

<b>Client</b>	HEALTH BENCHMARKS, INC. STANDARD ALGORITHM <i>Implemented for Blue Cross Blue Shield of Texas</i>		
<b>Measure Title</b>	RISK-ADJUSTED COMPLICATION LIKELIHOOD FOR SURGERIES: APPENDECTOMY AND CHOLECYSTECTOMY		
<b>Disease State</b>	Appendectomy and Cholecystectomy	<b>Indicator Classification</b>	Complication Rate
<b>Strength of Recommendation</b>	N/A		
<b>Organizations Providing Recommendation</b>	Department of Veteran Affairs National Surgical Quality Improvement Program		
<b>Clinical Intent</b>	To assess the risk adjusted complication rate for appendectomy and cholecystectomy.		
<b>Physician Specialties (suggested)</b>	General Surgery		

**Background**

**Disease Burden**

- Appendicitis is a very common condition, with an incidence of over 40,000 cases per year, [1] and is most often treated by appendectomy.[2]
- In 1997, over 5% of appendectomy procedures resulted in post-operative complications, including infection.[3]
- Cholecystectomy has an annual rate of 260.8 per 100,000 population.[4, 5]
- Complications related to cholecystectomy procedures occur in about 3-6% of cases.[6]

**Reason for Indicated Intervention or Treatment**

- Cohort studies have shown that appendectomy is an effective treatment for appendicitis.[7]
- Open and closed appendectomy have been shown to be safe procedures.[9, 10] Most often, complications are limited to elderly patients with comorbid conditions or are attributable to physician error or oversight.[11]
- For gallstones and other digestive disease, cholecystectomy is an effective treatment.[8]

**Evidence Supporting Intervention or Treatment**

- Studies have shown that there are substantial costs associated with

post-operative complication management, which can oftentimes be avoided. [12, 13] Surgical outcomes have also been shown to vary substantially by provider.[14, 15]

- Risk-adjustment methodologies have been used in several studies utilizing outcomes data to accurately reflect quality of care.[16, 17]
- Comorbidities have been shown to significantly increase the risk of death after surgery.[18]
- The National Surgical Quality Improvement Program (NSQIP) also recommends the use of risk-adjusted outcomes to identify aspects of surgical care that are in need of improvement.[19]

**Clinical Recommendations**

- NSQIP was created by the Department of Veteran Affairs as a result of the poor surgical care they were providing at the VA hospitals. Since the introduction of NSQIP, several VA hospitals have significantly reduced surgical complication rates.[20]
- Medical centers that perform surgery need to implement these risk-adjustment and measurement techniques in order to point out areas in which quality improvement efforts such as NSQIP can be deployed to improve the quality of surgical care. [13, 15, 20, 23, 24]

**Source** Health Benchmarks, Inc

**DERIVING THE UNADJUSTED RATE FOR A PROVIDER**

**Denominator**

**Denominator Definition** Any member who underwent an appendectomy or cholecystectomy (laparoscopic or other) during the 365 day period ending 30 days prior to the end of the measurement year.

**Denominator Codes** Appendectomy or laparoscopic appendectomy  
CPT code(s): 44950, 44955, 44960, 44970

Cholecystectomy or laparoscopic cholecystectomy  
CPT code(s): 47562, 47563, 47564, 47600, 47605, 47610, 47612, 47620

**Denominator Exclusion**

**Denominator Exclusion Definition** Members who underwent a major surgical procedure (other than repair of intestinal wound) 1-30 days after the index date, or members with diagnoses of hepatobiliary malignancies or choledochal cysts any time before the index date.

**Denominator Exclusion Codes** Major surgical procedure (other than repair of intestinal wound)  
ICD-9 surgical proc code(s): 01.xx-03.xx, 06.xx, 07.xx, 25.xx, 28.xx, 29.xx, 30.xx-39.xx, 42.xx-45.xx, 47.xx-59.xx, 65.xx-71.xx, 76.xx-81.xx, 85.xx

Diagnoses of hepatobiliary malignancies or choledochal cysts  
ICD-9 diagnosis code(s): 155.1, 156, 156.1, 156.8, 156.9

## Numerator

**Numerator Definition** Members with the following classes of complications 0-30 days after index date: cardiovascular, respiratory, infectious, incision, or gastrointestinal.

