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Long-term Functional Decline after High-Risk Elective Colorectal Surgery in Older Adults

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Abstract

BACKGROUND: Although most surgical outcomes research focuses on clinical endpoints and complications, older adult patients may value functional outcomes more. Yet, little is known about the risk of long-term functional disability after colorectal procedures.

OBJECTIVE: To understand the incidence and likelihood of functional decline after high-risk (i.e. 1% inpatient mortality) colorectal operations both without and with complications.

DESIGN: Retrospective matched cohort study.

SETTINGS: The Health and Retirement Study, a nationally representative, longitudinal survey of adults >50 years of age, collects data on functional status, cognition, and demographics, among other topics. The survey was linked with Medicare claims and National Death Index data from 1992 to 2012.

PATIENTS: Patients ≥65 years who underwent elective high-risk colorectal surgery with functional status measured before and after surgery. These patients were matched 1:3 to survey respondents who did not undergo major surgery, based on propensity scores.

MAIN OUTCOME MEASURES: Functional decline, the primary outcome, was defined as an increase in the number of activities of daily living and instrumental activities of daily living requiring assistance before and after surgery. Using logistic regression, we examined whether surgery without or with complications was associated with functional decline.

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RESULTS: We identified 289 patients who underwent high-risk colorectal surgery and 867 matched controls. Of the surgery patients, 90 (31%) experienced a complication. Compared to the controls, surgery patients experienced greater likelihood of functional decline (without complications: OR 1.82, 95% CI 1.22–2.71, and with complications: OR 2.96, 95% CI 1.70–5.14). Increasing age also predicted greater odds of functional decline (OR 2.09, per decade, 95% CI 1.57–2.80).

LIMITATIONS: The functional measures were self-reported by survey participants.

CONCLUSIONS: High-risk colorectal surgery, without or with complications, is associated with increased likelihood of functional decline in older adults. Patient-centered decision-making should include discussion of expected functional outcomes and long-term disability. See **Video Abstract** at <http://links.lww.com/DCR/Axxx>.

Abstract

Aunque en la mayoría de las investigaciones los resultados quirúrgicos se centran en los puntos finales clínicos y las complicaciones, actualmente se pueden valorar los resultados funcionales en el paciente añoso. Sin embargo, se sabe poco sobre el riesgo de la discapacidad funcional a largo plazo después de un procedimiento colorrectal.

Comprender la incidencia y la probabilidad del deterioro funcional después de operaciones colorrectales de alto riesgo (es decir, 1% de mortalidad hospitalaria) con y sin complicaciones. estudio de cohorte emparejado retrospectivo.

El seguimiento longitudinal representativo a nivel nacional en adultos de >50 años y que recopila datos sobre su estado funcional, su estado cognitivo y su demografía, entre otros temas es el llamado “Estudio de Salud en jubilados”. La encuesta se vinculó con los reclamos de Medicare y los datos del Índice Nacional de Defunciones entre 1992 y 2012.

Aquellos de 65 años que se sometieron a cirugía colorrectal electiva de alto riesgo con un estado funcional medido antes y después de la cirugía. Estos pacientes se compararon 1: 3 con los encuestados que no se sometieron a cirugía mayor, según puntajes de propensión.

La disminución funcional como resultado primario, se definió como un aumento en el número de actividades de la vida diaria y actividades instrumentales de la vida diaria que requieren asistencia antes y después de la cirugía. Mediante la regresión logística, evaluamos si la cirugía sin complicaciones y/o con complicaciones se asoció con un deterioro funcional.

Identificamos 289 pacientes que se sometieron a cirugía colorrectal de alto riesgo y 867 controles pareados. De los pacientes de cirugía, 90 (31%) experimentaron algún tipo de complicación. En comparación con los controles, los pacientes de cirugía experimentaron una mayor probabilidad de deterioro funcional (sin complicaciones: OR 1.82, IC 95% 1.22–2.71, y con complicaciones: OR 2.96, IC 95% 1.70–5.14). El aumento de la edad también predijo mayores probabilidades en el deterioro funcional (OR 2.09, por década, IC 95% 1.57–2.80).

