# Supplemental Digital Content

SDC 1. Diagnosis and procedure codes used in analysis

SDC2. Matching algorithm

SDC3. Complete results of match, including all variables

SDC4. Sensitivity analysis methodology

Supplemental Digital Content 1. Diagnosis and procedure codes used in analysis

eTable 1. CCS codes used to define cohort for practice-pattern analysis

|  |  |
| --- | --- |
| Category | CCS Category Description |
| 57 | Creation; revision and removal of arteriovenous fistula or vessel-to-vessel cannula for dialysis |
| 66 | Procedures on spleen |
| 67 | Other therapeutic procedures; hemic and lymphatic system |
| 70 | Upper gastrointestinal endoscopy; biopsy |
| 74 | Gastrectomy; partial and total |
| 75 | Small bowel resection |
| 76 | Colonoscopy and biopsy |
| 78 | Colorectal resection |
| 79 | Local excision of large intestine lesion (not endoscopic) |
| 80 | Appendectomy |
| 81 | Hemorrhoid Procedures |
| 84 | Cholecystectomy and common duct exploration |
| 85 | Inguinal and femoral hernia repair |
| 86 | Other Hernia Repair |
| 87 | Laparoscopy (GI only) |
| 89 | Exploratory laparotomy |
| 90 | Excision; lysis peritoneal adhesions |
| 94 | Other OR upper GI therapeutic procedures |
| 96 | Other OR lower GI therapeutic procedures |
| 99 | Other OR gastrointestinal therapeutic procedures |
| 165 | Breast biopsy and other diagnostic procedures on breast |
| 166 | Lumpectomy; quadrantectomy of breast |
| 167 | Mastectomy |
| 168 | Incision and drainage; skin and subcutaneous tissue |
| 169 | Debridement of wound; infection or burn |
| 170 | Excision of skin lesion |

eTable 2. *ICD-9 CM* codes used to define cohort for patient outcome analysis

|  |  |  |
| --- | --- | --- |
| Surgery Type | ICD-9 CM Codes | Complex=1 |
| Groin hernia repair | 53.01, 53.02, 53.03, 53.04, 53.05, 53.10, 53.11, 53.12, 53.13, 53.14, 53.15, 53.16, 53.17, 53.21, 53.29, 53.31, 53.39, 17.11, 17.12, 17.13, 17.21, 17.22, 17.23, 17.24 |  |
| Abdominal hernia repair-open | 53.51, 53.59, 53.61, 53.69 |  |
| Abdominal hernia repair -lap | 53.42, 53.43, 53.62, 53.63 |  |
| Umbilical hernia repair-open | 53.41, 53.49 |  |
| Diaphragmatic hernia repair-open | 53.72, 53.75 | 1 |
| Diaphragmatic hernia repair-lap | 53.71 | 1 |
| Cholecystectomy-open | 51.21, 51.22 |  |
| Cholecystectomy-lap | 51.23, 51.24 |  |
| Hepatectectomy | 50.3, 50.22 | 1 |
| Liver ablation-open | 50.23 |  |
| Liver ablation-lap | 50.25 |  |
| Pancreatectomy | 52.6, 52.7, 52.51, 52.52, 52.53, 52.59 | 1 |
| Splenectomy | 41.5, 41.43 |  |
| Esophagomyotomy | 42.7 | 1 |
| Anti reflux surgery-lap | 44.67 |  |
| Sleeve gastrectomy-lap | 43.82, 44.68 | 1 |
| Sleeve gastrectomy-open | 43.89 | 1 |
| Roux en Y gastric bypass-lap | 44.38 | 1 |
| Roux en Y gastric bypass-open | 44.31, 44.39 | 1 |
| Adjustable gastric band | 44.95 | 1 |
| Other bariatric | 44.3, 44.96, 44.97, 44.99, 44.5, 44.51, 45.9 | 1 |
| Gastrectomy | 43.5, 43.6, 43.7, 43.81, 43.89, 43.91, 43.99 | 1 |
| Vagotomy | 44.00, 44.01, 44.02, 44.03 |  |
| Gastroenterostomy | 44.38, 44.39 |  |
| Ulcer repair | 44.40, 44.41, 44.42 |  |
| Enterectomy | 45.61, 45.62 |  |
| Partial colectomy-lap | 17.31, 17.32, 17.33, 17.34, 17.35, 17.36, 17.39 |  |
| Partial colectomy-open | 45.71, 45.72, 45.73, 45.74, 45.75, 45.76, 45.79 |  |
| Total colectomy-lap | 45.81 |  |
| Total colectomy-open | 45.8, 45.82, 45.83 |  |
| Appendectomy | 47.01, 47.09 |  |
| Ostomy revision | 46.50, 46.51, 46.52, 46.40, 46.41, 46.43 |  |
| Ostomy creation | 46.01, 46.03, 46.10, 46.11, 46.13, 46.20, 46.21, 46.22, 46.23, 46.39 |  |
| Abdominal-perineal resection | 48.5, 48.50, 48.51, 48.52, 48.59 | 1 |
| Low anterior resection | 48.62, 48.63 | 1 |
| Other proctectomy | 48.40, 48.41, 48.42, 48.43,  48.49, 48.69 | 1 |
| Lysis of adhesions-lap | 54.51 |  |
| Lysis of adhesions -open | 54.59 |  |
| Mastectectomy | 85.41, 85.42, 85.43, 85.44, 85.45, 85.46, 85.47, 85.48 |  |
| Adrenalectomy | 07.21, 07.22, 07.29, 07.3 | 1 |
| Parathyroidectomy | 06.81, 06.89 |  |
| Partial thyroidectomy | 06.2, 06.31, 06.39, 06.51 |  |
| Total thyroidectomy | 06.4, 06.50, 06.52 |  |

