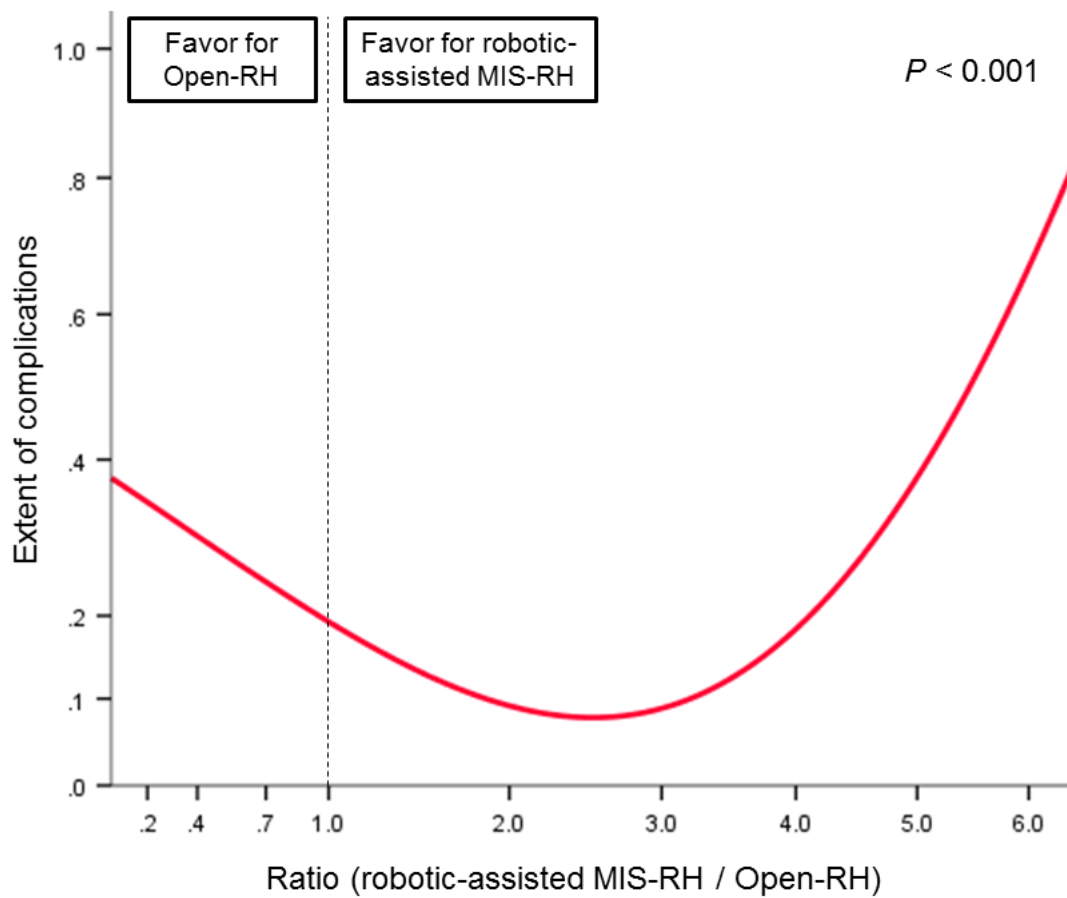**Supplemental Figure S1. Correlation between robotic-assisted MIS-RH / Open-RH ratio and extent of surgical morbidity.**



Total 11 models were assessed for the curve estimation in each cohort. The most-fit curve model was quadratic pattern. The analysis-determined cutoff of reflection point was ratio of >2.0. The vertical dashed line indicate the ratio of 1.0, implying that robotic-assisted MIS-RH and Open-RH was equally chosen. The both axes are shown in power scale to enhance the visualization of analysis.