Las medidas funcionales fueron autoinformadas por los participantes de la encuesta.

La cirugía colorrectal de alto riesgo, con o sin complicaciones, se asocia con una mayor probabilidad de deterioro funcional en adultos mayores. La toma de decisiones centradas en el

paciente deben incluir la discusión de los resultados funcionales esperados y la discapacidad a largo plazo. Vea el resumen del video en <http://links.lww.com/DCR/Axxx>.

Keywords

Activities of daily living; Colorectal surgery; Complications; Disability evaluation; Older adults; Recovery of function; Surgical procedures

INTRODUCTION

Adults over age 65 represent 40% of inpatient operations and experience a disproportionate share, more than 60%, of postoperative complications.^{1,2} Thus, surgical outcomes research in older adults has traditionally focused primarily on survival, postoperative complications (e.g., infection, bleeding, and organ failure),²⁻⁴ or risk scores for the identification of the highest risk patient subset.⁵⁻⁷

Little is known about older adults' postoperative functional independence, also described as functional status, even though patients value this highly when considering high-risk procedures.^{8,9} Functional status is often measured by the level of assistance required to accomplish activities of daily living (ADLs: walking, dressing, bathing, eating, transferring into and out of bed, and using the toilet) and instrumental ADLs (IADLs: preparing a hot meal, grocery shopping, using the telephone, taking medication, and managing finances). It is unclear whether observed changes in functional status postoperatively are driven by complications or intrinsic to the operation.¹⁰ Previously, functional outcomes have been evaluated for individual or heterogeneous groups of operations. For example, a study of breast surgery patients identified an association between oncologic and operative factors and decreased physical activity up to 1 year postoperatively.¹¹ Studies encompassing a variety of operations identified rates of decline as high as 45% at 1 month, though there was considerable variability in return to functional independence; patients undergoing pancreatic and thoracic surgery demonstrate worse early functional decline whereas those undergoing hepatobiliary operations or those who experienced severe complications demonstrate persistent loss of independence or slow recovery in patients.^{10,12} Less is known about the risk of functional disability after colorectal surgery specifically, and the association between complications and functional disability. Such knowledge deficits are important as colorectal patients comprise the majority of postoperative complications in general surgery.¹³ Previous work on colorectal procedures has focused on the nursing home community,¹⁴ a population with different baseline function and needs than community-dwelling individuals, or on countries outside of the US with more homogenous populations.^{15,16} Narrowing the scope to colorectal operations and exploring the functional limitations associated with procedures that carry the highest risk of unwanted outcomes has substantial potential to inform decisions about whether to have surgery or how patients and caregivers should prepare for the possibility of decreased independence.

In this context, we sought to explore the extent to which functional status changes for older adults undergoing elective colorectal surgery, particularly for operations that have previously been defined as "high risk", or with greater than or equal to 1% inpatient mortality.¹⁷ In

colorectal surgery, all major open colon and rectal resections meet these established “high risk” criteria. We hypothesized that older adults undergoing high-risk elective colorectal surgery would have increased likelihood of functional decline and that postoperative complications would worsen this decline. Secondarily, we questioned whether functional decline was associated with increased mortality after surgery. To answer these questions, we evaluated data from a nationally-representative survey on aging and health to understand the incidence and risk of functional decline after high-risk operations, focusing on colorectal procedures.

MATERIALS AND METHODS

Data Sources

We performed a retrospective cohort study using the Health and Retirement Study (HRS), a longitudinal biennial survey of community-dwelling adults age greater than 50 years.¹⁸ Most baseline surveys are conducted face-to-face and follow-up interviews are conducted either face-to-face or via telephone.¹⁹ The HRS survey includes measures of functional status, cognition, self-reported health, demographics, and financial management, among many others.¹⁹ HRS can be linked with Medicare claims data for approximately 85% of HRS participants age 65 years and older, permitting more detailed exploration of participants’ healthcare-related experiences.¹⁹ Linkage to the National Death Index permits identification of deceased participants. We analyzed a dataset linking the Health and Retirement Study (HRS), Medicare administrative claims, and the National Death Index from 1992 to 2012.

