

**Supplementary Table 1 International Classification of Disease, Tenth Revision  
Clinical Modification and International Classification of Disease, Tenth Revision  
Procedure Coding System**

|                                                 | <b>International Classification of Disease, Tenth<br/>Revision Clinical Modification</b> |
|-------------------------------------------------|------------------------------------------------------------------------------------------|
| Diagnosis                                       |                                                                                          |
| Cholangitis                                     | K83.x                                                                                    |
| Complications                                   |                                                                                          |
| Septic shock                                    | R65.21                                                                                   |
| Severe Sepsis                                   | R65.20                                                                                   |
| SIRS with acute organ dysfunction               | R65.11                                                                                   |
| SIRS without Acute organ dysfunction            | R65.10                                                                                   |
| Acute respiratory failure                       | J96.x                                                                                    |
| Acute kidney failure.                           | N17.x                                                                                    |
| Thrombocytopenia.                               | D69.6                                                                                    |
| Altered mental status.                          | R41.82                                                                                   |
| Abnormal coagulation.                           | R79.1                                                                                    |
| Bile duct perforation                           | K83.2, K83.3                                                                             |
| Post-procedural bleeding (associated with ERCP) | K91.84, K91.840, K91.841                                                                 |
| Chronic Pancreatitis                            | K86.1                                                                                    |
| Acute Pancreatitis                              | K85.90                                                                                   |
| Abdominal pain                                  | R10.x                                                                                    |
| Jaundice                                        | R17                                                                                      |
| Cholelithiasis                                  | K80.x                                                                                    |
| Choledocholithiasis                             | K80.5                                                                                    |
| Biliary obstruction                             | K83.1                                                                                    |
| Carcinoma of Intrahepatic Bile Duct             | C22.1                                                                                    |
| Malignant Neoplasm of Pancreas                  | C25.X                                                                                    |
|                                                 | International Classification of Disease, Tenth                                           |

## Revision Procedure Coding System

### Procedure

#### ERCP

0FJB8ZZ, 0FJD8ZZ, 0F9C8ZZ, 0F758DZ,  
0F768DZ, 0F788DZ, 0F798DZ, 0F7C8DZ,  
0F9580Z, 0F9680Z, 0F9880Z, 0F9980Z, 0F9C80Z,  
0FC58ZZ, 0FC68ZZ, 0FC88ZZ, 0FC98ZZ,  
0FCC8ZZ, 0FF58ZZ, 0FF68ZZ, 0FF88ZZ,  
0FF98ZZ, 0FFC8ZZ, 0FJD8ZZ, 0F7D8DZ,  
0F7F8DZ, 0F9D80Z, 0F9F80Z, 0FCD8ZZ,  
0FCF8ZZ, 0FFD8ZZ, 0FFF8ZZ

#### LCBDE

0FJB4ZZ, 0FT44ZZ, BF10YZZ, BF50200,  
BF502Z0, BF52200, BF522Z0, BF53200, BF532Z0

#### Biliary sphincterotomy

0F997ZX, 0F998ZX, 0F9C7ZX, 0F9C8ZX,  
0F5C8ZZ, 0FCC8ZZ, 0FFC8ZZ, 0FNC8ZZ,  
0FNC8Z, 0FNC8, 0F5C8ZZ, 0F7C8ZZ,  
0F7C8DZ, 0F9C80Z, 0F9C8ZX, 0F9C8ZZ,  
0F9C40Z, 0F9C4ZX, 0F9C4ZZ, 0FCC8ZZ,  
0FCC4ZZ, 0FC98ZZ, 0FDC8ZX, 0FD98ZX,  
0F9980Z, 0F998ZX, 0F998ZZ, 0FFC8ZZ,  
0FNC8ZZ, 0FBC8ZX, 0FBC8ZZ