*Note: This definition allows the measure to be reported as an inverted rate to facilitate a meaningful score interpretation across measures that are scored on the same scale.*

## Numerator Logic

Numerator logic for members who underwent an appendectomy:

Members who did not have diagnoses or procedures suggestive of complications 1-30 days after the index date. *This complication is common to both appendectomy and cholecystectomy.*

### AND

Members without previous history of cerebral infarction, did not have a cerebral infarction 0-30 days after index date. *This complication is common to both appendectomy and cholecystectomy.*

### AND

Members without previous history of DVT, did not have DVT or PE 1-30 days after index date. *These complications are common to both appendectomy and cholecystectomy.*

### AND

Members that did not have accidental puncture or foreign body accidentally left in the 0-30 days after the index date. *These complications are common to both appendectomy and cholecystectomy.*

### AND

Members that did not have gastrointestinal complications 1-30 days after the index date. *This is only applicable to appendectomy.*

Numerator logic for members who underwent a cholecystectomy:

Members who did not have diagnoses or procedures suggestive of complications 1-30 days after the index date. *This complication is common to*

*both appendectomy and cholecystectomy.*

Members without previous history of cerebral infarction, did not have a cerebral infarction 0-30 days after index date. *This complication is common to both appendectomy and cholecystectomy.*

**AND**

Members without previous history of DVT, did not have DVT or PE 1-30 days after index date. *These complications are common to both appendectomy and cholecystectomy.*

Members that did not have accidental puncture or foreign body accidentally left in the 0-30 days after the index date. *These complications are common to both appendectomy and cholecystectomy.*

**AND**

Members without gastrointestinal complications 1-30 days after the index date. *This is only applicable to cholecystectomy.*

**AND**

Members who did not receive a reoperative repair of common bile duct during the 1-30 days after the index date. *This is only applicable to cholecystectomy.*

**Numerator Codes**

Diagnoses or procedures suggestive of complications 1-30 days after index date. *These complications are common to both appendectomy and cholecystectomy.*

**Vascular**

Acute MI/ PTCA/ CABG:

ICD-9 diagnosis code(s): 410.xx

ICD-9 surgical proc code(s): 00.66, 36.01, 36.02, 36.05, 36.06, 36.07, 36.09, 36.1x, 36.2x

CPT-4 code(s): 33140, 92980-92982, 92984, 92995, 92996, 33510-33514, 33516-33519, 33521-33523, 33533-33536, 35600, 33572

CPT-4 code(s): 75940

Acute heart failure:

ICD-9 diagnosis code(s): 428.21, 428.31, 997.1

Post operative vascular complication:

ICD-9 diagnosis code(s): 997.7x

**Respiratory**

Respiratory failure:

ICD-9 diagnosis code(s): 518.81, 799.1

Pulmonary edema:

ICD-9 diagnosis code(s): 514, 518.4

Prolonged intubation:

ICD-9 surgical proc code(s): 96.72

Iatrogenic pneumothorax:

ICD-9 diagnosis code(s): 512.1

Reintubation:

ICD-9 surgical proc code(s): 96.04

Mechanical ventilation:

ICD-9 surgical proc code(s): 96.70, 96.71

**Incision Complications**

Seroma/hematoma/hemorrhage:

ICD-9 diagnosis code(s): 998.1x

Wound dehiscence:

ICD-9 diagnosis code(s): 998.3x, 54.61

Non-healing surgical wound:

ICD-9 diagnosis code(s): 998.83

**Infection**

Post operative infection:

ICD-9 diagnosis code(s): 998.5x

Infection/inflammation due to urinary catheter:

ICD-9 diagnosis code(s): 996.64

**Renal**

Acute renal failure:

ICD-9 diagnosis code(s): 584.xx, 997.5

**Neurologic**

CNS complication resulting from procedure:

ICD-9 diagnosis code(s): 997.0x

**Miscellaneous**

Misc post operative complications:

