Care of the Aging Patient: From Evidence to Action

Preoperative Assessment of the Older Patient
A Narrative Review

Lawrence B. Oresanya, MD; William L. Lyons, MD; Emily Finlayson, MD

IMPORTANCE Surgery in older patients often poses risks of death, complications, and functional decline. Prior to surgery, evaluations of health-related priorities, realistic assessments of surgical risks, and individualized optimization strategies are essential.

OBJECTIVE To review surgical decision making for older adult patients by 2 measures: defining treatment goals for elderly patients and reviewing the evidence relating risk factors to adverse outcomes. Assessment and optimization strategies for older surgical patients are proposed.

EVIDENCE ACQUISITION A review of studies relating geriatric conditions such as functional and cognitive impairment, malnutrition, facility residence, and frailty to postoperative mortality and complications (including delirium, discharge to an institution, and functional decline). Medline, EMBASE, and Web of Science databases were searched for articles published between January 1, 2000, and December 31, 2013, that included patients older than 60 years.

RESULTS This review identified 54 studies of older patients; 28 that examined preoperative clinical features associated with mortality (n = 1 422 433 patients) and 26 that examined factors associated with surgical complications (n = 136 083 patients). There was substantial heterogeneity in study methods, measures, and outcomes. The absolute risk and risk ratios relating preoperative clinical conditions to mortality varied widely: 10% to 40% for cognitive impairment (adjusted hazard ratio [HR], 1.26 [95% CI, 1.06-1.49] to 5.77 [95% CI, 1.55-21.55]), 10% to 17% for malnutrition (adjusted odds ratio [OR], 0.88 [95% CI, 0.78-1.01] to 59.2 [95% CI, 3.6-982.9]), and 11% to 41% for institutionalization (adjusted OR, 1.5 [95% CI, 1.02-2.21] to 3.27 [95% CI, 2.81-3.81]).) Risk ratios for functional dependence relating to mortality ranged from an adjusted HR of 1.02 (95% CI, 0.99-1.04) to an adjusted OR of 18.7 (95% CI, 1.6-215.3) and for frailty relating to mortality, ranged from an adjusted HR of 1.10 (95% CI, 1.04-1.16) to an adjusted OR of 11.7 (95% CI not reported) ($P < .001$). Preoperative cognitive impairment (adjusted OR, 2.2; 95% CI, 1.4-2.7) was associated with postoperative delirium (adjusted OR, 17.0; 95% CI, 1.2-239.8; $P < .05$). Frailty was associated with a 3- to 13-fold increased risk of discharge to a facility (adjusted OR, 3.16 [95% CI, 1.0-9.99] to 13.02 [95% CI, 5.14-32.98]).

CONCLUSIONS AND RELEVANCE Geriatric conditions may be associated with adverse surgical outcomes. A comprehensive evaluation of treatment goals and communication of realistic risk estimates are essential to guide individualized decision making.

JAMA. 2014;311(20):2110-2120. doi:10.1001/jama.2014.4573

Supplemental content at jama.com

Author Affiliations: Department of Surgery, Philip R. Lee Institute for Health Policy Studies, University of California, San Francisco (Oresanya, Finlayson); Division of Geriatric Medicine, Department of Medicine, University of Nebraska Medical Center, Omaha (Lyons).

Corresponding Author: Emily Finlayson, MD, MS, Philip R. Lee Institute for Health Policy Studies, 3333 California St, San Francisco, CA 94118 (emily.finlayson@ucsfmedctr.org).

Section Editor: Edward H. Livingston, MD, Deputy Editor, *JAMA*.

Although secular decreases in operative mortality have occurred,[1] a high risk of complications and mortality remain for older adults.[2-4] Cardiovascular, pulmonary, and renal disease are more common and contribute to greater perioperative complications in older patients. In addition to the comorbid risk factors that older patients share with younger ones, older patients may also have malnutrition and cognitive or functional impairment. Cognitive impairment may cause postoperative delirium.[5-7] Preoperative functional impairments limit patients' mobility. Functional impairment is an independent risk factor for postoperative complications and functional decline that may result from surgery.[8,9]

Consideration of the unique risks older patients have for perioperative complications is important because the population is aging and surgery is often necessary for older patients. More than 4 million major operations are performed annually in the United States in patients aged 65 years and older.[1] Consequently, there is an ever-increasing need to understand those aspects of disease in older adults that influence their perioperative outcomes. This review outlines an approach for discussing treatment goals with older adults considering surgery, systematically reviews geriatric conditions associated with mortality and adverse outcomes (eg, delirium, functional decline) following major inpatient surgery, then outlines an approach for preoperative assessment and optimization of perioperative care for the geriatric patient.