**Supplemental Table S1. ICD-9 code list.**

| ICD-9 Procedure Codes | |
|---|---|
| Radical hysterectomy (RH) | |
|       Laparoscopic abdominal RH | 6861 |
|       Abdominal RH | 6869 |
|       Laparoscopic vaginal RH | 6871 |
|       Vaginal RH | 6879 |
| Robot-assisted surgery | 1741, 1743, 1744, 1745, 1749 |
| Lymphadenectomy | 400, 401, 4024, 4029, 403, 4052, 4053, 4054, 4059, 409 |

| ICD-9 Diagnosis Codes | |
|---|---|
| Cervical cancer | 1800, 1801, 1808, 1809 |
| Obesity | 27800 |
| Morbid obesity | 27801 |
| History of other malignancy | See codes for CC14 |
| Metastatic disease | See codes for CC16 |
| History of chemotherapy | V5811, V662, V672, V8741 |
| History of radiation | V153, V661, E9268, E9269, V671 |

| **Perioperative complications** | |
|---|---|
| Position-dependent complications | |
| Fluid overload | 27669 |
| Laryngeal edema | 47825, 4786 |
| Air embolism | 9991, 9580 |
| Cerebral edema | 3485 |
| Pulmonary edema | 5184 |
| Respiratory failure | 5185, 5188, 99739 |
| Requirement for prolonged ventilation | 9671, 9672 |
| Aspiration | 77085, 77086, 99732 |
| Atelectasis | 7704, 7705 |
| Peripheral nerve injury | 953, 954, 955, 956, 957, 9970 |
| Ocular injury | 36100. 36101, 36102, 36103, 36104, 36105, 3612, 3613, 36283, 3700, 3713, 37140, 37142, 37170, 3712, 37250, 37271, 37272, 37273, 37289, 3729, 9180, 9181, 9182, 9189 |
| Cardiac arrhythmia, arrest, or failure | 427, 428, 429 |
| Compartment syndrome | 9589, 7297 |
| Rhabdomyolysis | 72888 |
| Bladder injury | 8670, 8671 |
| Ureteral injury | 8672, 8673 |
| Intestinal injury | 8632, 8633, 8634, 8635, 8628 |
| Vascular injury | 9020, 9021, 9022, 9023, 9024, 9025, 9028, 9029, 9049 |
| Postoperative hemorrhage | 99811, 9582, 2851 |
| Postoperative shock | 9980, 9954 |
| Wound complications | 9583, 99812, 99813, 9983, 9985, 99883 |
| Venous Thromboembolism/Pulmonary Embolism | 452, 453, 4151, 4162 |
| Cerebrovascular Accident | 4329, 433, 434, 435, 436, 437 |
| Myocardial Infarction | 410 |
| Pneumonia | 480, 481, 482, 483, 484, 485, 486, 99731, 99732 |
| Systemic Inflammatory Response Syndrome/Sepsis | 9959 |
| Ileus/Small Bowel Obstruction | 5601, 5603, 5608, 5609 |
| Intestinal perforation | 56983 |
| AKI | 584 |
| Pyelonephritis | 590 |
| Coagulopathy | 79092, 2867, 28659, 2866, 2867, 2869 |
| Electrolyte imbalance | 276 |
| Intraabdominal abscess | 56722, 56731, 56738, 5695 |

| **Charlson Comorbidity Index** | |
|---|---|
| CC1: Myocardial Infarction | 410, 411, 412 |
| CC2: Congestive Heart Failure | 39891, 40201, 40211, 40291, 40401, 40403, 40411, 40413, 40491, 40493, 4254, 4255, 4357, 4258, 4259, 428 |

