Published in final edited form as:

J Surg Res. 2013 May 1; 181(1): 106–113. doi:10.1016/j.jss.2013.01.032.

Postoperative complications and implications on patient-centered outcomes

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Abstract

Background—Postoperative complications increase patient morbidity and mortality and are a target for quality improvement programs. The goal of this study was to review the world's literature on postoperative complications in general surgery patients and to try to examine the effect of these complications on patient-centered outcomes.

Methods—A comprehensive search of the current literature identified 18 studies on the topic of postoperative complications in general surgery patients.

Results—Postoperative complications are common in general surgery patients and contribute to increased mortality, length of stay and need for an increased level of care at discharge (decline in disposition).

Conclusions—While the concept of patient-centered outcomes is not new, it has not been applied to postoperative complications. It is likely that the effect of complications on length of hospital stay and postoperative discharge reflects an impact of complications on these patient-centered outcomes. Future studies should consider the effect of complications on those outcomes that are most important to the individual patient.

Introduction

The number of surgical procedures performed annually in the United States continues to rise with more than 14 million admissions for surgical procedures reported in 2006.¹ Many of these patients will experience postoperative complications with complication rates as high as 30% in some patient groups.^{2, 3} Surgical quality improvement programs are becoming more prevalent in an effort to improve surgical outcomes. The ultimate goal is to measure outcomes and identify areas for improvement in an effort to decrease patient morbidity and mortality. Payers and regulators are also interested in patient outcomes and quality improvement. Many HMOs and the Centers for Medicare and Medicaid Services (CMS) use pay for performance and are now starting to withhold payment for complications deemed preventable in an effort to improve outcomes.⁴

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Perhaps more important to the practicing clinician than the financial impact of postoperative complications are the impact of these events on patient-centered outcomes. The concept of patient centered outcomes is not new. In fact, the Institute of Medicine's quality chasm report defined this type of care as care that "respects the individuality, values, ethnicity, social endowments, and information needs of each patient"⁵. While there is no standard set of patient-centered outcomes, any outcome that is important to patients and assists patients in medical decision making is typically considered patient centered. For example, survival, morbidity, symptoms, function, quality of life and patient satisfaction have been described as patient centered outcomes⁶⁻¹⁰. It is clear that postoperative complications will have negative effects on many issues that are most important to patients. For example, pelvic sepsis following ileal pouch surgery will likely negatively impact the patient's quality of life.¹¹ While this type of complication is extreme and clearly would impact quality of life, it is less clear if other complications will similarly affect patient-centered outcomes. Therefore, we wanted to determine if the literature supports the notion that postoperative complications have negative impacts on other types of patient-centered outcomes. The aim of this article was to review the current literature related to postoperative complications and summarize their risk factors, classification systems, and their impact on patient-centered outcomes.

Methods

A literature search was conducted in July 2012 using the PubMed database as demonstrated in Figure 1. For the purposes of this study, we considered the following as patient-centered outcomes: mortality, morbidity, quality of life, discharge disposition and length of stay. The search included the following key words: postoperative or surgical, complications, general surgery, laparoscopic versus open, disposition, morbidity, mortality, classification, quality of life and patient-centered outcomes. We limited our initial search to studies performed in adult humans, manuscripts written in English and performed in the last 10 years. The terms postoperative or surgical and complications and general surgery were used in combination with the other search terms to produce an initial list of 1074 potentially relevant studies. Abstracts of these publications were evaluated and publications were eliminated if they were not performed in general surgery patients or if they did not address the effect of complications on patient outcomes. The 26 abstracts which appeared to address the questions of this study were further analyzed. A reference review of the selected publications identified 5 more relevant trials. The initial search yielded 31 publications. These manuscripts were read, evaluated and narrowed to include only publications pertaining to general surgery patients with 18 remaining publications. Characteristics of the 18 included studies are listed in Table 1.

Results

Classification of Complications

A major limitation in the reporting of postoperative complications is that no standardized system for reporting or grading of complication severity exists. Many studies arbitrarily describe complications as "severe" or "minor" which results in difficulty comparing outcomes across the literature. Classification of complications was first proposed in 1992 by Clavien et al.¹² in an effort to standardize reporting of postoperative complications. The initial grading system placed an emphasis on morbidity and therapeutic treatment of complications when determining the severity of complications. The grading system is presented in Table 2. In 2004 Clavien and colleagues¹³ re-evaluated and revised the classification system as depicted in Table 3. An international survey demonstrated reproducibility of the classification with accuracy of grading ranging from 87-93%. Greater

than 90% of surgeons surveyed described the classification system as simple and reproducible.