eTable 3. ICD9-CM codes used to define postoperative complicationsa

|  |  |
| --- | --- |
| Description | ICD-9-CM Code |
| Pneumonia or other respiratory complication | 480.x-486.x, 507-507.9, 518.4, 518.5x, 518.8-518.89, 997.3x |
| Myocardial infarction and other cardiac complications | 410.00–410.91, 997.1 |
| Nervous system complications | 431.00-431.91, 433.00-433.91, 434.00-434.91, 436, 437.1, 997.0-997.09 |
| Deep venous thrombosis/pulmonary embolism | 415.11-415.19, 453.4x, 453.8x, 453.9x |
| Acute renal failure | 584-584.9 |
| Bleeding | 998.1, 998.11, 998.12; 998.2 AND 99.0-99.09b |
| Postoperative infection | 998.5, 998.51, 998.59, 996.64 |
| Mechanical wound complication | 998.13, 998.3-998.32 |
| Septicemia | 038-038.9, 790.7, 998.02 |
| Return to operating roomb | 06.02, 34.03, 54.12, 54.61, 54.92 |
| Other | 998.8, 998.89, 998.9, E87.00b |

a Diagnosis code only included if not present on admission

b Procedure codes

Supplemental Digital Content 2. Matching algorithm

1. Match exactly for the following variables:
   1. Hospital ID
2. Subject to (1), fine balance on the following variables:
   1. Surgeon experience (years from training)
   2. Primary surgical specialty
   3. Secondary surgical specialty
3. Subject to (1) and (2), minimize distance between cases and controls for the following variables:
   1. Age
   2. No. Comorbidities
   3. Median Income, USD
   4. Male
   5. Hispanic
   6. White
   7. African-American
   8. Other Racial Cat.
   9. Emergency Admission
   10. Urgent Admission
   11. Elective Admission
   12. Income Missing
   13. Medicare
   14. Medicaid
   15. Commercial insurance
   16. Self insurance
   17. Other Type of Payment
   18. Surgeon Age, y
   19. Clinical Experience, y
   20. No. of Procedures
   21. No. of Complex Procedures
   22. No. of Essential Procedures
   23. Comorbidities
   24. Community Based Residency
   25. University Affiliated Residency
   26. Military Residency
   27. University Residency
   28. Residency Type Unlisted
   29. Comorbidities

