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Trends in Compliance with Quality Assurance Metrics

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Background and Significance

Over 40 million major operative procedures are performed in the US annually and comprise 40% of healthcare expenditures, totaling 500 billion dollars.(1) Despite decades of research, perioperative mortality and morbidity remain a major healthcare system cost and detriment to long-term quality of life. More than ten percent of patients experience a significant event such as surgical site infection, reoperation, myocardial infarction, pulmonary embolus, or death.(2) Nearly 100,000 patients die after surgery each year. National data demonstrate a 3-fold variation in risk adjusted surgical morbidity and mortality, suggesting many opportunities for improvement in perioperative care.(3).

Although ongoing initiatives tend to focus on the surgeon and hospital, anesthesiologists play an important part of the surgical episode. Historically, anesthesiology has focused its efforts in reducing the risk of catastrophic, albeit infrequent, events leading to immediate morbidity and mortality, such as unrecognized esophageal intubation, failed airway access, and medication errors. The epidemiology of anesthetic mishaps suggests that these efforts have been successful. For example, the field has observed a decrease in anesthesia-caused mortality from 1 in 4,000 just 40 years ago to 1 in 200,000 today and has been hailed as a patient safety pioneer.(5)

Despite this success, there is growing recognition that anesthesiologists may play a substantial role in the risk of much more common adverse events after surgery. The anesthesiologist is integrally involved in the perioperative process – from weeks before surgery to days after -- as physicians responsible for preoperative optimization, testing, day of surgery anesthesia, and postoperative acute pain management or intensive care unit management. Anesthesiologists are fundamentally involved in the intraoperative episode.

Anesthesiology care demonstrates wide variation in practice. Sometimes, this variation is appropriate because the anesthesiologist is responding to patient comorbidities or procedure specific events. However, even after controlling for patient specific factors, there is a substantial amount of unexplained variation in fundamental elements of anesthesiology care. The same procedure and patient can be performed using completely different anesthetic techniques, hemodynamic management strategies, and medications. This variation in care can lead to a variation in outcome. (23)

- **Hemodynamic Management:** Despite expert opinion that blood pressure should be maintained within 20% of baseline, several studies have demonstrated that more than 40% of patients experience profound hypotension in the operating room, defined as systolic blood pressure of 79 mmHg or below.(8) These blood pressure levels have been demonstrated to be associated with acute kidney injury, myocardial ischemia, and death. (9-11)

- **Intraoperative ventilation strategies:** A recent prospective, randomized trial in major abdominal surgery demonstrated that the use of low intraoperative tidal volumes decreases the risk of postoperative pulmonary complications, including pneumonia and reintubation, by more than 50%, with no additional costs or adverse events. (12) The use of large tidal volumes and failure to administer intraoperative recruitment maneuvers is widespread.
- **Neuromuscular blockade (paralysis):** The use of intraoperative neuromuscular blockade for many patients undergoing general anesthesia is necessary to optimize surgical conditions and prevent catastrophic injury due to unintended patient movement. However, several trials have now demonstrated that most patients suffer from residual neuromuscular blockade at the conclusion of surgery, resulting in markedly increased risk of postoperative hypoxia, pneumonia, reintubation, and prolonged recovery room stay. (13-16)
- **Fluid balance:** Although fluid administration strategies have been studied in small prospective trials extensively, basic consensus regarding the definition of "liberal" versus "restrictive" intraoperative fluid administration is absent.(17) Prospective randomized controlled trials of restrictive fluid administration combined with vasopressor administration in major abdominal cases have demonstrated markedly reduced complications and length of stay. (18)
- **Fluid choice:** The use of colloid fluid therapy has been demonstrated to increase costs without an improvement in outcomes, yet there are no signs that the use of albumin or synthetic colloids has decreased. (19, 20) In addition, despite overwhelming evidence that discretionary transfusion of red blood cells above a hemoglobin of 10 mg/dl is rarely indicated, recent data demonstrate its continued occurrence in many perioperative patients.

The use of electronic health records (EHR) with detailed preoperative and intraoperative data allows an automated system to be developed to notify clinicians their compliance to both process of care metrics and outcome metrics. In 2014, Blue Cross Blue Shield of Michigan announced the creation of the Anesthesiology Performance Improvement Reporting Exchange (ASPIRE), a BCBSM-funded collaborative quality initiative, led by University of Michigan as the coordinating center. Like other BCBSM funded Collaborative Quality Initiatives (MSQC, MBSC, MSCTVS, etc), the primary goal of ASPIRE is to provide hospitals with confidential risk-adjusted feedback on outcome and process of care variation. In addition, ASPIRE creates an active best-practice sharing environment to enable data to spur action.

