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GERIATRIC GENERAL SURGERY

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General surgery encompasses many organ systems. This chapter, organized broadly by organ systems, highlights issues concerning the surgical care of elderly patients and reviews current understanding of specific disease states, covering recent research on such topics as the epidemiology, evaluation, management, and outcomes for each condition. Disorders of several organ systems that are also often treated by general surgeons are discussed separately (see Chapter 5 on noncardiac thoracic surgery and Chapter 3 on emergency medicine).

METHODS

The MEDLINE database was searched via the DIALOG Information Service. The time period covered was from 1980 to December 2000. The search strategy combined the MeSH terms for specific surgical procedures with terms denoting old age and also with the various terms for risk factors, postoperative care, postoperative complications, comorbidity, mortality, quality of life, prognosis, recovery, outcome, length of stay, and functional status. An additional requirement was that the term *age* or *aged* be present in the title or that the term *age factors* be present in the MeSH heading. Finally, terms that were excluded were those for specific surgical procedures relating to the specialties that are covered in other chapters and those terms for procedures in the realm of surgical specialties not included in this project, as well as those for liver transplantation, esophagoscopy, gastroscopy, and colonoscopy. The search resulted in 582 references. A final selection from these was made on the basis of a review of titles and abstracts.

OVERVIEW: PROCEDURES AND OUTCOMES

Emergency procedures account for a significant proportion of the operations on older people. A retrospective review of general surgery procedures performed in patients aged 70 and over at a large urban hospital found that 15% of the cases were emergencies. [1] Infection, intestinal obstruction, incarcerated hernia, and hemorrhage were the leading indications for operation. The review found postoperative morbidity and mortality rates to be significantly higher for emergency procedures (31% and 20%, respectively) than for elective procedures (6.8% and 1.9%, respectively) in the same age group. A companion study from the same group found that inguinal herniorrhaphy, colectomy, and cholecystectomy were the most common elective procedures. [2] In another study, of patients aged 90 years and over, operations on the digestive system were found to be the most common. [3] In this population, the observed 5-year survival rate was not significantly different from the expected survival rate for persons aged 90 years and over not undergoing an operation. A prospective audit of 1111 general surgical procedures in 1040 patients aged 65 and older revealed an overall mortality of 5.4%. [4] Patients aged 75 and older had

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a significantly higher postoperative mortality rate. Among patients aged 65 to 74 years, 14.5% required emergency operations, with a mortality rate of 12.9%. For patients aged 75 and older, 27.9% underwent emergency operations, with a mortality rate of 22.5%.

Two studies from Scandinavian countries have included data on the discharge disposition of elderly patients after general surgical and urologic operations. Schoon and Arvidsson found that in 1981, 78% of patients aged 80 years and older were admitted from home and 58% were discharged directly home. [5] In 1987, 85% were admitted from home and 73% were discharged directly home. Other researchers found that 74% of patients aged 80 and older undergoing general surgical procedures were admitted from home and 70% were discharged home. [6] Seventeen percent were admitted from a nursing home and 16% were discharged back to a nursing home.

In a prospective longitudinal study of 900 general surgical patients, 5-year survival was found to be lower in patients aged 65 years and over undergoing a general surgical procedure than in an aged-matched population. [7] Following an initially higher mortality in the 6 months after surgery, the survival rates in older patients undergoing operations matched that of controls. Specific factors associated with higher early mortality included nonelective admission, age over 75 years, American Society of Anesthesiologists (ASA) class 4 or 5, and major surgery. Although survival rates for specific diseases were not analyzed, survival rates for patients undergoing operation for malignant disease were calculated. Patients without malignancy had survival curves resembling those of an age-matched population. Although the postoperative mortality was similar in patients with and without malignancy, patients with malignant disease had a higher mortality rate for the first year after operation.

A cost analysis of resource utilization by older surgical patients found that this age group consumes a disproportionate share of resources. [8] Beginning at age 55, elderly patients were found to begin using a greater share of resources, and patients aged 65 and over, to account for 30% of all surgical admissions. The mean cost per patient stabilizes at 75 years of age. Because reimbursement per patient plateaus at about 55 years of age, the surgical care of patients aged 75 and older leads to significant financial losses. The proportion of emergency admissions and of intensive care unit use, and the need for blood transfusions progressively increases in the elderly patients. Only intensive care unit use was found to stabilize (at 25% to 30% of admissions) after age 65 years.

A 2-year study of 8899 patients aged 65 years and older undergoing surgery found that severity of illness is a better predictor than age of morbidity, mortality, and length of stay. [9] Outcomes for a given disease severity were found to be stable in patients from age 65 to 85 years and older.

To summarize the findings of recent research:

- Emergency operations, especially on the gastrointestinal system, account for a significant fraction of the general surgery procedures performed on older people.
- The survival rates of elderly patients undergoing elective general surgery operations are similar to those of age-matched groups.
- Costs associated with surgical care are significantly higher in older people.
- Severity of illness, rather than chronologic age, predicts postoperative morbidity, mortality, and length of stay.

GenSurg 1 (Level B): **Prospective cohort studies of specific surgical procedures are needed to identify the risk factors in the geriatric population for specific negative and positive outcomes.**

GenSurg 2 (Level B): **Prospective studies are needed to compare outcomes in younger and older patients for specific surgical procedures in outpatient settings or with short hospital stays. For example, is it possible to safely perform laparoscopic antireflux surgery in older patients with a 23-hour hospital stay?**

GenSurg 3 (Level B): **Case-control studies are needed to identify factors that place elderly patients at high risk for requiring emergency surgical procedures.**

GenSurg 4 (Level B): **Basic studies are needed to elucidate the differences in pathophysiology of the diseases and disorders in the elderly patient that lead to a high risk of requiring emergency surgical procedures.**

GenSurg 5 (Level B): **Guidelines for educating physicians to recognize diseases and risk factors that might predict an older patient's need for emergency surgical procedure should be developed; the guidelines would be based on findings of the research recommended in GenSurg 3 and GenSurg 4.**

ENDOCRINE DISEASE

The incidence of primary hyperparathyroidism is higher in older than in younger people, with estimates ranging as high as 1.5 per 100 patients. A comparison of preoperative symptoms, signs, and laboratory assessment has revealed more severe hyperparathyroidism in elderly (aged 70 years and older) than in younger patients. [10] Despite these differences, the cure rates and postoperative complication and death rates are similar in younger and elderly patients.

Similarly, thyroid disease is common among older people. In a study of 1631 patients aged 50 or older undergoing thyroid surgery, the most common indications for operation were found to be compression symptoms and risk of malignancy. [11] On analysis of resected specimens, the most common diagnosis was found to be multinodular goiter. A significantly higher prevalence of malignancy was found in patients aged 75 years and over. Postoperative complication rates were similar in patients aged 50–60, 61–74, and 75 and older.

