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GERIATRIC ANESTHESIA (S AKHTAR, SECTION EDITOR)

Perioperative Outcome in Geriatric Patients

Shamsuddin Akhtar[1]

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Abstract

Purpose of Review Increasing number of very old patients (> 80 year old) are presenting for invasive procedures and surgeries. This review addresses perioperative outcomes after cardiac and non-cardiac surgery, in octogenarians and older patients.

Recent Findings The overall rates of major upper abdominal cancer resections in octogenarians are increasing over time. Postoperative mortality, postoperative admission to the intensive care unit, and discharge to non-home disposition, after emergency general surgery, were strongly associated with age greater than 80 years. Though acceptable, perioperative morbidity and mortality tends to increase non-linearly after the age of 75 years in patients undergoing cardiac operations.

Summary Clinician-centric outcomes continue to dominate outcome reporting. Octogenarians have higher risk of mortality and increased rates of complications, both after cardiac and non-cardiac surgeries. Perioperative care is more resource intensive in the elderly. It is important to keep these factors in mind when contemplating interventions in very elderly individuals.

Keywords Aged · Hospital mortality · Octogenarians · Colorectal · Abdominal aortic aneurysm · Coronary artery bypass · Postoperative complications · Perioperative care

Introduction

The US Census Bureau estimates that the number of people age 65 years and older will double between 2010 and 2050 [1]. By 2030, people 65 years of age or older will account for 20% of the overall population. Age is associated with significant physiological changes, comorbidities, frailty, sarcopenia, and polypharmacy. The stress response to surgery is also affected by aging. Advanced age, comorbidities, and frailty have been associated with poor perioperative outcomes [2–4]. Polypharmacy (> 5 medications per day), complicates perioperative care with more chances of drug errors and drug-drug interactions [5]. Patients > 65 years old already account for approximately 60% of the general surgeon's workload and for approximately 50% of all emergent operations and 75% of operative mortality [6]. A fifth of elderly patients die in ICU settings and half of them require mechanical ventilation and a quarter undergo cardiopulmonary resuscitation in the days before their death [7]. Increasing number of very old patients (> 80 year old) are presenting for ever increasing complex invasive procedures and surgeries. Care of the geriatric patients is complicated and challenging and requires significantly increasing resources [8]. This review addresses current knowledge regarding perioperative outcomes after cardiac and non-cardiac surgery. Specifically, perioperative outcomes in octogenarians and older patients will be addressed.

Assessing Outcomes

Traditionally, traditionally perioperative outcomes have been determined by the clinicians, rather than the patients, and emphasized what happened in hospital, for example the length of hospital stay, complications, and early and organ dysfunction [9]. However, these clinician-determine outcomes may not be significant for the patients. The clinicians may perceive an operation or procedure to be successful; however, the patient may not have the same view if they suffer from chronic pain and disability and unable to return to baseline function. This is being increasingly recognized, and new methods of assessment are being developed to determine comprehensive way of determining outcomes [10].

Broadly, recovery after procedure or illness can be bundled into three phases, their cumulative duration exceeding that of

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✉ Shamsuddin Akhtar
shamsuddin.akhtar@yale.edu

[1] Department of Anesthesiology, Yale University School of Medicine, 333 Cedar Street, TMP # 3, PO Box: 208051, New Haven, CT 06520-8051, USA

the surgically focused enhanced recovery pathway. The recovery phases can be categorized as early, intermediate, and late [11••]. The early postoperative recovery phase has been defined as the first 24 h or the first 7 days. In the perioperative state, the speed and extent of recovery in the early phase is influenced most by pain, nausea, perioperative medications, and delirium. The intermediate phase of postoperative recovery has been defined as the first 28 or 60 days [12]. The extent of recovery in the intermediate phase is influenced most by pain, anxiety and depression, physical impairment, and cognitive dysfunction. The late postoperative recovery phase can be defined as the first 6 weeks or 3 months. Symptoms that afflict the early and intermediate phases of recovery can continue into this extended period and affect long-term outcomes. One should also recognize that reporting of a particular outcome is also dependent on the interest of the investigators and a particular clinical situation. For example, authors interested in modern ambulatory surgery are more likely to focus on patients' recovery at 24 h and may be up to seven postoperative days. While authors interested in recovery after major surgery are likely to be interested in long-term outcomes morbidity, mortality, quality of life, and discharge to home or advanced rehabilitation facility. These authors are more likely to develop and measure tools on three postoperative months and beyond. These outcomes are more important in geriatric patient where they may survive the initial hospitalization or procedure, but succumb to residual, long-term complications, or never return to baseline function and status of living, leading to persistent physical, mental, and cognitive disability.

