**Supplementary Information**

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Prefecture-Level Uptake of Robot-Assisted Colectomy in Japan: Association With Prior Robotic Rectal Surgery Activity in NDB Open Data

Masanori Sato, Kyota Tatsuta, Mikihiro Shimizu, Kosuke Sugiyama, Mayu Sakata, Toshiya Akai, Hiroya Takeuchi

Corresponding author: Masanori Sato
Department of Surgery, Hamamatsu University School of Medicine, Hamamatsu, Japan
Email: msnrsato@hama-med.ac.jp

**Supplementary Table S1** Detailed reimbursement procedure codes and year-specific classifications used in this study

| Organ | K-code | Reimbursement code | Reimbursed procedure | 2018-2019 | 2020-2021 | 2022-2023 | 2024 |
|---|---|---|---|---|---|---|---|
| Colon | K719 | 150180950 | Surgery for intestinal obstruction (colectomy: total colectomy, subtotal colectomy, or surgery for malignant tumor) | Excl | Excl | Excl | Excl |
| Colon | K719 | 150181910 | Colectomy (total colectomy, subtotal colectomy, or surgery for malignant tumor) | Excl | Excl | Excl | Excl |
| Colon | K719-3 | 150324910 | Laparoscopic colectomy for malignant tumor | Lap | Lap | Lap | Lap |
| Colon | K719-3 | 150442110 | Robot-assisted laparoscopic colectomy for malignant tumor | NA | NA | Rob | Rob |
| Rectum | K740 | 150187110 | Rectal resection | Excl | Excl | Excl | Excl |
| Rectum | K740 | 150187210 | Abdominoperineal resection | Excl | Excl | Excl | Excl |
| Rectum | K740 | 150245410 | Low anterior resection | Excl | Excl | Excl | Excl |
| Rectum | K740 | 150297510 | Ultra-low anterior resection | Excl | Excl | Excl | Excl |
| Rectum | K740 | 150420610 | Rectal resection with transanal anastomosis | NA | Excl | Excl | Excl |
| Rectum | K740-2 | 150325210 | Laparoscopic rectal resection | Lap | Lap | Lap | Lap |
| Rectum | K740-2 | 150337810 | Laparoscopic low anterior resection | Lap | Lap | Lap | Lap |
| Rectum | K740-2 | 150337910 | Laparoscopic abdominoperineal resection | Lap | Lap | Lap | Lap |
| Rectum | K740-2 | 150407210 | Robot-assisted laparoscopic rectal resection | Rob | Rob | Rob | Rob |
| Rectum | K740-2 | 150407310 | Robot-assisted laparoscopic low anterior resection | Rob | Rob | Rob | Rob |
| Rectum | K740-2 | 150407410 | Robot-assisted laparoscopic abdominoperineal resection | Rob | Rob | Rob | Rob |
| Rectum | K740-2 | 150429910 | Laparoscopic ultra-low anterior resection | NA | NA | Lap | Lap |
| Rectum | K740-2 | 150430110 | Laparoscopic rectal resection with transanal anastomosis | NA | NA | Lap | Lap |
| Rectum | K740-2 | 150450210 | Robot-assisted laparoscopic ultra-low anterior resection | NA | NA | NA | Rob |
| Rectum | K740-2 | 150450310 | Robot-assisted laparoscopic rectal resection with transanal anastomosis | NA | NA | NA | Rob |
| Stomach | K655 | 150168010 | Gastrectomy for malignant tumor | Open | Open | Open | Open |
| Stomach | K655-2 | 150323510 | Laparoscopic gastrectomy for malignant tumor | Lap | Lap | Lap | Lap |
| Stomach | K655-2 | 150406710 | Robot-assisted laparoscopic gastrectomy for malignant tumor | Rob | Rob | Rob | Rob |
| Stomach | K655-4 | 150337310 | Proximal gastrectomy for malignant tumor | Open | Open | Open | Open |
| Stomach | K655-5 | 150377910 | Laparoscopic proximal gastrectomy for malignant tumor | Lap | Lap | Lap | Lap |
| Stomach | K655-5 | 150406910 | Robot-assisted laparoscopic proximal gastrectomy for malignant tumor | Rob | Rob | Rob | Rob |
| Stomach | K657 | 150168110 | Total gastrectomy for malignant tumor | Open | Open | Open | Open |
| Stomach | K657 | 150429010 | Total gastrectomy for malignant tumor with jejunal pouch reconstruction | NA | NA | Open | Open |
| Stomach | K657-2 | 150323710 | Laparoscopic total gastrectomy for malignant tumor | Lap | Lap | Lap | Lap |
| Stomach | K657-2 | 150407110 | Robot-assisted laparoscopic total gastrectomy for malignant tumor | Rob | Rob | Rob | Rob |
| Stomach | K657-2 | 150429110 | Laparoscopic total gastrectomy for malignant tumor with jejunal pouch reconstruction | NA | NA | Lap | Lap |
| Prostate | K843 | 150209310 | Radical prostatectomy | Open | Open | Open | Open |
| Prostate | K843-2 | 150326510 | Laparoscopic radical prostatectomy | Lap | Lap | Lap | Lap |
| Prostate | K843-3 | 150338810 | Minimum-incision endoscopic radical prostatectomy | Lap | Lap | Lap | Lap |
| Prostate | K843-4 | 150390310 | Robot-assisted laparoscopic radical prostatectomy | Rob | Rob | Rob | Rob |