Congestive Heart Failure

Cardiac Arrhythmias

Valvular Disease

Pulmonary Circulation Disorders

Peripheral Vascular Disorders

Hypertension, Uncomplicated

Hypertension, Complicated

Paralysis

Other Neurological Disorders

Chronic Pulmonary Disease

Diabetes, Uncomplicated

Diabetes, Complicated

Hypothyroidism

Renal Failure

Liver Disease

Peptic Ulcer Disease Excluding Bleeding

AIDS/HIV

Lymphoma

Metastatic Cancer

Solid Tumor Without Metastasis

Rheumatoid Arthritis/Collagen Vascular

Coagulopathy

Obesity

Weight Loss

Fluid and Electrolyte Disorders

Blood Loss Anemia

Deficiency Anemia

Alcohol Abuse

Drug Abuse

Psychoses

Depression

* 1. Procedure Types

Groin hernia

Abdominal hernia (open)

Abdominal hernia (laparoscopic)

Umbilical hernia (open)

Diaphragmatic hernia (open)

Diaphragmatic hernia (laparoscopic)

Cholecystectomy (open)

Cholecystectomy (laparoscopic)

Hepatectomy

Liver ablation (open)

Liver ablation (laparoscopic)

Pancreatectomy

Splenectomy

Esophagectomy

Esophagomyotomy

Anti-reflux operations (laparoscopic)

Sleeve gastrectomy (laparoscopic)

Sleeve gastrectomy (open)

Roux en Y Gastric Bypass (laparoscopic)

Roux en Y Gastric Bypass (open)

Adjustable laparoscopic band placement

Other bariatric operations

Gastrectomy

Vagotomy

Gastroenterostomy

Operations for ulcers

Enterectomy

Partial colectomy (laparoscopic)

Partial colectomy (open)

Total colectomy (laparoscopic)

Total colectomy (open)

Appendectomy

Ostomy reversal or revision

Ostomy creation

Proctectomy (abdominal perineal resection)

Proctectomy (low anterior resection)

Proctectomy (other)

Lysis of Adhesions (laparoscopic)

Lysis of Adhesions (open)

Mastectomy

Adrenalectomy

Parathyroidectomy

Partial thyroidectomy

Total thyroidectomy

Supplemental Digital Content 3. Complete results of match, including all variables