To summarize the findings of recent research:

- Hyperparathyroidism and diseases of the thyroid are common in older people.
- Treatment outcomes for hyperparathyroidism are equivalent in older and younger patients.
- The results of surgical treatment of thyroid diseases are similar in older and younger patients.

GenSurg 6 (Level B): **Research is needed to determine the effect of hyperparathyroidism on quality of life, longevity, functional status, and cognitive status of older patients.**

GenSurg 7 (Level B): **Observational comparison of older and younger patients is needed to suggest whether hyperparathyroidism is recognized and treated surgically in the same percentage of older and younger patients.**

BREAST CANCER

Although breast cancer is not unique to older people, this age group is at the greatest risk for this malignancy. The incidence of invasive breast cancer in women aged 65 and older is almost six times greater than in younger women, and approximately two thirds of new breast cancers occur in women aged 50 and over. [12] The majority of patients present with stage I and II disease. [13] However, despite this stage distribution, most elderly patients undergo modified radical mastectomy instead of breast conservation surgery. [12–14] One analysis of treatment found that, adjusted for stage, patients aged 70 and older were less likely to receive therapy that is in agreement with National Institutes of Health treatment recommendations. [13] In a series of 184 patients aged 70 and older treated at the M. D. Anderson Cancer Center, [14] the postoperative mortality rate was found to be 1.6%, with all three deaths due to myocardial infarction. With a median follow-up of 80 months, 40% of deaths were due to breast cancer and 60% to other causes. The survival rate specific to breast cancer was 79% at 7 years. Data from the Surveillance, Epidemiology, and End Results Program (SEER) reveal 5-year relative survival rates of 85.2% and 86.5% for patients aged under 65 years and 65 years and older, respectively. [12] During a 30-month follow-up of 1800 postmenopausal women aged 55 years and older with breast cancer, 15% died. [13] Breast cancer was the cause of death in 51% of these cases. However, among patients aged 75 and older, only 38% of deaths were due to breast cancer; cardiovascular disease was the cause of death in 34% of these patients. Multivariate analysis revealed that age above 74 years was a significant determinant of decreased survival in patients with unknown stage or stage I or II breast cancer. Renal failure, liver disease, and stroke or transient ischemic attack were associated with a greater than twofold mortality risk.

Several randomized prospective European trials have investigated tamoxifen as primary therapy for patients aged 70 and over with operable breast cancer. In an early study by Gazet et al, [15] 116 patients aged 70 and over with surgically resectable breast cancer were randomized to tamoxifen (20 mg per day) or surgical resection (mastectomy or wide local excision) as primary therapy. Of the 56 patients in the surgical arm, 43 underwent wide local excision and 13 underwent mastectomy. Local recurrences, development of distant metastases, and death rates (overall and cancer-specific) were equivalent in the two groups, with a median follow-up of 3 years. A subsequent study by Robertson et al [16] evaluated tamoxifen (20 mg b.i.d.) versus wedge mastectomy as primary treatment of resectable breast cancer in 135 patients aged 70 and over. At 5 years, there were no significant differences between the two treatment arms in overall survival or metastasis-free survival. However, there was a significant difference in locoregional recurrence. In the tamoxifen group, 59% of patients experienced locoregional disease progression. In contrast, only 30% of patients in the surgical arm had a locoregional recurrence.

Several additional randomized trials compared tamoxifen alone and surgery with adjuvant tamoxifen in the treatment of resectable breast cancer in patients older than 70 years. A multicenter trial with 171 patients in the surgery-plus-tamoxifen arm (40 mg per day) and 183 in the tamoxifen-alone arm (40 mg per day) found no difference in survival or quality of life between the two groups at a median follow-up of 34 months. [17] Surgical treatment in the surgery-plus-tamoxifen arm consisted of local excision in the majority of patients, mastectomy in 23%, and quadrantectomy in 2%. However, there was a significant rate of local failure necessitating surgical intervention in the tamoxifen-only arm. These findings were confirmed in a larger study of 237 patients in the surgery-plus-tamoxifen arm (20 mg per day) and 236 patients in the tamoxifen-alone arm (160 mg loading dose, then 20 mg per day). [18] Although overall survival was unchanged, the surgery-plus-tamoxifen arm had a significantly greater disease-free survival, with a median follow-up of 3 years. A prospective randomized trial compared tamoxifen (20 mg per day) and placebo in elderly women (older than 65 years) with node-positive breast cancer after modified radical mastectomy. [19] The time to treatment failure was prolonged in the tamoxifen group (7.4 versus 4.4 years). Overall survival was improved in the tamoxifen group ($P = .063$).

Much of the research in breast cancer in older patients has dealt with the role of axillary lymph node dissection (ALND) because of the potential morbidity associated with this aspect of breast surgery. The data on complications after ALND are mixed. An early prospective study of arm lymphedema in patients undergoing ALND found a prevalence of 25% in patients aged 60 or older. [20] In contrast, this complication occurred in only 7% of younger patients, all of whom had a postoperative wound infection. Radiotherapy, including axillary radiation, had no effect on the rate of lymphedema. Lymphedema was also associated with division of the insertion of the pectoralis minor muscle in elderly patients undergoing ALND, 55% compared with 10% when the muscle was not divided. A subsequent randomized clinical trial of lumpectomy and axillary dissection with and without radiation therapy evaluated upper-extremity morbidity. [21] In contrast to the previous study, this trial found a higher frequency of upper-extremity symptoms in patients younger than 65 at up to 36 months after therapy. On multivariate analysis, only the number of lymph nodes removed and younger age were found to have a significant impact on arm morbidity at 3 to 12 months post-treatment.