Recent literature has demonstrated that hospital-level feedback may not be adequate to improve performance and clinical outcomes. (21) In addition to hospital level data and feedback, ASPIRE can disseminate provider-specific electronic feedback that may decrease variation in care known to impact complications and cost. ASPIRE uses the underlying EHR data integration foundation of the Multicenter Perioperative Outcomes Group to aggregate and analyze process of care and outcome data.

To date, there is no anesthesia standard of quality improvement practice regarding provider-specific feedback. The primary aim of this research on QI project is to determine whether provider-specific feedback affects quality improvement performance metrics. We believe that the start of individual provider performance feedback reports to ASPIRE members presents a unique opportunity to evaluate the efficacy of these tools.

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We propose to test the hypothesis that monthly provider specific feedback emails on ASPIRE quality metrics over a period of 9 months improves provider compliance as measured by a either a 10% improvement in the Total Performance Score or by moving from below to above the 90% performance threshold in the Total Performance Score Index.

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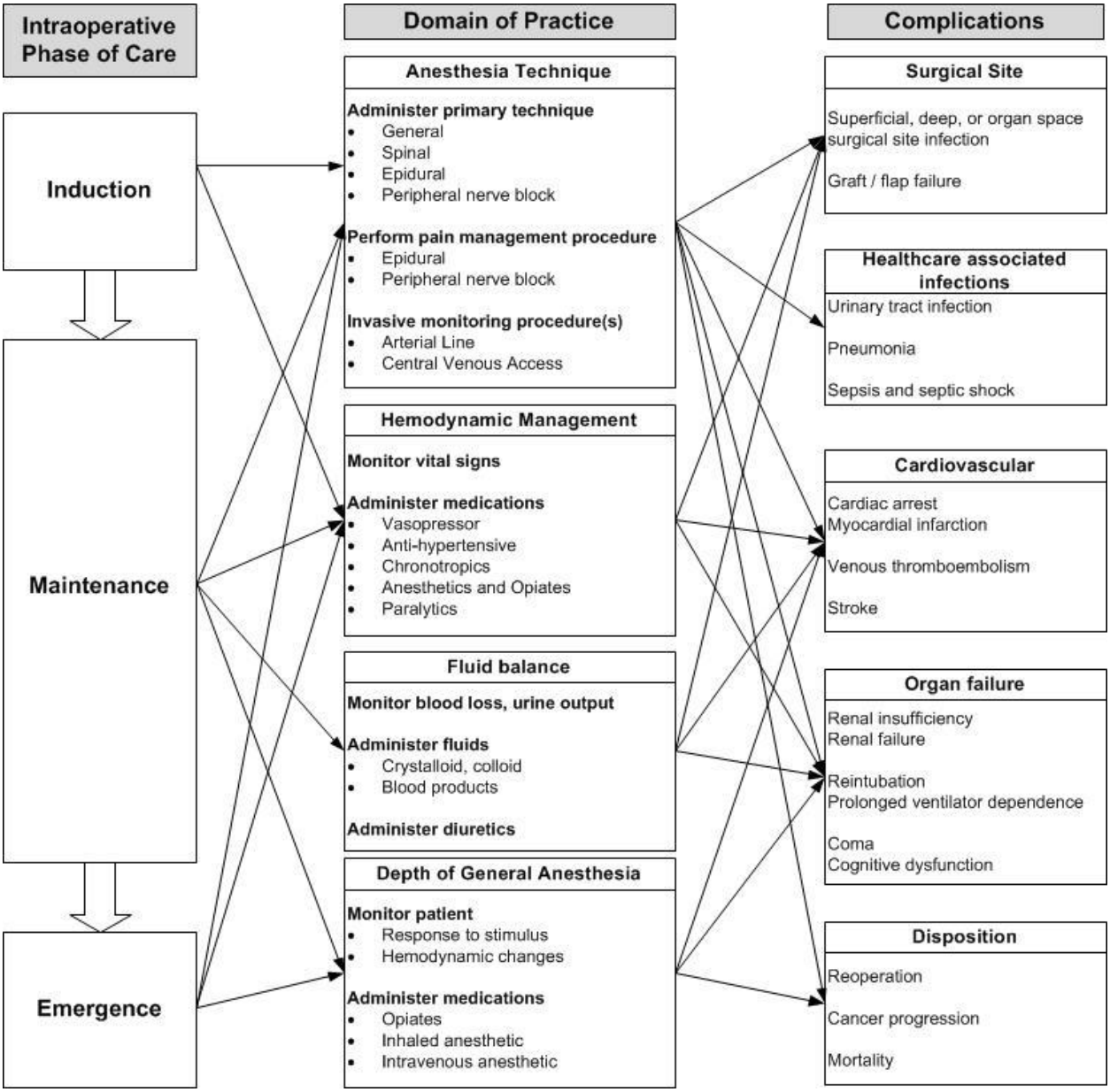
Figure **1**: The intraoperative domains of practice and associated complications