| | |
|---|---|
| CC3: Peripheral Vascular Disease | 0930, 4373, 440, 441, 442, 443, 444, 445, 446, 447, 448, 449, 451, 452, 453, 454, 455, 456 |
| CC4: Cerebrovascular Disease | 3623, 430, 431, 432, 433, 434, 435, 436, 437, 438 |
| CC5: Dementia | 290, 294, 331 |
| CC6: Chronic Pulmonary Disease | 415, 416, 490, 491, 492, 493, 494, 495, 496, 500, 501, 502, 503, 504, 505, 506, 507, 508, 510, 511, 512, 513, 514, 515, 516, 517, 518, 519 |
| CC7: Connective Tissue Disease | 710, 711, 712, 713, 714, 715, 716 |
| CC8: Peptic Ulcer Disease | 531, 532, 533, 534, 535 |
| CC9: Mild Liver Disease | 0701, 0703, 0705, 07070, 0709, 5710, 5713, 5714, 5716, 5718, 5719, 5731, 5732, 5733, 5738, 5739 |
| CC10: Diabetes without complications | 2490, 2500 |
| CC11: Diabetes with complications | 2491, 2492, 2493, 2494, 2495, 2496, 2497, 2498, 2499, 2501, 2502, 2503, 2504, 2505, 2506, 2507, 2508, 2509 |
| CC12: Paraplegia and hemiplegia | 3341, 342, 343, 344 |
| CC13: Renal disease | 403, 404, 580, 581, 582, 583, 584, 585, 586, 587, 588, 589, 590, 591, 592, 593 |
| CC14: Cancer | 140, 141, 142, 143, 144, 145, 146, 147, 148, 149, 150, 151, 152, 153, 154, 155, 156, 157, 158, 159, 160, 161, 162, 163, 164, 165, 170, 171, 172, 173, 174, 175, 176, 179, 180, 181, 182, 183, 184, 185, 186, 187, 188, 189, 190, 191, 192, 193, 194, 195, 200, 201, 202, 203, 204, 205, 206, 207, 208, 209 |
| CC15: Moderate or Severe Liver Disease | 4560, 4561, 4562, 570, 5711, 5712, 5715, 572, 5730, 5734, 5735, V427, 99682 |
| CC16: Metastatic Carcinoma | 196, 197, 198, 199 |
| CC17: HIV/AIDS | 042, 07953, 79571, V08 |

**Supplemental Table S2. Annualized hospital surgical volume for MIS-RH between 2007-2011.**

| Annualized SV | Centers | Proportion | Grouping |
|---|---|---|---|
| 1 | 69 | 42.3% | Low |
| 1.1-1.9 | 10 | 6.1% | Low |
| 2.0-2.9 | 42 | 25.8% | Mid |
| 3.0-4.0 | 28 | 17.2% | Mid |
| 4.1-5.0 | 6 | 3.7% | High |
| >5.0 | 8 | 4.9% | High |
| Total | 163 | 100% | |

Annualized SV of >4.0 MIS-RHs per year represented top 10decile of annualized SV that was used for the high-volume centers. Abbreviation: SV, hospital surgical volume for MIS-RH.

**Supplemental Table S3. Annualized hospital surgical volume for Open-RH between 2007-2011.**

| Annualized SV | Centers | Proportion | Grouping |
|---|---|---|---|
| 1 | 127 | 31.4% | Low |
| 1.1-2.4 | 77 | 19.0% | |
| 2.5-2.9 | 13 | 3.2% | |
| 3.0-3.9 | 36 | 8.9% | |
| 4.0-4.9 | 34 | 8.4% | |
| 5.0-5.9 | 26 | 6.4% | Mid |
| 6.0-6.9 | 19 | 4.7% | |
| 7.0-7.9 | 16 | 4.0% | |
| 8.0-8.9 | 16 | 4.0% | |
| 9.0-9.9 | 12 | 3.0% | |
| 10.0-11.9 | 9 | 2.2% | High |
| 12.0-14.9 | 10 | 2.5% | |
| ≥15 | 10 | 2.5% | |
| Total | 405 | 100 | |

Annualized SV of ≥9.0 Open-RHs per year represented top 10decile of annualized SV that was used for the high-volume centers. Abbreviation: SV, hospital surgical volume for Open-RH.