ICD-9 diagnosis code(s): 998.89, 998.9

Transfusion/serum reactions:

ICD-9 diagnosis code(s): 999.5-999.8, E8760

Cerebral infarction 0-30 days after index date. *This complication is common to both appendectomy and cholecystectomy.*

ICD-9 diagnosis code(s): 433.xx-435.xx

Cerebral infarction 1-365 days prior to the index date. *This complication is common to both appendectomy and cholecystectomy.*

ICD-9 diagnosis code(s): 433.xx-435.xx

DVT or PE 1-30 days after index date. *These complications are common to both appendectomy and cholecystectomy.*

Deep vein thrombosis:

ICD-9 diagnosis code(s): 453.xx

Pulmonary embolism:

ICD-9 diagnosis code(s): 415.1x

DVT or PE 0-12 month prior to index date. *This is applicable to both appendectomy and cholecystectomy.*

Deep vein thrombosis:

ICD-9 diagnosis code(s): 453.xx

Pulmonary embolism:

ICD-9 diagnosis code(s): 415.1x

Accidental puncture or foreign body accidentally left in the 0-30 days after the index date. *This is applicable to both appendectomy and cholecystectomy.*

Foreign body accidentally left:

ICD-9 diagnosis code(s): 998.4, 998.7, E8710, E8719

Accidental puncture during surgery:

ICD-9 diagnosis code(s): 998.2, E870.0

Gastrointestinal complications 1-30 days after the index date. *This is only applicable to appendectomy.*

**Gastrointestinal**

Bowel obstruction/ileus:

ICD-9 diagnosis code(s): 560.xx

Fistula of intestine:

ICD-9 diagnosis code(s): 569.81

Digestive complications due to procedure:

ICD-9 diagnosis code(s): 997.4

Enterolysis:

CPT-4 code(s): 44005, 44180

Surgical repair of intestinal wound:

ICD-9 surgical proc code(s): 46.71, 46.73, 46.75, 46.79

CPT-4 code(s): 44605

Gastrointestinal complications 1-30 days after the index date. *This is only applicable to cholecystectomy.*

**Gastrointestinal**

Bowel obstruction/ileus:

ICD-9 diagnosis code(s): 560.xx

Fistula of intestine:

ICD-9 diagnosis code(s): 569.81

Enterolysis:

CPT-4 code(s): 44005, 44180

Management of liver hemorrhage:

CPT-4 code(s): 47350-47362

Surgical repair of intestinal wound:

ICD-9 surgical proc code(s): 46.71, 46.73, 46.75, 46.79

CPT-4 code(s): 44605

T-tube complications:

ICD-9 diagnosis code(s): 996.64

Reoperative repair of common bile duct during the 1-30 days after the index date. *This is only applicable to cholecystectomy.*

CPT-4 code(s): 47701, 47720, 47721, 47740, 47760, 47765, 47780

**Physician Attribution**

**Physician Attribution Description** Score only the physician that performed the index date surgery.

**DERIVING THE PREDICTED RATE FOR A PROVIDER**

**Overview**

The risk of suffering a surgical complication is dependent both on the surgeon's skill and the patient's underlying demographic and clinical characteristics. For example, older, male patients with a history of diabetes have greater risk of having a heart attack in the 0-30 days after cholecystectomy than young, female patients without a history of diabetes. Therefore, to effectively compare one surgeon's skill in preventing surgical complications to another, it is extremely important to take account of the underlying demographic and clinical characteristics of their patients. Multivariate statistical modeling is used to fairly compare one surgeon to another. For this indicator, an adjusted surgical complication rate is determined for surgeons. This is done by taking into account the above referenced patient's underlying demographic and clinical characteristics. Some of these specific characteristics include: type of surgery, severity of disease at the time of surgery, patient's age, gender, and level of co-morbidity. More technical information is presented below.

**Statistical Methodology**

Patient populations are inherently variable, ensuring that providers will treat an array of patients that are likely different in composition of risk compared to patient pools treated by other providers. This variability, particularly with regard to general health status, can account for a large proportion of the measured quality of care differences between providers and lead to incorrect findings and conclusions if not considered. To generate a meaningful statistic that reflects only differences in provider practice patterns, appropriate statistical method such as the conventional logistic regression is used to model the probability of occurrence of the surgery complication by controlling for a variety of patient mix and severity of illness factors such as demographics (age, gender), comorbidities, types of procedures and disease severity during a specific period.