A comparison of 63 older (aged 65 or older) and younger women receiving breast irradiation following partial mastectomy found no increase in complications among the older women. [22] Although radiography is safe in older women, a retrospective study found that only approximately 40% of women aged 60 and older were referred for postoperative irradiation after segmental mastectomy. [23] In contrast, 82% of similar patients younger than 60 received postoperative radiotherapy. Among older women receiving postoperative radiation therapy, the local recurrence rate was significantly lower than in older women treated by segmental mastectomy alone (4.0% versus 39.1%). However, this improvement in locoregional control did not translate into improved survival in elderly patients receiving postoperative radiotherapy. Comparison of responses to radiation therapy found no differences in overall survival, disease-free survival, or local recurrence rates between patients aged 70 or older and a younger cohort undergoing lumpectomy and breast irradiation for stage I and II breast cancers. [24]

Several studies have examined the possibility of omitting axillary dissection in elderly patients. A study of 73 patients aged 65 years and older with stage I and II breast cancers and clinically negative axillary nodes assessed the outcomes for tumor excision followed by breast and regional lymph node irradiation.[25] Sixty-six of these patients were also treated with tamoxifen because of positive estrogen receptors or tumor size greater than 2 cm. With a median follow-up of 54 months, the 8-year probabilities of disease-free, metastasis-free, and overall survival were 84%, 86%, and 53%, respectively. A retrospective study of 78 patients aged 70 and older undergoing resection of T1 lesions followed 14 patients who did not undergo axillary dissection.[26] These patients were older (79 years versus 74 years) than patients undergoing ALND. Among patients having ALND, lymph nodes were positive in only 17%. Adjuvant therapy consisted of tamoxifen alone or in conjunction with radiation in 9 of the 14 patients not undergoing ALND and radiation alone in 1 of the 14 patients. The mean follow-up was 48, 43, and 31 months in node-positive, node-negative, and patients not having ALND, respectively. There were no significant differences in disease-free survival, recurrences, or death rates among the three groups. A randomized prospective trial comparing modified radical mastectomy to lumpectomy and tamoxifen (20 mg per day) found a significantly improved overall survival in the tamoxifen group at 6 years.[27] There was no difference in disease-free survival rates.

Following mastectomy, immediate or delayed breast reconstruction is an option. A retrospective review of 242 patients undergoing postmastectomy breast reconstruction found that only 18 were aged 60 or older.[28] Although 34% of the patients undergoing mastectomy were in the elderly age group, only 7% underwent reconstruction. In contrast, 38% of patients younger than 60 had postmastectomy reconstruction. Older patients undergoing reconstruction were more likely than younger patients to have a prosthetic implant. Overall, the elderly patients had a lower rate of postoperative complications than did younger patients, except among patients undergoing reconstruction with autogenous tissue flaps, where there were no significant differences between the postoperative complication rates in older or younger patients.

The role of screening mammography for older women remains uncertain. A retrospective cohort study of over 690,000 California women aged 66 to 79 years found a screening rate of 46%.[29] This rate declined with age to 40% in women aged 75 to 79. Screening was associated with a significantly lower rate of metastatic disease. However, no determination of impact on mortality could be made.

To summarize the findings of recent research:

- Breast cancer is more common in elderly than in younger women.
- The stage distribution of breast cancer is similar in younger and older patients.
- Survival appears to be diminished in older breast cancer patients; however, as breast cancer patients age, they are more likely to die from comorbidities than from breast cancer.
- Tamoxifen can be used as sole therapy in early-stage breast cancer in older patients; however, it has a significantly higher rate of local and regional recurrence than is found with surgery or surgery plus adjuvant tamoxifen.
- Tamoxifen is beneficial in older patients with node-positive breast cancer.

GenSurg 8 (Level A): **Randomized controlled trials should be performed to determine the effect of screening mammography on survival, treatment morbidity, functional outcomes, and costs as a function of age.**

GenSurg 9 (Level A): **Randomized controlled trials of breast cancer therapy in older women should be performed to compare the use of tamoxifen alone with tamoxifen plus surgery, in subgroups of ages ranging from 50 to 90 years. Outcomes measured would include survival, treatment morbidity, function, and cost. Subgroup analyses would identify which patients are likely to respond well to tamoxifen alone.**

GenSurg 10 (Level A): **Randomized controlled trials are needed to determine the minimum duration of tamoxifen therapy that is required for optimal effect in older breast cancer patients.**

GenSurg 11 (Level A): **Randomized controlled trials are needed to compare rates of recurrence and survival in groups of older breast cancer patients who are treated with and without axillary dissection.**

STOMACH DISORDERS

Disorders of the stomach requiring surgery can be a source of significant morbidity and mortality in older patients. Many reports regarding gastric disease in the older population focus on the management of gastric cancer, and most are from Asian and European centers because of the higher incidence of gastric malignancy in these locations than in the United States.

GASTROESOPHAGEAL REFLUX

Gastroesophageal reflux disease (GERD) is common among both younger and older people, with similar reported prevalence rates of approximately 20%. [30] However, the frequency of complications of GERD is higher in elderly patients. This may be due to differences in symptom thresholds for younger patients. A study of symptoms in 195 elderly patients with foregut symptoms found that 30% of patients with severe esophagitis had no symptoms of GERD. [31] A more recent study compared symptoms and response to esophageal acid perfusion in veterans younger than age 60 and in those aged 60 and older. [32] The younger patients reported more severe reflux symptoms than the older cohort, despite similarities in degrees of esophagitis and pH studies. In addition, the younger patients reported a shorter time to symptom perception and greater sensitivity to acid perfusion than did the elderly patients.

The evaluation and treatment of GERD in older and younger people is similar. The main treatment modality is acid suppression, typically with a proton-pump inhibitor. These medications are well tolerated by older patients. The role of laparoscopic antireflux surgery has not been well defined in elderly patients. A retrospective analysis of data prospectively collected on 36 patients aged 65 or higher found that their outcomes were similar to those of younger patients also undergoing laparoscopic antireflux surgery. [33] The older patients accounted for approximately 11% of the operations over a 6-year pe-

riod. Minor complications were more common in the elderly patients (13.9%) than in the younger patients (2.6%). The incidence of more severe complications was similar in the two groups. The only death occurred with a younger patient. At a median follow-up of 27 months, elderly and younger patients had similar rates of recurrent GERD symptoms, dysphagia, and fundoplication failure.

ULCER DISEASE

A recent report from the Mayo Clinic outlines the role of a specialized management team for the treatment of acute gastrointestinal bleeding. [34] In this series of patients (average age = 65 years), upper gastrointestinal hemorrhages accounted for 75% to 80% of the cases of gastrointestinal bleeding. Over half of these patients had a history of recent nonsteroidal anti-inflammatory drug (NSAID) use. Although no supporting data are provided, the author contends that early operative intervention should occur in elderly patients because of their limited physiologic reserve.

In a retrospective review of 40 high-risk patients presenting with perforated gastric ulcer, 18 (45%) were aged 70 years or older. [35] The mortality for this group of elderly patients was 44%. For the 12 patients aged 70 and older treated with omental patch closure of the perforated ulcer, the mortality was 58%. The mortality rate was 17% in the 6 patients undergoing partial gastrectomy. Analysis of 136 patients undergoing surgical treatment for complications of peptic ulcers found that perforation accounted for 67% of the cases and bleeding for 31%. [36] The postoperative complication rate was 66%, and the overall mortality was 30%. The death rates were equivalent in patients suffering perforation or bleeding, at 31%. Twenty-five of the 28 deaths in patients with perforation occurred in patients aged 70 or over. Similarly, almost three quarters of the deaths in patients requiring operation for bleeding were in this older age group.