Lap, conventional laparoscopic procedures; Rob, robot-assisted procedures; Open, open procedures; Excl, excluded from the analysis; NA, procedure code not available in the corresponding fiscal years.

**Supplementary Methods.** Correction rules for robotic system counts

Facility-level robotic system counts were corrected according to the following rules:

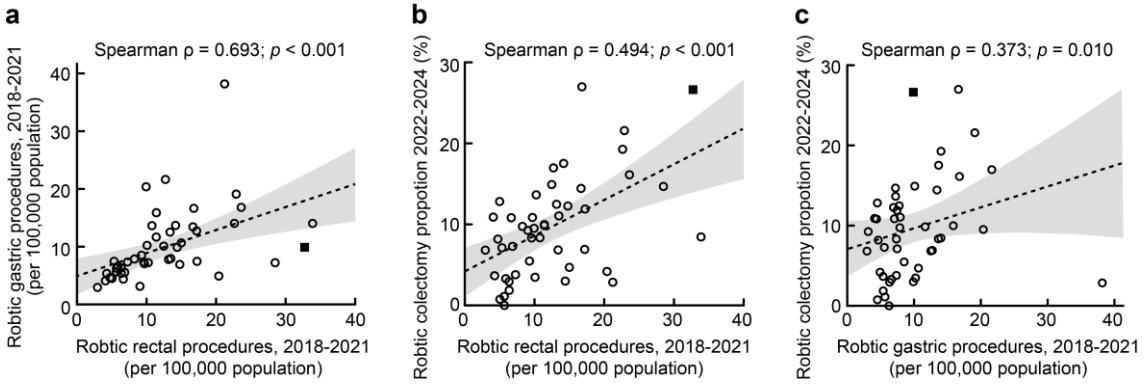
1. **Isolated zeros:** A zero between positive counts was replaced with the adjacent value or the mean of neighboring values, rounded down to the nearest integer.
2. **Isolated positive counts:** A positive count between zeros was corrected to zero unless supported by other evidence.
3. **Consecutive zeros:** Two or more consecutive zeros were generally retained.
4. **Sudden increases:** Unusually large increases in the final reporting year were replaced with the preceding year's count unless supported by other evidence.
5. **Minor changes:** Small year-to-year changes, generally involving one system, were retained.
6. **External confirmation:** Information from hospital websites and official reports took priority over these rules.
7. **Missing values:** Missing or unavailable values were not replaced with zero or estimated.

The results of the data review and corrections are summarized in Table SM1.

