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CROSS-CUTTING ISSUES

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Conservative estimates in the United States predict that the number of persons aged 65 years and over will grow from 35 million in 2000 to 78 million in 2011, accounting for more than 20% of the overall population. [1] The number of those aged 85 years and over will grow from 4 million to 18.2 million. If life expectancy continues to increase at the same rate seen in the 1990s, the number of oldest old could balloon to 31.2 million by the year 2050.

Many of our older citizens will require hospitalization for medical and surgical conditions. In 1996, people over 65 years of age accounted for 35% of all of the inpatient and outpatient operations performed in this country. [2] In 1998, people over 65 years of age accounted for 39% of all hospital admissions. [3] Of the 39%, patients older than 85 years accounted for 11.6% of the procedures. For the twelve most common procedures chosen for each age group, elderly patients averaged 747 procedures per 100,000. Averages per 100,000 for the rest of the population were 75 for those under 15 years, 204 for those between 15 and 44 years, and 338 for those between 45 and 64 years.

In general, elderly patients are more susceptible to many perioperative problems and complications, including any or all of the following: acute renal failure, adverse drug events (incidence 10% to 15%), [4,5] functional decline due to deconditioning and immobility (incidence 32%), [6,7] dehydration (prevalence 7%), [8] delirium (10% to 50% in postoperative patients), [9] depression, [10] falls (incidence 4 to 11 per 1000 patient days), [11] incontinence (prevalence 11% on admission and 23% on discharge), [12] infection (especially pneumonia and urinary tract infection), malnutrition (prevalence as high as 61%), [13,14] pressure ulcers (incidence 3%), [15] and untreated or undertreated pain syndromes.

Because of the enormous public health burden imposed by the growing elderly population and the urgent need for research progress in this area, the American Geriatrics Society, with funding from the John A. Hartford Foundation, convened representatives from the following surgical and related medical subspecialties: anesthesiology, cardiac surgery, emergency medicine, general surgery, gynecology, ophthalmology, orthopedic surgery, otolaryngology, physical medicine and rehabilitation, thoracic surgery, and urology. This research agenda–setting group was charged with evaluating the current state of knowledge to identify critical gaps in our knowledge and to develop specific recommendations to promote research into the problems of older citizens having surgical procedures. One key point emerged during these discussions—many facets of aging processes influence the diagnosis and treatment of older patients in more than one specialty. It was decided to address these cross-cutting issues together, rather than addressing them repeatedly and

separately in the specialty chapters. This chapter is a summary of the areas that cross multiple specialties and have impact on nearly all older surgical patients.

References

1. Statistical Abstract of the United States 1998: The National Data Book. Washington D.C.: Bernan Press. U.S. Department of Commerce, Bureau of Census, 1998.
2. Dennison C, Pokras R. Design and operation of the National Hospital discharge Survey: 1988 redesign. Vital Health Stat 2000;1(39).
3. Owings MF, Kozak LJ. Ambulatory and Inpatient Procedures in the United States, 1996. National Center for Health Statistics. Vital Health Stat 13(139), 1998.
4. Gray SL, Sager M, Lestico MR, Jalaluddin M. Adverse drug events in hospitalized elderly. J Gerontol A Biol Sci Med Sci 1998;53:M59-M63.
5. Leape LL, Brennan TA, Laird N, et al. The nature of adverse events in hospitalized patients. results of the Harvard Medical Practice Study II. N Engl J Med 1991;324:377-384.
6. Hansen K, Mahoney J, Palta M. Risk factors for lack of recovery of ADL independence after hospital discharge. J Am Geriatr Soc 1999;47:360-365.
7. Sager MA, Franke T, Inouye SK, et al. Functional outcomes of acute medical illness and hospitalization in older persons. Arch Intern Med 1996;156:645-652.
8. Warren JL, Bacon WE, Harris T, et al. The burden and outcomes associated with dehydration among US elderly, 1991. Am J Public Health 1994;84:1265-1269.
9. Inouye SK. Delirium in hospitalized elderly patients: recognition, evaluation, and management. Conn Med 1993;57:309-315.
10. Holmes J, House A. Psychiatric illness predicts poor outcome after surgery for hip fracture: a prospective cohort study. Psychol Med 2000;30:921-929.
11. Mahoney JE. Immobility and falls. Clin Geriatr Med 1998;14:699-726.
12. Palmer MH, McCormick KA, Langford A, et al. Continence outcomes: documentation on medical records in the nursing home environment. J Nurs Care Qual 1992;6:36-43.
13. Covinsky KE, Martin GE, Beyth RJ, et al. The relationship between clinical assessments of nutritional status and adverse outcomes in older hospitalized medical patients. J Am Geriatr Soc 1999;47:532-538.
14. Reuben DB, Greendale GA, Harrison GG. Nutrition screening in older persons. J Am Geriatr Soc 1995;43:415-425.
15. Williams S, Watret L, Pell J. Case-mix adjusted incidence of pressure ulcers in acute medical and surgical wards. J Tissue Viability 2001;11:139-142.

PHYSIOLOGIC CHANGES IN ORGAN SYSTEMS

The effects of aging on the cardiovascular, pulmonary, nervous, and renal systems are described in Chapter 2, Geriatric Anesthesia.

CELLULAR AND MOLECULAR CHANGES WITH AGING

The major principle underlying adverse changes with aging is that evolutionary pressure results in the selection of biochemical mechanisms that are beneficial in young organisms and that support reproduction, while it ignores their effects in older, postreproductive organisms. [1] Those effects are often deleterious. Important examples of "antagonistic

pleiotropy" are apoptosis and cellular senescence. Another example is enhanced oxidative stress imposed by an increased rate of generation of reactive oxygen species (ROS) in aging mitochondria and decreased ROS-scavenging activity in the older organism. As a result, there is an age-related increase in cellular inflammatory components, including nuclear factor kappa B (NF-kappa B), activator protein-1 (AP-1), and hypoxia inducible factor (HIF-1). Further, ROS damage lipid membranes, proteins, the endoplasmic reticulum, and both nuclear and mitochondrial DNA, particularly the latter. Notably, all of these deleterious effects are less prominent in the calorie-restricted organism, and this is thought by many to be the mechanism for improvements in health and longevity in many calorie-restricted experimental animals.

The deleterious effects of accumulation of ROS are perhaps the most dramatic at neuronal synapses where nerve cell mitochondria are concentrated, leading to a focal accumulation of ROS bordering the synapse. On the other hand, the adverse changes accompanying brain aging are at least partially mitigated by adaptive mechanisms, especially increases in the production of neurotrophic factors, chaperones (heat-shock proteins), antioxidant enzymes, Bcl-2, and a protein that inhibits apoptosis. In *Caenorhabditis elegans,* heat-shock protein (HSF-1) and other molecular chaperones appear to foster longevity.