Measures

Levels of assistance required for the 6 activities of daily living (ADLs: walking, dressing, bathing, eating, transferring into and out of bed, and using the toilet) and 5 instrumental ADL (IADLs: preparing a hot meal, grocery shopping, using the telephone, taking medication, and managing finances) are collected by self-report in each wave of the HRS survey. Functional limitation was defined using the sum of ADLs and IADLs requiring assistance. We categorized functional limitation into 3 groups as previously described: no limitations (0 activities requiring assistance), mild to moderate limitations (1–3 activities), severe limitations (≥ 4 activities).²⁰ The primary outcome, functional decline, was defined as an increase in the sum of activities requiring assistance from baseline or before the index surgery.

Cognitive impairment is measured by a 27-point scale administered during each HRS survey. This includes immediate and delayed 10-noun recall test, serial 7 subtractions test, counting backwards from 20 test. For HRS participants who are unable to answer for themselves, a proxy respondent is asked to complete the Informant Questionnaire on Cognitive Decline in the Elderly to rate the participant’s memory and ability to make judgments and decisions.²¹ Cognitive ability was then categorized into 3 groups: normal, mild cognitive impairment, and moderate to severe cognitive impairment, as previously described.^{20–23}

Patients and procedures

We selected our colorectal surgery cohort from a list of high-risk elective operations for older adults delineated by Schwarze et al., as procedures with inpatient mortality greater than or equal to 1% for patients age 65 years and older (ICD9 procedure codes 45.71–76, 45.79, 45.80, 45.95, 46.75, 46.94, 48.50, 48.62, 48.63).¹⁷ This list includes all major open colon and rectal resections (Appendix). All HRS survey respondents who underwent elective high-risk colorectal surgery and whose functional status was measured both before and after surgery were included. We matched each surgery patient to 3 controls, survey respondents who did not undergo major surgery, according to propensity scores based on a logistic regression modelling surgery versus controls as a function of sex, race, age, education, marital status, comorbidities, baseline cognitive impairment, baseline functional limitations, and year of survey. Surgical patients' functional limitations and cognitive impairment were compared at two survey time points: baseline (survey before surgery) and post-surgery (survey after surgery). Matched controls had a similar timeline for the two "pre" and "post" measurements; "pre" functional limitations and cognitive impairment were measured at the same survey year as the surgery patient to which they were matched, with "post" measurements at the next survey year. The main exposures were surgery without and with complications and the no surgery control group. Measured complications included pulmonary failure, pneumonia, myocardial infarction, deep vein thrombosis/pulmonary embolism, renal failure, surgical site infection (SSI), gastrointestinal bleeding, and hemorrhage, which are able to be identified in administrative data with accepted validity.^{24,25} Principal diagnosis ICD9 code was grouped into cancer/adenoma, diverticular disease, and other. The other group included the small number of patients (3) with inflammatory bowel disease.

Statistical Analyses

After propensity score matching, we evaluated the balance between surgery patients and controls using chi-square tests for each categorical covariate and ANOVA for each continuous covariate. We then evaluated the association between diagnosis and functional decline for surgery patients. Using logistic regression, we examined the association between the main exposures (surgery without and with complications and the no surgery control) and functional decline. To adjust for potential confounding variables, we adjusted for covariates that have been correlated previously with functional decline and were measured in our dataset, including sociodemographic factors (age, gender, race/ethnicity, educational attainment), and comorbid conditions,^{26–29} as well as baseline functional limitations, cognitive impairment,³⁰ and year of survey. Next, we evaluated the association between functional decline and overall survival using a Cox proportional hazards model. We did not have missing data.

Analyses were completed in SAS (SAS Institute Inc., Cary, NC, Version 9.4). The University of Michigan Institutional Review Board review approved this study (HUM00157651) as exempt.