eTable 4. Surgeon and patient characteristics for unmatched and matched cohorts

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Female Surgeons | | Male Surgeons | |  | |  | | |
|  | Unmatched | Matched | Matched | Unmatched | Unmatched | | Matched | | |
| Surgeon-level variables | Mean | | | | SD | P value | SD | P value | |
| Surgeon age, years | 48.52 | 47.33 | 47.71 | 54.30 | -0.65 | 0.00 | -0.04 | | 0.63 |
| Surgeon experience, years | 11.54 | 10.07 | 10.68 | 17.62 | -0.66 | 0.00 | -0.07 | | 0.46 |
| All procedures, number | 95.59 | 162.43 | 166.82 | 147.72 | -0.44 | 0.00 | -0.04 | | 0.73 |
| Complex procedures, number | 28.98 | 30.45 | 29.97 | 32.57 | -0.05 | 0.44 | 0.01 | | 0.94 |
| Essential procedures, number | 80.38 | 131.97 | 136.86 | 121.94 | -0.43 | 0.00 | -0.05 | | 0.66 |
|  | Proportion of surgeons | | | | Std.Diff | P value | Std.Diff | P value | |
| Residency-University Based | 0.68 | 0.66 | 0.66 | 0.66 | 0.03 | 0.57 | 0.00 | | 1.00 |
| Residency-University Affiliated | 0.22 | 0.22 | 0.22 | 0.22 | 0.00 | 0.99 | 0.00 | | 1.00 |
| Residency-Community Based | 0.05 | 0.05 | 0.04 | 0.05 | -0.00 | 0.98 | 0.03 | | 0.78 |
| Residency-Military | 0.00 | 0.01 | 0.01 | 0.02 | -0.12 | 0.00 | 0.00 | | 1.00 |
| Residency-Unknown | 0.05 | 0.07 | 0.07 | 0.05 | -0.00 | 0.92 | -0.03 | | 0.82 |
| Patient-level variables | Mean | | | | SD | P value | SD | P value | |
| Age, years | 54.51 | 54.86 | 54.78 | 56.41 | -0.25 | 0.00 | 0.01 | | 0.92 |
| Comorbidities, number | 2.09 | 2.13 | 2.11 | 2.22 | -0.19 | 0.00 | 0.02 | | 0.82 |
| Median Income, USD | 54454 | 53750 | 54005 | 53111 | 0.11 | 0.03 | -0.02 | | 0.85 |
|  | Mean proportion of patients per surgeon | | | | Std.Diff | P value | Std.Diff | P value | |
| Male | 0.30 | 0.42 | 0.42 | 0.42 | -0.68 | 0.00 | -0.00 | | 0.94 |
| Ethnicity-Hispanic | 0.12 | 0.12 | 0.11 | 0.10 | 0.08 | 0.15 | 0.06 | | 0.60 |
| Race-White | 0.71 | 0.71 | 0.72 | 0.76 | -0.20 | 0.00 | -0.05 | | 0.68 |
| Race-African-American | 0.13 | 0.14 | 0.13 | 0.12 | 0.11 | 0.04 | 0.01 | | 0.94 |
| Race-Other | 0.16 | 0.16 | 0.15 | 0.12 | 0.17 | 0.00 | 0.05 | | 0.64 |
| Admission-Emergent | 0.39 | 0.49 | 0.49 | 0.47 | -0.26 | 0.00 | 0.02 | | 0.86 |
| Admission-Urgent | 0.07 | 0.08 | 0.08 | 0.09 | -0.16 | 0.00 | -0.00 | | 0.98 |
| Admission-Elective | 0.55 | 0.43 | 0.44 | 0.44 | 0.33 | 0.00 | -0.02 | | 0.87 |
| Insurance-Medicare | 0.32 | 0.35 | 0.34 | 0.38 | -0.36 | 0.00 | 0.04 | | 0.68 |
| Insurance-Medicaid | 0.11 | 0.12 | 0.11 | 0.10 | 0.09 | 0.08 | 0.09 | | 0.34 |
| Insurance-Commercial | 0.49 | 0.45 | 0.46 | 0.44 | 0.29 | 0.00 | -0.09 | | 0.41 |
| Insurance-Self | 0.05 | 0.06 | 0.05 | 0.05 | -0.02 | 0.67 | 0.01 | | 0.92 |
| Insurance-Other | 0.03 | 0.03 | 0.03 | 0.03 | -0.07 | 0.16 | -0.01 | | 0.96 |
| Income Missing | 0.05 | 0.04 | 0.04 | 0.04 | 0.05 | 0.40 | -0.04 | | 0.56 |
| Comorbidities | Mean proportion of patients per surgeon | | | | Std.Diff | P value | Std.Diff | P value | |
| Congestive Heart Failure | 0.04 | 0.05 | 0.05 | 0.05 | -0.40 | 0.00 | 0.00 | | 0.96 |
| Cardiac Arrhythmias | 0.09 | 0.11 | 0.12 | 0.12 | -0.36 | 0.00 | -0.04 | | 0.70 |