#### Biliary ductal dilation

0F758ZZ, 0F768ZZ, 0F788ZZ, 0F798ZZ

#### Biliary duct stenting

0F758DZ, 0F768DZ, 0F788DZ, 0F798DZ,  
0F7C8DZ, 0F9580Z, 0F9680Z, 0F9880Z,  
0F9980Z, 0F9C80Z

#### Pancreatic sphincterotomy

0F9D8ZX, 0F9D8ZZ

#### Pancreatic ductal dilation

0F7D8ZZ, 0F7F8ZZ

#### Pancreatic duct stenting

0F7D8DZ, 0F7F8DZ, 0F9D80Z, 0F9F80Z

#### Ampullectomy

0F5C8ZZ, 0FBC8ZZ

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**Supplementary Table 2 Adjusting for demographics and hospital characteristics**

| Unweighted <i>n</i> = 67738 | Length of stay <sup>1</sup> [ $\beta$ (95%CI)]                | <i>P</i> value |
|-----------------------------|---------------------------------------------------------------|----------------|
| Procedure                   |                                                               |                |
| ERCP                        | Ref                                                           |                |
| LCBDE                       | 1.09 (0.82-1.37)                                              | < 0.001        |
|                             | Inflation-adjusted total cost <sup>1</sup> [ $\beta$ (95%CI)] | <i>P</i> value |
| Procedure                   |                                                               |                |
| ERCP                        | Ref                                                           |                |
| LCBDE                       | 3384.7 (2507.6-4261.7)                                        | < 0.001        |
|                             | 30-day readmission <sup>2</sup> [OR (95% CI)]                 | <i>P</i> value |
| Procedure                   |                                                               |                |
| ERCP                        | Ref                                                           |                |
| LCBDE                       | 1.06 (0.91-1.23)                                              | 0.45           |
| Unweighted <i>n</i> = 5354  | 30-day mortality <sup>2</sup> [OR (95% CI)]                   | <i>P</i> value |
| Procedure                   |                                                               |                |
| ERCP                        | Ref                                                           |                |
| LCBDE                       | 0.58 (0.29-1.18)                                              | 0.14           |

<sup>1</sup>Multivariable linear regression adjusting for age, biological sex, income quartile, insurance status, hospital size and teaching status, Charlson Comorbidity index, complications associated with endoscopic retrograde cholangiopancreatography (ERCP), and the cycle year.

<sup>2</sup>Multivariable logistic regression adjusting for age, biological sex, income quartile, insurance status, hospital size and teaching status, Charlson Comorbidity index, complications associated with ERCP, and the cycle year.

ERCP: Endoscopic retrograde cholangiopancreatography; LCBDE: Laparoscopic common bile duct exploration; OR: Odds ratio.