The assessment of postoperative recovery has developed from a single measurement at a single point in time to measurements of many variables at multiple time points. More recent assessment tools aim to target the right patients at the right time by detecting specific deficits in their recovery trajectories, whether due to pain, cognitive dysfunction, physical dysfunction, or some other characteristic. However, this process is recent and has not been widely adopted in outcome reporting. Outcomes after surgery are still being reported traditionally in terms of morbidity and mortality.

Outcomes After Non-cardiac Surgery

Emergency Surgery

By some estimates, patients > 65 years old account for approximately 50% of all emergent operations and 75% of operative mortality. In a retrospective review of patients, who were classified into non-elderly (< 80 years old) and elderly (≥ 80 years old), of all acute care surgery admissions at a large teaching hospital over 1 year [13], hernia repair was the most frequently performed emergency general surgery procedure in the elderly group. It constituted 17% of cases, versus 3% in the non-elderly group. Postoperative mortality, events in the post-anesthesia care unit, postoperative admission to the intensive care unit, and discharge to non-home disposition were strongly associated with age greater than 80 years. Emergency surgery due to intraabdominal catastrophe is associated with much higher incidence of mortality in the elderly patient than in the younger patients.

Oncological Surgeries

The older population is also at the higher risk of developing cancer, with 60% of new diagnoses of malignancies occurring in those aged 65 years or older. In a study evaluating the outcomes after surgery for elective colorectal surgery following the E.R.A.S. pathway, the authors conducted a retrospective review of 589 patients who underwent elective colorectal surgical interventions. Two hundred eleven patients were younger than 65 years, 175 patients were aged from 66 years to 75 years, and 203 patients were older than 75 years. End points of interest were postoperative complications, 90-day mortality, length of hospital stay, and readmission within 30 days after discharge. Though significant differences were noted in pre-existing comorbidities, statistical differences between the groups in surgical procedures ($p = 0.095$), operative time ($p = 0.823$), anastomotic leakage ($p = 0.960$), hospital stay ($p = 0.081$), readmission rate ($p = 0.904$), 90-day mortality ($p = 0.183$), and morbidity ($p = 0.973$) were not noted. Multivariate logistic regression analysis showed that advanced age in E.R.A.S. pathway is not a predictive factor of morbidity, readmission within 30 days, and 90-day mortality in the elderly. The authors concluded that there was no significant difference in morbidity, 90-day mortality, length of stay, or readmission rate in patients aged over 75 years compared with younger patients. E.R.A.S protocol could be safely implemented in elderly patients [14]. Another study aimed to assess the relationship between morbidity and mortality within 1 year after colorectal cancer resection in octogenarians compared with other age groups [15]. Postoperative morbidity disproportionally increased 1-year mortality in octogenarians when compared with the younger age group (37 vs 6.5%; $p < 0.001$). Anastomotic leak, abdominopelvic abscess, reoperation, and readmission rates were comparable among different age groups, but were associated with a disproportionate risk of increased 1-year mortality in octogenarians. Multivariate analysis indicated that older age and postoperative complications were the only two independent variables associated with 30- and 90-day mortality. Generally, data supports a substantial benefit for elderly patients undergoing laparoscopic, in comparison with open, colorectal surgery [16].