Clavien et al.¹⁴ again reassessed the grading system in 2009 using complex clinical situations collected from the University of Zurich weekly morbidity and mortality conferences. Surgeons from 7 centers around the world evaluated the scenarios and graded the complications with >90% agreement. The authors also noted variability in how the grading system was referenced in the literature and proposed it be referred to as the “Clavien-Dindo” classification.¹⁴

Another group has attempted to develop a classification system of complications found in the participant use file of the American College of Surgeons NSQIP.^{15, 16} Using the Accordion Severity Grading System, Strasberg and Hall assessed the ability of postoperative morbidity index (PMI) to quantify postoperative complication severity. Each complication was graded with the Accordion System and the graded complications were weighted to yield the total severity burden of each complication. This allowed the authors to compare outcomes and stratify complications according to severity following different surgical procedures.

Incidence of Post-operative Complications

We found the reported incidence of 30 day postoperative complications in general surgery patients to range from 5.8% to 43.5%.^{2, 3, 15, 17-19} Two studies further classified complications by surgeon defined severity. Cohen et al.¹⁷ differentiated “serious” morbidity, which included 11 complications the authors considered to be more significant. The serious morbidity rate in those patients undergoing colorectal operations was 11.4%, with overall morbidity rate of 24.3%. Others used the Clavien-Dindo grading system to evaluate postoperative complications.³ The overall complication rate was 37%, with 25.7% of complications classified as grade I, 48.6% grade II, 17.1% grade III, 5.7% grade IV and 2.9% grade V.

In addition to the grading systems applied to postoperative complications, authors have considered complications which required unplanned procedures post-operatively. Post-operative interventions were required within 30 days in 5.8% of colorectal patients in an analysis from the SEER-Medicare database (5.7% of colon cancer patients, 6.5% of rectal cancer patients).²⁰ Almoudaris et al.²¹ identified a similar re-operative rate of 4.8% in colorectal patients.

We were particularly interested to examine the effects of multiple complications on postoperative recovery and outcomes in the literature. We found only two studies that addressed multiple complications. Morris et al.²⁰ found two or more complications to be rare in only 0.4% of colorectal patients from the SEER-Medicare database. As may be expected, this group of patients experienced a higher risk of mortality (RR 7.2 vs 2.1) and prolonged hospitalization (RR 2.8 vs 2.2) as compared with patients who had one post-operative complication. Strasberg and Hall¹⁵ examined their institutional NSQIP data and found multiple complications to be ten times more prevalent than the SEER-Medicare data at 5%. This difference in prevalence likely reflects the differences in accuracy in capture of complications between the prospective, clinical data of NSQIP and the coded-data of the SEER-Medicare dataset.

Mortality

Four studies evaluated overall mortality in postoperative patients, which ranged from 0.79% to 5.7%.^{2, 15, 17, 22} A cohort analysis of colorectal cancer patients from the SEER database demonstrated an increase in postoperative mortality in patients who experienced

complications. Patients with multiple complications had the greatest risk ($RR = 7.2$), although patients with one complication were also at significantly increased risk of mortality ($RR = 2.1$).²⁰ A Veteran's Affairs' National Surgical Quality Improvement Project (NSQIP) study in patients after colectomy demonstrated a significant increase in 30 day mortality rates for all complications with the exception of superficial wound infection, UTI and DVT.² In this study, mortality following coma >24 hours increased from 5.6% to 79.5% when another complication occurred. The authors found a similar trend in mortality following cardiac arrest at 4.7% without a second complication and 78.4% when another complication occurred ($P < 0.0001$).²

Preoperative Risk Factors

Patient factors

Numerous patient factors have been found to increase risk for postoperative complications. Many of these factors are associated with functional status and reflect overall poor health. For example, Longo and colleagues² identified multiple preoperative factors from VA NSQIP data which predicted postoperative complications including dependent functional status, ASA class III-V, older age, residual neurological defects from prior CVA, and preoperative diagnosis of pneumonia. However, Morris et al.²⁰ evaluated the SEER database and found no increase in postoperative morbidity with increased age or chronic medical conditions, but did note that male gender ($RR = 1.3$) and presentation with an acute medical condition such as bowel perforation ($RR = 3$) were predictive of postoperative complications.

