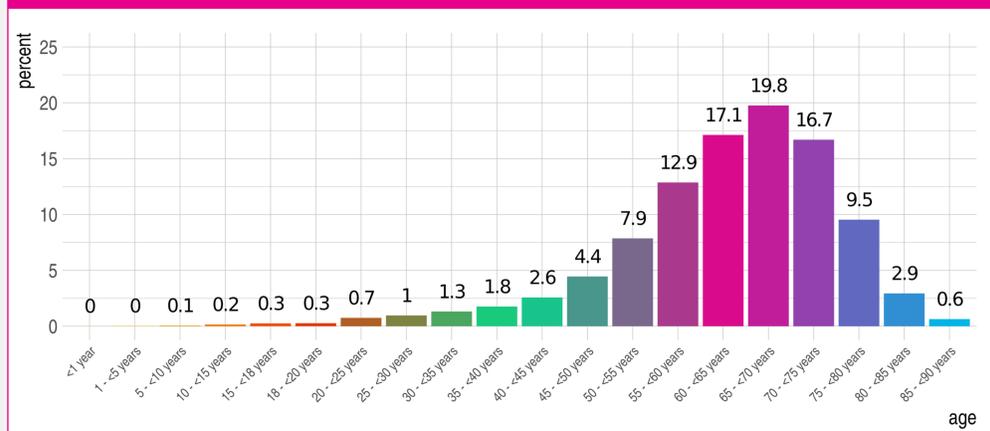
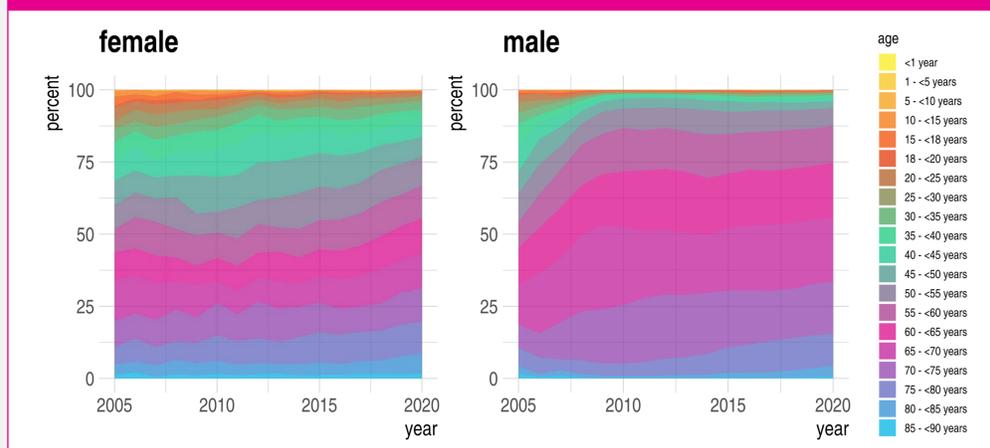


Figure 4. Percent of robot-assisted surgeries (5-987.-) in Germany from 2005 to 2020 by age



- Increasing diversification of the areas of application can be observed. The proportion of urology indications among performed RAS fell continuously between 2019 and 2022 from 70.2% to 58.9%, but increased for indications of other specialties, e.g., from 7.1% to 13.3% in orthopedics (see **Figure 5**).
- The proportion of RAS increased for most common DRG-classifications, e.g., from 4.3% in 2009 to 56.8% in 2020 for M01B (major surgery on the pelvic organs in men) and from 3.0% in 2012 to 22.4% in 2020 for L13B (kidney, ureter and large bladder surgery for neoplasms) (see **Figure 6**).

Figure 5. Percent of robot-assisted surgeries (5-987.-) in Germany from 2019 to 2022 by medical specialties

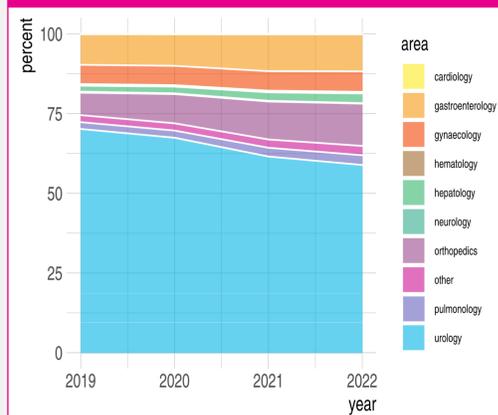
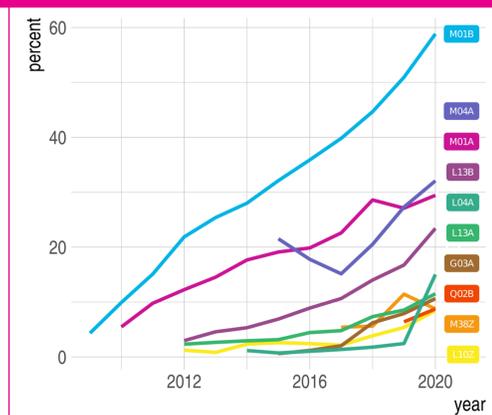


Figure 6. Percent of robot-assisted surgeries (5-987.-) in Germany from 2005 to 2020 within DRG



- Mainly complex robotic systems were used (5-987.0: 87.3%), as compared to robotic arms (5-987.1: 10.0%), or other systems (5-987.x: 2.8%).

CONCLUSIONS

- Use of RSS has proliferated over the past 15 years and is integrated in several medical specialties.
- We currently see clear differences in the use between sexes, potentially due to the common application of RAS in diseases of sex organs.
- RAS is most prevalent in urology and malignant prostate neoplasms, but also becomes more relevant in other medical specialties such as orthopedics or gastroenterology.
- We expect further growth in the use of robotic systems in the future, as well as continued diversification in application areas.

REFERENCES

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