PATTERNS OF PRACTICE

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Eff Clin Pract. 2001;4:172-177.

Operative Mortality with Elective Surgery in Older Adults

CONTEXT. For patients considering elective major surgery, information about operative mortality risks is essential for careful decision making. Because available information is often limited to educated guesses or optimistic data from case series, we examined surgical mortality by using nationwide data.

PRACTICE PATTERN EXAMINED. Operative mortality in 1.2 million patients in the Medicare system who were hospitalized between 1994 and 1999 for major elective surgery (six cardiovascular procedures and eight major cancer resections).

DATA SOURCE. MEDPAR file of the National Medicare claims database for patients 65 years of age and older.

OUTCOMES. Operative mortality, defined as death within 30 days of the operation or death before discharge.

RESULTS. Overall operative mortality varied widely according to procedure. Procedures associated with relatively low mortality risk included carotid endarterectomy (1.3%) and nephrectomy (2.3%). Overall mortality was greater than 10% for other procedures, such as mitral valve replacement (10.5%), esophagectomy (13.6%), and pneumonectomy (13.7%). In general, mortality risk increased with age. Operative mortality for patients 80 years of age and older was more than twice that for patients 65 to 69 years of age.

CONCLUSION. Population-based operative mortality for major surgery varies by procedure and patient age and is considerably higher than that typically reported in case series and trials.

To help patients make informed decisions about whether to undergo elective high-risk surgery, surgeons and primary care physicians need accurate information about surgical mortality risks. Accurate and generalizable surgical mortality data, however, are not readily available. As a result, physicians make guesses that "sound about right" or make estimates on the basis of personal experience and a small number of cases. Because many physicians are optimistic about the benefits of surgical interventions, such estimates are likely to be low; and because published data on surgical mortality tend to represent the experiences of tertiary care centers and only carefully selected patient samples, such data generally yield unrealistic risk estimates.

With this limited information, patients and physicians may find it difficult to realistically assess surgical mortality for a given procedure. To provide more generalizable information on surgical risk, we assessed the procedure-specific mortality for 14 elective high-risk surgical procedures—6 cardiovascular procedures and 8 major cancer resections—by using the national Medicare database.

This paper is available at ecp.acponline.org.

Methods

Data

By using data from the Medicare claims system, we examined 100% of national samples from the Health Care Financing Administration's MEDPAR and denominator files for 1994 through 1999. These files contain hospital discharge abstracts for acute-care hospitalizations of Medicare recipients under the hospital (Part A) insurance program. Only patients in fee-for-service arrangements are included in the MEDPAR file; thus, our sample excludes patients enrolled in risk-bearing HMOs. We excluded patients younger than 65 years or older than 99 years.

Sample Selection

Admissions for each of the six cardiovascular and eight major cancer procedures in our analysis were identified by using appropriate procedural codes from the *International Classification of Diseases*, version 9 (ICD-9) (**Table 1**). For each recorded hospital admission, only one procedure was counted.

We applied restrictions to create a homogeneous sample of patients undergoing elective surgery. We excluded patients requiring emergency procedures. Patients undergoing abdominal aortic aneurysm repair were excluded if their discharge abstracts contained diagnostic or procedural codes suggesting aneurysm rupture or thoracoabdominal aneurysm. We also excluded patients with end-stage renal disease (which we determined from the denominator file) among those patients with a lower-extremity bypass to reduce potential contamination with upper-extremity shunts and bypass procedures performed for dialysis access (ICD-9 codes do not distinguish between bypasses of the upper and lower extremities). Among patients with coronary artery bypass grafting, we excluded those undergoing simultaneous valve replacement. Finally, for the eight major cancer resections, our cohort was restricted to patients assigned a diagnostic code for the cancer associated with the operation (e.g., patients undergoing colectomy were also required to have a diagnostic code for colon cancer). After exclusions, we identified 1.2 million surgical admissions for analysis.

