**Appendix 1. Codes Used to Identify Cholecystectomy and Procedure Exclusions**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | | | **CPT-4** | | **ICD-9-CM Procedure** | | **UB-04 Revenue** | | **ICD-9-CM Diagnosis** |
| **Codes to identify cholecystectomy approach** | | | | | | | | | |
| Open | 47600, 47605, 47610 | | | 51.21, 51.22 | |  | |  | |
| Laparoscopic | 47562–47564 | | | 51.23, 51.24 | |  | |  | |
| **Codes used as supplemental evidence for cholecystectomy** | | | | | | | | | |
| Pathology | | 88304 | | |  | |  | |  |
| Anesthesia | | 00790 | | |  | |  | |  |
| Surgery-related revenue | |  | | |  | | 0201, 0360, 0361, 0369, 0370, 0379, 0490, 0499, 0963, 0964, 0975 | |  |
| **Codes for cholecystectomy exclusion** | | | | | | | | | |
| Cancer | |  | | |  | |  | | 140.0–172.9, 174.0–209.36, 209.70–209.79 |
| Chemotherapy | | 96400–96549, J9000–J9999, Q0083–Q0085 | | | 99.25 | | 0331, 0332, 0335 | | V58.11, V58.12, V66.2, V67.2 |
| End-stage renal disease | |  | | |  | |  | | 585.6, V45.1, V45.11, V45.12, V56.0, V56.1, V56.2, V56.8 |
| Organ transplant | |  | | |  | |  | | V42.0, V42.1, V42.6,V42.7, V42.81–V42.84 |
| Motor vehicle accidents | |  | | |  | |  | | E810.0–E825.9 |
| Fracture | |  | | |  | |  | | 800.00–809.1 |
| Abdominal compartment syndrome | |  | | |  | |  | | 729.73 |
| Gunshot wounds | |  | | |  | |  | | E922.0–E922.3, E922.8, E922.9, E928.7, E965.0–E965.4, E97.0, E979.4, E985.0–E985.4 |
| Abdominal surgery | | 43279–43425, 43496–43659, 43770–44346, 44615, 44640–45190, 45395–46505, 46700–47300, 47362–47399, 47490, 47525, 47530, 47570, 47579, 47700, 47760, 47765, 47780, 47785, 47800, 47801, 47802, 47900, 48000–49081, 49180–49255, 49320–49326, 49329, 49400, 49411–49429, 49435, 49436, 49491–49659, 49904–49999 | | |  | |  | |  |
| Complex cholecystectomy | | 47612, 47620 | | |  | |  | |  |