A Nationwide Inpatient Sample (NIS) was used to estimate the national trends of major upper abdominal resections (esophagus, stomach, liver, pancreas) for cancer in octogenarians (aged ≥ 80 years) from 2001 to 2011. Resection rates

performed per year were incidence-adjusted within this age group for each cancer type as determined by the NIS database [17]. Resection rates in octogenarians increased significantly over time, secondary to increasing trends in pancreatic and hepatic resections. Elixhauser comorbidity index scores increased from a mean of 3.61 to 4.20, suggesting increasing morbidity burden, whereas inpatient mortality during this time decreased from 13.6 to 8.2%. The authors concluded that the overall rates of major upper abdominal cancer resections in octogenarians are increasing over time and is principally driven by increases in liver and pancreatic resections. These increases were observed despite a less favorable patient morbidity profile over time. These patterns may suggest shifting selection criteria for octogenarians undergoing major abdominal surgery over time, in the context of diminishing postoperative mortality.

The majority of esophageal cancers manifest in patients older than 65 years, with greater than 33% of all cases and deaths occurring in patients older than 75 years. Given the increasing number of octogenarians with esophageal carcinoma, these patients are now frequently considered for esophagectomy. Paulus et al. reported postoperative outcomes in patients who underwent esophagectomy in their institution [18]. Of the 430 patients, 33 patients were > 80 years. Incidence of perioperative complications were noted to be similar in patients who were less than 80 years compared to patients who were between 80 and 89 years. One-year mortality was not statistically different between the younger patients 81% (95% C.I. 69–96) vs octogenarians 67% (95% C.I. 52–85). However, 3- and 5-year mortality was significantly decreased in the > 80-year-old cohort. Practitioner should also consider institutional outcomes for surgeries of interest, as they could differ. A retrospective evaluation of 216 patients who underwent pancreatoduodenectomy did not show differences in mortality between non-octogenarians and octogenarians patients [19].

Another study examined the effect of age on postoperative 30-day morbidity and mortality after surgery for ovarian cancer [20•]. Elderly patients 80 years or older were more likely to die within 30 days compared with patients younger than 60 years, 60 to 69 years old, and 70 to 79 years old (9.2 vs 0.6 vs 2.8 vs 2.5%). Elderly patient aged 80 years or older were more likely to develop pulmonary (9 vs 2 vs 5 vs 3%,) and septic (9 vs 3 vs 5 vs 4%) complications compared with patients younger than 60 years, 60 to 69 years old, and 70 to 79 years old, respectively. Compared with younger patients, octogenarians were 9-times more likely to die and 70% more likely to develop complications within 30 days after surgery.

Orthopedic Surgeries

Orthopedic surgical procedures for degenerative musculoskeletal conditions are among the most frequently performed surgical procedures in North America. The most frequent include inpatient hip, knee, and spinal procedures for osteoarthritis and spinal stenosis. Higher rates of complications have been reported elderly patients for elective orthopedic procedures [21, 22]. In one study, querying 5% of Medicare database, in patients who underwent elective total hip replacement, the octogenarian group had a greater risk of dislocation (+ 12%, $p = 0.01$), venous thromboembolism (+ 14%, $p < 0.001$), and mortality (+ 150%, $p < 0.001$), compared with the younger age cohort. A total of 21% of the octogenarians were readmitted after surgery compared with 12% for patients in the younger group (OR = 1.64, 95% confidence interval 1.54–1.75; $p < 0.001$) [23]. Dhall et al. evaluated a cohort of 3847 octogenarians with C2 fractures. 10.3% of them underwent surgical repair of their fractures. Complication rate was significantly higher in the surgery group [24]. The overall mortality rate was 12.8% and did not differ in patients who underwent surgery (10.3%), when compared to those who did not (13.0%; univariate OR 0.77, 95% CI (0.55–1.07)). The incidence of hospital discharge to home was 26.0% for the entire cohort. Surprisingly, a smaller proportion of patients who underwent surgery were discharged to home (18.8 vs 26.8%; univariate OR 0.63, 95% CI (0.48–0.83)). Thus, value of surgical intervention in very elderly patients needs to be further elucidated.

