OSHPD Technical Note for Calculating Volume of Cancer Surgeries in California Hospitals

Office of Statewide Health Planning and Development

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Literature Review Summary

To identify cancer surgeries for which there is evidence that volume is a meaningful differentiator of patient outcomes, especially mortality, the Cancer Prevention Institute of California (CPIC) staff (Christina A. Clarke, PhD and Lisa M. Moy, MPH) searched for all peer-reviewed manuscripts, including individual studies, systematic reviews, and meta-analyses relevant to the volume of curative cancer surgeries, mortality and other outcomes in the US published since the year 2000. With the assistance of Stanford medical librarians, CPIC implemented a PubMed search. The references of all manuscripts were reviewed to identify additional studies, as well as additional studies found through Google Scholar. The results of this search produced a number of systematic reviews and meta-analyses.

CPIC included in this literature review peer-reviewed scientific manuscripts describing associations between the volume of surgeries (with curative intent) and at least one patient outcome (e.g., mortality, complications). Some studies addressed multiple outcomes (generally, mortality and selected complications) but some studies (addressing lower-risk surgeries) did not address mortality at all.

Manuscripts were additionally subjected to a structured quality assessment. Of the 149 relevant manuscripts identified by the search strategy, 12 manuscripts were excluded due to quality concerns (predominantly lack of clinical, demographic, and/or surgeon-level adjustments in their analysis). Thus, the literature review included 137 high quality manuscripts.

Sufficient evidence was found of hospital volume-mortality associations for surgeries for: bladder, brain, breast (rare event), colon, esophagus, head/neck (heterogeneous), liver, lung, pancreas, prostate (rare event), rectal and stomach cancers (Table 1). It is noted that death following breast or prostate surgeries are very rare. While there was sufficient evidence for a relationship between volume and mortality for head and neck cancers as a single entity, the heterogeneity of surgeries and sub-sites included in this category weakens this evidence such that head and neck cancers were not included in this project. The evidence was generally weak or null for the other sites assessed (cervical, endometrial, kidney, ovarian, testes). Some but not all, studies in the literature review examined non-mortality outcomes after cancer surgery.

The final summary literature review document is not included here but is available upon request from the Office of Statewide Health Planning and Development (OSHPD) or the California HealthCare Foundation.

Table 1: Results of literature search by cancer site of directed surgery using Pubmed and related resources, 2014.

Cancer site	Quality Meta-analyses or Reviews	Other Relevant Studies (Quality Studies/Total Studies Identified)
Adrenal	0	1/1
Biliary Tract	0	2/2
Bladder	0	16/17
Brain	0	4/4
Breast	3	5/5
Cervical	0	1/1
Colorectal	5	9/9
Colon	3	16/16
Rectal	5	4/4
Endometrial	0	3/7
Esophagus	3	29/29
Head and Neck	0	6/7
Kidney	0	9/9
Leukemia	0	0/2
Liver	1	8/9
Lung	8	18/18
Oropharynx	0	Included in head and neck
Ovarian	0	6/7
Pancreas	3	28/28
Pituitary Gland	0	1/1
Prostate	6	16/16
Stomach (Gastric)	1	13/13
Testes	0	0/1
Thyroid	0	1/2
Vestibular schwanoma	0	Included in head and neck

Advisory Committee

A multidisciplinary advisory committee, composed of oncologists; health services researchers; and hospital, payer, and consumer representatives (Appendix A), was convened to provide guidance for this project. The group met periodically over the course of the project, culminating with an in-person meeting with OSHPD senior and executive staff in November 2014. No individual member of the advisory committee should be considered as endorsing all of the project approaches.

ICD-9 and CPT Code Selection

To capture inpatient surgeries, International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9) procedure and diagnostic codes (Appendix B) were identified that corresponded to cancer-directed operations for the specified malignancies. These codes were then tested using actual data and subsequently vetted by experts.

1. The ICD-9 coding manual was examined to identify codes related to the malignancies of interest.
2. The codes were reviewed with specialists to ensure that codes reflected cancer-directed surgeries.
3. All the codes in the literature review document were assessed for inclusion. Some of these codes were included, but many of the codes included in prior research studies were determined by the research team to be inconsistent with the goals of this project.
4. OSHPD Patient Discharge Data (PDD) were used to ensure that relevant ICD-9 procedure codes were not missed. First, we selected ICD-9 diagnosis codes for the malignancies of interest. Frequencies of the most common ICD-9 procedure codes associated with these diagnoses were then run to ensure that common ICD-9 procedure codes for these cancers were included in our lists.
5. The OSHPD data were used to ensure that relevant ICD-9 diagnosis codes were not missed. First, ICD-9 procedure codes were selected for the malignancies of interest. Then frequencies of the most common ICD-9 diagnosis codes associated with these surgeries were run to ensure that common ICD-9 diagnosis codes for these cancers were included in our lists.