**Supplemental Table S4. Patient demographics per hospital surgical volume (MIS-RH cohort, *n*=2,202).**

| Characteristic | Low-volume | Mid-volume | High-volume | *P*-value |
|---|---|---|---|---|
| Number | *n*=521 | *n*=1111 | *n*=570 | |
| Age (yr) | 46.6 (±12.0) | 45.8 (±12.4) | 48.6 (±12.0) | <0.001 |
| Year | | | | <0.001 |
|   2007 | 43 (8.3%) | 129 (11.6%) | 205 (36.0%) | |
|   2008 | 85 (16.3%) | 175 (15.8%) | 94 (16.5%) | |
|   2009 | 113 (21.7%) | 297 (26.7%) | 74 (13.0%) | |
|   2010 | 163 (31.3%) | 244 (22.0%) | 93 (16.3%) | |
|   2011 | 117 (22.5%) | 266 (23.9%) | 103 (18.1%) | |
| Race/ethnicity | | | | <0.001 |
|   White | 292 (56.2%) | 602 (54.1%) | 314 (55.0%) | |
|   Black | 42 (8.1%) | 36 (3.2%) | 59 (10.3%) | |
|   Hispanic | 57 (11.0%) | 193 (17.4%) | 91 (15.9%) | |
|   Asian | 25 (4.8%) | 59 (5.3%) | 25 (4.4%) | |
|   Others | 26 (5.0%) | 30 (2.7%) | 13 (2.3%) | |
|   Missing | 78 (15.0%) | 192 (17.3%) | 69 (12.1%) | |
| Obesity | | | | 0.001 |
|   No | 487 (93.7%) | 1041 (93.7%) | 515 (90.4%) | |
|   Class I-II | 23 (4.4%) | 47 (4.2%) | 50 (8.8%) | |
|   Class III | ** | 23 (2.1%) | ** | |
| Charlson Index | | | | 0.003 |
|   0 | 417 (80.2%) | 933 (84.1%) | 462 (80.9%) | |
|   1 | 73 (14.0%) | 121 (10.9%) | 84 (14.7%) | |
|   2 | 21 (4.0%) | 19 (1.7%) | 15 (2.6%) | |
|   ≥3 | ** | 37 (3.3%) | ** | |
| Median household income | | | | <0.001 |
|   <$39,000 | 84 (16.2%) | 220 (19.8%) | 143 (25.1%) | |
|   $39,000-$47,999 | 118 (22.7%) | 216 (19.4%) | 105 (18.4%) | |
|   $48,000-$62,999 | 112 (21.5%) | 302 (27.2%) | 123 (21.6%) | |
|   ≥$63,000 | 187 (36.0%) | 352 (31.7%) | 167 (29.3%) | |
|   Missing | 19 (3.7%) | 22 (2.0%) | 32 (5.6%) | |
| Primary expected payer | | | | <0.001 |
|   Medicare | 75 (14.4%) | 97 (8.7%) | 71 (12.5%) | |
|   Medicaid | 105 (20.1%) | 224 (20.2%) | 74 (13.0%) | |
|   Private including HMO | 332 (63.6%) | 671 (60.4%) | 392 (68.8%) | |
|   Others/missing | ** | 119 (10.7%) | 33 (5.8%) | |
| Hospital bed size | | | | <0.001 |
|   Small | 44 (8.4%) | 77 (6.9%) | 57 (10.0%) | |
|   Medium | 110 (21.1%) | 170 (15.3%) | 77 (13.5%) | |
|   Large | 367 (70.4%) | 846 (76.1%) | 436 (76.5%) | |
|   Missing | 0 | 18 (1.6%) | 0 | |
| Hospital teaching status | | | | <0.001 |
|   Rural | 0 | ** | 0 | |
|   Urban Non-Teaching | 110 (21.1%) | 335 (30.2%) | 95 (16.7%) | |
|   Urban Teaching | 411 (78.9%) | 751 (67.6%) | 475 (83.3%) | |
|   Missing | 0 | 18 (1.6%) | 0 | |
| Hospital region | | | | <0.001 |
|   Northeast | 166 (31.9%) | 157 (14.1%) | 194 (34.0%) | |
|   Midwest | 109 (21.0%) | 179 (16.1%) | 0 | |
|   South | 139 (26.7%) | 399 (35.9%) | 164 (18.8%) | |
|   West | 106 (20.4%) | 376 (33.8%) | 212 (37.2%) | |
| Lymphadenectomy | | | | 0.045 |
|   No | 54 (10.4%) | 79 (7.1%) | 39 (6.8%) | |
|   Yes | 467 (89.6%) | 1032 (92.9%) | 531 (93.2%) | |