RESULTS

Patient Characteristics

From 1992–2012, 289 survey respondents underwent high-risk elective colorectal surgery. This surgery cohort was matched to 867 controls who did not undergo major surgery. There were no significant differences in demographics, comorbidities, baseline functional limitations, or baseline cognitive impairment between the matched groups (Table 1). The matched cohorts were predominantly white (88% control group, 89% surgery) and male (63%, 63%). Of the surgery patients, 90 (31.1%) experienced complications, most commonly: gastrointestinal bleeding (11.6%), pulmonary failure (9.1%), and surgical site infection (6.1%). By diagnosis, the cancer/adenoma group were less likely to experience complications (45, 24%), compared to the diverticular disease group (33, 40%), and other diagnoses (10, 46%; $p=0.003$). The mean interval between baseline “pre” survey and surgery, or matched time for nonsurgical patients, was 366.4 (standard deviation (SD) 212.1) days. The mean interval between surgery, or matched time for nonsurgical controls, and follow up, or “post” survey was 357.5 (SD 191.9) days. The mean follow-up time for survival analysis was 6.4 (SD 4.8) years overall, with 5.2 (SD 4.1) years in the surgery cohort and 7.4 (SD 4.9) years in the control group.

Baseline Functional Limitations

Baseline rates of functional limitations were similar across the surgery and control groups, with no functional limitations in 73% of each cohort. Within the surgical cohort, patients who experienced postoperative complications had higher rates of baseline functional limitations than those without complications: 10% had severe functional limitations (versus 6% without complications) and 29% had mild to moderate functional limitations (versus 18% without complications) (Table 1).

Postoperative Functional Limitations and Functional Decline

Postoperatively, in the surgery without complications cohort, the proportion of patients with functional limitations increased: severe limitations increased from 6 to 10% ($p<0.001$) and mild to moderate limitations increased from 18 to 28% ($p<0.001$) (Figure 1). Surgery patients with complications were twice as likely to experience severe functional limitations (10 to 20%, $p<0.001$) with a smaller increased likelihood of mild to moderate functional limitations (29 to 33%, $p<0.001$).

Over the follow-up period, controls were predicted to have a 14.1% (95% Confidence Interval (CI) 11.6–16.7%) likelihood of functional decline, compared to 22.9% (95% CI 17.0–29.6%) for patients who had surgery without complications. The likelihood of functional decline was even higher for patients who experienced complications: 32.6% (95% CI 21.7–43.1%). (Figure 2) By diagnosis, surgery patients with cancer/adenoma were predicted to have 32.8% (95% CI 26.3–39.8%) likelihood of functional decline, compared to 24.4% (95% CI 15.6–35.1%) for diverticular disease, and 35.3% (95% CI 14.2–61.7%) for other diagnoses ($p=0.40$). After adjustment, surgery patients without and with complications experienced greater odds of functional decline (Odds Ratio (OR) 1.82, 95% CI 1.22–2.71 and OR 2.96, 95% CI 1.70–5.14, respectively), as compared to controls.

Between baseline and follow-up surveys, there was no improvement in any measure of patient-reported assistance with ADLs and IADLs; assistance with dressing remained the same for the surgery with complications group (Figure 3). At baseline, ADLs of walking and dressing had the highest rates of patients reporting a need for assistance. Post-surgery, the rates of reporting assistance for ADLs walking, bathing, and getting in and out of bed all increased, while dressing increased for the surgery without complications and controls, but remained unchanged for those with complications.

In multivariable logistic regression, a higher likelihood of functional decline was also associated with increasing age (OR 2.09, per decade >75 years, 95% CI 1.57–2.80), and both mild and moderate to severe baseline cognitive impairment (OR 1.66, 95% CI 1.05–2.65 and OR 4.26, 95% CI 1.45–12.53, respectively) (Table 2). Year of survey did not have an effect on likelihood of functional decline (OR 1.02, 95% CI 0.98–1.07). For the patients who experienced functional decline, adjusted overall 5-year survival was worse than for those without functional decline (Hazard Ratio 1.55, $p=0.01$).