To capture outpatient breast cancer surgeries, 2013 Current Procedure Technology (CPT) codes (Appendix B) were identified that corresponded to cancer-directed operations for breast malignancies. These codes were then tested using actual data and subsequently vetted by experts.

1. The CPT coding manual was examined to identify codes related to the malignancies of interest.
2. The codes were reviewed with specialists to ensure that codes reflected cancer-directed surgeries.
3. All the codes in the literature review document were assessed for inclusion. Some of these codes were included, but many of the codes included in prior research studies were determined by the research team to be inconsistent with the goals of this project.
4. American College of Surgeons National Surgical Quality Improvement Program data were used to ensure that relevant CPT codes were not missed. ICD-9 diagnosis codes were selected for the malignancies of interest. Frequencies of the most common CPT codes coded were then run to ensure that common CPT codes for these cancers were included in our lists.

Karl Bilimoria, MD, MS, Feinberg School of Medicine, Northwestern University, Division of Surgical Oncology, Director, Surgical Outcomes and Quality Improvement Center, led the code selection work for this project. CPT and ICD-9 code selections were reviewed in detail by Ryan P. Merkow, MD, MS, Department of Surgery, University of Chicago and Sandra Wong, MD, University of Michigan, Associate Chair for Clinical Affairs for the Department of Surgery, each of whom have extensive experience in selecting CPT and ICD-9 codes for oncologic surgeries.

OSHPD Methodology and Findings

Using the ICD-9 based coding methodology described above for the patient cohort definitions, OSHPD generated the analytical file for the study using the OSHPD PDD. Patients included in the analysis were discharged from California-licensed general acute care hospitals in the year of interest and had both the ICD-9 site-specific cancer diagnosis and the ICD-9 procedure code(s) associated with that cancer. Patients were excluded if they were less than 18 years of age; were in long-term acute care, hospice care, or pediatric facilities; or had a Major Diagnostic Code (MDC) of 14 (pregnancy and puperium). Volume counts were calculated at the patient discharge level, so patients may be represented more than once if they were admitted to hospital on separate dates for the same surgery with the same cancer diagnosis. However, follow-up analyses demonstrated that this rarely happens for the 11 cancer surgeries in question.

For breast cancer surgery, PDD and OSHPD Ambulatory Surgery Center (ASC) data were used to identify breast cancer surgeries (mastectomy and lumpectomy) that were performed in hospital inpatient and outpatient facilities. Only California state-licensed ASCs are required to report data to OSHPD so physician-owned centers and other centers not associated with hospitals were not included. Other data indicate that perhaps more than half of lumpectomy surgeries are performed at ASCs not associated with hospitals. Patients in the PDD were selected using the same methods described above; for ASC patients, ICD-9 codes were used to identify a breast cancer diagnosis, and CPT codes were used to identify surgeries. The same exclusions described for the PDD dataset were applied to breast cancer patients in the PDD and ASC with one exception—the ASC dataset does not provide MDC information, so patients with pregnancy-related diagnoses may be included.

The number of each cancer surgery performed in 2014 was determined for each hospital and provided to Laurence Baker, Ph.D., a consultant to this project, who is Professor of Health Research and Policy, and Chief of Health Services Research, Stanford University School of Medicine, for further analysis.

Hospital Variation in Cancer Surgery Volume

For each cancer type, the variation in surgery volume across hospitals was examined using descriptive analysis. For each cancer type, the number of hospitals performing at

least one surgery was first calculated and considered the population. For all cancer types, there are large numbers of hospitals that performed as few as 1 or 2 surgeries in 2014 (Table 2). At the same time, some hospitals performed relatively high volumes, accounting for a large percentage of all patients who underwent that surgery in 2014.