Another aspect of the biology of aging is impairment of angiogenesis in aged tissues. This is the result of poorly understood changes at molecular and cellular levels as well as at physiologic levels of regulation. Whatever the exact mechanism, endothelial cells, the hemostatic cascade, neurochemical mediators, and growth factors are all affected, and the ultimate result is delayed and impaired neovascularization and hence halting repair of injured tissues. [2]

Immunologic cellular mechanisms also change dramatically with aging. Graham et al have summarized the known changes in immunologic cellular mechanisms and the response to environmental changes. [3] Experiments include cultures of cells harvested from elderly volunteers and rodent models. There is evidence for T-cell and accessory-cell decline with age. Monocytes are clearly compromised in their function in the elderly specifically; they secrete less interleukin-1 and have decreased cytotoxicity and protein kinase translocation. [4] Disturbed signal transduction probably causes incomplete T-cell activation. Compromised T-cell activation in the elderly person is reflected in findings that cell surface alterations associated with activation are affected. For example, CD69 and CD71 upregulation does not take place. [5]

Damage to the cytoskeleton, paralleling aging may have profound effects on cell function. Cell cycle analyses of phytohemagglutinin (PHA)-stimulated cells from aged donors indicate a decreased frequency of cells entering S-phase with this age-related impairment of G1 progression correlating with decreased expression of c-jun, c-myc, c-myb, interleukin-2, and CD25. [6]

Aberrations in co-stimulatory pathways and receptors lead to compromised T-cell responses. Elderly cells, like certain other anergic (young) cells, may be able to actively suppress other cells in a mixed population, cells that otherwise would be capable of proliferation. [7] It has been long believed that a major dysfunction in T cells from elderly donors is a selectively decreased ability to secrete T-cell growth factors.

Many studies confirm that T cells from aged humans can also show defects in interleukin-2R expression, interleukin-2 secretion, and DNA synthesis after stimulation

with mitogens like PHA. [3] Among the transcription factors of known importance for interleukin-2 production, CD3-stimulated induction of NF-kappa B was also found to be decreased in old mice and humans. [8,9] One reason for insufficient NF-kappa B activation may be that the natural inhibitor I-kappa B is not adequately degraded because of compromised proteosome function. [8] As well as altered cytokine levels in aging, altered levels of cytokine antagonists might also influence cytokine networks.

> *CCI 1 (Level B)*: **Further basic scientific research should be carried out to better define the mechanisms and importance of cellular and molecular changes with aging, especially apoptosis, cellular senescence, the pathogenesis of nerve cell loss, the control over vascular repair and angiogenesis, and the impairment of immunologic cell function. Where possible, research should seek clues to the failure of older tissues to withstand stress as well as younger tissues.**

References

1. Campisi J. Cellular senescence and apoptosis: how cellular responses might influence aging phenotypes. Exp Gerontol 2003;38:5-11.
2. Edelberg JM, Reed MJ. Aging and angiogenesis. Front Biosci 2003;8:s1199-1209.
3. Pawelec G, Remarque E, Barnett Y, Solana R. T cells and aging. Front Biosci 1998;3:d59-d99.
4. Beckman I, Dimopoulos K, Xu XN, et al. T cell activation in the elderly: evidence for specific deficiencies in T cell/accessory cell interactions. Mech Ageing Dev 1990;51:265-276.
5. Lio D, Candore G, Cigna D, et al. *In vitro* T cell activation in elderly individuals: failure in CD69 and CD71 expression. Mech Ageing Dev 1996;89:51-58.
6. Pieri C, Recchioni R, Moroni F, et al. Phytohemagglutinin induced changes of membrane lipid packing, c-myc and c-myb encoded protein expression in human lymphocytes during aging. Mech Ageing Dev 1992;64:177-187.
7. Lombardi G, Sidhu S, Batchelor R, Lechler R. Anergic T cells as suppressor cells *in vitro*. Science 1994;264:1587-1589.
8. Trebilcock GU, Ponnappan U. Induction and regulation of NFkappaB during aging: role of protein kinases. Clin Immunol Immunopathol 1996;79:87-91.
9. Trebilcock GU, Ponnappan U. Evidence for lowered induction of nuclear factor kappa B in activated human T lymphocytes during aging. Gerontology 1996;42:137-146.

STRESS RESPONSE AS A FUNCTION OF AGING

At a clinical level, there have been innumerable observations, though no well-designed cohort studies, suggesting that older patients have a blunted response to stress and protracted recovery times. Many surgeons relate anecdotal stories of elderly patients who deteriorate for unclear reasons after what would have been a well-tolerated stress in a younger patient. On the other hand, some older patients seem to recover from major surgery with relatively little evidence of physiologic stress. The stress response is manifest in many organs and systems in the body and is accompanied by a complex interplay of adaptive and deleterious factors. Because the total organism is affected, it has been very difficult to explain why, on the average, the defense against stress is weaker in older patients than in younger ones.

Real proof that the stress response is detrimental remains elusive. Indirect evidence would be afforded if regional analgesia could be shown to attenuate the stress response

and minimize complications and mortality as compared with systemic anesthesia. There have been many well-designed and well-executed studies of this type, with somewhat conflicting results, [1] but meta-analyses have led to the conclusion that there is very little if any benefit afforded by the lesser stress of regional analgesia. [2] (See also the section on regional versus general anesthesia in Chapter 2, Geriatric Anesthesia.)

Many studies discuss the aging process in relation to specific organs, but few address the aging process in detail for the whole organism. There is a complex interplay between systems that requires exposition. Since the aging process is not static, the response to surgical stress will change as a function of age. Studies need to address the dynamic changes in overall function with aging. Little is known about the changes in functional reserve and how the body responds, or not, to multiple challenges. Aged animals or animal models that mimic the aging process are necessary to quantify these responses.

ALLOSTATIS AND HOMEOSTENOSIS

McEwen has attempted to develop a framework for understanding the response to stress. [3] His concept is that an acute stress, such as a surgical operation, particularly activates the neuroendocrine system, the autonomic nervous system, and the immune system; this response is called *allostasis*, meaning "maintaining stability through change." In this response, epinephrine, cortisol, and several cytokines act on receptors in various tissues to initiate defenses against trauma to the body. These responses are adaptive in the short run but may become damaging if not terminated on time. If they continue, they may produce down-regulation of receptors and actual tissue damage; this process is called *allostatic load*, meaning "the cost of an overactive, prolonged, or inefficiently managed allostatic response." McEwen speculates that such abnormal responses might be characteristic of older persons. An example of damaging effects from stress turned chronic is the subtle increase in integrated daily plasma cortisol levels that is present in many older people. This is thought to contribute to the memory loss of aging as a result of the well-established adverse effects of extra cortisol on the hippocampus. This is the only reasonably firm evidence thus far that the stress reaction is harmful.

In addition, the acute allostatic response may be weaker in the aged patient because of impairments in various organ systems. Thus, deflections from the norm are often greater and the return to the norm slower. This phenomenon has been referred to as the *homeostenosis* of aging. Specific deficiencies that contribute to age-related homeostenosis in the fluid and electrolyte sphere include impaired thirst perception, decreased glomerular filtration rate, increased secretion of antidiuretic hormone and atrial natriuretic peptide, dysregulation of aldosterone secretion, decreased urinary concentrating ability, and impairment of renal excretion of water, sodium, potassium, and acid. [4]

A major surgical operation is a classic example of a stress with predictable deflections from the homeostatic norm. The metabolic characteristics of the postoperative state were described in a remarkable series of publications by Francis Moore and his colleagues in the period from 1948 to 1965. These findings have been confirmed and extended since then. [4] The key features of the postoperative state are sodium and water retention, potassium loss, catabolism, and rapid loss of dry weight.