**Supplementary Table 3 Laparoscopic common bile duct exploration timing**

| Demographics (unweighted $n = 31802$ ) |             |       | None<br>( $n = 30330$ ; 95.4%) | Urgent<br>LCBDE<br>( $n = 389$ ; 1.22%) | Early LCBDE<br>( $n = 583$ ; 1.83%) | Late LCBDE<br>( $n = 500$ ; 1.57%) | $P$<br>value <sup>1</sup> |
|----------------------------------------|-------------|-------|--------------------------------|-----------------------------------------|-------------------------------------|------------------------------------|---------------------------|
| Age, years (mean, SE)                  |             |       | 64.6 (0.097)                   | 59.4 (0.90) <sup>2</sup>                | 59.1 (0.78) <sup>3, 5</sup>         | 60.4 (0.91) <sup>4</sup>           | <0.001                    |
| Sex, Female (% , SE)                   |             |       | 51.4 (0.31)                    | 51.4 (2.71)                             | 55.9 (2.21)                         | 54.1 (2.42)                        | 0.11                      |
| Income Quartile (% , 95% CI)           |             |       |                                |                                         |                                     |                                    | 0.48                      |
| 1                                      |             |       | 25.6 (0.27)                    | 24.0 (2.33)                             | 24.3 (1.96)                         | 24.0 (2.04)                        |                           |
| 2                                      |             |       | 27.6 (0.28)                    | 25.8 (2.39)                             | 27.6 (2.01)                         | 26.4 (2.18)                        |                           |
| 3                                      |             |       | 25.8 (0.28)                    | 23.5 (2.42)                             | 26.5 (2.02)                         | 26.5 (2.24)                        |                           |
| 4                                      |             |       | 20.9 (0.24)                    | 26.7 (2.43)                             | 21.6 (1.76)                         | 23.1 (1.99)                        |                           |
| Primary Payer (% , SE)                 |             |       |                                |                                         |                                     |                                    | <0.001                    |
| Medicare                               |             |       | 56.1 (0.31)                    | 45.9 (2.73) <sup>2</sup>                | 46.3 (2.22) <sup>3</sup>            | 51.7 (2.43)                        |                           |
| Medicaid                               |             |       | 9.81 (0.17)                    | 13.8 (1.93)                             | 10.6 (1.32)                         | 13.1 (1.58)                        |                           |
| Private                                |             |       | 28.9 (0.28)                    | 36.4 (2.63)                             | 36.7 (2.16)                         | 30.7 (2.31)                        |                           |
| Self-Pay                               |             |       | 2.41 (0.098)                   | <sup>8</sup>                            | 4.16 (0.89)                         | 2.04 (0.72)                        |                           |
| Other                                  |             |       | 2.69 (0.10)                    | <sup>8</sup>                            | 2.27 (0.61)                         | 2.41 (0.89)                        |                           |
| Elective Admission (% , SE)            |             |       | 11.8 (0.22)                    | 50.7 (2.75) <sup>2</sup>                | 9.89 (1.47) <sup>5</sup>            | 6.53 (1.27) <sup>4, 6</sup>        | <0.001                    |
| Weekend Admission (% , SE)             |             |       | 19.1 (0.25)                    | 8.78 (1.62) <sup>2</sup>                | 20.4 (1.76) <sup>5</sup>            | 24.7 (2.17) <sup>4, 6</sup>        | <0.001                    |
| Hospital Location (% , SE)             |             |       |                                |                                         |                                     |                                    | <0.001                    |
| Urban/non-Teaching                     |             |       | 14.7 (0.047)                   | 12.6 (1.76) <sup>2</sup>                | 19.5 (1.67) <sup>3, 5</sup>         | 14.7 (1.62) <sup>7</sup>           |                           |
| Urban/Teaching                         |             |       | 82.9 (0.051)                   | 82.0 (1.99)                             | 76.0 (1.82)                         | 82.3 (1.73)                        |                           |
| Rural                                  |             |       | 2.43 (0.024)                   | 5.33 (1.06)                             | 4.47 (0.92)                         | 3.04 (0.69)                        |                           |
| Hospital Bed size (% , SE)             |             |       |                                |                                         |                                     |                                    | 0.49                      |
| Small                                  |             |       | 10.9 (0.04)                    | 9.94 (1.49)                             | 11.2 (1.32)                         | 13.6 (1.58)                        |                           |
| Medium                                 |             |       | 21.1 (0.059)                   | 21.3 (2.32)                             | 23.2 (1.86)                         | 21.2 (2.04)                        |                           |
| Large                                  |             |       | 68.0 (0.061)                   | 68.7 (2.54)                             | 65.5 (2.08)                         | 65.2 (2.31)                        |                           |
| Charlson                               | Comorbidity | Index | 3.35 (0.02)                    | 1.82 (0.13) <sup>2</sup>                | 2.46 (0.13) <sup>3, 5</sup>         | 3.12 (0.17) <sup>6, 7</sup>        | <0.001                    |

(mean, SE)