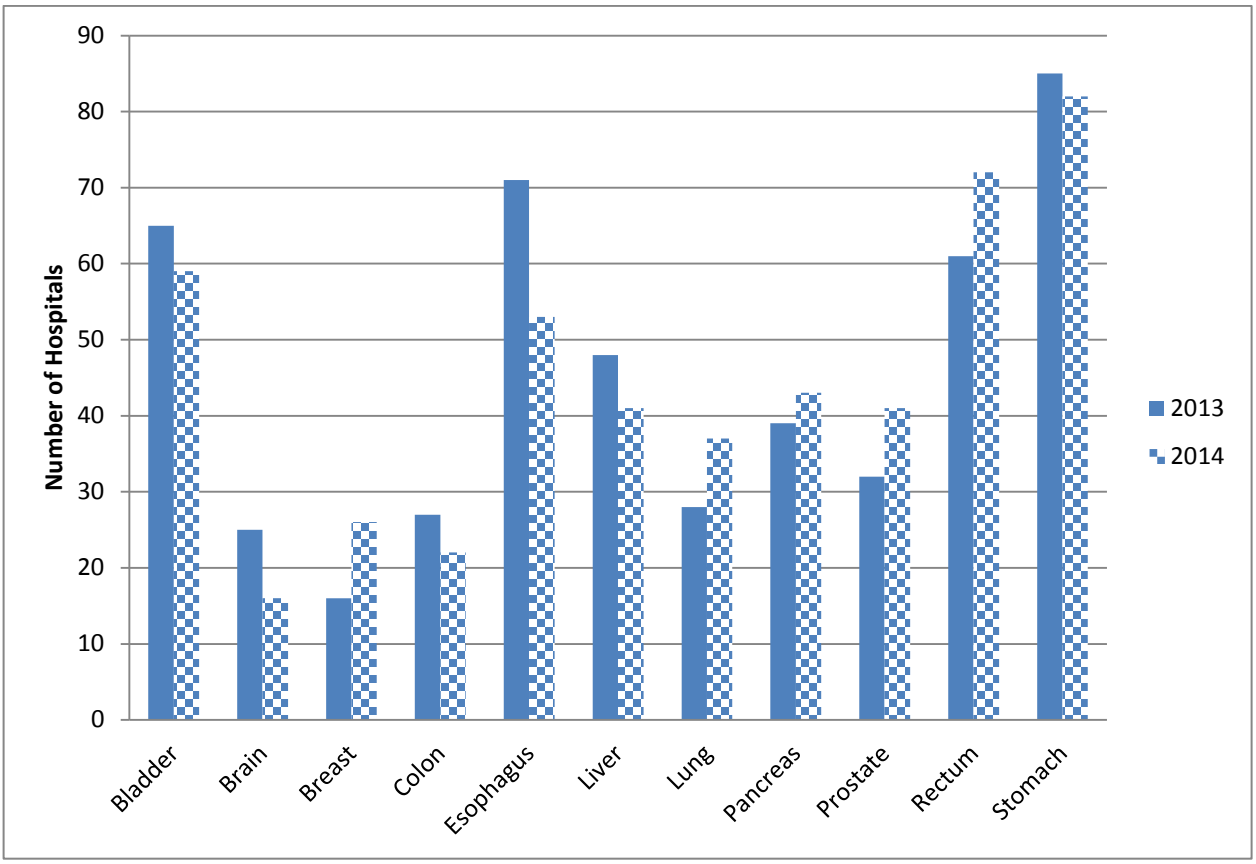
Table 2: Summary Statistics for Cancer Surgery Volume in California Hospitals, 2014 data.

	Cancer Type										
	Bladder	Brain	Breast	Colon	Esophagus	Liver	Lung	Pancreas	Prostate	Rectum	Stomach
Total surgeries	897	2,858	25,290	7,335	354	1,298	3,269	877	5,434	2,239	1,030
Hospitals with >0 surgeries	124	138	298	302	84	106	193	110	170	250	189
Surgeries per hospital (among hospitals w/ >0 surgeries)											
Mean	7.2	20.7	84.9	24.3	4.2	12.2	16.9	8.0	32.0	9.0	5.4
20th percentile	1	5	10	6	1	1	3	1	2	2	1
Median	3	9	47	17	2	4	9	4	13	5	3
80th percentile	8	25	143	41	7	15	28	10	45.5	14.5	7
Maximum	153	321	662	131	45	129	198	58	336	63	48
Hospitals with 1 surgery	35	8	15	9	38	29	23	32	28	44	49
Hospitals with 2 surgeries	24	8	11	13	15	12	14	11	13	28	33
Surgeries at 1- or 2-surgery hospitals	83	24	37	35	68	53	51	54	54	100	115
% of Surgeries at 1- or 2-surgery hospitals	9%	0.8%	0.1%	0.5%	19%	4%	1.6%	6%	1.0%	4%	11%
Number of surgeries in 80th percentile hospitals	640	1,833	14,825	3,527	213	909	1,762	579	3,844	1,288	587
% of Surgeries in 80th percentile hospitals	71%	64%	59%	48%	60%	70%	54%	66%	71%	58%	57%