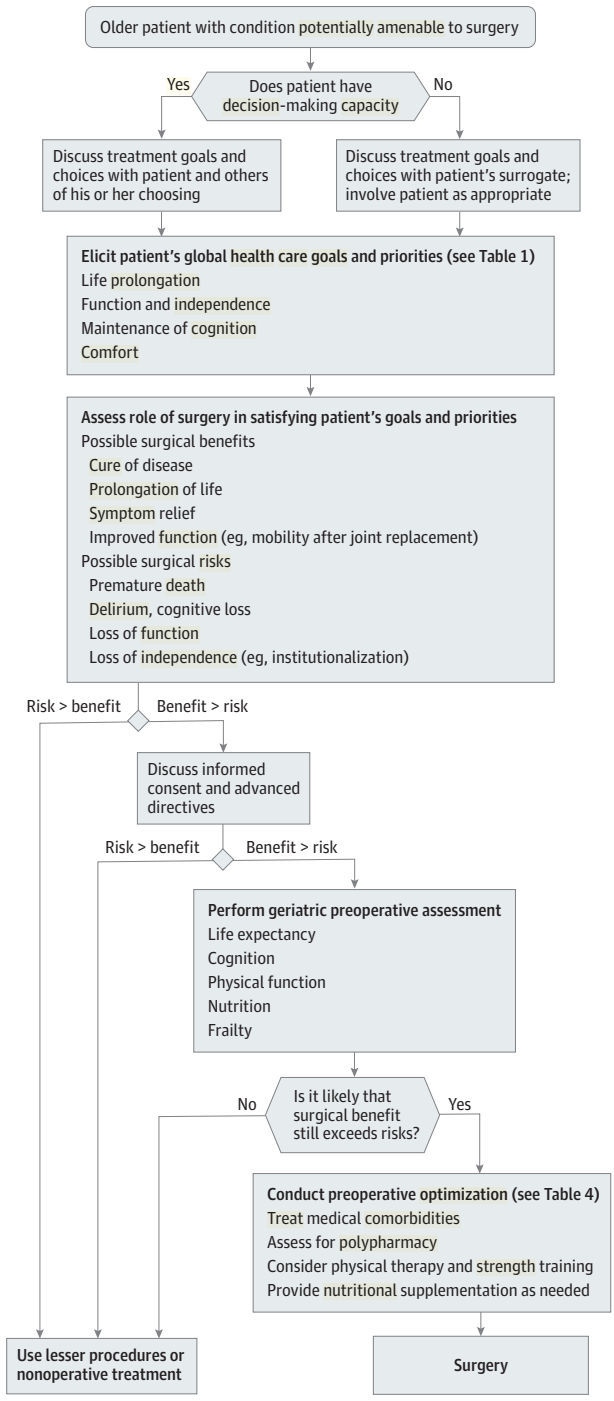
Discussing Treatment Goals With Older Adults Considering Surgery

Decisions to pursue surgery in older patients require realistic estimates of a patient's overall life expectancy and the perioperative mortality risk. An older patient's overall treatment goal is a key element of surgical decision making. Drawing on knowledge of a patient's cognitive function, health care goals, and social context, the primary care physician has a major role to play before consulting a surgeon, and will likely be involved in additional discussions and decision making afterward. The primary care physician contributes to the care process by assessing a patient's medical decision-making capacity and facilitating discussions about treatment goals and choices essential for informed consent. The **Figure** illustrates a suggested approach for assessing an older patient with a condition potentially amenable to surgery. After an older patient's decision-making capacity is established, the patient's health care priorities are then elicited (eg, prolongation of life, maintenance of independence). Next, a balanced and individualized assessment of whether the potential benefits of surgery (cure disease, relieve symptoms) outweigh the risks (death, functional decline). If surgery is unlikely to satisfy a patient's goals, nonoperative treatments may be pursued. After an older patient has consented to surgery, evaluation of geriatric conditions such as functional dependence, malnutrition, and frailty is performed. Targeted optimization such as strength training and nutritional supplementation should be initiated.

Assessment of Decision-Making Capacity

The capacity to make medical decisions includes the abilities to express a choice, comprehend information related to the choice, and understand the consequences of a decision. Aging is not necessar-

Figure. Assessment of an Older Patient With a Condition Potentially Amenable to Surgery



Algorithm illustrates a sequence of recommended activities to determine appropriateness for surgery and deliver care in a manner to maximize chances of a desired outcome. The assessment of the patient's decision-making capacity determines the degree to which surrogates are involved in making choices about treatment. The patient's goals and priorities should be assessed and these factors should influence whether surgical management is preferable to alternative approaches. Older patients considering surgery should undergo a preoperative assessment that includes medical conditions, geriatric syndromes, and life expectancy. Preoperative optimization strategies should target medical, functional, cognitive, and nutritional conditions.

Table 1. Eliciting a Patient's Treatment Goals, Priorities, and Insights

Potential Goal, Priority, or Insight	Sample Question
A dominant care goal	Is one of the following goals more important to you than anything else at this stage of life: Living as long as possible? Keeping your ability to take care of yourself and to live independently? Keeping comfortable, with minimal symptoms? Something else?
The source of life's meaning	What makes life worth living for you?
Unspoken concerns	Is there anything at this stage that has you really worried?
States considered to be worse than death	Can you imagine any way of living that, for you, would be worse than death?
Indicator(s) of what should prompt consideration of a transition from curative to palliative care	Would you be willing to go through just about anything to meet your goal? Can you imagine a situation in which you would want us to recognize that you have suffered enough or a situation in which you would prefer that we focus on keeping you comfortable?

Data adapted from Hallenbeck,[13] Sudore and Fried,[14] and Kaldjian et al.[15]

ily related to cognitive function and decision-making capacity.[10] Although impaired decision-making capacity is common among older patients, age alone may not predict incapacity independent of neuropsychiatric disorders such as dementia or delirium. A review[11] of high-quality studies examining instruments that evaluate medical decision-making capacity for treatment choices found 2.8% of healthy older adults lacked decision-making capacity, compared with 20% of persons with mild cognitive impairment and 54% of persons with Alzheimer disease. Querying the older patient for orientation to name, location, and date or using cognitive assessment tools such as the Mini-Cog help determine the patient's cognitive abilities and consequent risk for decisional incapacity.

Some patients, such as those with profound dementia, lack capacity to make any health care decision. Other patients' capacity to make decisions may be limited by the specific types of the decisions confronting them. Patients with modest levels of cognitive or psychiatric impairment may be capable of making low-risk or some degree of low-complexity decisions, but not more taxing ones.