**Appendix 2. Definitions of Risk Factors for Surgical Site Infection after Cholecystectomy**

| **Risk Factor** | **Days Relative to Cholecyst-ectomy** | **Number of Inpatient Facility, Provider/ Outpatient Facility, or Rx Drug Claims Required** | **ICD-9-CM Diagnosis Code** | **Drug Category** | **ICD-9-CM, CPT-4, or HCPCS Procedure Code** |
| --- | --- | --- | --- | --- | --- |
| **Patient comorbidities/ medications** |  |  |  |  |  |
| Alcohol abuse | -365 to +7 | ≥ 1, ≥ 2, n/a | 291.0–291.3, 291.5–291.9, 303.00–303.93, 305.00–305.03, V11.3 | n/a | n/a |
| Anticoagulopathy drugs | -120 to -1 | n/a, n/a, ≥ 1 | n/a | Coumarin anticoagulants | n/a |
| Blood loss anemia | -365 to -1 | ≥ 1, ≥ 2, n/a | 280–280.9, 648.20–648.24 | n/a | n/a |
| Cancer– lymphoma | -365 to +7 | ≥ 1, ≥ 2, n/a | 200.00–202.38, 202.50–203.82, 238.6, 273.3, V10.71, V10.72, V10.79 | n/a | n/a |
| Cancer– lymph node metastases | -365 to +7 | ≥ 1, ≥ 2, n/a | 196.0–196.9 | n/a | n/a |
| Cancer– metastatic cancer | -365 to +7 | ≥ 1, ≥ 2, n/a | 197.0–198.1, 198.3–198.7, 198.81–199.2, 209.70–209.79, 789.51 | n/a | n/a |
| Cancer– solid tumor | -365 to +7 | ≥ 1, ≥ 2, n/a | 140.0–172.9, 174.0–195.8, 209.00–209.36, 258.01–258.03, V10.00–V10.91 | n/a | n/a |
| Chronic anemia (non-blood loss) | -365 to +7 | ≥ 1, ≥ 2, n/a | 280.1–281.9, 285.21–285.29, 285.9 | n/a | n/a |
| Coagulopathy | -365 to +7 | ≥ 1, ≥ 2, n/a | 286.0–286.9, 287.1, 287.3–287.5, 289.84, 649.30–649.34 | n/a | n/a |
| Congestive heart failure | -365 to +7 120 to -1 Rx | ≥ 1, ≥ 2, ≥ 1 | 398.91, 402.01, 402.11, 402.91, 404.01, 404.03, 404.11, 404.13, 404.91, 404.93, 428.0–428.9 | Loop diuretics | n/a |
| Depression | -365 to +7 | ≥ 1, ≥ 2, n/a | 300.4, 301.12, 309.00, 309.1, 311 | n/a | n/a |
| Diabetes mellitus | -365 to +7  -365 to -1 Rx | ≥ 1, ≥ 2, ≥ 1 | 249.00–249.91, 250.00–250.93, 648.00–648.04 | Antidiabetics | n/a |
| DMARD drugs or biologic medical or drugs | -365 to -1,  -120 to -1 Rx | ≥ 1, ≥ 1, ≥ 1 | n/a | Antimalarials, alkylating agents, antimetabolites, inflammatory bowel agents, antirheumatic antimetabolites, pyrimidine synthesis inhibitors, immunosuppressive agents, antineoplastic- antibodies, interleukin-1 receptor antagonist (IL-1Ra), anti-TNF-alpha- monoclonal antibodies, soluble tumor necrosis factor receptor agents, selective costimulation modulators, interleukin-6 receptor inhibitors | C9230, C9249, C9264, J0129, J0135, J0718, J1438, J1745, J3262, J3490, J9310 |
| Drug abuse | -365 to +7 | ≥ 1, ≥ 1, n/a | 292.0, 292.82–292.9, 304.00–304.93, 305.20–305.93, 648.30–648.34 | n/a | n/a |
| Hypertension | -365 to +7  -365 to -1 Rx | ≥ 1, ≥ 2, ≥ 1 Rx plus 1 hypertension medical claim | 401.0, 401.1, 401.9, 402.00–405.99, 437.2, 642.00–642.04, 642.10–642.24, 642.70–642.94 | Beta blockers, calcium channel blockers, antihypertensives, diuretics, peripheral vasodilators, phosphodiesterase inhibitors, endothelin receptor antagologis,  prostaglandin vasodilators,  vasoactive natriuretics peptides | n/a |
| Liver disease | -365 to +7 | ≥ 1, ≥ 2, n/a | 070.22, 070.23, 070.32, 070.33, 070.44, 070.54, 456.0–456.21, 571.0, 571.2–571.9, 572.3, 572.8, V42.7 | n/a | n/a |
| Malnutrition/ weight loss | -365 to +7 | ≥ 1, ≥ 1, n/a | 260–263.9, 783.21, 783.22 | n/a | n/a |
| Obesity | -365 to +7 | ≥ 1, ≥ 1, n/a | 112.3, 256.4, 278.00, 278.01, 278.03, 649.10–649.14, 793.91, V85.30–V85.45 | n/a | n/a |