### Model specification

For j-th patient who received a surgical procedure from physician i, we modeled the complication indicator variable  $Y_{ij}$  (1 for complication and 0 otherwise) as follows:

$$\begin{aligned} G(E(Y_{ij})) = & \\ & \beta_0i \text{ (physician) } i \\ & + \beta_1 \text{ procedure indicator (appendectomy, laparoscopic appendectomy, cholecystectomy,} \\ & \text{laparoscopic cholecystectomy)} \\ & + \beta_2 \text{ Disease severity for appendectomy} \\ & + \beta_3 \text{ Disease severity for cholecystectomy} \\ & + \beta_4 \text{ Comorbidity} \\ & + \beta_5 \text{ age} \\ & + \beta_6 \text{ gender} \end{aligned}$$

Where  $E(Y_{ij})$  is the expected value of  $Y_{ij}$  and  $G$  is a monotonic differentiable link function that describes how the expected value of  $Y_i$  is related to the predictors. A binomial distribution for  $Y$  and logit link function, i.e., logistic regression will be applied to estimate the physician effect (indexed by  $\beta_0i$ ) on the likelihood of developing a complication after surgical procedure, controlling for the patient level characteristics variables.

### Covariates descriptions:

**Procedure type:** This variable allows the model to adjust for type of surgery (open vs. laparoscopic) performed.

Type 1: Laparoscopic appendectomy = CPT code: 44970

Type 2: Appendectomy = CPT code(s): 44950, 44955, 44960,

Type 3: Laparoscopic cholecystectomy = CPT procedure code(s): 47562, 47563, 47564

Type 4: Cholecystectomy = CPT code(s): 47600, 47605, 47610, 47612, 47620

**Disease severity for appendectomy:** This variable describes the severity of disease in the presentation for appendectomy. The more severe the disease, the greater is the likelihood for complications. The disease severity is an ordinal variable range 0 to 4 with 4 indicating most severe disease, and 0 least severe. Identification period is 0-3 days after index date.

Disease Severity	ICD-9 diagnosis code	Description
4	540.0	Acute appendicitis with peritonitis
3	540.1	Perforated appendicitis with or without abscess
2	540.9	Acute appendicitis with necrosis or necrotic appendicitis
1	541	Acute appendicitis
0		Other unspecific disease of appendix

**Severe disease for cholecystectomy:** Severe disease is defined as presence of acute cholecystitis or fistula of gall bladder. Identification period is 0-3 days after index date.

ICD-9 diagnosis code(s): 574.0x, 574.2x, 574.3x, 574.5x, 574.6x, 574.8x, 575.0, 575.12, 575.5

**Comorbidity:** To control for existing co-morbidity of patients, we will use the Charlson Comorbidity Index (CCI), a proprietary version of the Charlson algorithm that includes 19 conditions known to be associated with the highest risk of morbidity or mortality which is directly related to subsequent medical utilization. CCI will be calculated based on all claims data 1 year prior to index date.

**Age and Gender:** These variables will be used to control for patient demographic characteristics.

### Prediction

Physician must have at least 10 denominator cases to be scored. Based on the parameter estimates of physician indicators from the above model, the average risk adjusted likelihood of complication for physician  $i$  was obtained using the following equation:

$$P_i = \exp(\beta_{0i} + X\beta)/(1+\exp(\beta_{0i} + X\beta))$$

Where,

Exp: exponential function;

$\beta_{0i}$ : parameter estimates indexed physician effects;

$X\beta$ : the estimated regression coefficients from the model\*mean values for each covariate.

$P_i$  can be interpreted as the expected complication rate physician  $i$  would have if he/she treated all surgical procedures at his/her actual level of performance. Comparing risk adjusted complication rates across physicians would measure physician  $i$ 's performance assuming that this provider encountered the typical or average case distribution experienced by his/her peers.

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