In addition to preoperative functional status, overall frailty has been found to be associated with postoperative complications. While the operational definition of frailty is not agreed upon, it is widely accepted that the frailty phenotype exists when 3 of 5 symptoms are present. These symptoms include: measured slow walking speed, measured impaired grip strength, self-reports of declining activity levels, exhaustion, and unintended weight loss.²³ A study of patients over 65 years of age demonstrated an increase in postoperative complications in patients who were more frail with 2.06 fold increased risk in intermediately frail patients and 2.54 fold increased risk in frail patients as compared with robust patients.¹⁹ In an effort to improve patient outcomes by improving preoperative functional status, Mayo et al.³ evaluated the effects of prehabilitation in colorectal patients. Thirty three percent of patients were able to improve preoperative walking capacity, 29% of patients experienced a decline in their functional status and 38% maintained walking capacity. Although postoperative complication rates were similar between patients who improved and declined preoperatively, patients who deteriorated preoperatively were more likely to experience complications which required ICU admission or reoperation ($P = 0.008$).

Hospital factors

The impact of systems of care on postoperative complications is an active area of interest. It is clear that certain systems may manage postoperative complications more effectively and provide better overall patient support than others. Two studies evaluated differences in outcomes between hospitals, specifically postoperative complication rates and mortality. Almoudaris et al.²¹ separated hospital units in England into quintiles based on mortality and then evaluated differences between the highest mortality quintile (HMQ) and the lowest mortality quintile (LMQ). The hospitals with highest and lowest mortality were found to be similar in terms of number of total and ICU beds, use of imaging and number of operating rooms. Despite lack of significant differences in hospital characteristics and reoperation rates between quintiles, overall mortality rates differed from 4.1% to 7.6% and mortality after complication rates differed significantly from 11.1% in LMQ to 16.8% in HMQ.²¹ Ghaferi et al.¹⁸ identified significant differences between hospitals when comparing high

and low mortality hospitals (HMH, LMH). The authors noted increased complication rates (18% vs 3%) and overall mortality (19.1% vs 1.5%) in HMH compared with LMH. Patients at LMH were found to have fewer preoperative medical conditions (19.6% vs 22.6%); however other patient characteristics were similar between quartiles. Hospitals with lower mortality following complications were found to have higher nurse to patient ratios (OR 0.94), high hospital technology (0.65), hospital size >200 beds (OR 0.65), average daily hospital census >50% (OR 0.56) and teaching hospitals were also associated with lower mortality (OR 0.65).¹⁸

Operative Approach

Many groups have been interested in examining the operative approach on the rate of postoperative complications following colon and rectal surgery. Using the participant use file from NSQIP, we found that laparoscopic operation was an independent predictor of decreased rates of postoperative complications in patients undergoing elective colon resection with a primary anastomosis.²⁴ We have been particularly interested in understanding if this effect held true in older adults patients undergoing surgery for colon cancer. Using a propensity score analysis, we found that a laparoscopic operation was an independent predictor of decreased rates of postoperative complications.²⁴

Others have done similar work using SEER-Medicare, NIS and NSQIP data²⁵⁻²⁷ and demonstrated significantly decreased rates of postoperative complications in patients who undergo laparoscopic versus open colorectal surgery. An analysis of patients 65 years of age using the SEER-Medicare database revealed decreased complication rates in patients who underwent laparoscopic colectomy versus open colectomy for colon cancer (21.5% versus 26.3%). The mean age in this patient population was 77.9 years of age. Laparoscopic patients were more likely to have earlier stage disease, however rates of chemotherapy were similar between the laparoscopic and open groups.²⁵ Vaid and colleagues²⁶ analyzed over 60,000 patients from the NIS database and found patients were more likely to undergo laparoscopic colectomy if they had earlier stage disease and were treated at a large urban hospital. Overall postoperative complications were significantly higher in the open colectomy group (27.1%) as compared with the laparoscopic group (18.9%).²⁶ Outcomes of open versus laparoscopic colon resection for diverticulosis using ACS-NSQIP data revealed older patients with more comorbidities were more likely to undergo open colectomy. The overall 30 day morbidity in patients who had laparoscopic colectomy was significantly lower than open colectomy patients (11.9% versus 23.2%).²⁷