DISCUSSION

Using a nationally representative survey linked with Medicare claims and National Death Index, we found that patients undergoing high-risk elective colorectal surgery had increased likelihood of functional decline postoperatively. The likelihood of functional decline was even higher for patients who experienced postoperative complications. Furthermore, such decline was lasting enough to be captured at a follow-up HRS survey, which averaged about 1 year post-operatively. As expected, both increasing age and baseline cognitive impairment were also associated with increased odds of functional decline. Finally, we found that functional decline was also associated with worse 5-year overall survival.

A study of older adults residing in nursing homes who underwent colon cancer resections demonstrates that patients do not recover to baseline physical function after surgery, regardless of baseline level of functional limitations. They also found that functional limitations are associated with increased mortality at 1 year.¹⁴ In contrast, a Japanese study of patients over 75 years of age who underwent colorectal and gastric cancer resections had nearly full recovery of ADLs in 6 months after surgery.¹⁵ Although such studies provide important information with regard to postoperative physical function, they may not be generalizable to older American adults residing in the community. Our findings are generalizable to a broader population as they are derived from longitudinal data from a nationally representative population of community-dwelling adults in the U.S.

Some of the previous work investigating functional outcomes and surgery has also focused on functional trajectory after surgery, but fails to evaluate outcomes beyond one year. For instance, Stabenau et al. followed 250 patients before and one year after major musculoskeletal, abdominal, cardiothoracic, neurologic, and vascular operations.³¹ While the broad scope of operations limits applicability to patient-level cases, the study found that the level of pre-operative functional limitations was predictive of postoperative recovery; specifically, that half of patients with no baseline disability quickly returned to their baseline function, a quarter had gradual improvement (return to near-baseline in 4–5 months), and a

quarter had partial or little improvement. For patients with any baseline impairment, rapid improvement was limited to less than 17% of cases. While this study helps to identify the functional trajectory of patients after surgery, and indicate that functional decline may be lasting for many patients, it does not specify outcomes beyond one year or outcomes for specific operations. Herein, we demonstrate that functional limitations may persist beyond the acute perioperative period and may also lead to decreased long-term survival.

In the scope of our study, we found that elective high risk colorectal operations are associated with functional decline. While the included operations are primarily open colon and rectal resections, the data source does not include important granular details such as information on surgical decision making. Although it is possible that some of these patients may have benefitted from a laparoscopic approach, it is very likely that underlying disease process, case complexity, and patient factors influenced the choice of surgical approach.

As the proportion of older adults increases to more than 20% of the US population by 2030,³² understanding functional outcomes is crucial to inform patient and surgeon decision making and risk assessment. Our study demonstrates that approximately 20% of older adults undergoing high-risk elective colorectal surgery can anticipate lasting functional decline after surgery, beyond what they would experience without surgery. If these patients experience complications, the functional decline may be even worse and limit their ability to walk, bathe themselves, and get in and out of bed; all of which have serious implications for these patients and their caregivers. A focus on shared decision making, the costs and infrastructure for long-term care, and the effects of healthcare and complications on caregivers combine to make informed risk assessment and decision making a pertinent goal for patients, caregivers, and surgeons.

Our study has multiple limitations. First, the primary outcome relies on patient self-report, however multiple seminal studies also rely on self-report of ADLs and IADLs,^{10,33} and this method permits a large, nationally-representative sample, like HRS, in a way that physiologic functional testing does not. Second, the HRS survey waves occur biennially, therefore we are unable to comment on the trajectory of functional decline and potential for recovery. Because of this, it is possible that a study participant was surveyed, had an operation shortly thereafter and their next survey was 2 years later. Accordingly, this possibility would underestimate the true effect size of high-risk elective colorectal surgery on functional decline. Despite this, the fact that functional impairment is not fully resolved between surgery and survey indicates that the association between surgery and functional decline may be lasting in some cases, rather than self-limited. Identifying the likelihood of lasting functional decline may inform patient decision making, which was a goal of this study. Third, this study focused on high-risk elective colorectal surgery as these would represent those patients most vulnerable to unwanted outcomes, therefore our results are not generalizable to older adults undergoing all elective colorectal, laparoscopic colorectal, or all elective general surgical procedures. The included operations, however, are very common and are primarily open colon and rectal resections. Prior work indicates an association between laparoscopic surgery and functional decline.¹² Future work examining the relationship between laparoscopic colorectal surgery and functional decline and recovery is needed. It is possible that by including only the highest risk operations we have identified

