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## Surgical oncology outcomes in the aging US population



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### ABSTRACT

**Background:** As the population ages, an increasing number of older patients are undergoing major surgery. We examined the impact of advanced age on outcomes following major gastrointestinal cancer surgery in an era of improved surgical outcomes.

**Materials and methods:** This was a population-based, retrospective cohort study using the American College of Surgeons National Surgical Quality Improvement Program database. We evaluated patients undergoing major abdominal gastrointestinal cancer surgery from 2005-2012. Multivariable logistic regression was performed to determine the independent effect of advanced age on outcomes. Our primary outcome was 30-d mortality, and our secondary outcomes were 30-d major postoperative adverse events, discharge disposition, length of stay, reoperation, and readmission.

**Results:** Elderly ( $\geq 65$  y) patients were twice as likely to have multiple comorbidities as those  $< 65$  y but prevalence of comorbidities was similar across all older age groups. Mortality increased with age across all procedures ( $P < 0.05$ ). The risk of advanced age on mortality was highest in hepatectomy (odds ratio = 5.17, 95% confidence interval = 2.19-12.20) and that for major postoperative adverse events was highest in proctectomy (odds ratio = 2.32, 95% confidence interval = 1.53-3.52). Patients were more likely to be discharged to an institutional care facility as age increased across all procedures ( $P < 0.01$ ).

**Conclusions:** Despite being highly selected for surgery, elderly patients undergoing major gastrointestinal cancer surgery have substantially worse postoperative outcomes than younger patients ( $< 65$  y). The risk of age on postoperative outcomes was present across all operations but had its highest association with liver and rectal cancer resections.

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## Introduction

The US population continues to increase, and patients >65 y represent the largest proportion of this growth. In fact, this age group is expected to triple by 2050.<sup>1</sup> Concomitantly, there has been a corresponding increase in the number of elderly patients needing surgical care. More than one-third of operations performed in the United States are performed on patients >65 y.<sup>2</sup> Many of these cases are performed for the treatment and palliation of gastrointestinal (GI) cancers. The decision of when to operate can be difficult in the aging population because of their diminished physiological reserve, frailty, and comorbidity profiles.<sup>3–5</sup> Counseling patients about their perioperative risks of complications and death is an important part of informed consent in this patient population.

Over the past 15–20 y, there have been substantial efforts in the surgical community to improve outcomes, and accordingly, perioperative outcomes have improved for the population as a whole.<sup>6,7</sup> There have been less convincing data demonstrating a similar improvement when only investigating surgery in the geriatric community.<sup>8–13</sup>

Additionally, some of the more robust studies investigating this issue are outdated given the rapid improvements in surgical technique and overall quality of care.<sup>14–18</sup> The aim of this study therefore was to provide an updated analysis on the impact of advanced age on postoperative outcomes at a national level following major GI surgery for cancer.

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## Materials and methods

### Data source

For this study, we used the validated American College of Surgeons National Surgical Quality Improvement Program (ACS NSQIP) database. The ACS NSQIP prospectively and systematically collects patient records of surgical procedures performed at >400 hospitals throughout the United States. Data are gathered from medical charts by trained surgical clinical reviewers and are audited to ensure reliability. ACS NSQIP contains perioperative information including preoperative patient characteristics, intraoperative processes of care, and uniformly defined postoperative adverse occurrences ≤30 d of surgery.

### Study design

We selected all patients undergoing surgical resection for colon, rectal, gastric, pancreatic, and liver cancer between 2005 and 2012 from the ACS NSQIP database, based on *Current Procedural Terminology, Fourth Edition* codes and the *International Classification of Diseases, Ninth Revision, Clinical Modification* diagnosis codes (Supplemental Table 1). Patients were classified into four age groups, based on a recent gerontological classification aimed at better defining age-effect in the elderly population: patients aged <65 y, 65–74 y (young-old), 75–84 y (middle-old), and 85 y (oldest-old).<sup>19</sup>

Patient characteristics examined included gender, race (white versus other), body mass index, smoking status,

functional status (independent versus dependent), surgery status (elective versus emergency), and comorbidities (hypertension, diabetes, coronary artery disease, congestive heart failure, chronic obstructive pulmonary disease, cerebrovascular disease, neurologic disease, and renal disease). Major postoperative events were defined as experiencing at least one of the following events: in-hospital death, myocardial infarction, cardiac arrest, stroke, pulmonary embolism, sepsis, and shock. Patient discharge disposition status was classified as discharge to home (i.e., self-care), discharge to an institutional care facility (ICF; acute care, skilled/unskilled nursing facility or rehab facility), or death. Discharge data were only available for the years 2011–2012.

This study was submitted to our institutional review board and found to be exempt.

### Statistical analysis

Events and percentages were presented for patient demographics and comorbidities. Mantel–Haenszel test for trend was performed for comparisons of patient characteristics across age groups. Unadjusted analysis for in-hospital outcomes included major postoperative events, surgical site infections (SSI), length of stay (LOS), and discharge disposition status. Patients meeting multiple criteria for suffering a major postoperative event were included only once in the analysis.

Logistic regression was used to compare risks of major events and SSI across age groups, adjusting for patient demographics, comorbidities, time, and emergency status. Prolonged LOS was defined as above the 75% percentile. Linear regression was used for comparison among groups. A P value <0.05 was considered statistically significant. All analyses were performed using SAS, v9.3 (SAS Institute Inc., Cary, NC).

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## Results

A total of 64,154 patients underwent major GI cancer surgery. Older patients (age groups 65–74, 75–84, ≥85 y) had two-fold higher prevalence of multiple comorbidities than those <65 y, but the prevalence of comorbidities was similar among all older age groups. Patients ≥85 y were more likely to be female (63.6% versus 50.4%,  $P < 0.01$ ) and white (85.9% versus 76.4%,  $P < 0.01$ ) than those <65 y, especially for patients undergoing colectomy and pancreatectomy. Increasing age was associated with a decreased likelihood of obesity and an increased likelihood of being underweight ( $P < 0.01$ ). Smoking was inversely associated with age, and the lowest rate was in the oldest-old (range, 1.5%–6.5%;  $P < 0.01$ ). Patients were much more likely to be functionally dependent as they aged ( $P < 0.01$ ), except for those undergoing major hepatic resection. Emergent cases increased significantly with age in patients undergoing colectomy (5.9% (<65 y) versus 8.9% (≥85 y),  $P < 0.01$ ); similar trends were also seen for proctectomy. Conversely, emergency cases became less likely with age for patients undergoing gastrectomy and pancreatectomy. Detailed patient demographics are shown in Table 1.

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