Determining Treatment Goals

For patients with multiple morbidities nearing the end of life, using a goal-oriented rather than the traditional disease-oriented approach to collaborative decision making[12,13] is advisable. The physician should facilitate a patient's articulation of personal treatment goals. Physicians should also help align the patient's goals with proposed treatments.[12] When assessing a patient, the first step should be to establish the patient's overall life goals, then delineate the disease entities prognosis and treatment options, and then offer recommendations incorporating all of this information.[13]

Open-ended questions to elicit an older patient's goals and preferences that influence therapeutic decisions about surgery are summarized in **Table 1**. For example, to determine the dominant care goal, a clinician could ask "Is one of the following goals more important to you than anything else at this stage in life: Living as long as possible? Living independently?" It is important to elicit unspoken concerns with questions such as "Is there anything at this stage that has you really worried?"

Discussions should start regarding what treatment will address a patient's most important goal such as potentially curing a disease or maintaining independence. The time commitment involved in holding these discussions is substantial. Nonphysician team members may help in clarifying patient goals and priorities.[16-18] Patient priorities, once articulated, are often dynamic,[16,19] and should be revisited as clinical or personal conditions change.

After eliciting and clarifying goals and priorities, the primary physician and the surgeon should address the feasibility of implementing proposed treatment options. Some treatments are complex and burdensome. Patients with a history of poor adherence or inadequate social support may preclude complicated treatment regimens.[16,20] Since primary physicians have a longitudinal relationship with patients, they generally have a better understanding of the older patient's health priorities and ability to adhere to complex medical and surgical treatment strategies. Effective communication between the primary care physician and the surgeon is essential to assure that feasible treatment plans are made and the patient's goals are met.

Prognosis will influence treatment selection. For example, the decision to operate for an early-stage asymptomatic malignancy is very different in a vigorous healthy older patient than one who is frail with limited life expectancy. Although age is an important determinant of life expectancy, added multimorbidity and functional impairment may strongly influence overall prognosis. Physician resources include a variety of validated prognostic indices[21] and mortality calculators based on published prognostic indices (eg, http://www.eprognosis.org/).

Informed Consent

Confirmation of decision-making capacity and clarification of goals and priorities are essential before obtaining informed consent. Even well-educated patients may have difficulty grasping concepts of risk,[22] especially those having below-average numeracy skills. The surgeon may use the teach-back method to confirm that risks are understood. This method calls for patients to describe, in their own words, the key information related to the proposed procedure. Decision aids may improve patients' understanding of their condition, treatment options, and outcome probabilities[23] and might influence patients' decision to avoid surgery in favor of less-invasive treatments.[24] Patients can access a variety of resources and decision aids on the Internet (eTable in Supplement).

Risk Factors for Adverse Outcomes in Older Adults After Surgery: A Review of the Evidence

Search Methods and Results

A review was conducted to identify risk factors for mortality within 1 year of surgery in older individuals. Surgical mortality risk factors for older patients include cognitive impairment, functional dependence, malnutrition, frailty, and preoperative institutionalization. The Medline and EMBASE databases were searched from January 1, 2000, to December 31, 2013, using a combination of the terms: *surgery*, *risk factors*, *mortality*, *geriatric*, and *elders*. The initial search resulted in 5709 citations. After review, 5681 studies were ex-

cluded by 1 or more of the following criteria: participants did not undergo surgery, patients were younger than 60 years, mortality at less than 1 year was not reported, and no measures of association between risk factors and mortality were reported; and 28 relevant studies were identified. A search of bibliographies of relevant articles, along with manuscripts citing these articles, was also performed using Web of Science, yielding no additional relevant publications (eFigure 1 in Supplement).

A second review was conducted to identify geriatric syndromes associated with geriatric-related adverse surgical outcomes (cognitive impairment, functional dependence, frailty, and preoperative institutionalization). Outcomes of interest included delirium, discharge to an institution, and cognitive and functional decline. The initial search terms used to query Medline and EMBASE were (*elder, elderly, older adults, geriatric*) & (*surgery*) & (*delirium, cognitive decline, cognitive dysfunction, dementia, functional decline, functional dependence, discharge disposition*) & (*odd, odds ratio, relative risk, hazard ratio*). The date span queried was January 1, 2000, to December 31, 2013. The initial search yielded 1216 results. After review of manuscripts for measures of risk associated with geriatric syndromes (cognitive dysfunction, functional dependence, malnutrition, frailty, residential status), 27 articles were identified that reported geriatric syndromes associated with delirium, discharge to a facility, and functional decline. Reasons for exclusion after initial search were patients younger than 60 years, risk factor not assessed, and/or no measures of association for risk factors and outcomes reported. A search of bibliographies of relevant articles, along with manuscripts citing these articles, was also performed using Web of Science, yielding no additional relevant publications (eFigure 2 in Supplement).

Results

Operative Mortality

Among the 28 studies reporting geriatric syndromes associated with mortality following major inpatient surgery, categoric types were orthopedic, neurologic, urologic, otolaryngological, cardiothoracic, and abdominal (**Table 2**). Knee and hip arthroplasty, colectomy, and cardiac surgery, the most common major procedures in elderly patients,[1] were well represented in the studies identified. Studies were very heterogeneous in terms of methods, measures, and outcomes. Most studies reported on mortality within 30 days of surgery or at 1 year. Because of the wide variation in procedure types and settings (ie, elective vs emergent), absolute risks of mortality observed with each geriatric condition varied substantially. For example, mortality for patients with cognitive impairment ranged from 10% at 30 days after noncardiac surgery[30] to 29% at 1 year after hip fracture surgery.[33] A summary of overall cohort mortality rates and absolute risks associated with each condition is listed in Table 2.