Another important aspect of homeostasis is the maintenance of normal levels of intracellular calcium ions. Although there are age-related declines in various components of calcium movement systems, compensatory mechanisms seem to be capable of main-

taining overall intracellular calcium ion homeostasis. The effect of surgical stress on the calcium content of various intracellular compartments has not been well studied.

ENDOCRINE AND METABOLIC RESPONSE

Sympathetic Nervous System and Catecholamines

An acute stress, such as a major operation, activates the sympathetic nervous system and the adrenal medulla. These responses are exaggerated in elderly patients, who carry higher levels of norepinephrine in the nonstressed state and show an overreaction after stress. To a greater extent, the elevated plasma levels are a compensatory response to impaired adrenergic receptor and postreceptor function throughout the body. However, this analysis does not apply to epinephrine, whose secretion is decreased in older patients, both in the nonstressed and stressed state. The sympathetic nervous system is similar to the norepinephrine part of the equation: its basal activity is greater and activation is more vigorous in older patients than in younger ones, but sympathetic nervous system effects are no greater because aged organs are hyporesponsive to sympathetic stimuli. Because of the reduced secretion of epinephrine and impaired β-adrenergic receptor function, receptor-mediated vasorelaxation is impaired in older patients, as is cardioacceleration in response to exercise or other stress.[5] In addition, arterial baroreceptor function is decreased in older people, a phenomenon correlated with increased arterial stiffness and resulting in impaired responses to hypertensive and hypotensive drugs in older patients. Interestingly, habitual exercise results in improvement by about 50% in the baroreceptor sensitivity in older persons, but tonic sympathetic nervous system activity is higher than in younger adults in those who exercise as well as in those who do not.

Adrenocortical Hormones

While plasma cortisol levels rise subtly and those of aldosterone fall slightly, the plasma level of dehydroepiandrosterone (DHEA) and its sulfate plummet with age to 10% to 20% of their levels in young adults. On the basis of research in rodents and observational correlation studies in the human, it seems that this fall might predispose the older patient to age-associated increases in the incidence of diabetes mellitus, cancer, heart disease, and immunologic deficiency. However, randomized controlled trials of DHEA replacement therapy in older men and women have yielded mixed results, so that recent authors have been forced to conclude that there is no scientific basis for recommending widespread use of DHEA replacement in older adults.[6] It is important to note, however, that DHEA is present in the brain in concentrations that do not correlate with plasma levels and accordingly is probably synthesized in the brain, where it may have beneficial effects on cognitive function.

The glucocorticoid system has a different setting in older humans (and other primates) than in youth. The hypothalamo-pituitary-adrenal axis is more resistant to suppression by dexamethasone in older than in younger adults. Also, adrenocorticotropic hormone administration causes a greater rise in plasma cortisol. Circadian variation is blunted; afternoon cortisol levels do not fall as they do in younger people. This pattern is similar to that which accompanies depression and also is suggestive of chronic stress (allostatic load).

Gonadal Steroids

Older women are severely deficient in both estrogen and testosterone, so any further fall that might occur as a result of surgical stress would probably have no significant effect. However, their chronic deficiency of anabolic hormones might set the stage for a greater catabolic response to surgery than would occur in older men. There are no published studies bearing on this speculation. On the other hand, older men actually have higher plasma estradiol than older women and have very much higher plasma testosterone and free testosterone levels, as a result of the slow pace of the andropause ("male menopause"). Some older men do have plasma testosterone levels in the frankly hypogonadal range, and these patients may be candidates for testosterone replacement therapy, although there is no consensus on this as yet.

Trauma leads to a short-term decline in estrogen and testosterone production. It is conceivable that older men and women would benefit from a short course of testosterone or other anabolic steroid to combat the postoperative catabolic state, but there is no firm evidence on this as yet.

Pituitary Growth Hormone

Older people experience a decline in growth hormone secretion and in plasma insulin-like growth factor-1 concentration. Because of the high frequency of significant sarcopenia and weakness in older patients, many seniors are treated with intramuscular growth hormone. There is no solid clinical evidence to support this practice, and, in fact, there is strong evidence that muscle strength does not improve with replacement doses of growth hormone. Acute stress leads to a further decline in growth hormone production, and short-term growth hormone therapy has been suggested. However, one randomized controlled trial of growth hormone treatment in supraphysiologic doses for intensive-care-unit medical patients actually showed increased mortality in the treated group. [7] No randomized controlled trials could be found in which one group of elderly postoperative patients was injected with placebo and one with human growth hormone.

For further information on the postoperative catabolic state, see Chapter 2 on anesthesia in older patients. To summarize our scanty knowledge: Major surgery leads to a profound catabolic state manifested by sarcopenia and weakness. Its severity is correlated with age, comorbid diseases, a sedentary lifestyle, and malnutrition. Management of the latter three factors preoperatively and postoperatively is helpful, but no such therapy has been shown to prevent catabolism completely. Pituitary hormone output is low in critical illness as a result of decreased hypothalamic output of releasing hormones. Administration of multiple releasing factors (growth hormone secretogogues, thyrotropin-releasing hormone, and gonadotropin-releasing hormone) induces anabolism and gives promise as a method to present the wasting syndrome. [8] Much research is needed to guide management of the elderly postoperative patient. Our knowledge to date indicates that early mobilization may be helpful in minimizing loss of muscle, weakness, and functional decline.

Immunologic Response

As described above, aging is associated with depressed immune function, and surgery causes a further depression at least as great in older patients as in younger patients. [9] General anesthesia and the stress of the operation independently depress the immune

system. [1,10] Both humoral and cellular immune functions are affected, including suppression of natural killer cell function that may lead to an increased risk of metastases during tumor removal. Additionally, depressed immune function is associated with aging. [10] Presumably these effects contribute to higher infection rates in elderly patients, though a causal relationship has not been established between depressed cell counts or other isolated laboratory results and adverse postoperative outcomes. Attempts to enhance immune function in the perioperative period with nutritional supplements [11] or thymopentin [12] have demonstrated improved delayed-type hypersensitivity responses and other positive laboratory findings, but no study has examined the ability of such regimens to decrease postoperative infections.