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Methods

Hospitals currently participating in ASPIRE will be eligible to participate in this project. **No individual** at the participating site will see the individualized email compliance reports except for the specific provider. Only an aggregate of the compliance across the entire hospital will be supplied to the chairperson and the quality assurance directors. Each participating hospital will receive individual approval from their own institutional review board.

Pre-defined process of care and outcome metrics (Table 1) will be extracted from the ASPIRE database. The ASPIRE database is developed from the MPOG database. ASPIRE is simply the performance metrics side of MPOG. De-identified patient data will be extracted from the MPOG database in aggregate for the anesthesia providers to determine their overall compliance to the process of care and outcome metrics. The compliance metrics for each provider will be stored in the MPOG/ASPIRE database. Any measure implemented in production in between July 1, 2015 and July 1, 2016 will be incorporated into the analysis. The quality improvement system generates a monthly email to the provider stating their performance compared against the performance of their peers for each measure (Figure 2). Each measure is then hyperlinked back into ASPIRE analytics and data review application where the provider can visually review the cases that they failed on each measure. The visualization removes protected health information but is the representation of the physiologic monitoring, medication and fluids administered, laboratory values, and time-based events. Provider attribution for each measure will follow existing ASPIRE specifications (available at https://www.aspirecqi.org/aspire-measures). Each provider type (faculty, CRNA, resident/fellow) within a hospital participating in ASPIRE will be individually randomized to either receiving the electronic performance improvement email or not for a total of nine months. After the completion of the nine month randomization period, all providers will receive monthly ASPIRE performance improvement emails. Interim analyses to assess for futility and safety will be performed at three and six months.

ASPIRE continuously holds both via web interface, phone calls, and in-person meetings quality improvement meetings to inform all anesthesia care providers of the research on QI project. All providers have heard about this project for a minimum of six months and have experience with looking at sample emails and how to interpret the data. They also understand that within each department, the providers will be randomly assigned to receiving emails or not until the end of the research on QI project. All providers understand that their compliance rates are not reported to the chairperson or the quality champions. The chairperson and quality champions will only receive aggregate institutional level information across all providers on the specific metric compliance rates. They can **NOT** link any compliance rate to any one individual.

At the conclusion of the project, clinical outcomes of interest (Figure 1) will be extracted from the MPOG database via an honest broker using ICD-9 and ICD-10 codes and all-cause 30 day mortality. Table 2 lists the ICD-9 codes which will be used to define combined morbidity outcomes. (22)

ASPIRE will continue to report hospital level data on all process of care metrics (in aggregate) to the head of practice/chairperson and quality improvement champion at each site. We still encourage each

institution to implement their own quality improvement efforts concurrently with this project. This will be a rolling recruitment as each site is able to actively submit data which will be used for each metric and the randomization will occur for nine months after that time.

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Table 1: ASPIRE Quality Measures

Measure	Description
BP 01	Avoiding intraoperative hypotension
BP 02	Avoiding gaps in systolic or mean arterial pressure measurement
GLU 01	Percentage of cases with perioperative glucose > 200 (between anesthesia start-2 hours and anesthesia end) administration of an insulin bolus or infusion or glucose test recheck
GLU 02	Percentage of cases with glucose < 60 (between anesthesia start-2 hours and anesthesia end) with a glucose test recheck or administration of dextrose containing solution (between anesthesia start and anesthesia end + 2 hours)
NMB 01	Percentage of cases receiving a non-depolarizing neuromuscular blocker that have a TOF monitor documented
NMB 02	Percentage of cases receiving a non-depolarizing neuromuscular blockade medication with administration of neostigmine if time from last non- depolarizer administration to extubation is < 4 hours
PUL 01	Percentage of cases with median tidal volumes less than 10 ml/kg
TRAN 01	Hemoglobin or hematrocrit measurement for patients receiving discretionary intraoperative red blood cell transfusions
TRAN 02	Transfusion goal of hematocrit less than 30