Cognitive impairment was independently associated with perioperative mortality in 7 of 9 studies.[25-29,32,33] In most of the studies, cognitive impairment was determined by the presence of a clinical diagnosis of dementia. Mild cognitive impairment may not be clinically apparent and as many as 50% of patients with dementia may be undiagnosed.[51] Underdiagnosis of cognitive impairment or dementia introduces considerable bias into most studies associating cognitive impairment with the risk of adverse surgical outcomes. The largest study (>80 000 patients) found that cognitively impaired patients undergoing total knee arthroplasty had 1.8 times higher risk of 90-day mortality (adjusted hazard ratio [HR], 1.8; 95% CI, 1.1-3.1), compared with noncognitively impaired patients.[25] In another study of hip fracture surgery, older patients with cognitive impairment had a nearly 6-fold increased risk of 1-year mortality (adjusted HR, 5.8; 95% CI, 1.6-21.6), although the CIs were very wide.[29]

Eleven studies evaluated the association between functional dependence and mortality after surgery.[8,9,31,32,34-40] In general, functional dependence was associated with operative mortality. However, many studies had very wide CIs, indicating that the ability of the studies to accurately determine the strength of the association between functional dependence and mortality is limited. Reported risk ratios relating operative mortality to preoperative functional dependence ranged from a nonsignificant adjusted HR of 1.0 (95% CI, 1.0-1.0)[31] to one with very wide CIs (adjusted odds ratio [OR], 18.7; 95% CI, 1.6-215.3).[35] Functional dependence was defined in most studies as dependence in activities of daily living (ADLs).[40]

Perioperative risks associated with preoperative malnutrition varied widely. Malnutrition was assessed by the presence of weight loss, low serum albumin, low body mass index, and the Mini Nutritional Assessment score. Reports ranged from observing no independent association between malnutrition and 30-day mortality among octogenarians undergoing colon cancer surgery[28] to a nearly 59-fold increase in in-hospital mortality (adjusted OR, 59.2; 95% CI, 3.6-982.9), reported in a small single-center study.[35] The wide CIs in these studies temper conclusions about these associations because of uncertainty in the reported relationships.[52]

Frailty and its contribution to operative mortality were examined in 4 studies.[28,45-47] Frailty is a composite measure of geriatric conditions. Frailty is usually viewed in terms of a physical or a multidomain phenotype. All 4 studies identified in this review used a multidomain definition of frailty. Multidomain frailty includes measures of nutrition, physical activity, mobility, strength, energy, cognition, and mood. All studies found multidomain phenotype frailty to be associated with increased risk for operative mortality. One study, using the comprehensive 35-point assessment of frailty score, found that a 1-point increase in frailty score was associated with a 1.10-fold higher odds of mortality (adjusted OR, 1.10; 95% CI, 1.04-1.16) at 1 year following cardiac surgery.[47] In that same study, moderately and severely frail patients had 1-year mortality of 12% and 42%, respectively. Another study found a nearly 12-fold increase of mortality (adjusted OR, 11.7; $P < .001$) among frail patients undergoing emergency general surgery, but did not report CIs.[45]

Only 3 studies examined the association of admission from a long-term care facility with operative mortality.[48-50] In one study, 30-day mortality following colectomy was 27% for nursing home residents aged 65 to 75 years and more than 40% for nursing home residents older than 85 years.[49] Reported risk ratios for preoperative institutionalization ranged from an adjusted OR of 1.4 (95% CI, 1.1-1.6) for older patients undergoing colon cancer surgery[48] to an adjusted OR of 3.3 (95% CI, 2.8-3.8) for nursing home residents undergoing appendectomy.[49]

Table 2. Studies Examining the Association Between Geriatric Conditions and Mortality After Surgery