GASTRIC CANCER

A retrospective study attempted to clarify risk factors associated with postoperative complications in elderly patients undergoing total gastrectomy for cancer. [37] The prevalence of preoperative cardiopulmonary disease was found to be significantly higher in patients aged 65 and older than in the younger cohort. Both groups had similar distributions of tumor stage; there were no significant differences in preoperative renal function or nutritional status between the two groups. The rate of postoperative complications was significantly higher in the older patients (44.4%) than in the younger patients (19.2%). Although mortality was also higher in the older group (11.1%) than in the younger group (3.5%), this difference was not statistically significant. A report from Japan of 382 patients undergoing curative resection of early gastric cancer found that increasing age is associated with a lower long-term survival rate. [38] Of the 25 patients dying of recurrent disease, median survival was significantly shorter in patients aged 55 years or over (1.7 years) than in younger patients (5.6 years). In another study of 380 patients undergoing total gastrectomy, 43% were aged 70 or older. [39] Chronic lung disease, hypoalbuminemia, diabetes mellitus, and electrocardiogram changes were found to be more common among the older patients. The postoperative complication rate was higher in the older cohort. However, postoperative mortality was not significantly different in the two groups, nor was there a significant difference in long-term survival.

A study by Wu et al examined the quality of life after gastric resection for cancer in 433 patients aged 65 and older. [40] The two groups compared were patients aged 65 to 74 years and patients aged 74 years and over. The postoperative morbidity and mortality rates were higher in the older group. Multivariate analysis found that age and extent of gastric resection were independent predictors of postoperative mortality. There was no difference in long-term survival between the two age groups. After accounting for 261 deaths (180 due to gastric cancer, 21 due to postoperative mortality) and 22 patients lost to follow-up, researchers assessed quality of life using the Spitzer index in 125 of the patients aged 65 to 74 and 25 of the patients over age 74 and found no significant differences in Spitzer index scores between the two groups. All patients, except one receiving chemotherapy, had normal work and daily activities; 16% had a lack of energy and 14% had experienced a period of anxiety or depression.

To summarize the findings of recent research:

- The prevalence of GERD is similar in younger and older patients; however, the incidence of severe and complicated GERD is higher in elderly patients.
- The morbidity and mortality rates for complications of peptic ulcer disease in older patients are high.
- Emergency operations for gastric disease are associated with high rates of postoperative complications and death.
- The postoperative morbidity rates after gastrectomy for gastric cancer are higher in elderly patients than in younger patients. The postoperative mortality rates are similar for these two groups of patients.
- Long-term survival rates after gastric resection for gastric cancer are similar in younger and older patients.

GenSurg 12 (Level B): **Observational cohort studies are needed to determine if presentation and pathophysiology of peptic ulcer disease are different in older and younger people.**

GenSurg 13 (Level B): **Prospective cohort studies are needed to seek clues as to how complications of peptic ulcer disease in older patients can be prevented.**

GenSurg 14 (Level B): **Cohort studies on older patients are needed to identify risk factors for peptic ulcer disease.**

GenSurg 15 (Level B): **Observational cohort studies tests are needed of putative methods to reduce the morbidity and mortality of emergency operations for peptic ulcer disease in older patients.**

GenSurg 16 (Level A): **Randomized controlled trials of the most promising method for reducing the morbidity and mortality of emergency surgery for peptic ulcer disease in older patients are needed.**

GenSurg 17 (Level B): **Cohort studies are needed to seek alternatives to nonsteroidal anti-inflammatory drugs for use by older patients.**

GenSurg 18 (Level A): **As possibly safer nonsteroidal anti-inflammatory drugs are developed, they should be tested in randomized controlled trials for safe use by older patients.**

GenSurg 19 (Level B): **Outcome studies and prospective cohort studies are needed to build evidence as to optimum treatment for each stage of gastric cancer, including ways to palliate the near-terminal and terminal phases.**

GenSurg 20 (Level B): **Cohort or outcome studies are needed to gain information about the effectiveness of using newer treatment methods, such as photodynamic therapy, for treating elderly patients with stomach disorders.**

COLORECTAL DISEASE

Colorectal disease is a significant concern for older people. Many report abnormalities in bowel function. The incidence of benign and malignant conditions of the large intestine increases with age. For American women between the ages of 60 and 79, the probability of developing colorectal cancer is 3%; for American men in the same age group, the probability is 4%. [41]

DIVERTICULAR DISEASE

Diverticulosis and diverticulitis are more common in older than in younger people. Colon resection to manage these problems is occasionally required and represents the most common indication for colectomy for benign disease in older people. One evaluation of the metabolic responses to elective colon resection found no age-related changes. [42] In a nonrandomized prospective comparison of elective laparoscopic and open colectomy for sigmoid diverticulitis, it was found that laparoscopic surgery was associated with a lower requirement for postoperative parenteral analgesics, lower postoperative morbidity, a shortened length of stay, and a reduced requirement for postoperative inpatient rehabilitation. [43] The main factors associated with the reduction in postoperative morbidity are lower rates of wound infection and pulmonary infection. Another prospective cohort study of elective laparoscopic colorectal surgery in older patients found that 80% of previously independent patients undergoing laparoscopic procedures return home but that only 43% undergoing open procedures were able to do so ($P = .025$). [44] A higher proportion of the patients undergoing open colorectal surgery (46%) were discharged to a rehabilitation facility; only 11% of those undergoing laparoscopic procedures needed such facilities ($P = .016$). Earlier retrospective studies had also demonstrated the safety of laparoscopic colorectal surgery in older patients. One study found that although patients aged 70 years and older had more cardiopulmonary comorbidities than younger patients, there was no difference in major or minor postoperative complication rates for younger and older patients. [45] Another study, in which 38% of the patients aged 60 years and older had medical comorbidities, showed equivalent rates of postoperative complications, conversion to open procedures, length of ileus, and hospital length of stay for older patients and a procedure-matched group younger than 60 years. [46]

In contrast to elective resection for diverticulosis, emergent management of lower gastrointestinal bleeding can have significant death and complication rates. Among 49

patients at a single institution undergoing total abdominal colectomy for bleeding, 71% were found to require an emergency operation, with a mortality rate of 34%. [47] The mortality rate was found to increase with advancing age, from 20% in patients younger than 70 years to 39% in patients aged 70 years and older.