> *CCI 2 (Level B)*: **There is urgent need for studies comparing cohorts of younger and older patients having the same operation, or at least operations of comparable stress, in which a vast array of measures would be made of components of the stress response and of clinical outcomes immediately postoperatively and serially over the next 2 months or more.**

> *CCI 3 (Level B)*: **In studies designed like those described in CCI 2, there should be a focus on identifying the mechanisms for ending the acute stress response and how they are altered with aging. This can be done by looking for correlates of the acute response, the turning off of the acute response, and the degree of allostatic load.**

> *CCI 4 (Level A)*: **Interventions designed to minimize the stress of surgery or maximize the defenses of older patients should be tested in randomized controlled trials of older patients (ideally stratified into frail and nonfrail) undergoing a common major operation, such as open colon resection or aortic aneurysm repair.**

> *CCI 5 (Level A)*: **The efficacy of long-term replacement doses of estrogen, androgen, dehydroepiandrosterone, and growth hormone aiming to prevent frailty in older people has been difficult to establish. Randomized controlled trials are needed on the short-term use of these hormones, singly or in combinations, preoperatively and postoperatively, in attempts to blunt the catabolic and other possibly deleterious aspects of the postoperative stress response.**

> *CCI 6 (Level A)*: **Randomized controlled trials with sufficient numbers of patients, especially elderly patients, are needed to establish firmly whether early or ultra-early ambulation programs improve postoperative recovery, complication rates, lengths of stay, and patient satisfaction. The effect of early ambulation needs to be dissected out from the package of accelerated rehabilitation programs. Later, the other components of these packages can be studied singly and in combination, again by randomized controlled trials wherever possible.**

CCI 7 (Level B): **Further exploratory work is necessary to evaluate general and specific stimulators and suppressors of the inflammatory and immune responses to stress.**

References

1. Liu S, Carpenter RL, Neal JM. Epidural anesthesia and analgesia: their role in postoperative outcome. Anesthesiology 1995;82:1474-1506.
2. Rodgers A, Walker N, Schug S, et al. Reduction of postoperative mortality and morbidity with epidural or spinal anaesthesia: results from overview of randomised trials. BMJ 2000;321: 1493.
3. McEwen BS. Interacting mediators of allostasis and allostatic load: towards an understanding of resilience in aging. Metabolism 2003;52:10-16.
4. Luckey AE, Parsa CJ. Fluid and electrolytes in the aged. Arch Surg 2003;138:1055-1060.
5. Schutzer WE, Mader SL. Age-related changes in vascular adrenergic signaling: clinical and mechanistic implications. Ageing Res Rev 2003;2:169-190.
6. Legrain S, Girard L. Pharmacology and therapeutic effects of dehydroepiandrosterone in older subjects. Drugs Aging 2003;20:949-967.
7. Ruokonen E, Takala J. Dangers of growth hormone therapy in critically ill patients. Curr Opin Clin Nutr Metab Care 2002;5:199-209.
8. Van den Berghe G. Endocrinology in intensive care medicine: new insights and therapeutic consequences. Verh K Acad Geneeskd Belg 2002;64:167-187; discussion 187-188.
9. Rinder CS, Mathew JP, Rinder HM, et al. Lymphocyte and monocyte subset changes during cardiopulmonary bypass: effects of aging and gender. J Lab Clin Med 1997;129:592-602.
10. Verhoef J. Transient immunodepression. J Antimicrob Chemother 1990;26 Suppl C:23-29.
11. Tepaske R, Velthuis H, Oudemans-van Straaten HM, et al. Effect of preoperative oral immune-enhancing nutritional supplement on patients at high risk of infection after cardiac surgery: a randomised placebo-controlled trial. Lancet 2001;358:696-701.
12. Faist E, Ertel W, Salmen B, et al. The immune-enhancing effect of perioperative thymopentin administration in elderly patients undergoing major surgery. Arch Surg 1988;123:1449-1453.

WOUND HEALING

Healing in the human body is a formidable process even in the young patient. In the older patient, minimal trauma may become a challenge for survival. Failure of wound healing in the elderly person is a chronic disabling condition; it occurs commonly in our society, requiring a major investment of medical care.

Wound healing may be impaired as a result of an inability to adequately express genes that facilitate escape from cell stasis by initiating cell division, thus commencing the healing process.[1] Many of the processes involved in wound healing are impaired in elderly persons. Using an animal model to study cellular proliferation, Marcus et al showed significantly higher proliferative indices in the young that were found to be sustained through 4 weeks while levels substantially declined in the aged.[2] However, in elderly patients not suffering from concomitant diseases, the rate of wound healing is normal or only slightly reduced.[3]

Although there have been many human, animal, and cell culture studies, no consensus exists on the ability of older organisms to heal an acute wound. Not only various systemic factors such as endocrine and hematologic diseases, nutritional deficiencies, and medications but also regional disorders such as vascular and neural diseases may impair wound

healing. [4] These complicating conditions occur more commonly in aged subjects, thus rendering interpretation of human studies more difficult.

Nagy et al studied young and old patients who had sustained penetrating trauma and found that older patients have a poorer prognosis, longer stays in the hospital, and more protracted rehabilitation. [5] These researchers noted that elderly patients who sustain penetrating trauma have more comorbidities than their younger counterparts and concluded that this accounts for the older patients' longer hospital stay and lesser ability to be discharged home. However, the elderly patients studied were not found to have an increased complication rate. The findings suggest that improved wound healing for the elderly patient may require improved clinical approaches.

Specific tissues have been evaluated. One of the easiest to study is the skin. Age-related changes in the structure and function of the skin do occur. Some of these changes result from chronic solar radiation exposure rather than chronologic age alone. [3] The tensile strength of wounds, accumulation of wound-healing factors, and rate of wound closure have all been examined in relation to chronologic aging. However, the clinical impact of these changes in acute wound healing is small.

Poor healing in chronic wounds may be more often related to comorbid conditions than to age alone. The fact that the majority of chronic wounds occur in elderly populations has contributed to the conclusion that aging itself may influence healing. Holt et al made small epithelial defects on the legs of young and old volunteers and studied the rate of collagen production. [6] They found that in healthy humans, aging leads to delayed epithelialization. No effect of age on collagen synthesis was noted, although accumulation of wound noncollagenous protein was decreased. They postulated that this decrease might impair the mechanical properties of scarring in aged human beings. In studying the extracellular matrix of the skin, Meyer and Stern found that neither the concentration nor polymer size of hyaluronan changes as a function of age. [7] However, enhanced association with the tissue occurs, presumably through hyaluronan-binding proteins and alterations in the histolocalization of hyaluronan. Such observations may underlie some of the changes in human skin that occur with aging. Ballas and Davidson suggested that proteolysis might have a significant role in delayed wound healing in aged animals. They looked at fibroblasts from normal skin and from granulation tissue. [8] They noted that although granulation tissue fibroblasts from young and old rats show similar collagen gel contractility, skin fibroblasts from old rats display greater collagen gel contractile behavior than young skin fibroblasts. Greater gel contractility of fibroblasts from old rats appear to result, in large part, from the ability of those cells to cause generalized gel degradation. Gelatin zymography indicated a greater abundance of matrix metalloproteinase-2 in supernatants from gels containing skin fibroblasts from old rats. Taken together, these results suggest that the age-associated healing delay in the rat may not be related to the appearance or abundance of distinct myofibroblast or apoptotic cell populations

Other tissues have been studied. Following tooth extraction, alveolar bone was found to heal at the same rate in both young and old persons. [9] However, the chondrogenic potential of periosteal tissue from long bones declines significantly with age. [10] Even within certain healing tissues there may be a dual population of cells. Stanley and Osler took biopsies from venous ulcers and noted that the nonhealing ulcers had a higher percentage of cells that demonstrated in-vitro metabolic senescence. [11] But Serletti et al, treating musculoskeletal defects in patients with vascular disease, noted that free-tissue transfer in

the elderly population demonstrates success rates similar to those of the general population. [12]

Local tissue oxygenation may be affected by age. Xia et al studied the effect of hypoxia on migration of keratinocytes isolated from human donors of increasing age. [13] The keratinocytes from elderly donors were found to have depressed migratory activity when exposed to hypoxia, as opposed to an increase in migration in young cells. This same group then studied enhancement of sluggish senescent healing by hyperbaric oxygen or transforming growth factor, or both. [14] They noted that the greatest improvement is from hyperbaric oxygen alone.