Outcome

Our primary outcome was operative mortality. Because deaths after protracted hospital courses are common

TABLE 1

Procedures Studied and Their ICD-9 Codes*

PROCEDURE	ELECTIVE ADMISSIONS, 1994–1999, *n*	ICD-9 CODE
Cardiovascular procedures†		
Carotid endarterectomy	307,777	38.12 (P)
Coronary artery bypass graft	293,228	36.10–36.19 (P)
Lower-extremity bypass graft	155,576	39.29 (P)
Abdominal aortic aneurysm repair	85,170	38.44 (P) or 39.25 (P) and 441.4, 441.7 ,or 441.9
Aortic valve replacement	69,301	35.21 (P) or 35.22 (P)
Mitral valve replacement	27,191	35.23 (P) or 35.24 (P)
Major cancer resections‡		
Colectomy	133,148	45.73–45.76 (P) and 153–154
Pulmonary lobectomy	50,729	32.4 (P) and 162–165.9
Nephrectomy	35,768	55.51 (P) and 189–189.9
Gastrectomy	15,657	43.5–43.99 (P) and 151–151.9
Cystectomy	14,731	57.70–57.79 (P) and 188–198.9
Pneumonectomy	6856	32.5 (P) and 162–165.9
Major pancreatic resection	5210	52.51 (P), 52.53 (P) or 52.7 (P) and 152–152.9 or 156–157.9
Esophagectomy	4080	42.40–42.42 (P) or 43.99 (P) and 150–150.9

**ICD-9 = International Classification of Diseases, version 9; (P) = procedure code.*
†To be included, patients required having at least one of the listed procedure codes on the Medicare claim.
‡To be included, patients required having at least one procedure and one diagnostic code for the relevant cancer on the Medicare claim.

TABLE 2

Age-Specific Mortality for Major Cardiovascular Operations in Medicare, 1994–1999*

PROCEDURE	OPERATIVE MORTALITY BY PATIENT AGE, %					
	65–69 yr	70–74 yr	75–79 yr	80–84 yr	85–99 yr	OVERALL
Mitral valve replacement	7.3%	9.6%	12.3%	15.7%	20.9%	10.5%
Aortic valve replacement	4.9%	6.3%	7.8%	9.4%	10.3%	7.1%
Abdominal aortic aneurysm repair	2.8%	3.6%	5.3%	7.2%	11.8%	4.5%
Coronary bypass graft	2.8%	3.8%	5.1%	6.7%	8.6%	4.1%
Lower-extremity bypass graft	2.0%	2.6%	3.4%	4.5%	7.0%	3.3%
Carotid endarterectomy	1.0%	1.1%	1.4%	1.7%	2.3%	1.3%

**95% CI > ±2% are shown in blue.*

with complex procedures such as esophagogastrectomy and pancreatic resection, we used a combined measure of 30-day and in-hospital mortality to assess surgical deaths. For example, a patient who was discharged from the hospital 1 day after carotid endarterectomy and died 2 weeks later was counted as an operative death. In addition, a patient who died in the hospital 6 weeks after esophagectomy was also considered an operative death. By using an inclusive definition of operative mortality, we could capture patients with an early discharge whose deaths are probably attributable to the surgical intervention, as well as patients who experienced several postoperative complications and died in the hospital more than 30 days after surgery.

Results

Cardiovascular Procedures

Table 2 shows the operative mortality for the six cardiovascular procedures. Carotid endarterectomy had the

TABLE 3

Age-Specific Mortality for Major Cancer Resections in Medicare, 1994–1999*

PROCEDURE	OPERATIVE MORTALITY BY PATIENT AGE, %					
	65–69 yr	70–74 yr	75–79 yr	80–84 yr	85–99 yr	OVERALL
Pneumonectomy	11.8%	13.4%	16.0%	21.6%	45.0%†	13.7%
Esophagectomy	10.7%	13.3%	17.0%	18.9%	23.5%†	13.6%
Major pancreatic resection	7.1%	8.1%	11.9%	14.0%	12.6%†	9.3%
Gastrectomy	6.2%	7.1%	8.9%	10.3%	16.4%	8.6%
Pulmonary lobectomy	3.6%	4.8%	6.1%	7.0%	9.0%	5.0%
Cystectomy	2.3%	3.7%	5.5%	7.5%	9.3%	4.4%
Colectomy	1.8%	2.4%	3.2%	4.6%	7.2%	3.5%
Nephrectomy	1.2%	1.7%	2.9%	3.0%	5.1%	2.3%

**95% CI > ±2% are shown in blue.*

†Fewer than 100 admissions. The smallest cohort included 40 patients ages 85 and older undergoing pneumonectomy, 18 of whom died. Thus, this operative mortality estimate of 45% has the widest CI in this paper (29.3% to 61.5%).

lowest overall operative mortality (1.3%). Overall mortality for medium-risk procedures (lower-extremity bypass graft, coronary artery bypass graft, and abdominal aortic aneurysm repair) ranged from 3.3% to 4.5%. Valve replacement surgery was associated with the highest overall risk (7.1% and 10.5% for aortic and mitral valve replacements, respectively).