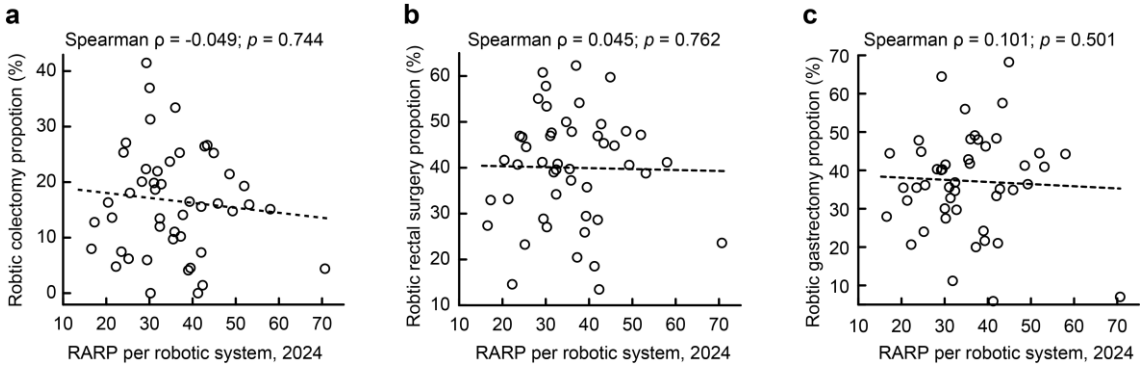
**Table SM1 (Supplementary Methods).** Summary of review and correction of robotic system counts

| Reason for correction | External verification recorded, n | Records, n |
|---|---|---|
| **Final corrections** | **35** | **63** |
| Isolated zeros between positive counts | 6 | 12 |
| Isolated or unsupported positive counts | 7 | 17 |
| Consecutive zeros or decreases | 10 | 19 |
| Other corrections based on longitudinal review and external information | 12 | 15 |
| **Proposed corrections withdrawn** | **23** | **23** |
| **Total records reviewed** | **58** | **86** |

Records represent facility-year observations. Correction categories are mutually exclusive. External verification was recorded separately and may overlap with the correction reasons. For withdrawn corrections, the original reported values were retained.




**Supplementary Figure S1.** Relationships among prior robotic rectal surgery experience, prior robotic gastrectomy experience, and subsequent robotic colectomy uptake. Scatterplots show prefecture-level associations between **a**, cumulative robot-assisted rectal and gastrectomy procedures during 2018–2021; **b**, prior robot-assisted rectal surgery experience and the robotic colectomy proportion during 2022–2024; and **c**, prior robot-assisted gastrectomy experience and the robotic colectomy proportion during 2022–2024. Proportions were calculated using pooled procedure counts for 2022–2024. Prior robotic experience is expressed as cumulative procedures during 2018–2021 per 100,000 population. Each point represents one prefecture, and Shizuoka Prefecture is indicated by a filled square in each panel. Lines indicate fitted linear regression lines, with shaded areas representing 95% confidence intervals. Spearman's correlation coefficients (ρ) and *p*-values are shown in each panel.




**Supplementary Figure S2.** Association between RARP utilization per robotic system and robotic gastrointestinal surgery uptake in 2024. Scatterplots show prefecture-level associations between the number of RARP procedures per robotic system and the proportions of **a**, robot-assisted colectomy; **b**, robot-assisted rectal surgery; and **c**, robot-assisted gastrectomy in 2024. Each point represents one prefecture. Dashed lines indicate fitted linear regression lines. Spearman's correlation coefficients (ρ) and *p*-values are shown in each panel. RARP, robot-assisted radical prostatectomy.

**Supplementary Table S2.** Sensitivity analyses of the association between prior robotic rectal surgery experience and robotic colectomy uptake

| **Analysis** | **Adjusted difference, percentage points (95% CI)** | ***p* value** |
|---|---|---|
| Primary analysis (suppressed counts = 5) | 2.75 (0.60–4.89) | 0.012 |
| Lower-bound imputation | 2.73 (0.75–4.71) | 0.007 |
| Upper-bound imputation | 2.79 (0.42–5.17) | 0.021 |
| Weighted by eligible colectomy volume | 3.17 (0.88–5.46) | 0.007 |

Coefficients represent adjusted percentage-point differences in robotic colectomy proportion per 1-SD increase in prior robotic rectal experience. All analyses used the fully adjusted model. Suppressed counts were assigned lower-bound values (0 for 2018–2021 and 1 for 2022–2024), 5 (primary analysis), or 9 (upper bound), with reported zeros retained as zero. The weighted analysis used the primary imputation and was weighted by eligible colectomy volume. CI, confidence interval; SD, standard deviation.