| Obesity– bariatric surgery | -365 to -1 | ≥ 1, ≥ 1, n/a | n/a | n/a | 43.82, 44.31, 44.38, 44.39, 44.68, 44.95, 43644, 43645, 43842–43847, S2082, S2085 |
| Obesity– obstructive sleep apnea | -365 to +7 | ≥ 1, ≥ 2, n/a | 327.23 | n/a | n/a |
| Oral corticosteroids | -120 to -1 | n/a, n/a, ≥ 1 | n/a | Glucocorticosteroids | n/a |
| Peripheral vascular disease | -365 to +7 | ≥ 1, ≥ 2, n/a | 440.0–440.9, 441.00–441.9, 442.0–442.9, 443.1–443.9, 444.21, 444.22, 447.1, 449, 557.1, 557.9, V43.4 | n/a | n/a |
| Pneumonia or urinary tract infection | -30 to -1 | ≥ 1, ≥ 1, n/a | 482–482.9, 485, 486, 510.0, 510.9, 513.0,  590.0–590.2, 590.80, 590.9, 595.0, 599.0 | n/a | n/a |
| Psychoses | -365 to +7 | ≥ 1, ≥ 2, n/a | 295.00–298.9, 299.10, 299.11 | n/a | n/a |
| Renal failure | -365 to +7 | ≥ 1, ≥ 2, n/a | 403.01, 403.11, 403.91, 404.02, 404.03, 404.12, 404.13, 404.92, 404.93, 585–586, V42.0, V45.1–V45.12, V56.0–V56.8 | n/a | n/a |
| Skin disease | -365 to +7 | ≥ 1, ≥ 2, n/a | 690–690.18, 691.8, 694.0–694.5, 694.60, 694.8, 694.9, 695.0–695.4, 695.50–695.9, 696.0–696.8, 697.0–697.9, 698.2–698.9 | n/a | n/a |
| Smoking | -365 to +7  -365 to -1 Rx | ≥ 1, ≥ 1, ≥ 1 | 305.1, 649.00–649.04, V15.82 | Smoking deterrents | n/a |
| Smoking-related diseases | -365 to +7 | ≥ 1, ≥ 2, n/a | 162.2–162.9, 231.1, 410.00–411.89, 412–413.9, 414.8, 414.9, 430–438.9, 491.20, 491.21, 496 | n/a | n/a |
| *Staphylococcus aureus* infection | -365 to -1 | ≥ 1, ≥ 1, n/a | 041.11, 041.12, 038.11, 038.12, 482.41, 482.42 | n/a | n/a |
| **Operative factors** |  |  |  |  |  |
| Acute cholecystitis or obstruction | -7 to +7 | ≥ 1, a ≥ 1, a n/a | 574.0–574.01, 574.11, 574.21, 574.3–574.31, 574.41, 574.51, 574.6–574.61, 574.71, 574.8–574.81, 574.91, 575.0, 575.12, 575.2, 575.3, 575.5, 576.2, 576.4 | n/a | n/a |
| Other/ chronic cholecystitis | -7 to +7 | ≥ 1, a ≥ 1, a n/a | 574.1–574.11, 574.4–574.41, 574.7–574.71, 574.8–574.81, 575.1–575.12 | n/a | n/a |
| Cholelithiasis | -7 to +7 | ≥ 1, a ≥ 1, a n/a | 574.0–574.01, 574.1–574.11, 574.2–574.21, 574.6–574.61, 574.7–574.71, 574.8–574.81, 574.9–574.91 | n/a | n/a |
| Choledocholithiasis | -7 to +7 | ≥ 1, a ≥ 1, a n/a | 574.3–574.31, 574.4–574.41, 574.5–574.51, 574.6–574.61, 574.7–574.71, 574.8–574.81, 574.9–574.91 | n/a | n/a |
| Laparoscopic approach | -7 to +7 | ≥ 1, ≥ 1, n/a | n/a | n/a | 51.23, 51.24, 47562–47564 |
| Laparoscopic to open conversion during operation | -7 to +7 | ≥ 1, a ≥ 1, a n/a | V64.4, V64.41 | n/a | n/a |
| Cholangiography | 0 | ≥ 1, ≥ 1, n/a | n/a | n/a | 51.10, 51.11, 87.53, 47560, 47561, 47563, 47605 |
| Endoscopic retrograde cholangiopancreatography | 0 | ≥ 1, ≥ 1, n/a | n/a | n/a | 51.10, 43260–43273 |
| Bile duct explorationb | 0 | ≥ 1, ≥ 1, n/a | n/a | n/a | 51.41–51.43, 51.49, 51.51, 51.59, 51.69, 51.71, 51.79, 51.95, 47564, 47610, 47701, 47711, 47712, 47715, 47999 |
| Other bile duct proceduresc | 0 | ≥ 1, ≥ 1, n/a | n/a | n/a | 47400–47480, 47500–47511, 47740, 47741 |
| **Postoperative factors** |  |  |  |  |  |
| Chronic anemia | 0 to 29 and before an SSI | ≥ 1, ≥ 1, n/a | 280–285.9, 998.11 | n/a | n/a |
| Pneumonia or urinary tract infection | 0 to 29 and before an SSI | ≥ 1, ≥ 1, n/a | 482–482.9, 485, 486, 510.0, 510.9, 513.0,  590.0–590.2, 590.80, 590.9, 595.0, 599.0 | n/a | n/a |