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Statistical Analysis

All statistical analysis will be completed using a de-identified dataset for which the analyst will have no link back to each of the individual's unique names. We will combine several key process of care measures into a process of care bundle for the analysis. The bundle for each participating site will include the process of care quality measures included on month 1 of the email feedback program. If there were more than one instance that a provider could pass or fail for a specific case, if the provider passed or failed at least once it would pass or fail for the entire case. The primary outcome will be the proportion of providers that achieve improvement in performance from start to end of the study period. We will exclude providers that already met all the metric thresholds for the primary analysis.

Our primary analysis will include all providers. Secondary analysis will include performers not meeting threshold measures. Improvement in performance will be determined by the following method:

1. The performance rates for the measures of each site's bundle will be summed. This total will be known as the Total Performance Score. The Total Performance Score Index will be the score divided by the number of measures in the bundle.
2. Improvement is defined as greater than or equal to 10% change in the performance index from beginning to end of study, OR
3. Total Performance Score Index crossing the 90% threshold between study beginning or end.

The threshold for what will be considered a performer not meeting threshold measures will be determined by examining the distribution of the bundle compliance. Randomization is pre-determined at the start of the project and is NOT based on if the provider is classified as a performer meeting threshold measures or not. Additional analyses will be conducted to compare providers meeting threshold measures or not across the randomized groups. Each provider's baseline compliance rate will be determined by the performance from the first month's feedback email. In addition, we will do a secondary analysis investigating if the providers that met all the threshold metrics prior to the project further improved during the study period. A sub-group analysis excluding the coordinating center is planned.

The primary analysis will only include sites where all provider types are randomized (attendings/residents/CRNAs). Sites where one provider type (ie attending or CRNA) was randomized and the other provider type was not will be included in a secondary analysis.

To assess our primary hypothesis of the impact of provider-specific emails on overall compliance during the nine-month study period, a repeated measures generalized linear model (GLM) will be used. Between-subjects (randomization to email) and within-subjects (compliance) analyses will be reported. The primary analysis will be stratified by provider type (faculty, fellow, resident, and CRNA). A sub-group analysis excluding the coordinating center is planned.

For our secondary analysis to determine if a provider who already met the threshold performance metric prior to the study further increased in their compliance a linear regression will be used.

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Outcome analyses will be performed only using data related to inpatient / admit day of procedure operations. First, to determine if providers receiving an email about their specific bundled compliance affects a patient's overall combined morbidity and mortality a binary logistic regression model will be used. The dependent variable will be combined morbidity and mortality as a Boolean concept. The independent variables entered into the model will be: primary provider AND primary attending both received an email, primary provider did NOT receive an email but the primary attending did receive an email, primary provider did receive an email but the primary attending did NOT receive an email, elixhauser comorbidity score of 2 or more, ASA (binary concept as 1,2 versus 3,4), age (binned by decade of life), male gender, BMI (defined by the World Health Organization Classifications). We can then determine whether providers receiving feedback emails have a risk adjusted improved combined morbidity and mortality rate. If we find this to be true, a mediation analysis at the provider level will be performed to determine if our independent variable (email received) influences the mediator variable (bundle compliance rate) which thereby influences the dependent variable (outcome of interest). We will report the direct effect for receiving the email on the provider's outcome rate as well as the indirect effect of the email that passes through the bundle compliance rate to affect the outcome rate. These values will be reported as the proportion of total effect that is mediated by compliance. Sensitivity analyses for residents/fellow and CRNAs will also be performed. A sub-group analysis excluding the coordinating center is planned.

For our secondary aim, the ASPIRE analytics platform has audit tools that enable us to ascertain if a specific provider logged into the system to investigate their failed cases. We will therefore look at the bundle compliance rates for all low compliance performers by log-in use (Boolean concept) to ASPIRE website over the nine month study period. Any log into the website during the nine month period will be considered inclusion in the log-in "exposure variable". This will be accomplished using a repeated measures GLM. All analyzes will be performed using STATA version 14.