|                                              |               |                          |                          |                             |        |
|----------------------------------------------|---------------|--------------------------|--------------------------|-----------------------------|--------|
| Septic Shock (% , SE)                        | 0.57 (0.044)  | 8                        | 8                        | 8                           | 8      |
| Severe Sepsis (% , SE)                       | 0.46 (0.041)  | 8                        | 8                        | 8                           | 8      |
| SIRS with Organ Failure (% , SE)             | 0.064 (0.014) | 8                        | 8                        | 8                           | 8      |
| SIRS without Organ Failure (% , SE)          | 0.91 (0.053)  | 8                        | 8                        | 8                           | 8      |
| Respiratory Failure (% , SE)                 | 2.34 (0.094)  | 3.69 (1.21)              | 8                        | 5.30 (1.06) <sup>4</sup>    | <0.001 |
| Kidney Failure (% , SE)                      | 13.0 (0.21)   | 7.54 (1.51) <sup>2</sup> | 10.9 (1.34)              | 17.1 (1.81) <sup>6, 7</sup> | <0.001 |
| Thrombocytopenia (% , SE)                    | 3.89 (0.12)   | 3.08 (1.04)              | 4.24 (0.87)              | 4.20 (0.89)                 | 0.84   |
| Altered Mental Status (% , SE)               | 0.19 (0.026)  | 8                        | 8                        | 8                           | 8      |
| Abnormal Coagulation (% , SE)                | 1.51 (0.079)  | 8                        | 8                        | 8                           | 8      |
| Bile Duct Perforation (% , SE)               | 0.64 (0.051)  | 8                        | 2.07 (0.75)              | 8                           | 0.001  |
| Post Procedural Bleeding (% , SE)            | 0.36 (0.039)  | 8                        | 8                        | 8                           | 8      |
| Chronic Pancreatitis (% , SE)                | 5.58 (0.15)   | 4.31 (1.10)              | 8                        | 3.15 (0.93)                 | 0.069  |
| Acute Pancreatitis (% , SE)                  | 7.51 (0.16)   | 8                        | 3.06 (0.75) <sup>3</sup> | 4.49 (0.96)                 | <0.001 |
| Abdominal Pain (% , SE)                      | 3.48 (0.12)   | 2.67 (0.99)              | 5.05 (0.94)              | 5.31 (1.12)                 | 0.052  |
| Jaundice (% , SE)                            | 5.85 90.14)   | 8                        | 3.58 (0.83)              | 5.64 (1.09)                 | 0.002  |
| Cholelithiasis                               | 6.01 (0.15)   | 15.9 (2.13) <sup>2</sup> | 18.0 (1.74) <sup>3</sup> | 20.0 (1.98) <sup>4</sup>    | <0.001 |
| Choledocholithiasis (% , SE)                 | 1.89 (0.083)  | 8                        | 8                        | 2.35 (0.58)                 | 0.15   |
| Biliary obstruction (% , SE)                 | 85.2 (0.23)   | 56.8 92.74) <sup>2</sup> | 51.8 (2.23) <sup>3</sup> | 53.5 (2.42) <sup>4</sup>    | <0.001 |
| Carcinoma of Intrahepatic Bile Duct (% , SE) | 5.10 (0.14)   | 3.45 (0.92)              | 4.34 (0.82) <sup>3</sup> | 2.99 (0.77)                 | 0.06   |
| Malignant Neoplasm of Pancreas (% , SE)      | 17.2 (0.23)   | 6.14 (1.28) <sup>2</sup> | 6.24 (1.00) <sup>3</sup> | 9.41 (1.30) <sup>4</sup>    | <0.001 |

<sup>1</sup>Continuous variables compared using weighted linear regression. Categorical variables compared using Chi-squared analysis.

<sup>2</sup>Statistical Differences between No ERCOP and Urgent ERCP (Bonferroni p < 0.008)

<sup>3</sup>Statistical Differences between No ERCOP and Early ERCP (Bonferroni p < 0.008)

<sup>4</sup>Statistical Differences between No ERCOP and Late ERCP (Bonferroni p < 0.008)

<sup>5</sup>Statistical Differences between Urgent ERCOP and Early ERCP (Bonferroni p<0.008)

<sup>6</sup>Statistical Differences between Urgent ERCOP and Late ERCP (Bonferroni p<0.008)

<sup>7</sup>Statistical Differences between Early ERCOP and Late ERCP (Bonferroni p<0.008)

<sup>8</sup>Not shown due to HCUP regulations regarding 10 or fewer observed observations.  
Group were excluded from comparisons.