COLORECTAL CANCER

Given the prevalence of colorectal cancer and the fact that the risk of developing the disease increases with age, colorectal malignancy is a common problem in older people. One analysis found that 75% of new colorectal cancers occur in patients aged 65 years or older. [48] The same analysis found 40% of patients to have five or more comorbidities, and 80%, one or more conditions considered to have a high or moderate life impact threat. There was no significant relationship between age and stage at presentation; however, the risk ratio for death was almost twice as high in patients aged 75 or over. An analysis of Medicare claims data found a 5% perioperative mortality for colectomy for colon cancer in patients aged 65 years and older. [49] Furthermore, the risk of mortality was significantly increased in men and with increasing age. The risk of perioperative mortality was found to be 31% higher in men than in women. The relative mortality risk was twice that of patients younger than 85 years and three times that of patients younger than 75 years. Overall, 1- and 2-year survival rates were 76% and 63%, respectively. Even after adjusting for differences in life expectancy, logistic regression analysis demonstrated a detrimental impact of increasing age on survival. Contradictory results were found in a study from Ireland that investigated outcomes for colorectal cancer in patients aged 70 years or more who constituted 44% of the patients treated for colorectal cancer at a single institution over a 6-year period. [50] Although the elderly patients presented more commonly than younger patients with complications of their malignancy requiring emergency intervention (18% versus 11%), there were no differences between younger and older patients in the postoperative mortality rates overall, for elective procedures, or for emergency procedures. Differences in 5-year survival rates for the elderly and younger groups were not statistically significant. Overall 5-year survival was 52% for the elderly patients and 45% for the younger cohort. For those patients undergoing potentially curative resection, the respective rates were 68% and 59%.

A study from Japan found more advanced colorectal cancer among patients aged 80 years and over with a sedentary as opposed to active lifestyle. [51] Furthermore, sedentary patients with stage III colorectal cancer had shorter survival. Postoperative mortality was also highest in the sedentary group undergoing palliative operations, although the mortality rate for sedentary patients undergoing potentially curative resection was the same as for active patients. Unfortunately, the mortality rates were not controlled for pre-existing morbidities. Another study comparing total rectal resection and coloanal anastomosis found no difference in outcomes between young and elderly patients with rectal tumors. [52] Specifically, there were no differences in perioperative morbidity or functional results, quality of life, and performance status. This is counter to the commonly held belief that older patients do not do well with coloanal anastomoses because of debilitating diarrhea. The functional outcome of coloanal anastomosis in elderly patients was subsequently confirmed in a study by Dehni et al. [53] This nonrandomized study found no significant difference in functional results of coloanal anastomosis with colonic J-pouch between patients older than 75 years and younger patients (mean age = 58 years). Similar func-

tional outcomes with ileoanal reservoir have been demonstrated in patients aged 50 years and older [54,55] or 60 years [56] and in younger patients, even though the procedure is performed for benign colonic disease and typically in a younger patient population.

Whether older patients more commonly require colostomy is unknown; however, most surgeons seem to be more likely to perform a colostomy in older patients than to forgo surgery and risk anastomotic leakage. These colostomies are frequently performed as part of an emergency procedure and commonly are never closed. A study by Wong et al [57] confirms the morbidity associated with colostomy closure in older patients. This retrospective review of 84 patients aged 70 years and older showed a higher incidence (13% versus 5%) of postoperative complications in older than in younger patients.

To summarize the findings of recent research:

- Benign and malignant colorectal diseases are more common in older people.
- Postoperative complication rates for elective laparoscopic colectomy are lower than for elective open colectomy in older patients.
- Emergency procedures are associated with significantly higher complication and death rates.

***GenSurg 21 (Levels B and A)*: Nonrandomized or randomized trials comparing appropriate management options for complications of diverticular disease in older patients are needed.**

***GenSurg 22 (Level A)*: Randomized controlled trials are needed to compare the various colorectal cancer screening methods now in use for their efficacy in elderly patients.**

***GenSurg 23 (Level B)*: Exploratory studies are needed to elucidate the roles of emerging technologies in the management of colorectal cancer in elderly patients.**

LIVER RESECTION

Few general surgery procedures are as strongly associated with the potential for physiologic disruption, morbidity, and mortality as are major liver resections. One would anticipate that, given older patients' limited physiologic reserve, they would tolerate this procedure poorly. Because of the increased incidence of colorectal cancer and other gastrointestinal cancers causing liver metastases with advancing age, the need for liver-directed therapy will continue to increase in this patient population. Because colorectal liver metastases represent the most common indication for liver resection in this country and the incidence of hepatocellular carcinoma is significantly lower, only liver resection for metastatic disease will be reviewed herein.

A retrospective review of 41 patients undergoing liver resection showed a similar rate of postoperative morbidity and mortality in patients aged 70 years and older when they were compared with a group with a mean age of 57 years. [58] An earlier study demonstrated similar morbidity and mortality rates following major liver resection in older patients (mean age = 74 years) and a younger cohort (mean age = 46 years). [59] In addition, postoperative liver function was similar in the elderly and the younger patients. Fong et al analyzed outcomes from liver resection for colorectal cancer metastases in a group of 128

patients aged 70 years and older, constituting 22% of the liver resections performed at a single institution over an 11-year period. [60] The perioperative mortality and complication rates of 4% and 41%, respectively, were comparable to the rates in younger patients. Additionally, long-term survival rates were not found to be significantly different in elderly and younger patients following resection.

Overall, it seems that liver resection can be performed safely in older people. However, most reports are from high-volume specialty centers whose results may be better than those of lower-volume centers.

GenSurg 24 (Level B): **Cohort studies are needed to determine the role, safety, and efficacy of newer liver-directed therapies in older patients, for example, cryoablation, radiofrequency ablation, and hepatic artery infusion.**

BILIARY DISEASE

Cholecystectomy is one of the most commonly performed general surgery procedures. In an analysis of more than 42,000 cholecystectomies performed in 1989, the overall mortality was found to be less than 1%. [61] Postoperative mortality was highest in patients aged 65 years and older (0.5% versus 0.03% for those younger than 65 years). Complication rates, length of stay, and charges were also higher in these older patients. Subsequent studies have evaluated laparoscopic cholecystectomy in older patients. Pessaux et al prospectively evaluated laparoscopic cholecystectomy in 102 patients aged 75 years or older. [62] Over one third of these patients were ASA class III or IV, and one third had acute cholecystitis, whereas only 14% of younger patients did. Older patients had higher rates of postoperative complications (13.7% versus 6.6%) and higher rates of conversion to an open procedure (21.6% versus 12.9%). An earlier study had similar findings: an overall complication rate of 14.5% in patients aged 60 years and older. [63] No significant difference between the complication rates of patients aged 60 to 69 (11%) and of those aged 70 or greater (20%) was found. An analysis of 18,500 patients aged 80 to 105 years undergoing cholecystectomy found that significantly more patients undergoing laparoscopic cholecystectomy were discharged home (75% versus 68% for open cholecystectomy), and fewer were discharged to a skilled nursing facility (8% versus 11%). [64] The postoperative mortality rate was significantly lower for patients undergoing laparoscopic cholecystectomy (1.8%) than for patients undergoing open cholecystectomy (4.4%). In a study of 144 patients aged 65 and older undergoing laparoscopic cholecystectomy, no episodes of hypercarbia or hypotension were found despite the presence of cardiopulmonary disease in 64% of these patients. [65]

Laparoscopic cholecystectomy also has a significant role in the management of biliary pancreatitis in elderly patients. A retrospective analysis of the management of gallstone pancreatitis found similar morbidity and mortality rates for laparoscopic cholecystectomy in patients aged 65 or older and in younger patients. [66] In each age group, slightly over 20% of patients were initially treated without cholecystectomy or endoscopic retrograde cholangiography, usually because the patient refused treatment. Among those managed

without cholecystectomy or endoscopic retrograde cholangiography, 20% were readmitted with recurrent pancreatitis and subsequently underwent surgery.