Source	Procedure	Sample Size	Age, y	Follow-up	Overall Mortality No. (%)	Absolute Risk (%)	Risk Ratio (95% CI)
Cognitive Impairment							
Retrospective cohort							
Bozic et al, 2012[25]	Hip arthoplasty	83 011	≥65	90 d	NR	NR	HR 1.84 (1.10-3.07)
Bozic et al, 2012[26]	Knee arthroplasty	40 919	≥65	90 d	2	11.8	HR 2.04 (1.55-2.69)
Modini et al, 2012[27]	Colectomy	215	≥65	30 d	35 (16)	NR	OR 4.47 (1.73-11.41)
Neumanet al, 2012[28]	Colectomy	25 358	≥80	1 y	22	NR	HR 1.90 (1.64-2.19)
Schaller et al, 2012[29]	Hip fracture	173	≥65	1 y	NR	17 (18)	HR 5.77 (1.55-21.55)
Story,[30] 2010	Multiple types	4158	≥70	30 d	216 (5)	58 (10)	OR 1.4 (1.0-2.0)
Prospective cohort							
Dubljanin-Raspopovoc et al, 2013[31]	Hip fracture	228	≥65	1 y	57 (25)	NR	HR 0.99 (0.88-1.10)
Ho et al, 2005[32]	Cardiac	1543	≥65	6 mo	7.8	NR	OR 1.26 (1.06-1.49)
Kim et al, 2012[33]	Hip fracture	415	≥60	1 y	61 (15)	12 (29)	HR 1.44 (1.18-1.71)
Functional Impairment							
Retrospective cohort							
Belleli et al, 2012[34]	Hip fracture	390	≥65	1 y	NR	NR	HR 3.98 (1.41-11.27)
Finlayson et al, 2012[9]	Colectomy	6822	≥65	1 y	53	56	HR 1.26 (1.14-1.39)
Ganai et al, 2007[35]	Abdominal	89	≥70	In-hospital	20	NR	OR 18.70 (1.60-215.30)
Hamel et al, 2005[36]	Multiple types	26 648	≥80	30 d	2186 (8)	NR	OR 1.30 ($P < .001$)
Kennedy et al, 2011[37]	Colectomy	5914	≥65	30 d	3	NR	OR 1.86 (1.42-3.04)
Kiran et al, 2012[38]	Colectomy	10 750	≥70	30 d	8	NR	OR 2.73 (2.24-3.32)
Nafiu et al, 2011[39]	Vascular	25 337	≥65	30 d	4	NR	OR 3.78 (3.27-4.48)
Turrentine et al, 2006[8]	Multiple types	6953	≥80	30 d	7	NR	OR 3.2 (1.3-8.1)
Prospective cohort							
Dubljanin-Raspopovoc et al, 2013[31]	Hip fracture	228	≥65	1 y	57 (25)	NR	HR 1.02 (0.99-1.04)
Ho et al, 2005[32]	Cardiac	1543	≥65	6 mo	8	NR	OR 1.54 (1.19-2.00)
Kristjansson et al, 2010[40]	Colectomy	182	≥70	30 d	2	NR	HR 9.69 (3.01-31.22)
Malnutrition							
Retrospective cohort							
Ganai et al, 2007[35]	Abdominal	89	≥70	In-hospital	20	NR	OR 59.20 (3.60-982.90)
Hamel et al, 2005[36]	Multiple types	26 648	≥80	30 d	8	NR	OR 1.70 ($P < .001$)
Kennedy et al, 2011[37]	Colectomy	5914	≥65	30 d	3	NR	OR 1.51 (1.09-2.79)
Kiran et al, 2012[38]	Colectomy	10 750	≥70	30 d	8	NR	OR 3.05 (2.35-3.96)
Lidsky et al, 2012[41]	Colectomy	997	≥65	30 d	125 (13)	NR	OR 4.08 (1.90-8.75)
Maurer et al, 2002[42]	Cardiac	1448	≥75	In-hospital	97 (7)	10	OR 1.97 (1.12-3.44)
Morgan et al, 2011[43]	Cystectomy	220	≥75	90 d	28 (13)	NR	HR 2.50 (1.40-4.45)
Nafiu et al, 2011[39]	Vascular	25 337	≥65	30 d	4	NR	OR 2.40 (1.82-3.18)
Neuman et al, 2012[28]	Colectomy	25 358	≥80	1 y	22	NR	HR 0.88 (0.78-1)
Schaller et al, 2012[29]	Hip fracture	173	≥65	1 y	NR	NR	HR 7.25 (1.61-33.74)
Story et al, 2010[30]	Multiple types	4158	≥70	30 d	215 (5)	85 (15)	OR 2.50 (1.80-3.50)
Prospective cohort							
McNicol et al, 2007[44]	Multiple types	1102	≥70	30 d	30 (6)	17	OR 2.23 (1.09-4.57)

(continued)

Table 2. Studies Examining the Association Between Geriatric Conditions and Mortality After Surgery (continued)

Source	Procedure	Sample Size	Age, y	Follow-up	Overall Mortality No. (%)	Absolute Risk (%)	Risk Ratio (95% CI)
Frailty							
Retrospective cohort							
Farhat et al, 2012[45]	Abdominal	35 334	≥60	30 d	NR	NR	OR 11.70 (*P*< .001)
Neuman et al, 2012[28]	Colectomy	25 358	≥80	1 y	22	NR	HR 4.74 (4.33-5.18)
Prospective cohort							
Kristjansson et al, 2012[46]	Colectomy	176	≥70	30 d	3 (1)	NR	HR 3.39 (1.82-6.29)
Sündermann et al, 2011[47]	Cardiac	400	≥75	1 y	12	42	OR 1.10 (1.04-1.16)
Admitted From Facility							
Retrospective cohort							
Devon et al, 2011[48]	Colectomy	12 415	≥75	In-hospital	NR	NR	OR 1.37 (1.14-1.64)
Finlayson et al, 2011[49]	Appendectomy	96 259	≥65	30 d	NR	241 (12)	OR 3.27 (2.81-3.81)
	Ulcer surgery	21 799	≥65	30 d	NR	997 (42)	OR 1.79 (1.63-1.96)
	Cholecystectomy	739 056	≥65	30 d	NR	4546 (11)	OR 2.65 (2.56-2.75)
	Colectomy	273 994	≥65	30 d	NR	7839 (32)	OR 2.06 (1.99-2.12)
Mirbagheri et al, 2010[50]	Abdominal	179	≥85	In-hospital	31 (17)	NR	OR 1.50 (1.02-2.21)

Abbreviations: HR, hazard ratio; NR, not reported; OR, odds ratio.

Geriatric Syndromes Associated With Mortality in the Oldest Surgical Patients

To explore the possibility that risk factors affect mortality differently in the oldest of old patients (≥80 years), this review examined the association between geriatric syndromes and perioperative mortality in the 4 studies evaluating geriatric syndromes and mortality among surgical patients aged 80 years and older.[8,28,36,50] Among the oldest old patients undergoing noncardiac surgery, 2 studies found 30-day mortality among octogenarians between 6% and 8%.[8,36] In this population (≥80 years), functional dependence was associated with a 1- to 3-fold increased risk of mortality (adjusted OR, 1.3; *P* < .01 to adjusted OR, 3.2; 95% CI, 1.3-8.1). Mirbagheri et al[50] found that patients aged 85 years and older experienced in-hospital mortality of 17% after abdominal surgery, and that admission from a residential facility was associated with increased risk (adjusted OR, 1.50; 95% CI, 1.02-2.21). In an analysis of colon cancer octogenarians, Neuman et al[28] found that patients undergoing curative colectomy had an overall 1-year survival rate of 78% and that frailty (adjusted HR, 4.74; 95% CI, 4.33-5.18) and dementia (adjusted HR, 1.90; 95% CI, 1.64-2.19), but not malnutrition (adjusted HR, 0.88; 95% CI, 0.78-1.0) were associated with mortality.