Abbreviations: CPT-4, Current Procedural Terminology, 4th edition; DMARD, disease-modifying antirheumatic drugs; HCPCS, Healthcare Common Procedure Coding System; ICD-9-CM, International Classification of Diseases, 9th Revision, Clinical Modification; n/a, not applicable; Rx, prescription; SSI, surgical site infection.

a Diagnosis on the same claim as a code for cholecystectomy

b Includes exploration of common duct or other bile duct, portoenterostomy, excision of bile duct tumor or choledochal cyst, placement of choledochal stent, unlisted biliary tract procedure, incision of bile duct for relief of obstruction, excision of other bile duct, repair of bile ducts, removal of prosthetic device from bile duct

c Includes hepaticotomy/hepaticostomy, choledochotomy/choledochostomy, trans duodenal sphincterotomy/sphincteroplasty, cholecystotomy/cholecystostomy, injection procedure for cholangiography, introduction of a percutaneous transhepatic catheter or stent, cholecystoenterostomy with Roux-en-Y

**Appendix 3. Univariate Results of Cholecystectomy Patient and Operative Factors by Patient Sex**

| **Variable** | **Category** | **Male**  **n (%)** | **Female**  **n (%)** | ***Pa*** |
| --- | --- | --- | --- | --- |
| **Total** |  | 16,776 | 49,790 |  |
| Age | 18–25 years | 658 (3.9) | 4,036 (8.1) | <0.001 |
|  | 26–30 years | 948 (5.7) | 4,834 (9.7) |  |
|  | 31–35 years | 1,449 (8.6) | 5,566 (11.2) |  |
|  | 36–40 years | 1,918 (11.4) | 6,290 (12.6) |  |
|  | 41–45 years | 2,342 (14.0) | 6,864 (13.8) |  |
|  | 46–50 years | 2,605 (15.5) | 7,071 (14.2) |  |
|  | 51–55 years | 2,674 (15.9) | 6,453 (13.0) |  |
|  | 56–60 years | 2,511 (15.0) | 5,363 (10.8) |  |
|  | 61–64 years | 1,671 (10.0) | 3,313 (6.7) |  |
| Acute cholecystitis/obstruction |  | 5,415 (32.3) | 12,271 (24.6) | <0.001 |
| Other/chronic cholecystitis |  | 14,057 (83.8) | 42,531 (85.4) | <0.001 |
| Cholelithiasis |  | 12,623 (75.2) | 37,659 (75.6) | 0.308 |
| Choledocholithiasis |  | 765 (4.6) | 1,924 (3.9) | <0.001 |
| Surgical approach | Laparoscopic approach | 16,326 (97.3) | 49,206 (98.8) | <0.001 |
|  | Laparoscopic converted to open approach | 243 (1.4) | 292 (0.6) |  |
|  | Planned open approach | 207 (1.2) | 292 (0.6) |  |
| Cholangiography |  | 5,358 (31.9) | 15,389 (30.9) | 0.013 |
| Endoscopic retrograde cholangiopancreatography / bile duct exploration |  | 186 (1.1) | 541 (1.1) | 0.811 |
| Other bile duct procedures |  | 72 (0.4) | 231 (0.5) | 0.563 |

a *P* per chi-square test