Major Cancer Resection

Table 3 shows that the operative mortality for eight cancer resections ranged from 2.3% to 13.7%. At 2.3%, nephrectomy carried the lowest risk. Colectomy, cystectomy, and pulmonary lobectomy were associated with mortality risks of 3.5% to 5.0%. The highest overall mortality (8.6% to 13.7%) was observed for gastrectomy, major pancreatic resection, esophagectomy, and pneumonectomy.

Age and Operative Mortality

Figures 1 and **2** illustrate that operative mortality generally increased with age. For most procedures, the surgical risk in patients older than 80 years of age was twice as high as the risk in patients aged 65 to 69 years. Operative mortality exceeded 15% for patients older than 80 years of age who had mitral valve replacement, esophagectomy, or pneumonectomy.

Discussion

In this paper, we report the procedure-specific operative mortality for Medicare recipients undergoing 14 major cardiovascular and cancer operations. As expected, actual nationwide operative mortality is higher than that reported in many published series, a fact documented previously with carotid endarterectomy.[1, 2] We report an overall mortality of 1.3% for carotid endarterectomy, which is higher than the mortality reported in both the North American Symptomatic Carotid Endarterectomy Trial (0.6%) and the Asymptomatic Carotid Atherosclerosis Study (0.1%).[3, 4] Surgical mortality for other procedures was higher than that reported in surgical texts. For example, a recently published textbook reports the operative mortality for aortic and mitral valve replacements to be 2% to 5% and 3% to 9%, respectively.[5] Operative mortality for esophagectomy was estimated at 2% to 7%.[5] These estimates are substantially lower than our observed mortality (7.1% for aortic valves, 10.5% for mitral valves, and 13.6% for esophagectomy). This discrepancy is particularly large in older patients.

The source of this discrepancy between population-based operative mortality and published operative mortality is multifactorial. First, many published studies have selection bias. Studies often are performed at academic tertiary centers, and their results may differ from experiences in other hospital settings. In addition, trials are designed with inclusion criteria that tend to exclude patients who are older and sicker.[2] Finally, results from case series and trials are more likely to be submitted and published if the observed mortality is low, resulting in a publication bias toward lower operative mortality.

Although the risks reported in our analysis may be useful as a starting point, physicians who counsel patients about risks with elective surgery need to consider other factors. While age may be the most impor-

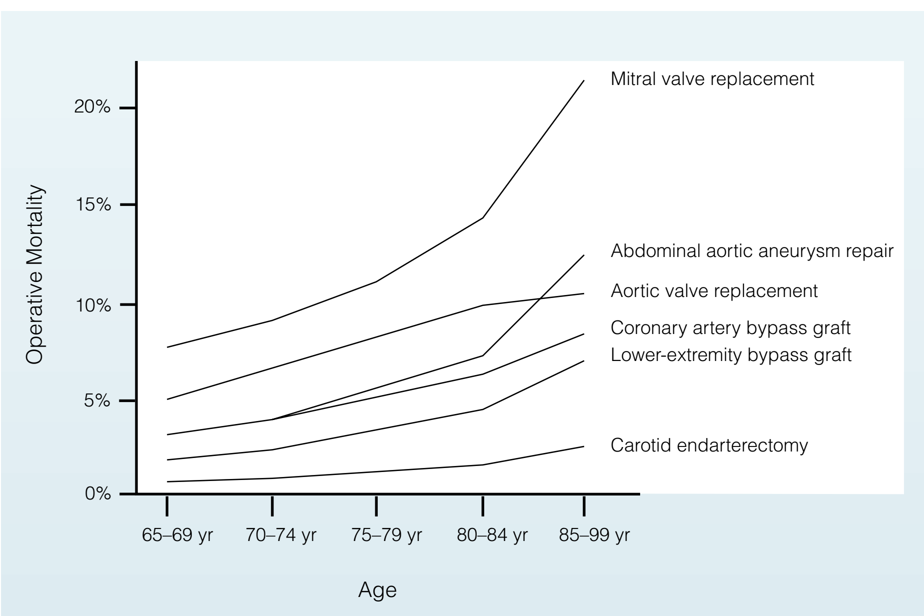

FIGURE 1. Age and operative mortality in six cardiovascular procedures from 1994–1999.