Nonfatal Geriatric Outcomes

Twenty-seven publications were identified that reported results of studies evaluating the association of preoperative risk factors in older patients with the outcomes of delirium, discharge to a facility, and functional decline (**Table 3**). Orthopedic, urologic, vascular, cardiac, and abdominal inpatient operations were assessed. The studies were heterogeneous in terms of methods, measures, and outcomes assessment. Most studies (19) evaluated postoperative delirium in older patients. The incidence of delirium ranged from 5% to 60%. The influence of preoperative cognitive impairment on postoperative delirium was the most commonly studied relationship. Assessment of cognitive impairment varied widely and included having a preoperative diagnosis of dementia or undergoing a mini-mental status or neuropsychiatric testing. Baseline cognitive impairment was associated with a 2- to 17-fold increased risk of postoperative delirium (adjusted OR, 2.2 [95% CI, 1.4-2.7] to 17.0 [95% CI, 1.2-239.8])[5-7,54-58,60,64] Three studies found no association between baseline cognitive impairment and delirium.[59,63,65] Two studies evaluated the association of preoperative ADL dependence with delirium—one reported a 12-fold increased risk (adjusted OR, 11.7; 95% CI, 2.5-56.1)[35] and the other reported no associated risk (adjusted OR, 0.89; 95% CI, 0.46-1.74).[62] A single study of preoperative frailty found that frail patients were twice as likely as nonfrail patients to develop delirium (adjusted OR, 1.84; 95% CI, 1.07-3.15).[61]

Three studies evaluated preoperative risk factors in older patients on postoperative functional decline. Rates of functional decline after surgery ranged from 24% at 1 year[9] to 61% at 2 years.[33] One study reported a modest association between preoperative functional decline and worsening functional status at 1 year after surgery (adjusted HR, 1.2; 95% CI, 1.1-1.3).[9] A second study comparing the most functional to least functional patients found no association (adjusted HR, 0.7; 95% CI, 0.3-1.9) between baseline functional dependence and functional decline at 1 year.[68] These studies were limited by "floor effects" that occur when scores are grouped at maximal poor functioning, reducing the ability to detect clinically important changes in functional status. Kim et al[33] found that older adults with cognitive impairment were at higher risk for functional decline 2 years after surgery (adjusted HR, 2.64; 95% CI, 1.09-5.85) than cognitively intact patients.

Discharge disposition was evaluated in 5 studies.[29,48,69,70,72] Frail patients were 3 to 13 times more likely (adjusted OR, 3.2 [95% CI, 1.0-10.0] to 13.0 [95% CI, 5.1-33.0]) to be discharged to a facility after surgery.[70,72] Compared with cognitively intact patients, older patients with cognitive impairment were twice as