Figure 2: Sample compliance email

ASPIRE

Anesthesia Performance Improvement and Reporting Exchange

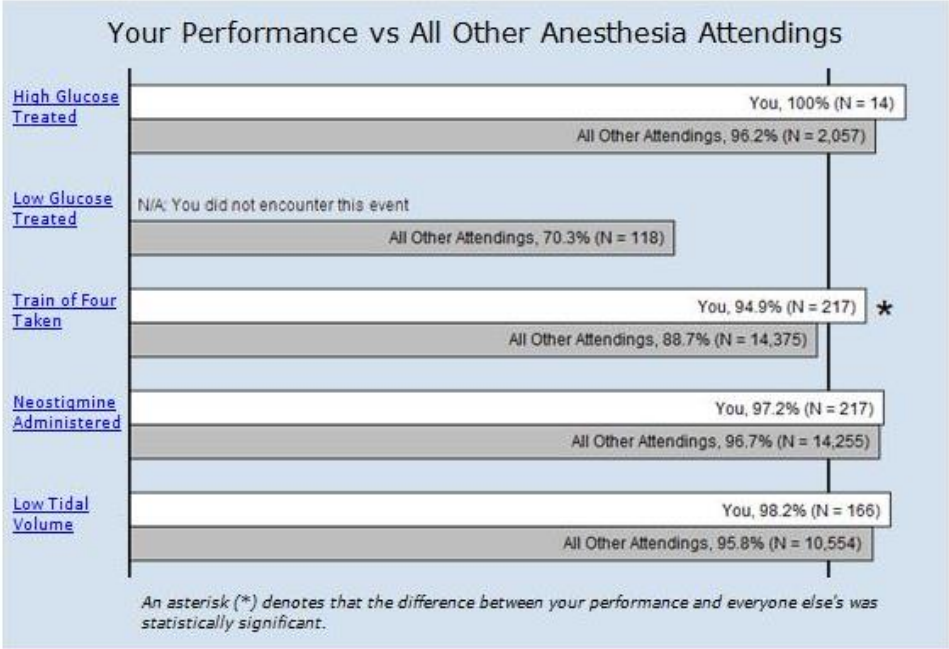
Hello Nirav,

The ASPIRE team has compiled a report regarding your performance as an anesthesia attending from 6/1/2014 to 7/15/2015. This report contains performance measures targeting five departmental areas of concern. If you'd like a case-by-case breakdown of cases that fail a particular measure, simply click on the graph and you will be taken to our reporting website (ASPIRE login required).

Because of the wide variation in patient-specific needs, the current performance threshold for these measures is 90%.

If you have any questions or feedback please send them to anes-aspire@med.umich.edu. Thank you for your participation in ASPIRE.

Sincerely,
The ASPIRE Team



Frequently Asked Questions

Why am I receiving this?
How were these measures chosen?
Does anyone else have access to these results?
I believe my report is inaccurate. Who do I contact?
Can I opt out of receiving these reports?
How do I login to ASPIRE?

Table 2: ICD-9 Codes for Combined Morbidity

Morbidity	ICD-9	Descriptions
Cardiac	429.4	Functional disturbances after cardiac surgery Cardiac insufficiency after cardiac surgery or due to prosthesis Heart failure after cardiac surgery or due to prosthesis Postcardiotomy syndrome Postvalvulotomy syndrome *Excludes: Cardiac failure in the immediate postoperative period (997.1)*
	458.21	Hypotension of hemodialysis Intradialytic hypotension
	458.29	Other iatrogenic hypotension Postoperative hypotension
	977.1	Cardiac arrest during or resulting from a procedure insufficiency during or resulting from a procedure Cardiorespiratory failure during or resulting from a procedure Heart failure during or resulting from a procedure *Excludes: The listed conditions as long-term effects of cardiac surgery or due to the presence of cardiac prosthetic device (429.4)*
Myocardial Infarction		Troponin measured outside the 95% coefficient of variation
Respiratory	518.7	TRALI
	997.3	Respiratory complications *Excludes: Iatrogenic (postoperative) pneumothorax (512.1)* *Iatrogenic pulmonary embolism (415.11)* *Mendelson's syndrome in labor and delivery (668.0)* *specified complications classified elsewhere, such as:* *Adult respiratory distress syndrome (518.5)* *Pulmonary edema, postoperative (518.4)* *Respiratory insufficiency, acute, postoperative (518.5)* *Shock lung (518.5)* *Tracheostomy complications (519.00–519.09)* *TRALI (518.7)*
	997.31	Ventilator-associated pneumonia Use additional code to identify organism
	997.39	Other respiratory complications Mendelson's syndrome resulting from a procedure Pneumonia (aspiration) resulting from a procedure
Gastrointestinal	564.2	Postgastric surgery syndromes Dumping syndrome Jejunal syndrome Postgastrectomy syndrome Postvagotomy syndrome *Excludes: Malnutrition after gastrointestinal surgery (579.3)* *Postgastrojejunostomy ulcer (534.0–534.9)*
	564.3	Vomiting after gastrointestinal surgery Vomiting (bilious) after gastrointestinal surgery