**Supplemental Table 4 The proportion of biliary obstruction**

| Unweighted<br>31802                               | <i>n</i> = | LOS <sup>1</sup> | No LCBDE as the<br>reference group |            | Urgent LCBDE as<br>the reference group |            |
|---------------------------------------------------|------------|------------------|------------------------------------|------------|----------------------------------------|------------|
|                                                   |            | Mean (SE)        | Beta (95%CI)                       | P<br>value | Beta (95%CI)                           | P<br>value |
| LCBDE                                             |            |                  |                                    |            |                                        |            |
| None ( <i>n</i> = 30330)                          |            | 4.89 (0.027)     | REF                                |            |                                        |            |
| Urgent LCBDE ( <i>n</i> = 389)                    |            | 3.74 (0.18)      | -0.46 (-0.84 to -0.078)            | 0.018      | REF                                    |            |
| Early LCBDE ( <i>n</i> = 583)                     |            | 4.36 (0.13)      | -0.29 (-0.54 to -0.038)            | 0.023      | 0.57 (0.13-1.01)                       | 0.011      |
| Late LCBDE ( <i>n</i> = 500)                      |            | 8.92 (0.32)      | 3.65 (3.07-4.23)                   | <<br>0.001 | 4.56 (3.91-5.21)                       | <<br>0.001 |
| Inflation-<br>Adjusted<br>Total Cost <sup>1</sup> |            |                  |                                    |            |                                        |            |
|                                                   |            | Mean (SE)        | Beta (95%CI)                       | P<br>value | Beta (95%CI)                           | P<br>value |
| LCBDE                                             |            |                  |                                    |            |                                        |            |
| None ( <i>n</i> = 30330)                          |            | 16968.8 (80.3)   | REF                                |            |                                        |            |
| Urgent LCBDE ( <i>n</i> = 389)                    |            | 18269.3 (607.4)  | 2483.1 (1123.9-3842.3)             | <<br>0.001 | REF                                    |            |
| Early LCBDE ( <i>n</i> = 583)                     |            | 16434.4          | -26.5 (-921.8 to 868.7)            | 0.95       | -998.6 (-2680.8 to 0.24)               |            |

|                                                         |                                    |                        |            |                   |                  |
|---------------------------------------------------------|------------------------------------|------------------------|------------|-------------------|------------------|
| 583)                                                    | (463.5)                            |                        |            | 683.4)            |                  |
| Late LCBDE ( <i>n</i> = 500)                            | 25127.1<br>(1049.9)                | 6996.2 (5105.9-8886.5) | < 0.001    | 6204.9<br>8446.9) | (3962.8- < 0.001 |
|                                                         | 30-Day<br>Readmission <sup>2</sup> |                        |            |                   |                  |
| LCBDE                                                   | % (SE)                             | OR (95%CI)             | P<br>value | OR (95%CI)        | P<br>value       |
| None ( <i>n</i> = 30330)                                | 25.6 (0.27)                        | REF                    |            |                   |                  |
| Urgent LCBDE ( <i>n</i> = 389)                          | 17.5 (2.08)                        | 0.74 (0.56-1.00)       | 0.053      | REF               |                  |
| Early LCBDE ( <i>n</i> = 583)                           | 20.9 (1.78)                        | 0.81 (0.65-1.01)       | 0.057      | 1.01 (0.67-1.50)  | 0.98             |
| Late LCBDE ( <i>n</i> = 7002)                           | 25.7 (2.08)                        | 1.00 (0.80-1.25)       | 0.99       | 1.27 (0.85-1.88)  | 0.24             |
| (Unweighted <i>n</i> = 30-day<br>Mortality <sup>2</sup> | % (SE)                             | OR (95%CI)             | P<br>value | OR (95%CI)        | P<br>value       |
| LCBDE                                                   |                                    |                        |            |                   |                  |
| None ( <i>n</i> = 6702)                                 | 5.27 (0.26)                        | REF                    |            |                   |                  |
| Urgent LCBDE ( <i>n</i> = 63)                           | 2.37 (1.68)                        | 0.47 (0.10-2.17)       | 0.33       | REF               |                  |
| Early LCBDE ( <i>n</i> = 114)                           | 3.04 (13.5)                        | 0.63 (0.22-1.79)       | 0.38       | 0.69 (0.11-4.42)  | 0.69             |
| Late LCBDE ( <i>n</i> = 123)                            | 3.26 (1.75)                        | 0.56 (0.18-1.71)       | 0.31       | 0.87 (0.13-6.02)  | 0.89             |

<sup>1</sup>Multivariable linear regression adjusting for age, biological sex, income quartile, insurance status, hospital size and teaching status, Charlson Comorbidity index, complications associated with ERCP, and the cycle year.

<sup>2</sup>Multivariable logistic regression adjusting for age, biological sex, income quartile, insurance status, hospital size and teaching status, Charlson Comorbidity index,

complications associated with ERCP, and the cycle year.