Table 3. Studies Examining Risk Factors for Adverse Outcomes After Surgery

Source	Procedure	Sample Size	Age, y	Follow-up	Overall Incidence No. (%)	Risk Factor	Absolute Risk (%)	Risk Ratio (95% CI)
Postoperative Delirium								
Retrospective cohort								
Ganai et al, 2007[35]	Abdominal	89	≥70	In-hospital	60%	Functional dependence	NR	OR 11.7 (2.5-56.1)
Tei et al, 2010[53]	Colectomy	129	≥71	In-hospital	14 (11)	Cognitive impairment	NR	OR 7.79 (1.77-38.31)
Prospective cohort								
Ansaloni et al, 2010[5]	Multiple types	351	≥65	In-hospital	47 (13)	Cognitive impairment	16 (35)	OR 2.6 (1.2-5.8)
Bakker et al, 2012[6]	Cardiac	201	≥70	7 d	63 (31)	Cognitive impairment	NR	OR 2.32 (1.2-4.46)
Chrispal et al, 2010[54]	Hip fracture	81	≥60	In-hospital	17 (21)	Cognitive impairment	4 (24)	OR 16.96 (1.2-239.8)
Dai et al, 2000[55]	Multiple types	701	≥65	In-hospital	36 (5)	Cognitive impairment	NR	RR 4.4 (2.08-9.29)
Freter et al, 2005[56]	Orthopedic	132	≥65	In-hospital	18 (14)	Cognitive impairment	NR	OR 8.26 (2.44-27.99)
Furlaneto et al, 2006[57]	Hip fracture	103	≥65	In-hospital	30 (29)	Cognitive impairment	NR	OR 3.04 (1.24-7.40)
Juliebo et al, 2009[58]	Hip fracture	237	≥65	In-hospital	68 (36)	Cognitive impairment	NR	OR 2.93 (1.4-6.11)
Koebrugge et al, 2009[59]	Abdominal	71	≥65	In-hospital	17 (24)	Cognitive impairment	NR	OR 0.67 (0.43-1.04)
Lee et al, 2011[60]	Hip fracture	425	≥65	In-hospital	35%	Cognitive impairment	76 (54)	OR 3.35 (2.21-5.17)
Leung et al, 2011[61]	Multiple types	63	≥65	3 d	17 (25)	Frailty	57	OR 1.84 (1.07-3.15)
Leung et al, 2005[62]	Multiple types	219	≥65	3 d	46%	Functional dependence	NR	OR 0.89 (0.46-1.74)
Nie et al, 2012[63]	Hip fracture	123	≥60	6 d	16 (13)	Cognitive impairment	NR	OR 3.88 (0.45-33.19
Otomo et al, 2013[7]	Cardiac	153	≥60	7 d	16 (11)	Cognitive impairment	NR	OR 4.54 (1.21-16.51)
Rudolph et al, 2007[64]	Multiple	1161	≥60	7 d	99 (8)	Cognitive impairment	NR	OR 2.2 (1.4-2.7)
Rudolph et al, 2009[65]	Cardiac	231	≥60	In-hospital	63 (52)	Cognitive impairment	NR	OR 0.8 (0.6-1)
Sasajima et al, 2000[66]	Vascular	110	≥60	7 d	32 (29)	Cognitive impairment	10 (56)	OR 3.3 (0.8-13.5)
Sasajima et al, 2012[67]	Vascular	299	≥60	7 d	88 (29)	Cognitive impairment	30 (54)	OR 2.8 (1.4-5.6)
Functional Decline								
Retrospective cohort								
Finlayson et al, 2012[9]	Colectomy	6822	≥65	1 y	24%	Functional dependence	60	HR 1.21 (1.11-1.32)
Prospective cohort								
Kim et al, 2012[33]	Hip fracture	465	≥60	2 y	61%	Cognitive impairment	NR	HR 2.64 (1.09-5.84
Kwon et al, 2012[68]	Multiple types	204	≥65	1 y	51 (28)	Functional status	NR	OR 0.66 (0.23-1.89)[a]
Discharge to Facility								
Retrospective cohort								
Aharonoff et al, 2004[69]	Hip fracture	89 723	≥65	In-hospital	32 130 (36)	Cognitive impairment	NR	OR 2.18 (2.05-2.30)
Devon et al, 2011[48]	Colectomy	33 238	≥60	In-hospital	NR	Residential status	NR	OR 5.97 (4.59-7.77)
Prospective cohort								
Makary et al, 2010[70]	Multiple types	594	≥65	In-hospital	NR	Frailty	42	OR 3.16 (1.0-9.99)
Robinson et al, 2011[71]	Multiple types	223	≥65	In-hospital	66 (30)	Frailty	44 (67)	OR 13.02 (5.14-32.98)
Schaller et al, 2012[29]	Hip fracture	173	≥65	In-hospital	NR	Cognitive impairment	33 (35)	HR 7.37 (1.75-30.95)

Abbreviations: HR, hazard ratio; NR, not reported; OR, odds ratio.

[a] Highest quartile vs lowest quartile.

likely to be discharged to a facility after surgery (adjusted OR, 2.2; 95% CI, 2.1-2.3).[69] In a population-based study of patients undergoing colectomy, older adults admitted from a care facility were 6 times more likely to be discharged to a facility compared with older patients admitted from home (adjusted OR, 6.0; 95% CI, 0.0-7.8).[48]

Calculating Surgical Risk for Use in Decision Making

A number of tools are available to facilitate individualized perioperative risk assessment. However, there are no geriatric-specific tools and no single instrument incorporates every important geriatric variable.

Risk calculators that include surgical risk factors can provide a starting point for discussions about operative risk in older patients. The American College of Surgeons National Surgery Quality Improvement Program developed and validated a morbidity and mortality risk calculator for patients undergoing surgery that is now publicly available (http://riskcalculator.facs.org). It includes several geriatric variables (including age, functional health status, and albumin level) that are entered into the calculator and standardized charts are generated indicating the patient's risk for complications and death.[73] Important risk factors for adverse outcomes in older patients, however, are often not included in these tools. Moreover, information about health outcomes and quality of life among older patients with surgical diseases who choose not to have surgery is lacking. Because advances in medical management of chronic conditions have extended the life expectancy for patients with end-stage organ dysfunction, many multimorbid older adults may experience morbidity and mortality from untreated surgical diseases.

Preoperative Assessment and Optimization of the Older Patient

If it is determined that, on balance, surgery is more likely to benefit than harm a patient, the next step is to identify modifiable risk factors that may benefit from preoperative intervention (**Table 4**). This evaluation should include review of specific geriatric domains. Older patients are at substantially higher risk for morbidity and mortality than younger patients even for the less-complex procedures (ie, cholecystectomy). Therefore, thorough assessments are essential for all older patients being considered for surgery.

Assessment of Geriatric Conditions

Cognition

For apparently intact older patients, a cognitive assessment such as the Mini-Cog or a simple query about orientation to name, location, and date should be a part of the initial evaluation. Additional risk factors for delirium such as vision and hearing impairment, polypharmacy, and alcohol abuse should be identified.[71,83] Patients with cognitive impairment may benefit from preoperative evaluation by a geriatrician and, if possible, patients with substance abuse should be referred to a specialist for detoxification.[75] Patients should be reminded to bring their assistive devices (hearing aids, glasses, dentures) to the hospital.