Number of Low-volume Hospitals in 2013 and 2014

To examine whether volume patterns were similar over time, we repeated the analysis described above for 2010 and 2012. Patterns were generally consistent over time. For example, the number of hospitals performing 1 or 2 surgeries in 2013 and 2014 are shown in Figure 1.

Figure 1. Number of hospitals performing 1 or 2 surgeries, 2013 and 2014, by cancer type.



Characteristics of Low-Volume Hospitals

To better understand the characteristics of hospitals performing low volumes of surgeries, we examined data on the bed size, teaching status, ownership type, and geographic location (urban or rural/frontier) of each hospital from OSHPD records. For each cancer, we then calculated the distribution across categories of these characteristics for hospitals performing 1 or 2 surgeries and also calculated for reference the distribution of all California hospitals across these categories. Results are shown in Tables 3 and 4. Hospitals performing low volumes of surgeries were not dissimilar to the average hospital in California. Low-volume hospitals were found among both large and small hospitals, urban and rural hospitals, teaching and non-teaching hospitals, and in all ownership groups.

Table 3: Distribution of Low-Volume Hospitals by Bed Size.

	Number Hospitals	Percent by Bed Size						
		0-49	50-99	100-149	150-199	200-249	250-299	300+
All CA hospitals	341	14%	9%	19%	11%	14%	7%	27%
Hospitals with 1 or 2 surgeries								
Bladder	59	0%	5%	20%	5%	20%	8%	41%
Brain	16	0%	0%	19%	13%	19%	13%	38%
Breast	26	27%	19%	35%	12%	8%	0%	0%
Colon	22	41%	5%	36%	9%	9%	0%	0%
Esophagus	53	2%	4%	4%	9%	19%	9%	53%
Liver	41	2%	2%	17%	10%	27%	5%	37%
Lung	37	5%	8%	32%	16%	14%	5%	19%
Pancreas	43	0%	5%	7%	14%	7%	14%	53%
Prostate	41	5%	7%	27%	10%	22%	10%	20%
Rectal	72	11%	17%	28%	21%	17%	1%	6%
Stomach	82	1%	7%	16%	16%	27%	5%	28%

Table 4: Distribution of Low-Volume Hospitals by Ownership, Teaching Status, and Geography.

	Number Hospitals	Percent by Ownership			% by Teaching		% by Geography	
		Nonprofit	Investor Owned	Government	Yes	No	Urban	Rural/ Frontier
All CA hospitals	341	59%	23%	18%	8%	92%	76%	24%
Hospitals with 1 or 2 surgeries								
Bladder	59	76%	14%	10%	7%	93%	97%	3%
Brain	16	56%	31%	13%	0%	100%	94%	6%
Breast	26	35%	42%	23%	0%	100%	62%	38%
Colon	22	41%	32%	27%	0%	100%	59%	41%
Esophagus	53	70%	13%	17%	13%	87%	91%	9%
Liver	41	73%	17%	10%	5%	95%	85%	15%
Lung	37	57%	35%	8%	5%	95%	86%	14%
Pancreas	43	67%	19%	14%	16%	84%	88%	12%
Prostate	41	71%	22%	7%	2%	98%	90%	10%
Rectal	72	53%	31%	17%	0%	100%	64%	36%
Stomach	82	62%	29%	9%	6%	94%	90%	10%

Distance Needed to Travel to Higher Volume Hospitals

We examined the travel distance that would be needed for a patient seen at a hospital performing low-volume surgeries (1 or 2 surgeries at a cancer site) to reach a higher volume facility. For purposes of this analysis, we defined a high-volume facility to be in the top 20% of the volume distribution statewide for the given cancer. We obtained the latitude and longitude location of each hospital in the top 20% of the volume distribution by cancer from OSHPD records, and the population centroid of the residence zip code for each patient seen at a 1- or 2-surgery hospital from public records. We then computed the distance each patient would have had to travel to reach the nearest “high-volume” facility. We tabulated the number of patients by distance categories. Results are shown in Table 5. Significant numbers of patients receiving care at low-volume facilities could access a high-volume facility within 20 miles of their residence zip code. For most cancers, between two-thirds and three-quarters of patients could reach a high-volume facility within 50 miles. We repeated the analysis excluding Kaiser patients and facilities (Table 5) because their surgeries for some cancers may be limited to only a couple hospitals, and found similar results.