Mean (±SD) or number (percentage per column) is shown. Chi-square test or one-way ANOVA test for *P*-value. ** Suppressed per the HCUP requirement (1-10). Total number may not be 2,202 due to weighted values.

**Supplemental Table S5. Independent characteristics for MIS-RH hospital surgical volume (*n*=2,202).**

| Characteristic | Adjusted-OR (95%CI) | *P*-value |
|---|---|---|
| Year | | <0.001 |
| 2007 | 8.34 (3.99-17.4) | |
| 2008 | 1.58 (0.91-2.77) | |
| 2009 | 1.30 (0.79-2.16) | |
| 2010 | 0.86 (0.52-1.41) | |
| 2011 | 1 | |
| Hospital bed size | | 0.003 |
| Small | 6.16 (1.97-19.2) | |
| Medium | 0.78 (0.48-1.25) | |
| Large | 1 | |
| Hospital teaching status | | <0.001 |
| Rural | 1 | |
| Urban Non-Teaching | 0.95 (0.50-1.83) | |
| Urban Teaching | 3.88 (2.15-7.00) | |
| Hospital region | | <0.001 |
| Northeast | 1 | |
| Midwest | 0.23 (0.13-0.41) | |
| South | 0.96 (0.57-1.62) | |
| West | 2.82 (1.48-5.38) | |

A generalized equator estimation model with conditional backward method (final stopping rule at *P*<0.05) was fitted in the analysis. Missing cases in hospital bed size and teaching status were not used due to the possibility of multicollinearity. Abbreviations: OR, odds ratio; and CI, confidence interval.