Table 4. Preoperative Assessment and Optimization in the Older Patient

Domain	Assessment	Preoperative Optimization Strategies
Cognition	Mini-Cog Test[74] 3-Item recall Clock draw Identify risk factors for delirium[71] Visual and hearing impairment Alcohol abuse Medications	Formal assessment by geriatrician for patient identified to have cognitive impairment on screening[75] Remind patient to be bring all assistive devices (glasses, hearing aids) to hospital Limit use of sedating psychotropic medications preoperatively[76]
Function	Evaluate ability to perform activities of daily living and instrumental activities of daily living Obtain history of falls[75] Timed up and go testof more than 15 seconds[77]	Refer patients with functional deficiencies or history of falls for formal evaluation by a physical therapist before surgery[78,79] Obtain assistive devices Plan for in-hospital and postdischarge rehabilitation therapy
Nutrition	Perform a Mini Nutritional Assessment[80] Measure albumin and prealbumin levels	Patients at severe nutritional risk by Mini Nutritional Assessment should be referred to dietician for formal assessment[78,79] Consider preoperative nutritional supplementation in patients at severe nutritional risk according to European Society for Parenteral and Enteral Nutrition guidelines[78,81]
Frailty	Assess for the following indicators of frailty[72,82] Mini-Cog score of 3 or less Albumin level of 3.3g/dL or less More than 1 fall in the last 6 months Hematocrit level of less than 35%Timed up and go test of more than 15 seconds More than 3 comorbidities	Consider preoperative strength training[78,79] Provide nutritional supplementation[78,79]

Function

The functional assessment begins with screening the patient's ability to perform ADLs and inquiring about a history of falls. Patients who require assistance with any ADLs need a more detailed evaluation of ADLs and instrumental ADLs. To further assess limitations with gait and mobility, a timed up and go test can be performed. In a timed up and go test, the patient is observed and timed while rising from a chair, walking 10 feet, turning, and returning to sit back down. A timed up and go score of more than 15 seconds is associated with increased perioperative morbidity in surgical patients.[84] Patients with functional deficits in ADLs or timed up and go assessment should be referred to a physical and occupational therapist for further evaluation of the need for preoperative physical therapy, assistive devices, and plans for postoperative rehabilitation.[75,78]

Nutrition

Malnutrition is common in older patients and is associated with poor surgical outcomes. Screening for malnutrition includes measurement of body mass index, serum albumin and prealbumin, and a query about unintentional weight loss. The Mini Nutritional Assessment is a simple and effective tool for identifying patients at severe nutritional risk.[80] Patients at severe nutritional risk should undergo nutritional assessment by a dietician prior to surgery and preoperative nutritional support should be considered.[81]

Polypharmacy

Nearly half of older adults receive a potentially inappropriate medication during their surgical hospitalization.[85] To minimize the risk of perioperative adverse drug reactions, all preoperative medications should be reviewed for appropriateness and potentially inappropriate medications should be stopped using START and STOPP criteria.[86,87]

Frailty

A number of approaches have been used to assess frailty in surgical patients[70,82] and these approaches can identify targets for optimization. Robinson et al[82] assessed frailty using 6 clinical markers; Mini-Cog score if 3 or less, an albumin level of 3.3g/dL or less, more than 1 fall in the last 6 months, a hematocrit level of less than 35%, dependence with at least 1 ADL, and the presence of at least 3 comorbidities. The presence of at least 4 of these markers predicts 6-month mortality with a sensitivity of 81% and specificity of 86%.

Prehabilitation is the process of enhancing functional capacity preoperatively to facilitate a patient's ability to withstand physiologic stress.[88]Prehabilitation was effective in improving functional recovery in older orthopedic patients.[79,89,90] Small studies of the effect of prehabilitation on morbidity and mortality in older patients undergoing general and cardiovascular surgery are heterogeneous and had mixed results.[91-93] Many of these studies used a single intervention such as strength training. More recently, studies using a multimodal approach to prehabilitation (ie, multiple simultaneous optimization interventions) have shown promising results.[78,79] In a recent study of colorectal surgery, 80% of older patients who were enrolled in a trimodal prehabilitation program, including protein supplementation, anxiety reduction, and an exercise program, had returned to baseline function at 8 weeks compared with only 40% in the preintervention control group.[78] In another before-and-after study of the effect of preoperative comprehensive geriatric assessment and multimodal prehabilitation education (home exercise, nutrition, relaxation techniques, and pain management), outcomes were significantly improved among patients who underwent the intervention (pneumonia, 4% postintervention period vs 20% preintervention period; delirium, 6% postintervention period vs 19% preintervention period; and length of stay, 12 days postintervention period vs 16 days preintervention period).[79] Multimodal interventions aimed at modifying a range of geriatric conditions are likely to yield the most benefit in older patients.

Conclusions

Geriatric conditions are associated with adverse surgical outcomes. The decision to proceed with surgery in the frail older adult requires careful deliberation. As outlined in this article, the patient's goals, priorities, and life expectancy need to be assessed to determine whether surgical management is preferable to alternative approaches. Older patients considering surgery should undergo a preoperative assessment that includes an evaluation of comorbidities and geriatric conditions. Individualized preoperative optimization strategies should target medical, functional, cognitive, and nutritional conditions.

A comprehensive evaluation of treatment goals and communication of realistic estimates of operative risk is essential when counseling older patients about surgery and obtaining informed consent.

ARTICLE INFORMATION

Conflict of Interest Disclosures: All authors have completed and submitted the ICMJE Form for Disclosure of Potential Conflicts of Interest and none were reported.

Funding/Support: This work was supported by funding from The SCAN Foundation

Care of the Aging Patient Series: Authors interested in contributing Care of the Aging Patient articles may contact the section editor Dr Livingston at edward.livingston@jamanetwork.org.

Care of the Aging Patient: From Evidence to Action is produced and edited at the University of California, San Francisco, by Kenneth Covinsky, MD, Louise Walter, MD, Louise Aronson, MD, MFA, and Anna Chang, MD; Amy J. Markowitz, JD, is managing editor.

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