Over the years, it has been postulated that exogenous hormone therapy might be beneficial for improving well-being and possibly helping wound healing. Isolated reports have suggested that this might be true. The decrease in testosterone levels with age is both central (pituitary) and peripheral (testicular) in origin. [15] Because serum levels of sex-hormone-binding globulin increase with aging, the decrease in free testosterone is of even greater magnitude. Some have proposed that preoperative administration of exogenous testosterone should be routine, but the evidence supporting this is far from conclusive. [16] Exogenous administration of estrogen for women has not been effective. [16]

> ***CCI 8 (Level B)***: **Clinical cohort studies should address whether it is possible to stimulate or accelerate wound healing by the use of hormones systematically or locally. Attention should also be paid to "overshoots," such as the occurrence of hyperplasia that may continue unabated, to the detriment of the organism.**

> ***CCI 9 (Level A)***: **Depending on the findings in cohort studies about the use of hormones to stimulate wound healing (CCI 8), selective randomized controlled trials should be conducted to test the performance of the most promising interventions.**

References

1. Kudravi SA, Reed MJ. Aging, cancer, and wound healing. In Vivo 2000;14:83-92.
2. Marcus JR, Tyrone JW, Bonomo S, et al. Cellular mechanisms for diminished scarring with aging. Plast Reconstr Surg 2000;105:1591-1599.
3. Thomas DR. Age-related changes in wound healing. Drugs Aging 2001;18:607-620.
4. Van de Kerkhof PC, Van Bergen B, Spruijt K, Kuiper JP. Age-related changes in wound healing. Clin Exp Dermatol 1994;19:369-374.
5. Nagy KK, Smith RF, Roberts RR, et al. Prognosis of penetrating trauma in elderly patients: a comparison with younger patients. J Trauma 2000;49:190-193; discussion 193-194.
6. Holt DR, Kirk SJ, Regan MC, et al. Effect of age on wound healing in healthy human beings. Surgery 1992;112:293-297; discussion 297-298.
7. Meyer LJ, Stern R. Age-dependent changes of hyaluronan in human skin. J Invest Dermatol 1994;102:385-389.
8. Ballas CB, Davidson JM. Delayed wound healing in aged rats is associated with increased collagen gel remodeling and contraction by skin fibroblasts, not with differences in apoptotic or myofibroblast cell populations. Wound Repair Regen 2001;9:223-237.
9. Amler MH. Age factor in human alveolar bone repair. J Oral Implantol 1993;19:138-142.

10. O'Driscoll SW, Saris DB, Ito Y, Fitzimmons JS. The chondrogenic potential of periosteum decreases with age. J Orthop Res 2001;19:95-103.
11. Stanley A, Osler T. Senescence and the healing rates of venous ulcers. J Vasc Surg 2001;33:1206-1211.
12. Serletti JM, Higgins JP, Moran S, Orlando GS. Factors affecting outcome in free-tissue transfer in the elderly. Plast Reconstr Surg 2000;106:66-70.
13. Xia YP, Zhao Y, Tyrone JW, et al. Differential activation of migration by hypoxia in keratinocytes isolated from donors of increasing age: implication for chronic wounds in the elderly. J Invest Dermatol 2001;116:50-56.
14. Bonomo SR, Davidson JD, Tyrone JW, et al. Enhancement of wound healing by hyperbaric oxygen and transforming growth factor beta3 in a new chronic wound model in aged rabbits. Arch Surg 2000;135:1148-1153.
15. Basaria S, Dobs AS. Hypogonadism and androgen replacement therapy in elderly men. Am J Med 2001;110:563-572.
16. Shackelford DP, Lalikos JF. Estrogen replacement therapy and the surgeon. Am J Surg 2000;179:333-336.

PHARMACOLOGY

There is a lengthy history of original research, review articles, editorials, and textbook chapters focusing on use of pharmaceuticals by elderly patients. The body of work includes descriptions of the pharmacokinetics and pharmacodynamics of specific drugs in older people and inappropriate medication use . Most of this literature is descriptive; there are few analytic studies. The available experimental studies are mostly evaluations of the efficacy of therapeutics for specific conditions. Studies that examine the impact of organizational interventions, such as computerized patient order entry, to reduce prescribing errors, improve patient safety, and introduce systems to assure quality are new additions to the literature. The largest category of the pharmacologic literature in geriatrics focuses on suboptimal prescribing and adverse drug events; common topics include the misuse, overuse, or underuse of pharmaceuticals; polypharmacy; and drug-disease or drug-drug interactions. (For additional relevant discussion, see Chapter 2, Geriatric Anesthesia.)

MISUSE, OVERUSE, AND UNDERUSE OF MEDICATIONS

Inappropriate medication use by community-dwelling older persons is common. Hanlon et al analyzed information from the Duke Established Populations for Epidemiologic Studies of the Elderly, rounds two (1989–90) and three (1992–93). [1] They report rates of inappropriate drug use of 27% and 22.5%, respectively. Inappropriate use was determined by use of the Beers criteria. [2] One limitation of these criteria is the paucity of evidence on the use of many medications among elderly people since they commonly are excluded from clinical trials. The latest version of inappropriate drug use criteria was published in 1997 [3] and is used currently to measure quality of care. Chin et al showed that in one setting, 10.6% of patients were taking a potentially inappropriate medication on presentation to the emergency department. [4] Of these, 3.6% were given the inappropriate medication in the emergency department and 5.6% were prescribed one at discharge. Though not as common as potentially inappropriate medications, drug-disease interactions are not uncommon. As new drugs become available, a mechanism must be established to update the current criteria. Naranjo et al [5] proposed a method for estimating the probability of adverse drug

reactions in 1981, but this work needs updating. Cluff as far back as 1965 recommended surveillance methods. [6] This, too, is an area of needed inquiry.

Overuse by elderly persons of both prescription and nonprescription drugs is seen with increasing frequency. Causes are multifactorial and include redosing because of forgetfulness or lack of perceived effect of prescribed doses and self-medication with over-the-counter remedies.

Underuse of effective medications by older patients—for example, angiotensin-converting enzyme inhibitors for congestive heart failure—has been well documented. Suboptimal management of chronic conditions potentially leads to worse perioperative and rehabilitation outcomes.