Table 5: Minimum distance to reach a top 20% volume hospital, for patients seen in 1- or 2-surgery hospitals.

Cancer	Total patients at 1- or 2-surgery hospitals	Number of patients by distance to nearest hospital in top 20% of hospitals, miles						% within 20 miles	% within 50 miles	Cutoff to be a top 20% hospital
		0-5	5-10	10-20	20-50	50-100	100+			
For all patients, counting distance to all hospitals										
Bladder	83	5	13	16	23	10	16	41%	69%	8
Brain	24	3	4	8	1	6	2	63%	67%	25
Breast	37	8	11	5	3	4	6	65%	73%	143
Colon	35	6	10	1	4	8	6	49%	60%	41
Esophagus	67	4	12	12	19	8	12	42%	70%	7
Liver	52	6	4	13	13	12	4	44%	69%	15
Lung	51	6	10	15	9	6	5	61%	78%	28
Pancreas	53	3	9	9	16	9	7	40%	70%	10
Prostate	53	7	14	9	13	5	5	57%	81%	46
Rectal	100	10	15	15	28	9	23	40%	68%	15
Stomach	114	14	24	23	26	15	12	54%	76%	7
For patients seen at non-Kaiser hospitals, counting distance to only non-Kaiser hospitals										
Bladder	69	4	8	10	23	8	16	32%	65%	6
Brain	24	2	4	9	1	6	2	63%	67%	22
Breast	37	2	11	8	3	6	7	57%	65%	109
Colon	34	7	7	3	3	8	6	50%	59%	38
Esophagus	60	2	9	11	18	9	11	37%	67%	5
Liver	45	6	4	11	9	10	5	47%	67%	15
Lung	50	3	11	19	6	6	5	66%	78%	25
Pancreas	49	2	3	13	15	8	8	37%	67%	9
Prostate	37	2	10	7	11	3	4	51%	81%	44
Rectal	94	9	17	8	26	15	19	36%	64%	13
Stomach	108	9	19	25	28	15	12	49%	75%	7

Appendix A
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Appendix B
ICD-9 diagnosis, procedure and CPT procedure codes

Cancer	Code	Brief text
Bladder		
Diagnosis	188.x	Malignant neoplasm of bladder
Procedure	57.6	Partial cystectomy
	57.7	Total cystectomy
	57.71	Radical cystectomy
	57.79	Other total cystectomy
Brain		
Diagnosis	191.x	Malignant neoplasm of brain
	198.3	Secondary malignancy brain
Procedure	01.52	Hemispherectomy
	01.53	Lobectomy of brain
	01.59	Other excision or destruction of lesion or tissue of brain
Breast		
Diagnosis	174.x	Malignant neoplasm of female breast
	175.x	Malignant neoplasm of male breast
	233.0	Carcinoma in situ of breast
Procedure (ICD-9)	85.21	Local excision of lesion of breast
	85.22	Resection of quadrant of breast
	85.41	Unilateral simple mastectomy
	85.42	Bilateral simple mastectomy
	85.43	Mastectomy with excision of regional lymph nodes
	85.44	Bilateral extended simple mastectomy
	85.45	Unilateral radical mastectomy
	85.46	Bilateral radical mastectomy
	85.47	Unilateral extended radical mastectomy
	85.48	Bilateral extended radical mastectomy
CPT	19301	Partial mastectomy
	19302	Partial with axillary lymphadenectomy
	19303	Simple mastectomy
	19304	Subcutaneous mastectomy
	19305	Radical mastectomy
	19306	Radical mastectomy
	19307	Modified radical mastectomy
	19125	Needle localization excision
Colon		
Diagnosis	153.x	Malignant neoplasm of colon
	230.3	Carcinoma in situ of colon
Procedure	17.31	Laparoscopic multiple segmental resection of large intestine
	17.32	Laparoscopic cecectomy
	17.33	Laparoscopic right hemicolectomy
	17.34	Laparoscopic resection of transverse colon
	17.35	Laparoscopic left hemicolectomy