To summarize the findings of recent research:

- Cholecystectomy is one of the most frequently performed operations in older patients.
- Elderly patients present with a greater proportion of complicated biliary disease.
- The morbidity and mortality rates for cholecystectomy are higher in elderly than in younger patients.
- In elderly patients laparoscopic cholecystectomy has a lower mortality rate than does open cholecystectomy.

GenSurg 25 (Level A): **Randomized controlled trials are needed to compare the safety and effectiveness for older patients of outpatient or short-stay cholecystectomy with the safety and effectiveness of longer hospital stays.**

GenSurg 26 (Level B): **Basic physiologic and biochemical studies are needed to learn why older patients are more likely than younger patients to present with complicated biliary disease.**

PANCREATIC DISEASE

Pancreatic cancer remains a significant source of cancer deaths. As with most malignancies, the risk increases with age. Although the perioperative morbidity and mortality associated with pancreatic resection has historically been high, these rates have markedly improved over the past decade. A study of 42 patients with a mean age of 75 years found perioperative morbidity and mortality rates of 31% and 9%, respectively, for radical pancreatic resection. [67] Another early report by Hannoun et al of 44 patients aged 70 and older undergoing pancreaticoduodenectomy (Whipple procedure) between 1970 and 1990 showed a mortality rate of 4.5%. [68] The postoperative morbidity rate was 36% in this group. The mortality and morbidity rates in patients undergoing operations after 1985 were 3.7% and 33.0%, respectively. The death and complication rates in a younger cohort of 179 patients (mean age = 57 $\pm$ 10 years) were 10% and 35%, respectively. The mortality and morbidity rates in younger patients undergoing operations after 1985 were 1.8% and 32%, respectively. Five-year survival rates were equivalent in the two groups. Subsequent studies have confirmed low postoperative mortality following pancreatic resection in older patients, [60,69–72] with several having no mortality in elderly patients undergoing resection. In these reports, long-term survival after pancreatic resection was equivalent in the elderly and younger patients.

Research has made it clear that pancreatic resection can be performed safely in older people. However, as with liver resection, most reports are from high-volume specialty centers whose results may be better than those at lower-volume centers.

GenSurg 27 (Level B): **Cohort or case-control studies are needed to determine what are the most appropriate selection criteria for pancreatic resection in older patients.**

***GenSurg 28 (Level A)*: Exploratory prospective cohort studies are needed to suggest how elderly patients with pancreatic cancer are best palliated.**

CEREBROVASCULAR DISEASE

The incidence of atherosclerotic vascular disease increases with age. The mean age of patients in most reports approaches or exceeds 65 years. An analysis of the economic impact of vascular surgery in older people showed that elderly patients undergoing peripheral vascular surgery accounted for almost half of the hospital admissions and generated a disproportionately higher percentage (58%) of total hospital costs. [73] Older people have a significantly higher mortality associated with emergency vascular procedures (38.2%) than with elective procedures (2.3%). [74] Assessment of functional outcome after vascular procedures showed that 65% of patients were living at home and 35% in a nursing facility; 58% were fully ambulatory and 15% were confined to a wheelchair or bedridden. [74]

As the third leading cause of death in the United States, cerebrovascular disease is a significant source of morbidity and mortality in older people. Carotid endarterectomy is an accepted therapy in selected patients for the prevention of stroke in the presence of extracranial atherosclerotic vascular disease. On the basis of the Asymptomatic Carotid Atherosclerosis Study (ACAS), carotid endarterectomy is indicated in patients with asymptomatic carotid lesions causing at least 60% stenosis and whose surgical risk is less than 3% and life expectancy is at least 5 years. [75,76] On the basis of the European Carotid Surgery and the North American Symptomatic Carotid Endarterectomy (NASCET) trials, carotid endarterectomy is recommended in patients with symptomatic lesions causing 70% to 99% stenosis. [77,78] For symptomatic patients with 50% to 69% stenosis, carotid endarterectomy was found to yield a moderate reduction in stroke risk in the NASCET [79] but not in the European trial. [78] Unfortunately, both ACAS and NASCET excluded patients over the age 79 years.

A comparison of carotid endarterectomy in patients older and younger than 75 years found equivalent stroke and death rates in the two groups. [80] The combined stroke and death rates were 4% and 6% for patients younger than 75 years and 75 years and older, respectively. Perioperative strokes were the most common cause of death in the younger age group. In contrast, the most common cause of death in the older age group was cardiac. Additional studies have confirmed the safety of carotid endarterectomy. This is especially important given the fact that patients older than 79 years were excluded from the original NASCET [77] and from the ACAS. [76] In the follow-up NASCET report on symptomatic patients with moderate stenosis (50% to 69%), patients aged 80 years and over were included. [79] Sixty-four percent of the patients in the surgical arm and 59% of the patients in the medical arm were aged 65 or older. Seventeen percent of the patients randomized to carotid endarterectomy were aged 75 or older, and 14% of patients randomized to medical therapy were in this age group. Although older patients were eligible for enrollment, no age-specific results were provided. Patients with moderate carotid stenosis had only a moderate reduction in stroke risk with endarterectomy, and patients with less than 50% stenosis had no benefit from operation.

The incidence of perioperative stroke in elderly patients has been reported to vary, from approximately 1% to 19%. [81–86] The highest stroke rate reported was 19.2% in 26 patients

older than 80 years, as compared with 2.2% in younger patients.[84] These strokes accounted for half of the strokes in the entire cohort of 254 patients. Other single-institution studies have reported postoperative combined stroke and death rates of 1.1%[85] and 2.9%[82] for patients aged 80 years and older. These studies reported stroke-free survival rates greater than 95%. A single-institution report on carotid endarterectomy in 58 patients 75 years and older showed a combined stroke and death rate of 6.4% and a rate of 3.2% in 115 younger patients, but this difference was not statistically significant.[81] There was no significant difference in cardiac morbidity between the two groups (7.9% for the older group and 7.2% for the younger patients).