Adverse events associated with drug withdrawal are less well studied. Hanlon refers to earlier work he and colleagues did on adverse events associated with the withdrawal of prescription medications. [1] For 124 patients in the study, 238 medications were discontinued. Possible or probable adverse events were noted in 26% (62) of the withdrawn drugs; 41% of these were classed as major events. Kennedy et al found that withdrawal of drugs not related to the operation increased postoperative complications. [7]

Few studies are available that assess the impact of payment and policy changes on patient outcomes; ways to align financial incentives with desired outcomes are also little studied. System changes can, and should, facilitate medication use that maximizes therapeutic response and minimizes untoward events. A study from Montreal reported adverse events associated with drug costs. Tamblyn et al noted a 9% decrease in use of essential drugs, a 14% increase in emergency department visits, and a doubling of adverse events, all associated with the introduction of a 25% copayment. [8]

PERIOPERATIVE PHARMACEUTICALS

Studies of drugs in the perioperative period include investigations of the pharmacokinetics of specific drugs. Studies of premedication include evaluations of morphine by O'Sullivan et al, [9] fentanyl by Bentley et al, [10] and clonidine by Filos et al. [11] Bennett et al reviewed the literature to produce guidelines for prescribing perioperative medications to patients with renal failure. [12]

The use of patient-controlled analgesia by elderly patients has received limited attention. The few papers are small randomized controlled trials; two used morphine and one used propofol. [13–15] The morphine studies were for control of postoperative pain. [13,14] Herrick et al examined the use of patient-controlled propofol intraoperatively during cataract operation. [15] All three studies reported adequate pain control or sedation and increased patient satisfaction in comparison with standard fixed-dose and time-administered medications.

Postoperative cognitive impairment in older patients is a significant problem. A few descriptive or analytic studies have associated drug choice with cognitive impairment. [16–18]

Nausea and vomiting are unpleasant side effects. Tarkkila et al conducted a small randomized trial of three regimens to prevent nausea and vomiting in arthroplasty patients. [19] They reported superiority of premedication with oral promethazine (10 mg) and transder-

mal scopolamine (1.5 mg) in reducing nausea and vomiting over oral diazepam (5 to 15 mg) or oral promethazine alone. In one of the few studies involving older patients, Thune et al tested metoclopramide for laparoscopic cholecystectomy patients ranging in age from 21 to 79 years and found decreased postoperative nausea in comparison with the results of using no medication. [20]

COMPLEMENTARY (ALTERNATIVE) MEDICINE

There is an increasing use of complementary or alternative medicine in the United States population, including folk remedies. These medicines include substances that have a pharmacologic effect. Often, patients fail to report to surgeons their use of such substances, or they continue to take them throughout the surgical experience, assuming that they are of little importance. Virtually no reports exist concerning the effect of complementary or alternative medicines on the elderly surgical patient.

> *CCI 10 (Level B)*: **Clinicians in the specialties need support in their management during the perioperative period of the multiple medications that the typical older patient takes. Systems should be developed to routinely monitor inappropriate drug use and to provide methods to improve the quality of prescribing to older patients.**

> *CCI 11 (Level B)*: **Research is needed on the consequences of drug withdrawal in elderly surgical patients.**

> *CCI 12 (Level A)*: **Randomized controlled trials of system changes that might optimize medication use by older patients are needed.**

> *CCI 13 (Level A)*: **The short- and long-term effectiveness of interventions aimed at optimizing the management of chronic disease and comorbid conditions in older patients during the perioperative period should be assessed.**

> *CCI 14 (Level B)*: **New, easily usable guidelines for prescribing to patients with renal failure are needed.**

> *CCI 15 (Level B)*: **A meta-analysis is needed to obtain a more accurate estimate of the value of patient-controlled drug delivery for elderly surgical patients.**

> *CCI 16 (Level B)*: **The interaction of ethanol with other drugs and its effects on the elderly trauma victim need to be investigated.**

> *CCI 17 (Levels D, C)*: **The effects of complementary or alternative medicines on the incidence of complications in elderly surgical patients are unknown and should be investigated by observational cohort studies and ultimately for selected medications by randomized controlled trials.**

References

1.   Hanlon JT, Shimp LA, Semla TP. Recent advances in geriatrics: drug-related problems in the elderly. Ann Pharmacother 2000;34:360-365.

2. Cornoni-Huntley J, Ostfeld AM, Taylor JO, et al. Established populations for epidemiologic studies of the elderly: study design and methodology. Aging (Milano) 1993;5:27-37.

3. Beers MH. Explicit criteria for determining potentially inappropriate medication use by the elderly: an update. Arch Intern Med 1997;157:1531-1536.

4. Chin MH, Wang LC, Jin L, et al. Appropriateness of medication selection for older persons in an urban academic emergency department. Acad Emerg Med 1999;6:1232-1242.

5. Naranjo CA, Busto U, Sellers EM, et al. A method for estimating the probability of adverse drug reactions. Clin Pharmacol Ther 1981;30:239-245.

6. Cluff LE, Thornton G, Seidl L, Smith J. Epidemiological study of adverse drug reactions. Trans Assoc Am Physicians 1965;78:255-268.

7. Kennedy JM, van Rij AM, Spears GF, et al. Polypharmacy in a general surgical unit and consequences of drug withdrawal. Br J Clin Pharmacol 2000;49:353-362.

8. Tamblyn R, Laprise R, Hanley JA, et al. Adverse events associated with prescription drug cost-sharing among poor and elderly persons. JAMA 2001;285:421-429.

9. O'Sullivan G, Bullingham RE, McQuay HJ, et al. A comparison of intramuscular and sublingual buprenorphine, intramuscular morphine and placebo as premedication. Anaesthesia 1983;38:977-984.

10. Bentley JB, Borel JD, Nenad RE, Gillespie TJ. Age and fentanyl pharmacokinetics. Anesth Analg 1982;61:968-971.

11. Filos KS, Patroni O, Goudas LC, et al. A dose-response study of orally administered clonidine as premedication in the elderly: evaluating hemodynamic safety. Anesth Analg 1993;77:1185-1192.

12. Bennett WM, Aronoff GR, Morrison G, et al. Drug prescribing in renal failure: dosing guidelines for adults. Am J Kidney Dis 1983;3:155-193.

13. Wasylak TJ, Abbott FV, English MJ, Jeans ME. Reduction of postoperative morbidity following patient-controlled morphine. Can J Anaesth 1990;37:726-731.

14. Egbert AM, Parks LH, Short LM, Burnett ML. Randomized trial of postoperative patient-controlled analgesia vs intramuscular narcotics in frail elderly men. Arch Intern Med 1990;150:1897-1903.

15. Herrick IA, Gelb AW, Nichols B, Kirkby J. Patient-controlled propofol sedation for elderly patients: safety and patient attitude toward control. Can J Anaesth 1996;43:1014-1018.