| Valvular Disease | 0.03 | 0.03 | 0.03 | 0.04 | -0.20 | 0.00 | 0.03 | | 0.68 |
| Pulmonary Circulation Disorders | 0.01 | 0.02 | 0.02 | 0.02 | -0.17 | 0.00 | 0.04 | | 0.59 |
| Peripheral Vascular Disorders | 0.02 | 0.03 | 0.03 | 0.04 | -0.27 | 0.00 | -0.07 | | 0.37 |
| Hypertension, Uncomplicated | 0.37 | 0.38 | 0.39 | 0.40 | -0.29 | 0.00 | -0.07 | | 0.41 |
| Hypertension, Complicated | 0.04 | 0.05 | 0.05 | 0.06 | -0.32 | 0.00 | 0.03 | | 0.60 |
| Paralysis | 0.01 | 0.01 | 0.01 | 0.01 | -0.05 | 0.34 | 0.01 | | 0.91 |
| Other Neurological Disorders | 0.03 | 0.03 | 0.03 | 0.03 | -0.18 | 0.00 | 0.05 | | 0.51 |
| Chronic Pulmonary Disease | 0.14 | 0.16 | 0.16 | 0.16 | -0.20 | 0.00 | 0.10 | | 0.23 |
| Diabetes, Uncomplicated | 0.12 | 0.13 | 0.13 | 0.13 | -0.12 | 0.02 | 0.02 | | 0.80 |
| Diabetes, Complicated | 0.01 | 0.01 | 0.01 | 0.02 | -0.11 | 0.03 | -0.03 | | 0.70 |
| Hypothyroidism | 0.11 | 0.10 | 0.10 | 0.10 | 0.03 | 0.62 | 0.05 | | 0.53 |
| Renal Failure | 0.05 | 0.06 | 0.06 | 0.07 | -0.26 | 0.00 | -0.01 | | 0.91 |
| Liver Disease | 0.04 | 0.05 | 0.05 | 0.05 | -0.11 | 0.04 | 0.05 | | 0.56 |
| Peptic Ulcer Disease Excluding Bleeding | 0.00 | 0.01 | 0.01 | 0.01 | -0.23 | 0.00 | -0.02 | | 0.79 |
| AIDS/HIV | 0.00 | 0.00 | 0.00 | 0.00 | 0.09 | 0.14 | 0.10 | | 0.21 |
| Lymphoma | 0.01 | 0.01 | 0.01 | 0.01 | -0.03 | 0.58 | 0.06 | | 0.40 |
| Metastatic Cancer | 0.12 | 0.07 | 0.07 | 0.07 | 0.40 | 0.00 | -0.03 | | 0.70 |
| Solid Tumor Without Metastasis | 0.34 | 0.18 | 0.17 | 0.19 | 0.54 | 0.00 | 0.05 | | 0.50 |
| Rheumatoid Arthritis/Collagen Vascular | 0.02 | 0.02 | 0.02 | 0.02 | 0.01 | 0.90 | 0.06 | | 0.41 |
| Coagulopathy | 0.02 | 0.03 | 0.03 | 0.04 | -0.20 | 0.00 | -0.02 | | 0.79 |
| Obesity | 0.13 | 0.15 | 0.16 | 0.13 | -0.05 | 0.37 | -0.04 | | 0.75 |
| Weight Loss | 0.05 | 0.07 | 0.07 | 0.07 | -0.33 | 0.00 | 0.01 | | 0.92 |
| Fluid and Electrolyte Disorders | 0.14 | 0.19 | 0.18 | 0.20 | -0.52 | 0.00 | 0.01 | | 0.91 |
| Blood Loss Anemia | 0.01 | 0.01 | 0.01 | 0.01 | -0.17 | 0.00 | -0.03 | | 0.78 |
| Deficiency Anemia | 0.01 | 0.02 | 0.02 | 0.02 | -0.08 | 0.17 | -0.07 | | 0.50 |
| Alcohol Abuse | 0.02 | 0.02 | 0.02 | 0.02 | -0.11 | 0.03 | 0.02 | | 0.83 |
| Drug Abuse | 0.01 | 0.02 | 0.02 | 0.01 | -0.06 | 0.27 | 0.05 | | 0.56 |
| Psychoses | 0.01 | 0.01 | 0.01 | 0.01 | -0.06 | 0.25 | -0.02 | | 0.80 |
| Depression | 0.09 | 0.10 | 0.10 | 0.10 | -0.05 | 0.39 | 0.04 | | 0.71 |
| Procedures | Mean proportion of patients per surgeon | | | | Std.Diff | P value | Std.Diff | P value | |
| Groin hernia repair | 0.01 | 0.02 | 0.02 | 0.02 | -0.26 | 0.00 | -0.08 | | 0.39 |
| Abdominal hernia repair-open | 0.04 | 0.04 | 0.04 | 0.07 | -0.32 | 0.00 | -0.05 | | 0.41 |
| Abdominal hernia repair -lap | 0.01 | 0.02 | 0.02 | 0.02 | -0.21 | 0.00 | -0.06 | | 0.58 |
| Umbilical hernia repair-open | 0.01 | 0.01 | 0.01 | 0.01 | -0.05 | 0.25 | 0.01 | | 0.84 |
| Diaphragmatic hernia repair-open | 0.00 | 0.00 | 0.00 | 0.00 | -0.12 | 0.00 | 0.02 | | 0.84 |
| Diaphragmatic hernia repair-lap | 0.00 | 0.00 | 0.01 | 0.01 | -0.14 | 0.00 | -0.12 | | 0.22 |