Effect of Complications on Patient-Centered Outcomes

Length of Stay

Only one reviewed study described the effect of complications on hospital length of stay. Morris and colleagues²⁰ found that 50.2% of patients who required reoperation due to postoperative complications had a prolonged hospitalization, defined as >14 days, as compared with 22.5% of patients who did not require reoperation. Patients with one postoperative complication were at increased risk of prolonged hospitalization (RR 2.2) and not surprisingly patients with multiple complications were at even higher risk (RR 2.8).

Post-operative Disposition

A short term outcome which has largely been ignored in postoperative outcomes analysis is discharge disposition. The ability to return home or to the level of assistance required preoperatively is important to patients and may have implications on longer term outcomes. In a retrospective cohort study of older adults, Legner et al.²² described postoperative disposition and its effects on survival. In a population of patients with average age of 75,

80.3% were discharged home with self-care postoperatively, 6.4% home with assistance and 11% were discharged to an institutional care facility (ICF) after surgery. Factors associated with ICF placement were older age, lower income, female gender and urgent or emergent admission. The odds of discharge to ICF increased 2 fold in patients who suffered from one or more postoperative complications. Placement in ICF at discharge was associated with higher 30 day (4.3% vs 0.4%), 90 day (12.6% vs 1.4%) and 1 year (22.2% vs 5.9%) postoperative mortality ($P<0.001$). It is interesting to note that those patients discharged home with assistance fared better than those placed in an ICF. However, postoperative mortality was higher in patients who required assistance at home compared to those discharged home with self-care.²² These observations support the notion that older adult postoperative patients who require a higher level of care upon discharge do worse than those patients who can go home on their own. While this may lead to the conclusion that higher level of care is predictive of mortality, it more likely is a marker for poor state of health.

The effect of age on the need for a higher level of care after colorectal surgery was examined by Devon and colleagues.²⁸ They found age over 80 to be a significant predictor in discharge disposition as compared to patients 65-74 years of age (OR 11.59). They also demonstrated older patients were more likely to need homecare at discharge (OR 1.71 versus OR 1.19), but this group was more likely to have required home-care prior to surgery. In this study, patients who had a stoma placed during their hospitalization were most likely to require homecare at discharge (OR 3.89).²⁸

Discussion

While different classification systems exist to describe the severity of postoperative complications, there is no standardized method for reporting the severity of complications. The first obstacle in developing a classification system is to identify which outcomes are the most important markers of complication severity. Patient mortality following surgery is less than 6% within the studies evaluated here and is likely too rare to be an adequate measure of complication severity. Post-operative length of stay, need for reoperation, readmission rates and decline in disposition are all markers of patient outcomes, however they may be less useful for grading complications and more useful as targets for quality improvement projects. Current systems tend to focus on long term morbidity and necessity for further treatments or procedures, which reflect the impact of complications on patient recovery and long term outcomes. The Clavien-Dindo classification is easy to use and interpret, has been demonstrated to be reliable across users^{14, 29} and may be a good candidate for more systematic classification of complications.

The occurrence of a postoperative complication indicates an important change in the recovery of a patient. It confers an increased risk of reoperation, prolonged length of stay, decline in disposition and increased mortality. Several studies have attempted to identify preoperative factors which predispose patients to complications and poorer outcomes. However, these studies have been performed retrospectively and therefore it is likely that younger and healthier patients were recommended for surgery resulting in significant selection bias in the studied patient populations. Within the limits of these studies, patients who are at increased risk of postoperative complications have been found to have overall poorer health and functional status preoperatively.^{2, 20} Unfortunately, many of these factors cannot be modified preoperatively in an effort to improve patient outcomes. They do provide more information for surgeons who can then better counsel patients preoperatively regarding risks of postoperative complications and mortality. Mayo et al. demonstrated that prehabilitation in colorectal patients did not affect the incidence of postoperative complications, however patients were less likely to require a second procedure or ICU admission if functional status improved preoperatively.³ Further research regarding

preoperative optimization of patients and outcomes such as postoperative functional status, disposition and mortality may determine if prehabilitation improves longer term outcomes.