16. Herrick IA, Ganapathy S, Komar W, et al. Postoperative cognitive impairment in the elderly: choice of patient-controlled analgesia opioid. Anaesthesia 1996;51:356-360.

17. Larson EB, Kukull WA, Buchner D, Reifler BV. Adverse drug reactions associated with global cognitive impairment in elderly persons. Ann Intern Med 1987;107:169-173.

18. Bowen JD, Larson EB. Drug-induced cognitive impairment: defining the problem and finding solutions. Drugs Aging 1993;3:349-357.

19. Tarkkila P, Torn K, Tuominen M, Lindgren L. Premedication with promethazine and transdermal scopolamine reduces the incidence of nausea and vomiting after intrathecal morphine. Acta Anaesthesiol Scand 1995;39:983-986.

20. Thune A, Appelgren L, Haglind E. Prevention of postoperative nausea and vomiting after laparoscopic cholecystectomy: a prospective randomized study of metoclopramide and transdermal hyoscine. Eur J Surg 1995;161:265-268.

CLINICAL OUTCOMES ASSESSMENT

Although independence is the usual endpoint for rehabilitation, older patients may value other goals more than independence or even in lieu of independence. [1] One study of outpatient geriatric assessment observed that geriatric assessment studies to date have measured primarily functional status, health services use, costs of care, caregiver stress,

and patient and family satisfaction. [2] Interviews with patients and families indicated that the most common goals sought from geriatric assessment were obtaining education and referrals and improving social and family relationships. These goals have not systematically been measured in the assessment of health care outcomes of geriatric assessment programs.

MEASUREMENT CONSIDERATIONS AND FUNCTIONAL OUTCOMES

An important psychometric consideration is the relative responsiveness of condition-specific and generic health status measures in assessing outcomes. Condition-specific measures were used in one study of surgical outcomes for degenerative lumbar spinal stenosis. [3] Measurements were performed preoperatively and again at 6 months following operation. Questions about condition-specific symptoms were concerned with effects of the disease on the patient and included issues such as pain (frequency and location). Physical function questions asked about activities such as walking distance, walking for pleasure, and shopping. Generic measures used included the Sickness Impact Profile. Minimal clinically relevant improvement was estimated by the use of patient satisfaction as the external criterion. The condition-specific measures were found to be more sensitive and discriminating than the physical function questions and were therefore recommended as better primary endpoints for future studies. However, the effects of surgical procedures can be reflected in generic measures such as the Medical Outcomes Study Short Form 36-item health survey (SF-36) and those broader generic health measures. Health-related quality-of-life (HRQOL) measures permit a broader assessment of the impact of surgical procedures. [4]

Applying a common instrument across surgical or medical conditions, in addition to condition-specific measures, may help reveal shared risk factors for poorer clinical outcomes. The American Society of Anesthesiologists' Physical Status Score (ASA-PS) is one such global measure that could be applied to the preoperative assessment of the patient. [5] Since its development in 1961, multiple studies have demonstrated the strong correlation of poor physical status with higher rates of morbidity and mortality. The increasing information that has been assembled about older patients suggests that certain common measures also may predict outcomes across diagnoses and syndromes. For example, assessment of shared risk factors for falls, incontinence, and functional dependence has revealed that these different syndromes all have the same four independent predisposing factors: slow timed chair stands (lower-extremity impairment), decreased arm strength (upper-extremity impairment), decreased vision and hearing (sensory impairment), and either a high anxiety or depression score (affective impairment). [6]

The measurement of the outcomes of health care interventions—like emergency department visits, operations, and rehabilitation—will require the measurement of functional outcomes. HRQOL measures such as the SF-36 include physical function measures. Understanding the factors that contribute to poor functional outcomes will clarify which interventions may be harmful to function and which interventions could be modified to yield better functional outcomes. For instance, age and prefracture residence at a nursing home have been found to predict walking—not mortality—at 6 months after hip fracture. [7] However, functional measures have been found to predict both short-term and 2-year post-hospitalization mortality in a large study of nonsurgical patients. [8]

The measurement of hospitalization outcomes depends upon practicality, especially where some measures appear to be appropriate for routine clinical use to help physicians and others improve the care of older adults. For example, generic measures like the Nottingham Health Profiles have been presented as feasible for common hospital conditions.[9]

POSTOPERATIVE MORTALITY

Several large studies evaluated surgical outcomes in patients 80 years and older. Warner et al reported results of a retrospective cohort study of patients 100 years or older who were operated on between 1975 and 1994 with follow-up through 1995.[10] Eighty-eight percent of the patients were in American Society of Anesthesiologists (ASA) class III or worse. Only one major complication occurred, and the 48-hour, 30-day, and 1-year mortality rates were 0%, 16.1%, and 35.5%. These rates were comparable to the rate expected for age-matched controls.

Two reviews evaluated outcomes in patients 90 years and older.[11,12] An additional three case series evaluated outcomes in surgical cases involving persons 80 years and older.[13–15] In-hospital mortality rates (around 1 month mortality) were 13.4% (for major surgeries only), 1.6% (when cataract cases were included), and 5.2%, 4.6%, and 6.2% (overall, the three studies respectively). Overall, these findings fit with a trend of declining mortality rates following operations in octogenarians from greater than 20% in the 1960s to 10% in the 1970s, to under 10% in several more recent series. In these studies, ASA-PS status was found to be correlated with mortality. Additional risk factors included congestive heart failure, the presence of neurologic diseases, and a history of arrhythmias.

The literature on postoperative mortality in older adults covers two postoperative time periods for mortality. For nonorthopedic procedures, most series report mortality from the time during hospitalization to about 1 month after. The hip fracture literature, however, evaluates mortality at 3 months to 1 year and even later. For series on deaths during the index hospitalizations, risk factors for mortality have included advanced age, male gender, ASA-PS score, congestive heart failure, emergency surgery, renal disease, and major operations. One study evaluated cardiac ejection fraction, noting a mortality rate of 9.3% if ejection fractions were less than 50% but a 1.2% overall mortality rate.[16]

Recent studies of mortality focus on orthopedic fractures. Hamlet et al reported a 4.5 lower relative risk of mortality at 3 years in patients in ASA class I and II groups (N = 62) in comparison with class III and higher (10% mortality versus 50% mortality).[17] Zuckerman et al also reported increased mortality in the 12 months after hip fracture procedures with delay of 48 hours or more for operation.[18] However, when ASA-PS is added in calculating the adjusted hazard ratio, the timing of operation was no longer found to be statistically significant.

As the system of perioperative care improves, so do outcomes. Operative mortality was carefully examined in a Canadian study of older patients undergoing coronary artery bypass graft (CABG) procedures.[19] The risk-severity score and operative mortality were examined in 3330 consecutive patients aged 70 years and older who underwent isolated CABG procedures between 1982 and 1996. Operative mortality was found to have declined significantly from 17.2% to 8.9% despite an increase in prevalence of high-risk elderly patients from 16.2% to 26.9%. Poor ventricular function and repeat CABG procedures had the greatest impact on mortality.