**Supplemental Table S6. Patient demographics per hospital surgical volume (Open-RH cohort, *n*=11,187).**

| Characteristic | Low-volume | Mid-volume | High-volume | *P*-value |
|---|---|---|---|---|
| Number | *n*=1611 | *n*=5637 | *n*=3939 | |
| Age (yr) | 48.8 (±14.3) | 45.9 (±12.8) | 45.7 (±12.0) | <0.001 |
| Year | | | | <0.001 |
| 2007 | 337 (20.9%) | 1193 (21.2%) | 1163 (29.5%) | |
| 2008 | 324 (20.1%) | 1180 (20.9%) | 815 (20.7%) | |
| 2009 | 372 (23.1%) | 1181 (21.0%) | 830 (21.1%) | |
| 2010 | 340 (21.1%) | 1324 (23.5%) | 814 (20.7%) | |
| 2011 | 238 (14.8%) | 758 (13.4%) | 318 (8.1%) | |
| Race/ethnicity | | | | <0.001 |
| White | 854 (53.0%) | 2770 (49.1%) | 1893 (48.1%) | |
| Black | 126 (7.8%) | 593 (10.5%) | 322 (8.2%) | |
| Hispanic | 276 (17.1%) | 718 (12.7%) | 688 (17.5%) | |
| Asian | 108 (6.7%) | 259 (4.6%) | 121 (3.1%) | |
| Others | 48 (3.0%) | 249 (4.4%) | 154 (3.9%) | |
| Missing | 200 (12.4%) | 1047 (18.6%) | 761 (19.3%) | |
| Obesity | | | | 0.030 |
| No | 1493 (92.6%) | 5115 (90.8%) | 3629 (92.1%) | |
| Class I-II | 74 (4.6%) | 342 (6.1%) | 215 (5.5%) | |
| Class III | 45 (2.8%) | 179 (3.2%) | 95 (2.4%) | |
| Charlson Index | | | | <0.001 |
| 0 | 1207 (74.9%) | 4209 (74.7%) | 2993 (76.0%) | |
| 1 | 270 (16.8%) | 1083 (19.2%) | 804 (20.4%) | |
| 2 | 91 (5.6%) | 254 (4.5%) | 95 (2.4%) | |
| ≥3 | 43 (2.7%) | 90 (1.6%) | 47 (1.2%) | |
| Median household income | | | | <0.001 |
| <$39,000 | 365 (22.6%) | 1440 (25.6%) | 1231 (31.2%) | |
| $39,000-$47,999 | 389 (24.1%) | 1380 (24.5%) | 782 (19.8%) | |
| $48,000-$62,999 | 398 (24.7%) | 1302 (23.1%) | 922 (23.4%) | |
| ≥$63,000 | 403 (25.0%) | 1319 (23.4%) | 928 (23.6%) | |
| Missing | 57 (3.5%) | 195 (3.5%) | 77 (2.0%) | |
| Primary expected payer | | | | <0.001 |
| Medicare | 238 (14.8%) | 507 (9.0%) | 303 (7.7%) | |
| Medicaid | 297 (18.4%) | 1214 (21.5%) | 811 (20.6%) | |
| Private including HMO | 959 (59.5%) | 3286 (58.3%) | 2258 (57.3%) | |
| Others/missing | 118 (7.3%) | 629 (11.2%) | 567 (14.4%) | |
| Hospital bed size | | | | <0.001 |
| Small | 172 (10.7%) | 192 (3.4%) | 361 (9.2%) | |
| Medium | 407 (25.3%) | 1317 (23.4%) | 333 (8.5%) | |
| Large | 999 (62.0%) | 4003 (71.0%) | 3245 (82.4%) | |
| Missing | 33 (2.0%) | 124 (2.2%) | 0 | |
| Hospital teaching status | | | | <0.001 |
| Rural | 34 (2.1%) | 90 (1.6%) | 0 | |
| Urban Non-Teaching | 715 (44.4%) | 1155 (20.5%) | 347 (8.8%) | |
| Urban Teaching | 829 (51.5%) | 4267 (75.7%) | 3592 (91.2%) | |
| Missing | 33 (2.0%) | 124 (2.2%) | 0 | |
| Hospital region | | | | <0.001 |
| Northeast | 323 (20.0%) | 804 (14.3%) | 496 (12.6%) | |
| Midwest | 383 (23.8%) | 1332 (23.6%) | 779 (19.8%) | |
| South | 438 (27.2%) | 2175 (38.6%) | 1721 (43.7%) | |
| West | 467 (29.0%) | 1326 (23.5%) | 944 (24.0%) | |
| Lymphadenectomy | | | | 0.007 |
| No | 92 (5.7%) | 234 (4.2%) | 207 (5.3%) | |
| Yes | 1519 (94.3%) | 5403 (95.8%) | 3732 (94.7%) | |

Mean (±SD) or number (percentage per column) is shown. Chi-square test or one-way ANOVA test for *P*-value. Total number may not 11,187 due to weighted values.