Hip fractures are very common and serious events in elderly patients. Hip fracture is a public health issue, which increases the risk of mortality in geriatric patients. Recently, a meta-analysis was conducted to determine the risk factures that are associated with increased risk of mortality in patients with of hip fractures [25]. Eighteen cohort studies, involving 223,875 patients, were included in this meta-analysis. In addition to comorbidities, the most prominent factors associated with mortality were higher age (HR 1.51, 95% CI 1.37, 1.67; $p < 0.001$), male gender (HR 1.91, 95% CI 1.67, 2.19; $p < 0.001$), cognitive impairment (HR 2.06, 95% CI 1.25, 3.40; $p = 0.005$), delirium (HR 2.14, 95% CI 1.50, 3.05; $p < 0.001$), and dementia (HR 2.72, 95% CI 1.41, 5.26; $p = 0.003$).

Outcomes After Cardiovascular Surgery

The incidence of atherosclerotic heart disease, peripheral vascular disease, valvular heart disease, and arrhythmias increases with aging [26]. With improvements in perioperative care, and higher proportion of elderly patients with reasonable functional capacity, the proportion of elderly patients presenting for cardiovascular surgery continues to increase. Many octogenarians and nonagenarians are presenting for cardiovascular procedures.

Cardiac

Krane et al. published a retrospective analysis of 1003 octogenarians who underwent cardiac surgery over 20-year period

at their institution. Mean age was 82.3 years (range, 80 to 94 years). Patients underwent aortic valve replacement (AVR, $n = 303$), coronary artery bypass grafting (CABG, $n = 403$), or aortic valve replacement with coronary artery bypass grafting (AVR + CABG, $n = 297$) between 1987 and 2006. Overall 30-day mortality rate was 8.4%, i.e., 7.9% for AVR, 7.4% for CABG, and 10.1% for AVR + CABG, differences not being statistically significant. The overall in-hospital mortality rate was 7.1% and was significantly higher in patients undergoing AVR + CABG (10.1%) compared with the isolated procedures (6.6% for AVR and 5.2% for CABG). In this study the mortality after AVR, CABG, and AVR + CABG was about three times higher in octogenarians compared with younger patients, at their institution [27•].

Another retrospective population-based cohort study of adult patients receiving elective cardiac surgery between January 1, 2004, and December 31, 2009, was reported [28]. Outcomes reported were 30-day and 1- and 5-year mortality, postoperative complications, and ICU/hospital lengths of stay. Of 6843 patients who underwent cardiac surgery, 544 (7.9%) were octogenarians. There was an increasing trend in the proportion of octogenarians undergoing surgery during the study period (0.3% per year). Octogenarians were more likely to have combined procedures (valve plus coronary artery bypass or multiple valves) compared with younger patients. Crude 30-day and 1-year and 5-year mortality for octogenarians were 3.7, 10.8, and 29.0%, respectively. Compared to younger patients, octogenarians had higher adjusted 30-day (OR 4.83, 95% CI 1.30–17.92; $p = 0.018$) and 1-year mortality (OR 4.92; 95% CI, 2.32–10.46; $p < 0.001$). Postoperative complications were more likely among octogenarians. Octogenarians had longer postoperative stays in ICU and hospital and higher rates of ICU readmission. After multi-variable adjustment, age > 80 years was an independent predictor of death at 30 days and 1 year.

Thorsteinsson et al. assessed age-dependent trends in postoperative mortality in patients undergoing coronary artery bypass surgery(CABG) in Denmark [29]. The 30-day mortality rate was 3%, increasing with age (1% in patients < 60 years, 8% in octogenarians). The long-term mortality rate at 1 and 5 years was 2 and 7% (age < 60 years) and 14 and 36% (age > 80 years), respectively. The proportion of patients > 75 years increased from 10 to 20%, during the study period as well as the proportion of patients undergoing urgent or emergency surgery. Age and emergency surgery were the main predictors of 30-day mortality: age > 80 years [hazard ratio (HR) 5.75, 95% confidence interval (CI) 4.41–7.50], emergency surgery (HR 5.23, 95% CI 4.38–6.25).