**Supplemental Table 5 Demographics**

| Demographics (unweighted <i>n</i> = 31802) | None ( <i>n</i> = 30330; 95.4%)      | Urgent LCBDE ( <i>n</i> = 389; 1.22%)    | Early LCBDE ( <i>n</i> = 583; 1.83%)        | Late LCBDE ( <i>n</i> = 500; 1.57%)       | <i>P</i> value <sup>1</sup> |
|--------------------------------------------|--------------------------------------|------------------------------------------|---------------------------------------------|-------------------------------------------|-----------------------------|
|                                            | (%, SE)                              | (%, SE)                                  | (%, SE)                                     | (%, SE)                                   |                             |
| Biliary Sphincterotomy                     | 28.9 (0.28)                          | 4.91 (1.13) <sup>2</sup>                 | 5.67 (0.98) <sup>3</sup>                    | 4.34 (0.95) <sup>4</sup>                  | < 0.001                     |
| Biliary Ductal Dilation                    | 4.82 (0.13)                          | 12.8 (1.75) <sup>2</sup>                 | 21.7 (1.79) <sup>3, 5</sup>                 | 16.6 (1.79) <sup>4</sup>                  | < 0.001                     |
| Biliary Ductal Stent                       | 80.5 (0.24)                          | 8                                        | 8                                           | 8                                         | 8                           |
| Pancreatic Sphincterotomy                  | 8                                    | 8                                        | 8                                           | 0.35 (0.26)                               | 0.52                        |
| Pancreatic Ductal Dilation                 | 0.52 (0.045)                         | 0.24 (0.024)                             | 0.21 (0.21)                                 | 0.61 (0.35)                               | 0.65                        |
| Pancreatic Ductal Stent                    | 13.6 (0.26)                          | 8                                        | 8                                           | 8                                         | 8                           |
|                                            | None<br>( <i>n</i> =1,487;<br>4.74%) | Urgent ERCP<br>( <i>n</i> =5,833; 18.6%) | Early ERCP<br>( <i>n</i> =16,645;<br>53.1%) | Late ERCP<br>( <i>n</i> =7,380;<br>23.5%) |                             |
| Biliary Sphincterotomy                     | 5.01 (0.59)                          | 23.3 (0.62) <sup>2</sup>                 | 29.0 (0.38) <sup>3, 5</sup>                 | 28.9 (0.57) <sup>4, 6</sup>               | <0.001                      |
| Biliary Ductal Dilation                    | 17.6 (1.04)                          | 4.43 (0.29) <sup>2</sup>                 | 4.27 (0.16) <sup>3</sup>                    | 6.17 (0.31) <sup>4, 6, 7</sup>            | <0.001                      |
| Biliary Ductal Stent                       | 8                                    | 79.4 (0.55)                              | 81.2 (0.32) <sup>5</sup>                    | 79.7 (0.51) <sup>f</sup>                  | 0.003                       |
| Pancreatic Sphincterotomy                  | 8                                    | 0.25 (0.074)                             | 0.16 (0.037)                                | 0.19 (0.048)                              | 0.58                        |
| Pancreatic Ductal Dilation                 | 8                                    | 0.41 (0.10)                              | 0.49 (0.057)                                | 0.75 (0.11)                               | 0.06                        |
| Pancreatic Ductal Stent                    | 8                                    | 24.2 (0.65)                              | 10.6 (0.27) <sup>5</sup>                    | 11.3 (0.42) <sup>6</sup>                  | <0.001                      |

<sup>1</sup>Categorical variables compared using Chi-squared analysis.

<sup>2</sup>Statistical Differences between No ERCOP and Urgent ERCP (Bonferroni p<0.008)

<sup>3</sup>Statistical Differences between No ERCOP and Early ERCP (Bonferroni p<0.008)

<sup>4</sup>Statistical Differences between No ERCOP and Late ERCP (Bonferroni p<0.008)

<sup>5</sup> Statistical Differences between Urgent ERCOP and Early ERCP (Bonferroni  $p < 0.008$ )

<sup>6</sup> Statistical Differences between Urgent ERCOP and Late ERCP (Bonferroni  $p < 0.008$ )

<sup>7</sup> Statistical Differences between Early ERCOP and Late ERCP (Bonferroni  $p < 0.008$ )

<sup>8</sup> Not shown due to HCUP regulations regarding 10 or fewer observed observations.  
Group were excluded from comparisons.