Individual hospitals have been found to have differences in postoperative mortality which cannot entirely be explained by patient factors and postoperative complication rates. Although teaching status, hospital size, technology and nurse staffing have been associated with improved mortality rates, many of the differences between hospital mortality rates are not well explained by the current literature.^{18, 21} A better understanding of what system variables contribute to these differences would allow for institution of quality improvement programs in higher mortality hospitals in an effort to improve patient outcomes.

Multiple studies²⁴⁻²⁷ have demonstrated that laparoscopic colon and rectal resections result in decreased complication rates as compared with open resection. In addition to decreased complications, patients who undergo laparoscopic colon and rectal resections have been shown to have shorter postoperative length of stay and improved overall and cancer free survival as compared with open resections, which may make the patients who have had open resections in the past better candidates for laparoscopic surgery.^{25, 26, 30} However, interpreting results from these retrospective reviews is difficult as patients were offered laparoscopic versus open resection according to surgeon preference and historically laparoscopic surgery has been offered to earlier stage cancer patients at larger urban hospitals and younger patients with less comorbidities.²⁵⁻²⁷ Therefore, it is difficult to ascertain if patients who undergo laparoscopic procedures have better outcomes due to the operative approach or because they were healthier with earlier stage disease preoperatively. Future studies comparing patients with similar comorbidities and cancer stage who receive laparoscopic versus open procedures as well as studies assessing why surgeons recommend laparoscopic versus open procedures would provide much needed clarification on this topic.

Most studies only address the first surgical complication or evaluate the presence of any complication compared with no complication in their analysis. As Morris et al. described, multiple postoperative complications place patients at significantly increased risk of mortality and prolonged hospital stay.²⁰ Further studies are needed to identify patient factors which increase the risk for more than one postoperative complication. Similarly, it is unknown if some complications confer greater risk for 2nd, 3rd or more complications. It is likely that certain complications are more prone to occurring together, however this type of analysis was not uncovered in our review of the current literature. More information regarding outcomes following multiple complications may reveal a significant source of postoperative morbidity and mortality and targets for surgical quality improvement programs.

Traditionally mortality, length of stay and cost have been used as measures of patient outcomes. Other patient-centered measures, which may be equally important, are now being considered including discharge disposition, quality of life and functional status. Little is currently published in the general surgical literature on these outcomes, for example our review did not recover any studies addressing quality of life in general surgical patients. Further studies to identify which outcomes are most important to patients, how best to counsel patients regarding these outcomes preoperatively and quality improvement projects aimed at improving patient-centered outcomes are needed.

In addition, most publications limit analysis of patient outcomes to 30 days postoperatively. However, as Legner et al. demonstrated, factors such as decline in discharge disposition may lead to poor longer term outcomes, including increased mortality.²² Further studies regarding postoperative complications and both short and long term patient-centered outcomes will likely demonstrate that complications have a negative effect on many

outcomes including quality of life, functional status and discharge disposition. More information regarding what specific functional or medical changes cause patients to have a decline in functional status and need for more assistance after discharge may identify areas for intervention. Furthermore, studies aimed at understanding what places those patients discharged to ICF at higher risk of mortality may provide areas for quality improvement. With more knowledge regarding which patients are at risk for disposition decline, worsening of functional status and changes in postoperative quality of life, patients and providers will be better informed preoperatively and better able to understand the long term risks of surgery.

Acknowledgments

Supported by a training grant from the National Institutes of Health (T32 CA090217).