In a statewide analysis of almost 10,000 patients undergoing carotid endarterectomy over a 5-year period, over half of the patients were aged 70 or older and 10% were aged 80 or older.[83] As patient age increased, so did medical complexity. There were no significant differences in stroke and mortality rates for patients younger than 65 (1.7%, 0.8%), aged 65 to 69 (1.6%, 0.9%), aged 70 to 79 (1.8%, 0.9%), or aged 80 and older (1.3%, 1.4%). However, lengths of stay and hospital charges were significantly higher in patients aged 70 and older. Examination of a sample of Medicare beneficiaries undergoing carotid endarterectomy found no increased stroke risk in patients over 80 years old;[86] however, the mortality risk was doubled.

To summarize the findings of recent research:

- Stroke is a significant source of morbidity and mortality in older people.
- Stroke can be prevented with appropriate performance of carotid endarterectomy.
- The results of carotid endarterectomy are similar across the age spectrum.

GenSurg 29 (Level B, then A): **Cohort studies followed possibly by randomized controlled trials are needed to determine beyond what age carotid endarterectomy is minimally or not beneficial.**

GenSurg 30 (Level B): **Prospective studies are needed to determine the incidence and prevalence of cerebrovascular disease in older patients. As with screening for other conditions, prospective studies are needed to evaluate the impact of screening for carotid disease on longevity, quality of life, stroke rate, and financial implications. Cohort studies are needed to determine if there is a subset of older patients (eg, smokers, those with hypertension) who benefit from screening for carotid disease.**

PERIPHERAL OCCLUSIVE DISEASE

As with cerebrovascular disease, elderly patients have an increased incidence of atherosclerotic disease of the lower extremities. In one study of patients undergoing lower-extremity bypass, patients aged 75 years and over represented 28% of all reconstructions during a 9-year period.[87] Among the group of 166 elderly patients undergoing lower-extremity revascularization, 26% had incapacitating claudication and 74% had critical limb ischemia as manifested by rest pain (20%) or ulceration or gangrene (54%). The perioperative mortality rate was 5.4%, and the early and late limb salvage rates were 93%

and 83%, respectively, in the elderly patients. One report of 108 patients aged 80 and over with more severe limb ischemia—all had rest pain and 40% presented with acute ischemia—found much worse results, with a limb salvage rate of only 51% and an overall mortality rate of 25%. [88] The limb salvage, amputation, and mortality rates were best for patients with chronic ischemia who underwent active treatment consisting of angioplasty, thrombolytic therapy, vascular reconstruction, or embolectomy. In contrast, limb salvage and amputation rates were the worst for patients with chronic ischemia who received only supportive care. The mortality rate was higher for patients with acute ischemia undergoing active treatment than for patients with chronic ischemia.

Choi et al analyzed data prospectively collected over a 10-year period on 629 consecutive patients aged 80 or older who underwent infrainguinal vascular reconstruction. [89] These elderly patients constituted 16% of the 3886 procedures performed. There were significantly lower proportions of males, patients with diabetes, and active smokers in the elderly age group than in the younger group. Sixty-eight percent of the older patients underwent reconstruction for tissue loss, as compared with 55% of patients younger than age 80. Only 4.5% of elderly patients underwent surgery for claudication, whereas in 14.6% of the younger patients this was the indication for surgery. Postoperative mortality was higher among the older patients, 4.6% versus 2.8%. Long-term patency and limb salvage rates were higher in the elderly patients; however, cumulative survival was significantly less.

A review of distal bypasses (below the tibioperoneal trunk) in 125 patients aged 75 and older found a limb salvage rate of 81.7% at 5 years and a cumulative graft patency rate of 81.6%. [90] The proportion of patients aged 85 and older progressively increased such that they accounted for 22% of all distal bypasses in the 75 and older group during the last 6 years of the study. The perioperative mortality was 8% in patients aged 75 and older. The primary cause of death was perioperative myocardial infarction. Of the 10 patients suffering myocardial infarction, 7 died.

Tretinyak et al administered the Medical Outcomes Study 36-item Short Form (SF-36) to 46 male veterans (mean age = 67 years) prior to and after lower-extremity bypass. [91] These patients had lower health-related quality-of-life scores than did age-matched controls, and following revascularization only physical function scores improved significantly. Using a different assessment tool, Gibbons et al administered a health status questionnaire to 276 patients undergoing infrainguinal bypass. [92] Among the 156 patients completing questionnaires before and 6 months after infrainguinal revascularization, significant improvements in the mean vitality, instrumental activities of daily living, mental well-being, and lower-extremity discomfort scores were reported after bypass surgery. There was no significant improvement in the mean general health rating.

To summarize the findings of recent research:

- The likelihood of critical limb ischemia increases with age.
- Good patency and limb salvage rates can be obtained.
- The primary cause of postoperative mortality is cardiac disease.

***GenSurg 31 (Level B)*: Cohort studies comparing the results of endovascular therapy, thrombolytic therapy, and interventional vascular radiology in older patients are needed.**

GenSurg 32 (Level B): **Cohort studies are needed to determine selection criteria for lower-extremity bypass in older patients.**

GenSurg 33 (Level B): **Exploratory studies (eg, case series, cohort studies, outcomes studies) are needed to learn how best to improve limb salvage rates in peripheral vascular disease in older patients.**

ABDOMINAL AORTIC ANEURYSM

Abdominal aortic aneurysm (AAA) repair has traditionally been associated with a high perioperative mortality, to be weighed against the fact that aneurysm rupture has a significant death rate. Recent studies have reported improved complication and death rates following aneurysm repair. In one, patients aged 80 and over undergoing elective repair were found to have a 3% postoperative mortality rate. [93] The perioperative mortality of patients undergoing emergency repair was found to be 20%. Other studies have also documented large differences in mortality and morbidity rates between elective and emergent AAA repair. [74,82,94] A report from Australia found no difference in the mortality rates for elective AAA repair between patients older than 80 years and patients younger than 80 years. [94] However, the mortality rate of emergency AAA repair was 60% for the patients older than 80 years but only 20% for the younger cohort. Comparison of long-term survival at 5 years in elderly patients undergoing elective AAA repair with survival of the general population (United States) matched for aged, sex, and race found no difference. [74]

Recently, endovascular repair of AAA has been proposed as a technique to diminish the morbidity and mortality and enhance recovery from AAA repair. Using a decision analysis model, Finlayson et al evaluated the effect of availability of endovascular repair on the threshold size for performing AAA repair. [95] The threshold aneurysm diameter for recommending endovascular repair was significantly reduced only in men aged 80 and over. However, this reduction of the threshold for repair resulted in only a small increase (0.2 years) in quality-adjusted life expectancy.