the upper limit of the effect of surgery, though the goal of our study was to evaluate the effect of high risk surgery on the patient-centered outcomes of functional limitations and decline. The generalizability of our results is also strengthened by our data source: the HRS is a nationally-representative sample. Fourth, the data is from 1992 to 2012, with a midpoint in the early 2000s, and surgical care and rescue have improved in the last two decades, particularly with growing attention to the unique needs of older adults.³⁴ While we did not find any temporal effect on functional decline, trends in perioperative care are not reflected in the data set and temporal changes in patient selection may confound the improvements in perioperative care. Accordingly, it is possible that we have overestimated the effect of functional decline, however with the aging American population, the magnitude of the effect of functional decline remains. Lastly, there may be unmeasured confounding variables that we were unable to address.

CONCLUSION

In summary, high-risk elective colorectal surgery is associated with increased likelihood of functional decline in older adults and decreased survival. Accordingly, colorectal surgeons should communicate this increased risk with their patients, particularly patients at higher risk for complications. Patients value functional independence after surgery and understanding the risk may be very important in the decision making process. While this study provides additional information that may inform shared decision making around high-risk elective colorectal surgery, it is unclear whether it will lead patients to change their decision to have surgery, but may allow patients and their support networks to plan better for this possible outcome. Although there is natural functional decline with age, whether and to what extent additional decline observed postoperatively can be mitigated will be important to study moving forward. Finally, it is critical that surgical outcomes research capture outcomes that are meaningful to patients such as functional outcomes with regard to expected recovery and long-term consequences after surgery.

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Appendix

Included procedures, as defined by: Schwarze et al. Development of a list of high-risk operations for patients 65 years and older. *JAMA Surg.* 2015;150(4):325–331.

Name of Procedure	ICD9
Total Intraabdominal Colectomy	45.8
Abdominoperineal Resection	48.5
Open and other multiple segmental resection of large intestine	45.71

Name of Procedure	ICD9
Open and other cecectomy	45.72
Open and other right hemicolectomy	45.73
Open and other resection of transverse colon	45.74
Open and other resection of left hemicolectomy	45.75
Open and other sigmoidectomy	45.76
Other and unspecified parital excision of large intestine	45.79
Large-to-large intestinal anastomosis	45.94
Suture of laceration of large intestine	46.75
Revision of anatomosis of large intestine	46.94
Anterior resection of rectum with synchronous colostomy	48.62
Other anterior resection of rectum	48.63

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Figure 1:
Unadjusted proportion of patients with functional limitations (mild/moderate versus severe), both pre- and post-surgery, by surgery and complications.

Figure 2:

Adjusted likelihood of functional decline, by surgery and complications, with 95% confidence intervals.

Figure 3:

Proportions of cohorts requiring assistance with activities of daily living (ADLs) and instrumental ADLs (IADLs), at baseline and follow-up. Each bar includes pre (baseline) and post (follow-up, postoperative for the surgery group) for each ADL or IADL, by group (surgery without complications, surgery with complications, no surgery controls).

Table 1:

Baseline characteristics for matched patients undergoing surgery versus no surgery controls.