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Figure 1.
Literature Selection

Table 1

Characteristics of Included Studies

Journal	Year	First Author	Database Used	Surgical Procedures	# of Patients	Classification System	Complication Rate	Mortality Rate
Dis Colon Rectum	2000	Longo	VA-NSQIP ¹	Colectomy	5853	-----	28%	5.7%
Surgery	2011	Mayo	Single Institution Database	Colorectal	133	Clavien-Dindo	37%	-----
Surgery	1992	Clavien	Single Institution Chart Review	Cholecystectomy	650	Clavien-Dindo	12%	0%
Ann Surg	2004	Dindo	Single Institution Database	General Surgery ²	6336	Clavien-Dindo	16.4%	1.2%
Ann Surg	2009	Clavien	Literature Review	General Surgery	-----	Clavien-Dindo	-----	-----
J Am Coll Surg	2011	Strasberg	ACS-NSQIP ³	Abdominal Surgery ⁴	676	Postoperative Morbidity Index	13.8%	0.8%
J Am Coll Surg	2010	Porembka	Single Institution NSQIP	General Surgery	1,857	Accordion Severity Grading System	38%	-----
J Am Coll Surg	2009	Cohen	ACS-NSQIP	Colorectal	28,863	Author Discretion	24.3%	3.9%
J Am Coll Surg	2010	Ghaferi	NIS ⁵	Pancreatotomy	16,900	-----	18-33%	1.5-19.1%
J Am Coll Surg	2010	Makary	Single Institution Prospective	General Surgery	594	-----	3.9-43.5%	-----
Ann Surg	2007	Morris	SEER ⁶ Medicare	Colorectal	26,638	Reoperation = Complication	5.8%	-----
Br J Surg	2011	Almoudaris	Hospital Episode Statistics	Colorectal	144,542	Reoperation = Complication	17.4-19.1%	4.1-7.6%
Ann Surg	2009	Legner	Single Institution Database	Abdominopelvic ⁷	89,405	-----	-----	2.5%
Ann Surg	2009	Kennedy	ACS-NSQIP	Colorectal	8,660	-----	14-27%	-----
World J Surg Onc	2012	Cummings	SEER Medicare	Colectomy	27,436	-----	21.5-26.3%	3.3-5.8%
Ann Surg	2012	Vaid	Cost & Utilization Project NIS	Colectomy	63,950	-----	18.9-27.1%	1.7-2.4%
Surg Endosc	2012	Kakarla	ACS-NSQIP	Colectomy	7,629	Author Discretion	11.9-23.2%	0.3-0.8%
Surgery	2011	Devon	Ontario Cancer Registry	Colorectal	33,238	-----	-----	1.7-10.2%

¹ VA-NSQIP = Veteran's Administration National Surgical Quality Improvement Project

² Includes colorectal, liver, pancreas, esophagus, hernia and soft tissue procedures.

³ ACS-NSQIP = American College of Surgeon's National Surgical Quality Improvement Project

⁴ Includes inguinal hernia, appendectomy, laparoscopic cholecystectomy, hepatectomy and pancreaticoduodenectomy.

⁵ NIS = National Inpatient Sample

⁶SEER = Surveillance, Epidemiology and End Results

⁷Includes cholecystectomy and colectomy.

Table 2

Initial Clavien Classification System (1992)

Grade	Definition
Grade I	Any complication which would resolve spontaneously if left untreated without need for pharmacological intervention *. Must result in hospital stay <2x median expected hospitalization.
Grade II	Potentially life threatening complication with need for some form of intervention. Does not result in lasting or residual disability or organ resection.
Grade IIa	Complications requiring medications other than allowed for Grade I.
Grade IIb	Complications requiring invasive procedures or reoperation.
Grade III	Complications with residual or lasting disability or which require organ resection.
Grade IV	Death as a result of any complication.

* Allowed medications in Grade I complications include: analgesic, antipyretic, antiemetic and antidiarrheal drugs.

Table 3

Revised Clavien-Dindo Classification (2004)

Grade I	Any deviation from normal postoperative course without need for pharmacological [*] treatment or surgical, endoscopic and radiological intervention. Bedside treatment of wound infections included.
Grade II	Requiring pharmacological treatment other than allowed for grade I. Blood transfusions and total parenteral nutrition also included.
Grade III	Requiring surgical, endoscopic and radiological intervention.
Grade IIIa	Intervention not under general anesthesia.
Grade IIIb	Intervention under general anesthesia.
Grade IV	Life threatening complication requiring ICU management. Includes CNS complications.
Grade IVa	Single organ dysfunction (including dialysis).
Grade IVb	Multiorgan dysfunction.
Grade V	Death of patient.

^{*} Allowed therapeutic regimens in Grade I complications include: antiemetics, antipyretics, analgetics, diuretics, electrolytes and physiotherapy.