	564.4	Other postoperative functional disorders Diarrhea after gastrointestinal surgery *Excludes: Colostomy and enterostomy complications (569.60–569.69)*
	569.6 569.71 567.79	Colostomy and enterostomy complications
	579.3	Other and unspecified postsurgical nonabsorption Hypoglycemia after gastrointestinal surgery Malnutrition after gastrointestinal surgery
	997.4	Digestive system complications Complications of: Intestinal (internal) anastomosis and bypass, not elsewhere classified, except that involving urinary tract Hepatic failure specified as due to a procedure Hepatorenal syndrome specified as due to a procedure Intestinal obstruction NOS specified as due to a procedure *Excludes:* *Specified gastrointestinal complications classified elsewhere, such as:* *Blind loop syndrome (579.2)* *Colostomy or enterostomy complications (569.60–569.69)* *Gastrojejunal ulcer (534.0–534.9)* *Gastrostomy complications (536.40–536.49)* *Infection of esophagostomy (530.86)* *Infection of external stoma (569.61)* *Mechanical complication of esophagostomy (530.87)* *Pelvic peritoneal adhesions, female (614.6)* *Peritoneal adhesions (568.0)* *Peritoneal adhesions with obstruction (560.81)* *Postcholecystectomy syndrome (576.0)* *Postgastric surgery syndromes (564.2)* *Vomiting after gastrointestinal surgery (564.3)*
Urinary	997.5	Urinary complications Complications of: External stoma of urinary tract Internal anastomosis and bypass of urinary tract, including that involving intestinal tract Oliguria or anuria specified as due to procedure Renal: Failure (acute) specified as due to procedure Insufficiency (acute) specified as due to procedure Tubular necrosis (acute) specified as due to procedure *Excludes:* *Specified complications classified elsewhere, such as:* *Postoperative stricture of:* *Ureter (593.3)* *Urethra (598.2)*
Bleeding	998.1	Hemorrhage or hematoma or seroma complicating a procedure *Excludes:*

		Hemorrhage, hematoma, or seroma: *Complicating cesarean section or puerperal perineal wound (674.3)* *Due to implanted device or graft (996.70–996.79)*
	998.11	Hemorrhage complicating a procedure
	998.12	Hematoma complicating a procedure
	998.13	Seroma complicating a procedure
Infection	519.01	Infection of tracheostomy Use additional code to identify type of infection, such as: Abscess or cellulitis of neck (682.1) Septicemia (038.0-038.9) Use additional code to identify organism (041.00-041.9)
	536.41	Infection of gastrostomy Use additional code to identify type of infection, such as: Abscess or cellulitis of abdomen (682.2) Septicemia (038.0-038.9) Use additional code to identify organism (041.00-041.9)
	530.86	Infection of esophagostomy Use additional code to specify infection
	997.62	Infection (chronic) Use additional code to identify the organism
	998.5	Postoperative infection *Excludes:* *Bleb associated endophthalmitis (379.63)* *Infection due to:* *Implanted device (996.60–996.69)* *Infusion, perfusion, or transfusion (999.31–999.39)* *Postoperative obstetrical wound infection (674.3)*
	998.51	Infected postoperative seroma Use additional code to identify organism
	998.59	Other postoperative infection Abscess: postoperative Intraabdominal postoperative Stitch postoperative Subphrenic postoperative Wound postoperative Septicemia postoperative Use additional code to identify infection
	999.3	Other infection Infection after infusion, injection, transfusion, or vaccination Sepsis after infusion, injection, transfusion, or vaccination Septicemia after infusion, injection, transfusion, or vaccination Use additional code to identify the specified infection, such as: septicemia (038.0-038.9) *Excludes:* *The listed conditions when specified as:* *Due to implanted device (996.60–996.69)* *Postoperative NOS (998.51–998.59)*

Mortality		30 day all-cause mortality

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