Sociodemographic and Clinical Characteristics	No Surgery* N=867		All Surgery* N=289		Surgery, Without Complications N=199		Surgery With Complications N=90		p value**
	n	%	n	%	n	%	n	%	
Age at Index Operation, years (mean, SD)	76.1	7.3	75.6	0.1	75.2	6.9	76.5	6.9	0.15
Male	549	63%	183	63%	127	64%	56	62%	0.80
Race									0.99
White	762	88%	257	89%	177	89%	80	89%	
Black	88	10%	26	9%	18	9%	8	9%	
Other	17	2%	6	2%	4	2%	2	2%	
Marital Status									0.17
Married	472	54%	165	57%	119	60%	46	51%	
Not Married	395	46%	124	43%	80	40%	44	49%	
Highest Level of Education									0.87
< High School	208	24%	68	24%	48	24%	20	22%	
High School	460	53%	159	55%	109	55%	50	56%	
Undergraduate	114	13%	36	13%	23	12%	13	14%	
Graduate	85	10%	26	9%	19	10%	7	8%	
Elixhauser Comorbidity Score, mean (SD)	0.3	1.0	0.4	1.0	0.3	0.9	0.6	1.3	0.04
Baseline Functional Limitations***									0.02
No Limitation	632	73%	208	73%	153	77%	55	61%	
Mild to Moderate	155	18%	61	22%	35	18%	26	29%	
Severe	80	9%	20	8%	11	6%	9	10%	
Baseline Cognitive Impairment****									0.35
No Impairment	628	72%	209	72%	146	73%	63	70%	
Mild	182	21%	68	24%	47	24%	21	23%	
Moderate to Severe	57	7%	12	5%	6	3%	6	7%	
Diagnosis: Cancer/Adenoma	-	-	188	65%	143	72%	45	51%	0.003
Diverticular Disease	-	-	82	28%	49	25%	33	38%	
Other	-	-	18	6%	8	4%	10	11%	
Length of Stay, days, mean (SD)	-	-	9.33	5.8	7.7	4.0	13.0	7.2	<0.001
Intensive Care Unit Stay	-	-	109	43%	56	28%	53	59%	<0.001

* No Surgery matched by age, demographics, comorbidities, baseline functional class and baseline cognitive class to the All Surgery group. No statistically significant differences between matched groups were found.

** p value from chi square or ANOVA test comparing Surgery Without Complication and Surgery With Complication groups.

*** Functional Limitations determined by sum of ADLs (walking, dressing, bathing, eating, getting out of bed, and toileting) and IADLs (preparing a hot meal, shopping for groceries, making telephone calls, taking medicines, and managing money); 0 = no limitations; 1–3 = mild to moderate; > 4 = severe.

**** Cognitive Impairment determined by a 27-point self-administered test; > 11 = normal; 7–11 = mild cognitive impairment; 0–6 = severe; for patients who were unable to be interviewed, proxies were interviewed using a validated tool; excellent, very good or good = mild cognitive impairment; fair or poor = severe.

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Table 2:

Results of the multivariable logistic regression model predicting functional decline. Ref = reference.

Sociodemographic and Clinical Characteristics	Functional Decline		
	OR	95% CI	p
Surgery			<.0001
No Surgery	ref		
Surgery without Complications	1.82	1.22–2.71	
Surgery with Complications	2.96	1.70–5.14	
Female Sex	1.01	0.64–1.60	0.963
Race			0.083
White	ref		
Black	0.65	0.33–1.30	
Other	0.20	0.04–0.98	
Age (by decade)	2.09	1.57–2.80	<.0001
Comorbidities (Elixhauser CI)	1.12	0.94–1.35	0.215
Married Status	0.72	0.46–1.12	0.140
Education			0.241
Less than High School	ref		
High School	0.63	0.39–1.02	
Undergraduate	0.73	0.38–1.40	
Graduate	0.52	0.22–1.23	
Year of Survey	1.02	0.98–1.07	0.348
Baseline Functional Limitations *			<.0001
None	ref		
Mild to Moderate	0.54	0.32–0.92	
Severe			
Baseline Cognitive Impairment **			0.008
None	ref		
Mild	1.66	1.05–2.65	
Moderate to Severe	4.26	1.45–12.53	

* Functional Limitations determined by sum of ADLs (walking, dressing, bathing, eating, getting out of bed, and toileting) and IADLs (preparing a hot meal, shopping for groceries, making telephone calls, taking medicines, and managing money); 0 = no limitations; 1–3 = mild to moderate; > 4 = severe.

** Cognitive Impairment determined by a 27-point self-administered test; > 11 = normal; 7–11 = mild cognitive impairment; 0–6 = severe; for patients who were unable to be interviewed, proxies were interviewed using a validated tool; excellent, very good or good = mild cognitive impairment; fair or poor = severe.