| Cholecystectomy-open | 0.02 | 0.03 | 0.02 | 0.03 | -0.24 | 0.00 | 0.11 | | 0.19 |
| Cholecystectomy-lap | 0.13 | 0.18 | 0.18 | 0.18 | -0.33 | 0.00 | -0.02 | | 0.88 |
| Hepatectectomy | 0.00 | 0.01 | 0.01 | 0.01 | -0.17 | 0.00 | 0.02 | | 0.85 |
| Liver ablation-open | 0.00 | 0.00 | 0.00 | 0.00 | -0.10 | 0.01 | -0.07 | | 0.54 |
| Liver ablation-lap | 0.00 | 0.00 | 0.00 | 0.00 | -0.04 | 0.45 | 0.03 | | 0.57 |
| Pancreatectomy | 0.01 | 0.01 | 0.01 | 0.02 | -0.17 | 0.00 | 0.03 | | 0.77 |
| Splenectomy | 0.01 | 0.01 | 0.01 | 0.01 | -0.02 | 0.66 | -0.09 | | 0.29 |
| Esophagomyotomy | 0.01 | 0.01 | 0.01 | 0.01 | -0.10 | 0.04 | 0.01 | | 0.93 |
| Anti reflux surgery-lap | 0.00 | 0.00 | 0.01 | 0.01 | -0.12 | 0.00 | -0.13 | | 0.54 |
| Sleeve gastrectomy-lap | 0.01 | 0.02 | 0.02 | 0.02 | -0.04 | 0.49 | 0.07 | | 0.66 |
| Sleeve gastrectomy-open | 0.01 | 0.02 | 0.03 | 0.02 | -0.03 | 0.56 | -0.09 | | 0.57 |
| Roux en Y gastric bypass-lap | 0.00 | 0.00 | 0.00 | 0.00 | -0.05 | 0.18 | 0.01 | | 0.88 |
| Roux en Y gastric bypass-open | 0.02 | 0.02 | 0.02 | 0.01 | 0.06 | 0.29 | 0.05 | | 0.67 |
| Adjustable gastric band | 0.00 | 0.00 | 0.00 | 0.00 | -0.09 | 0.01 | -0.03 | | 0.57 |
| Other bariatric | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.81 | 0.02 | | 0.86 |
| Gastrectomy | 0.00 | 0.00 | 0.00 | 0.00 | -0.05 | 0.26 | 0.01 | | 0.89 |
| Vagotomy | 0.01 | 0.01 | 0.02 | 0.02 | -0.21 | 0.00 | -0.09 | | 0.52 |
| Gastroenterostomy | 0.00 | 0.00 | 0.00 | 0.00 | -0.08 | 0.02 | 0.09 | | 0.09 |
| Ulcer repair | 0.00 | 0.00 | 0.00 | 0.01 | -0.23 | 0.00 | -0.03 | | 0.59 |
| Enterectomy | 0.01 | 0.01 | 0.01 | 0.01 | -0.07 | 0.21 | -0.01 | | 0.88 |
| Partial colectomy-lap | 0.04 | 0.05 | 0.05 | 0.05 | -0.20 | 0.00 | -0.02 | | 0.84 |
| Partial colectomy-open | 0.03 | 0.07 | 0.07 | 0.05 | -0.19 | 0.00 | -0.05 | | 0.71 |
| Total colectomy-lap | 0.06 | 0.09 | 0.09 | 0.09 | -0.31 | 0.00 | -0.03 | | 0.79 |
| Total colectomy-open | 0.00 | 0.00 | 0.00 | 0.00 | 0.04 | 0.52 | 0.13 | | 0.40 |
| Appendectomy | 0.00 | 0.01 | 0.01 | 0.01 | -0.14 | 0.00 | -0.12 | | 0.26 |
| Groin hernia repair | 0.11 | 0.12 | 0.13 | 0.12 | -0.09 | 0.11 | -0.01 | | 0.91 |
| Ostomy revision | 0.02 | 0.03 | 0.03 | 0.02 | -0.05 | 0.31 | -0.03 | | 0.84 |
| Ostomy creation | 0.02 | 0.03 | 0.02 | 0.02 | -0.11 | 0.02 | 0.13 | | 0.07 |
| Abdominal-perineal resection | 0.00 | 0.01 | 0.01 | 0.00 | -0.05 | 0.33 | 0.14 | | 0.37 |
| Low anterior resection | 0.01 | 0.03 | 0.02 | 0.02 | -0.08 | 0.11 | 0.14 | | 0.36 |
| Other proctectomy | 0.01 | 0.01 | 0.01 | 0.01 | -0.00 | 0.94 | 0.12 | | 0.49 |
| Lysis of adhesions-lap | 0.01 | 0.01 | 0.01 | 0.01 | -0.15 | 0.00 | -0.09 | | 0.12 |
| Lysis of adhesions-open | 0.02 | 0.02 | 0.02 | 0.03 | -0.16 | 0.00 | -0.00 | | 0.98 |
| Mastectectomy | 0.30 | 0.04 | 0.01 | 0.06 | 0.75 | 0.00 | 0.07 | | 0.01 |
| Adrenalectomy | 0.00 | 0.00 | 0.01 | 0.00 | -0.03 | 0.62 | -0.11 | | 0.43 |
| Parathyroidectomy | 0.01 | 0.01 | 0.01 | 0.01 | -0.03 | 0.57 | -0.01 | | 0.90 |
| Partial thyroidectomy | 0.01 | 0.01 | 0.01 | 0.01 | -0.09 | 0.08 | -0.09 | | 0.53 |
| Total thyroidectomy | 0.02 | 0.02 | 0.03 | 0.01 | 0.03 | 0.56 | -0.09 | | 0.47 |