**Supplemental Table S7. Multivariable analysis for perioperative complication (Open-RH cohort).**

| Characteristic | OR (95%CI) | *P*-value |
|---|---|---|
| Age (yr) | 1.01 (1.01-1.02) | <0.001 |
| Year | | <0.001* |
| 2007 | 1 | |
| 2008 | 1.24 (1.11-1.40) | <0.001 |
| 2009 | 1.05 (0.93-1.18) | 0.432 |
| 2010 | 0.94 (0.83-1.06) | 0.290 |
| 2011 | 1.29 (1.12-1.49) | <0.001 |
| Race/ethnicity | | <0.001* |
| White | 1 | |
| Black | 1.44 (1.25-1.67) | <0.001 |
| Hispanic | 0.90 (0.80-1.02) | 0.092 |
| Asian | 1.10 (0.91-1.34) | 0.333 |
| Others | 1.46 (1.19-1.79) | <0.001 |
| Missing | 0.92 (0.82-1.04) | 0.177 |
| Obesity | | <0.001* |
| No | 1 | |
| Class I-II | 0.97 (0.82-1.16) | 0.758 |
| Class III | 1.77 (1.39-2.25) | <0.001 |
| Charlson Index | | <0.001* |
| 0 | 1 | |
| 1 | 2.02 (1.82-2.23) | <0.001 |
| 2 | 2.45 (1.99-3.02) | <0.001 |
| ≥3 | 8.60 (5.58-13.3) | <0.001 |
| Median household income | | <0.001* |
| <$39,000 | 1 | |
| $39,000-$47,999 | 1.02 (0.91-1.15) | 0.694 |
| $48,000-$62,999 | 1.24 (1.10-1.38) | <0.001 |
| ≥$63,000 | 1.10 (0.98-1.24) | 0.120 |
| Missing | 0.64 (0.50-0.82) | <0.001 |
| Primary expected payer | | <0.001* |
| Medicare | 1 | |
| Medicaid | 1.00 (0.84-1.20) | 0.985 |
| Private including HMO | 0.76 (0.65-0.89) | 0.001 |
| Others/missing | 0.94 (0.78-1.14) | 0.532 |
| Hospital teaching status | | <0.001* |
| Rural | 1 | |
| Urban Non-Teaching | 0.35 (0.21-0.58) | <0.001 |
| Urban Teaching | 0.29 (0.20-0.42) | <0.001 |
| Missing | 0.36 (0.26-0.52) | <0.001 |
| Hospital region | | <0.001* |
| Northeast | 1 | |
| Midwest | 1.29 (1.12-1.49) | <0.001 |
| South | 1.44 (1.26-1.64) | <0.001 |
| West | 1.17 (1.02-1.34) | 0.023 |
| Lymphadenectomy | | |
| No | 1 | |
| Yes | 1.84 (1.52-2.24) | <0.001 |
| Hospital surgical volume | | 0.007* |
| Low | 1.19 (1.04-1.35) | 0.011 |
| Mid | 0.98 (0.89-1.07) | 0.595 |
| High | 1 | |

A binary logistic regression model with conditional backward method. All the covariates with *P*<0.05 in univariable analysis were entered in the initial model, and the least significant covariate was removed

until the final model retained only the covariates with $P<0.05$. *$P$-value for interaction. Abbreviations: OR, odds ratio; and CI, confidence interval.

**Supplemental Table S8. Multivariable analysis for perioperative mortality (Open-RH cohort, *n*=11,187).**

| Characteristic | OR (95%CI) | *P*-value |
|---|---|---|
| Age (yr) | 1.07 (1.04-1.11) | <0.001 |
| Charlson Index | | <0.001* |
| 0 | 1 | |
| 1 | na | 0.986 |
| 2 | 11.7 (3.67-37.2) | <0.001 |
| ≥3 | 41.6 (14.0-124) | <0.001 |
| Hospital surgical volume | 0.80 (0.68-0.94) | 0.006 |

A binary logistic regression model with conditional backward method. All the covariates with *P*<0.05 in univariable analysis were entered in the initial model, and the least significant covariate was removed until the final model retained only the covariates with *P*<0.05. Hospital surgical volume was analyzed as a continuous variable due to no death in the large-volume group. *\*P*-value for interaction. Abbreviations: OR, odds ratio; and CI, confidence interval.