Cancer	Code	Brief text
	17.36	Laparoscopic sigmoidectomy
	17.39	Other laparoscopic partial excision of large intestine
	45.71	Open and other multiple segmental resection of large intestine
	45.72	Open and other cecectomy
	45.73	Open and other right hemicolectomy
	45.74	Open and other resection of transverse colon
	45.75	Open and other left hemicolectomy
	45.76	Open and other sigmoidectomy
	45.79	Other and unspecified partial excision of large intestine
	45.81	Laparoscopic total intra-abdominal colectomy
	45.82	Open total intra-abdominal colectomy
	45.83	Other and unspecified total intra-abdominal colectomy
Esophagus		
Diagnosis	150.x	Malignant neoplasm of esophagus
	151.0	Malignant neoplasm of cardioesophageal junction
	230.1	Carcinoma in situ of esophagus
Procedure	42.40	Esophagectomy, not otherwise specified
	42.41	Partial esophagectomy
	42.42	Total esophagectomy
	42.5x	Intrathoracic anastomosis of esophagus
	42.6x	Antesternal anastomosis of esophagus
	43.5	Partial gastrectomy with anastomosis to esophagus
	43.99	Other total gastrectomy
Liver		
Diagnosis	155.x	Malignant neoplasm of liver and intrahepatic bile ducts
	156.x	Malignant neoplasm of gallbladder and extrahepatic bile ducts
	197.7	Liver, specified as secondary
	209.72	Secondary neuroendocrine liver
	230.8	Carcinoma in situ of liver and biliary
Procedure	50.22	Partial hepatectomy
	50.3	Lobectomy of liver
Lung		
Diagnosis	162.3	Malignant neoplasm of lung upper lobe, bronchus or lung
	162.4	Malignant neoplasm of Middle lobe, bronchus or lung
	162.5	Malignant neoplasm of lower lobe , bronchus or lung
	162.8	Malignant neoplasm of other parts of bronchus or lung
	162.9	Malignant neoplasm of lung, unspecified
	231.2	Carcinoma in situ of bronchus/lung

Cancer	Code	Brief text
Procedure	32.20	Thoracoscopic excision of lesion or tissue of lung
	32.29	Other local excision or destruction of lesion or tissue of lung
	32.30	Thoracoscopic segmental resection of lung
	32.39	Other and unspecified segmental resection of lung
	32.41	Thoracoscopic lobectomy of lung
	32.49	Other lobectomy of lung
	32.50	Thoracoscopic pneumonectomy
	32.59	Other and unspecified pneumonectomy
	32.6	Radical dissection of thoracic structures
Pancreas		
Diagnosis	157.x	Malignant neoplasm of pancreas
Procedure	52.51	Proximal pancreatectomy
	52.52	Distal pancreatectomy
	52.53	Radical subtotal pancreatectomy
	52.59	Other partial pancreatectomy
	52.6	Total pancreatectomy
	52.7	Whipple procedure
Prostate		
Diagnosis	185	Malignant neoplasm of prostate
Procedure	57.71	Pelvic exeneration
	60.4	Retropubic prostatectomy
	60.5	Radical prostatectomy
	60.69	Other prostatectomy
Rectum		
Diagnosis	154.0	Malignant neoplasm of rectosigmoid junction
	154.1	Malignant neoplasm of rectum
	230.4	Carcinoma in situ of rectum
Procedure	48.50	Abdominoperineal resection of the rectum, not otherwise specified
	48.51	Laparoscopic abdominoperineal resection of the rectum
	48.52	Open abdominoperineal resection of the rectum
	48.59	Other abdominoperineal resection of the rectum
	48.61	Transsacral rectosigmoidectomy
	48.62	Anterior resection of rectum with synchronous colostomy
	48.63	Other anterior resection of rectum
	48.64	Posterior resection of rectum
	48.69	Other partial resection of rectum
	68.8	Pelvic evisceration
Stomach		
Diagnosis	151.x	Malignant neoplasm of stomach
	230.2	Carcinoma in situ of stomach

Cancer	Code	Brief text
Procedure	43.42	Local excision of other lesion or tissue of stomach
	43.5	Partial gastrectomy with anastomosis to esophagus
	43.6	Partial gastrectomy with anastomosis to duodenum
	43.7	Partial gastrectomy with anastomosis to jejunum
	43.81	Partial gastrectomy with jejunal transposition
	43.82	Laparoscopic vertical (sleeve) gastrectomy
	43.89	Open and other partial gastrectomy
	43.91	Total gastrectomy with intestinal interposition
	43.99	Other total gastrectomy