Supplemental Digital Content 4. Sensitivity analysis

In an observational study, one concern is that bias from a hidden covariate can give the impression that a treatment effect exists when in fact no effect is present. Bias from hidden confounders can also mask an actual treatment effect leaving the analyst to conclude there is no effect when in fact such an effect exists. We explored this possibility using a test of equivalence and a sensitivity analysis. For the sensitivity analysis, we conducted a test of equivalence to test the hypotheses that τ is not small.

Under a test of equivalence, we test the following null hypothesis H\_0^((δ)): |τ|>δ. Rejecting H\_0^((δ)) provides a basis for asserting with confidence that |τ|<δ. H\_0^((δ)) is the union of two exclusive hypotheses: H ⃐\_0^((δ)): τ≤-δ and H ⃑\_0^((δ)): τ≥δ, and H\_0^((δ)) is rejected if both H ⃐\_0^((δ)) and H ⃑\_0^((δ)) are rejected. We can apply the two tests without correction for multiple testing since we test two mutually exclusive hypotheses. Thus, we can test whether the estimate from our study is different from other possible treatment effects which are represented by δ.

With a test of equivalence, it is not possible to demonstrate a total absence of effect, but if this were a randomized trial we could safely test that our estimated effect is not as large as δ. That is, we may be able to reject H\_0^((δ)): |τ|>δ. In an observational study, however, there are additional complications. Since the treatment was not randomly assigned, it may be the case that we reject the null hypothesis of equivalence due to hidden confounding. However, using a sensitivity analysis we may find evidence that the test of equivalence is insensitive to biases from nonrandom treatment assignment.