The age cutoff to define elderly is controversial in cardiac surgery, empirically ranging from ≥ 65 to ≥ 80 years. Afilalo et al. studied a cohort from 6671 consecutive adult patients undergoing cardiac surgery at three hospitals in the USA and Canada. Logistic regression models and generalized additive models were used to fit to the data. The age distribution was 50 to 59 years $n = 1244$ (18.9%), 60 to 69 years $n = 2144$ (32.6%), 70 to 79 years $n = 2000$ (30.4%), and ≥ 80 years $n = 1183$ (18.0%) patients. After controlling for sex and type of operation, the relationship between age and 30-day operative mortality was found to be nonlinear. Mortality rises steeply after age 75 years for CABG and approaches 80 years for isolated valve surgery [30•].

Vascular

Randomized trials have shown that endovascular repair offers a perioperative survival benefit over open repair for patients with a large abdominal aortic aneurysm [31]. Though the difference in long-term survival after 6 years of followup has not been shown, increasing number of elderly patients are presenting for major vascular surgeries. Peterss et al. retrospectively analyzed surgical outcomes in patients aged 75–79, and 80 and above, who underwent elective aneurysm repair. One hundred eight patients aged 75–79 (mean age 76.9 ± 1.5 years) and 72 patients aged 80 and above (mean age 82.2 ± 2.1 years). Operative outcome and survival was compared with 727 contemporary younger patients aged < 75 years (mean age 56.6 ± 11.7 years). Postoperatively, patients who were > 80 years and 75–79 years showed a higher incidence of prolonged ventilation (21.4, 8.4, 2.9%, respectively), low cardiac output syndrome (11.4, 1.9, 2.2%), multi organ failure (2.9, 0, 0.1%), hemofiltration (8.6, 0.9, 0.6%), and infection (10.0, 6.5, 3.5%). Operative mortality was significantly increased in the > 80 years (11.1%) and 75–79 years (3.7%) group compared to younger patients (1.4%). Mid-term survival differed significantly between the surgical groups [32•]. This study shows that in contemporary practice octogenarians have higher incidence of perioperative morbidity and mortality after elective aneurysm repair. Advanced age is associated with high surgical mortality; however, for octogenarians surviving surgical repair, long-term outcome is acceptable [33].

Another study was undertaken to determine the outcomes of open and endovascular AAA repair in this population on a national level in nonagenarians. A retrospective review of the Nationwide Inpatient Sample Database was conducted to determine all patients 90 years and older who underwent either an open or endovascular repair of a non-ruptured AAA from 1997 to 2008 [34]. Preoperative comorbidities and postoperative complications in the inpatient setting were recorded. The primary end point was mortality. Secondary end points were postoperative neurologic, cardiac, and respiratory complications. This group was then compared with all adult patients less than 90 years old (age, 18–89) who had undergone repair of a non-ruptured AAA during this same period. Four hundred twenty-three patients 90 years and older underwent repair of a non-ruptured AAA (compared with 52,370 < 90). Of these, 132 patients underwent open repair (31%) and 291 (69%)

underwent endovascular repair. Inpatient mortality was 18.3% for the ≥ 90 open, 4.6% for the < 90 open, 3.1% for the ≥ 90 endovascular, and 1.2% for < 90 endovascular group.

Conclusion

The proportion of patients who are more than 80 years old, and presenting for complex surgeries, continues to increase. This trend is likely to continue and will be a challenge for caregivers and the healthcare system. Though there is a realistic move to improve outcome reporting measures, which are more holistic, patient-oriented, and less clinician-centric, (for example morbidity and mortality) or are driven by institutional needs (for example the length of stay), those measures have not been adopted frequently. Clinician-centric outcomes continue to dominate outcome reporting. Octogenarians have higher risk of mortality and increased rates of complications both after cardiac and non-cardiac surgeries. Perioperative care is more resource intensive in the elderly. Elderly patients are less likely to return to baseline levels of activity, and be discharged home, or to their preoperative living facility. It is important to keep these factors in mind when contemplating interventions in very elderly individuals.

Compliance with Ethical Standards

Conflict of Interest Shamsuddin Akhtar declares that he has no conflict of interest.

Human and Animal Rights and Informed Consent This article does not contain any studies with human or animal subjects performed by any of the authors.

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