The costs of screening for and treating AAA in older people are substantial. When a simulation model incorporating several different screening scenarios is used, costs for screening by palpation and ultrasound for positive physical examination findings are estimated to lead to an estimated gain of 20 life-years (0.2 years per person) at $28,741 per life-year for a model cohort of 10,000 men aged 60 to 80 years followed for 20 years. [96] Screening by a single ultrasound would yield 57 additional life-years at a cost of $41,550 per life-year. A second ultrasound examination after 5 years would gain 1 life-year at an estimated cost of $906,769. This must be counterbalanced by the costs associated with emergent AAA repair. A cost analysis of Australian patients undergoing AAA repair found little difference in the cost of elective repair among patients younger than 80 years and those 80 years and older ($8081 and $10,305 per patient, respectively). [94] In contrast, the costs associated with emergency repair were $28,243 and $24,555 per patient for younger and older patients, respectively. However, the cost per survivor of emergency AAA repair was significantly higher for the older patients ($61,384) than for the younger patients ($35,303).

To summarize the findings of recent research:

- As with other conditions, emergency repair for AAA is associated with significantly higher rates of complications and death, as well as higher cost.

- Elective AAA repair in older patients has perioperative morbidity and mortality rates and a survival rate similar to that in younger patients.

GenSurg 34 (Level B): **Studies are needed to identify criteria for selecting patients who should be screened for abdominal aortic aneurysm and the screening methods to use.**

GenSurg 35 (Level A): **Randomized controlled trials are needed to compare results using newer endovascular repairs in elderly high-risk patients with results in traditional surgical abdominal aortic aneurysm repair.**

PRESSURE ULCERS

Pressure ulcers are due to prolonged periods of immobility. Elderly patients are at greater risk for this. Furthermore, the incidence of pressure ulcers in surgical patients is significantly higher than in other hospitalized populations. [97] Attempts to identify and prevent pressure ulceration in surgical patients have been difficult owing to the length of operative procedures, operating room bed design, and lack of knowledge about the intrinsic and extrinsic factors responsible for ulceration. A prospective study of a method for predicting pressure-ulcer development found no significant difference in the rate of ulceration between patients aged 65 years and older (22%) and patients younger than 65 (15%). [98] A randomized prospective trial found a 21.5% incidence of pressure ulcers, predominantly on the buttocks and coccyx, within 6 days of surgery. [97] The use of a special mattress overlay had no effect on the incidence of pressure ulceration.

To summarize: because of their general immobility, elderly patients undergoing surgery may be at increased risk for pressure ulceration.

GenSurg 36 (Level B): **Cohort studies are needed to suggest whether prevention and treatment strategies for pressure ulcers that are applicable to younger patients are also applicable to older patients.**

CHALLENGES IN GENERAL SURGERY FOR ELDERLY PATIENTS

Older people represent the fastest growing segment of the U.S. population. They also represent the segment most likely to require medical and surgical care. As shown in this review, in most instances the outcomes for elective operations in elderly patients are similar to those in younger patients. However, emergency procedures in the older people are associated with especially high rates of complications and death. The challenge is to identify at-risk patients and intervene before the condition necessitates emergency intervention.

In addition to this challenge, the role of emerging technology and techniques in caring for older patients remains poorly defined. In several instances, such as laparoscopic cholecystectomy and laparoscopic colectomy, this patient group appears to have benefited from the development of minimally invasive techniques. However, the place of other therapies, such as endovascular repair of aneurysms and gene therapy, is undefined.

KEY RESEARCH QUESTIONS IN GERIATRIC GENERAL SURGERY

***GenSurg KQ1*: How can elderly patients at high risk for emergency procedures be identified?**

Hypothesis-generating studies will require prospective cohort studies that determine the most common general surgical emergencies in older patients, the underlying causes of those emergencies, and whether the emergencies could be avoided. These conditions will probably include peptic ulcer disease, biliary disease, hernias, colonic disease, and trauma. It is essential that outcome measures are not limited to the usual surgical indices, that is, 30-day morbidity and mortality figures. In the older population, the measures must also include long-term outcomes, quality of life, and the effect of these interventions on the families.

Hypothesis-testing studies would be based on relationships delineated in the hypothesis-generating studies. The success of the therapies for preventing or lessening the impact of these conditions would be the basis for clinical trials. For example, elderly patients present with a greater proportion of complicated biliary disease. If specific factors associated with complicated biliary disease were identified, then a trial of intervention to ameliorate those factors could be undertaken. The same would occur for other diseases associated with a significant incidence of emergency presentations and high morbidity and mortality, such as ulcer disease and gastrointestinal hemorrhage. In addition, when high-risk patients are identified, outcomes for different treatment modalities can be compared in prospective trials.

***GenSurg KQ2*: What are the differences in pathophysiology of the disease processes in the older patient leading to surgical emergencies?**

Hypothesis-generating studies would require large, prospective databases and cohort studies similar to those for GenSurg KQ1. This priority also requires measurement of physiologic, biochemical, immunologic, and genetic variables to determine the underlying physiologic differences of biliary disease, ulcer disease, and other gastrointestinal abnormalities that commonly require emergent intervention.

Hypothesis-testing studies would be based on the findings generated by the cohort studies. For example, is there a specific protein, hormone, or other factor that accounts for a higher incidence of complicated biliary disease in older people? Once the pathologic "factor" is identified, randomized trials of treatments manipulating the factor could be undertaken. Several areas of research appear promising at this time: the molecular biology of aging, the effects of malnutrition, the impaired immune response in the older patient, and infectious disease, especially viral disease and susceptibility to "normal" pathogens.

***GenSurg KQ3*: What factors impact on procedure-specific risk-benefit projections in elderly patients?**

Hypothesis-generating studies will require the use of existing databases, the development of newer prospective databases, and prospective cohort

studies. Current databases that could be accessed include the American College of Surgeons Tumor Registry, the National VA Surgical Quality Improvement Program, and the Centers for Medicare and Medicaid Services. Newer databases would need to be developed that incorporate information related to elderly patients. Input variables would include demographics, specific comorbidities, specific procedural data, and outcomes such as morbidity, mortality, discharge destination, quality of life, and functional status. From these studies, specific factors and procedure-related outcomes could be categorized.

Hypothesis-testing studies would be based on factors and outcomes following the above studies. Large, multi-institutional randomized clinical trials would be required to answer such questions as these: At what age (in the absence of other comorbidities) do the risks of carotid endarterectomy outweigh the benefits? When does screening mammography cease to be effective from the standpoint of breast cancer mortality or cost?

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