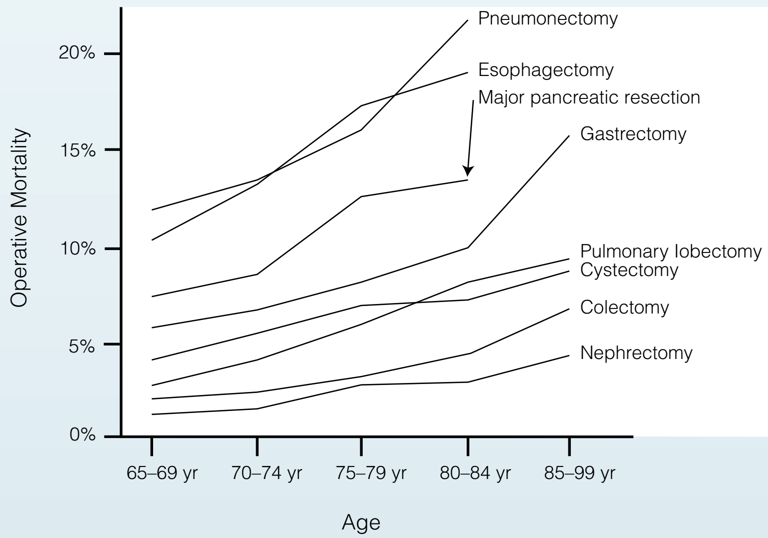

FIGURE 2. Age and operative mortality in eight major cancer resections, 1994–1999. No data are provided for 85- to 99-year-olds undergoing pneumonectomy, esophagectomy, or major pancreatic cancer because each involved fewer than 100 admissions.

tant predictor of operative mortality, other patient characteristics, such as comorbid diagnoses, reoperation, and urgency of operation, should be considered. Specific details about the procedure can also modify risk. Complexity of the operation is also important: For lower-extremity arterial bypass, a femoral to above-knee popliteal bypass is likely to carry less risk than a complex bypass to a distal vessel. Similarly, for abdominal aortic aneurysm, open repair is associated with higher operative risk than that for endovascular repair.

In addition to patient-level characteristics, surgical risk estimates should also incorporate hospital factors. Because operative mortality varies across individual surgeons and hospitals, a patient's risk for operative mortality is influenced by where and by whom the operation is performed. In several states, hospital- and surgeon-level mortality data for coronary artery bypass graft are publicly released.[6] Recently, Web sites have emerged that grade hospitals according to their observed operative mortality for selected procedures.[7] However, this kind of information generally is not available for most procedures. When such data are not available, hospital procedure volume may serve as a proxy for predicting superior outcomes.[8–11]

While hospital, surgeon, and patient characteristics are important variables in estimating surgical risk for individual patients, population-based operative mortality can be used as a starting point to help patients understand surgical risk when deciding whether to undergo elective surgery. These data are likely to give more realistic estimates of surgical risk than those data reported in the medical literature.

Take-Home Points

- **Patients deserve the best information possible from their physician when making a decision about major elective surgery.**
- **Quoted estimates on mortality risks are often based on educated guesses or optimistic data from clinical trials or case studies.**
- **Using 1994–1999 Medicare data, we determined the national mortality experience for 14 major elective surgeries.**
- **Mortality for many surgeries was considerably higher than that reported from clinical trials or case studies. For older patients, the operative mortality was frequently higher than 10%.**
- **Patients and physicians should have ready access to operative mortality data based on observed mortality in actual practice.**

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Grant Support

This study was supported by a grant from the Agency for Healthcare Research and Quality (R01 HS10141-01). Dr. Birkmeyer is also supported by a Career Development Award from the Veterans Affairs Health Services Research and Development program. The views expressed herein do not necessarily represent the views of the Department of Veterans Affairs or the U.S. Government.

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