PROCESS AND LENGTH-OF-STAY ISSUES

Hospitals are hazardous settings for older persons' care. [20] Health care costs can be reduced by shortening stays, provided adverse outcomes do not occur. Optimal methods for identifying factors that affect hospital length of stay may be a clustered model rather than stepwise regression models in which possible predictors are highly correlated. [21] However, most studies to date have used stepwise regression models. In addition, controlling for severity of disease is a difficult methodologic issue. In one evaluation, wide variations in hospital lengths of stay for hip fracture patients could not be explained by severity adjustments. [22]

Factors directly related to types of operation and modifications of surgical practice may account for some changes in length of stay. [23,24] Early and sufficient feeding postoperatively can reduce length of stay. [25] In studies of comorbidities, visual impairment was found to contribute 2.4 days ($P < .001$) to average length of stay in a series of multivariate models. [26] In another study, the use of sedative-hypnotic medications was found to be associated with longer hospital stays and higher hospital costs after controlling for severity of illness and comorbid conditions. [27] Several studies of medical patients showed that cognitive impairment and delirium can increase length of stay, as can prior impaired function. [20] These factors are likely to affect the outcomes of surgical patients as well. The role of age can be an independent risk factor for increased length of stay, controlling for other variables in surgical as well as medical patients. [28–32]

The Uniform Data System documents acute hospital and rehabilitation hospital lengths of stay along with functional status, using the Functional Independence Measure (FIM) for patients receiving inpatient rehabilitation. Comparison of data from 1990 to 1999 show substantial decreases in acute hospital lengths of stay (22 days to 11 days) and rehabilitation hospital lengths of stay (32 days to 20 days) for stroke survivors. There was no major change in rehabilitation admission median FIM (63 versus 64) or discharge median FIM (92 versus 91). [33,34] Most likely, unmeasured economic and administrative factors led to such significant decreases in length of stay at a national level.

PATIENT SATISFACTION

Patients' views of their care have been increasingly cited as important in the assessment of health care. [35–39] From patient focus groups and health care provider interviews, Gerteis et al identified seven primary dimensions of patient-centered care: respect for patients' values, preferences, and expressed needs; coordination and integration of care; information, communication, and education; physical comfort; emotional support and alleviation of fear and anxiety; involvement of family and friends (care partners); and transition and continuity (caring for self away from the health setting). [40]

The concept of patient satisfaction with care represents several aspects of these dimensions. Ware et al defined eight dimensions: interpersonal manner, technical quality, accessibility or convenience, financial aspects, physical environment, availability of providers and facilities, continuity of care, and efficacy or outcomes. [41] Some studies specifically examined patient satisfaction in relation to age and found that older patients generally were more satisfied. [38] In one national survey of acute hospital care, older patients reported fewer problems than younger patients did. [42,43] The reasons for this are unclear but

may be related to the fact that elderly patients have acquired a tolerance for the health care system that has provided their care for so many years.

Studies of surgical and rehabilitation outcomes are evaluating dimensions of patient satisfaction as well as interventions that might improve satisfaction ratings. [44–47] Using the Picker Institute Consumer Satisfaction Survey, one study of hip and knee arthroplasty patients found increased patient satisfaction from 77% to 92% resulting from improvement of patient care processes between acute hospital and rehabilitation settings. [46] Higher satisfaction among stroke patients was found to be associated with higher function at discharge in a sample of 8900 patients evaluated at 80 to 180 days after discharge from inpatient rehabilitation. [47] Functions most associated with satisfaction were transfers, social cognition, and locomotion.

> *CCI 18 (Level B)*: **Observational cohort studies are needed to identify the most important preoperative predictors of functional outcome in elderly surgical patients.**

> *CCI 19 (Level A)*: **Interventional studies should be performed to help determine whether early identification and treatment of pre-existing risk factors leads to improved postoperative, posthospitalization, and rehabilitation outcomes in elderly surgical patients.**

> *CCI 20 (Level B)*: **Existing data from previous research studies on surgical outcomes should be re-examined for age-specific and age-stratified data to validate risk assessment and surgical complication rates in the older-old and oldest-old surgical patients.**

> *CCI 21 (Level A)*: **Prospective, age-specific, and age-stratified intervention studies are needed to help determine whether age is an independent risk factor for poorer surgical outcome for various specific surgical procedures and whether early identification and treatment of other risk factors lead to improved postoperative mortality rates and reduce hospital and intensive care unit lengths of stay for elderly surgical patients. These studies should be longitudinal to determine, among other outcomes, whether transfers out of acute-care facilities to other health care facilities actually decrease health care costs.**

> *CCI 22 (Level B)*: **Prospective patient satisfaction surveys are needed to identify the most important factors for elderly patients, including functional outcomes, quality of life, and return to independent living.**

> *CCI 23 (Level A)*: **Interventional studies are needed to determine whether early identification and treatment of comorbidities and postoperative complications in elderly surgical patients lead to improved patient satisfaction indices, functional outcomes, quality of life, and return to independent living.**

References

1. Spiro HM. Old doctors and old patients. Pharos Alpha Omega Alpha Honor Med Soc 1988;51:19-23.
2. Bradley EH, Bogardus ST, Jr., van Doorn C, et al. Goals in geriatric assessment: are we measuring the right outcomes? Gerontologist 2000;40:191-196.
3. Stucki G, Liang MH, Fossel AH, Katz JN. Relative responsiveness of condition-specific and generic health status measures in degenerative lumbar spinal stenosis. J Clin Epidemiol 1995;48:1369-1378.
4. Lieberman JR, Dorey F, Shekelle P, et al. Outcome after total hip arthroplasty: comparison of a traditional disease-specific and a quality-of-life measurement of outcome. J Arthroplasty 1997;12:639-645.
5. Dripps LA, Eckenhoff JE. The role of anesthesia in surgical mortality. JAMA 1961;178: 261-266.
6. Tinetti ME, Inouye SK, Gill TM, Doucette JT. Shared risk factors for falls, incontinence, and functional dependence: unifying the approach to geriatric syndromes. JAMA 1995;273: 1348-1353.
7. Browner WS, Li J, Mangano DT. In-hospital and long-term mortality in male veterans following noncardiac surgery. The Study of Perioperative Ischemia Research Group. JAMA 1992;268:228-232.
8. Inouye SK, Peduzzi PN, Robison JT, et al. Importance of functional measures in predicting mortality among older hospitalized patients. JAMA 1998;279:1187-1193.
9. O'Brien J, Bowie C. A methodology for collecting outcome measures for common hospital conditions. J Public Health Med 1992;14:380-384.
10. Warner MA, Saletel RA, Schroeder DR, et al. Outcomes of anesthesia and surgery in people 100 years of age and older. J Am Geriatr Soc 1998;46:988-993.
11. Adkins RB, Scott HW. Surgical procedures in patients aged 90 years and older. South Med J 1984;77:1357-1364.
12. Hosking MP, Warner MA, Lobdell CM, et al. Outcomes of surgery in patients 90 years of age and older [see comments]. JAMA 1989;261:1909-1915.
13. Liu LL, Leung JM. Predicting adverse postoperative outcomes in patients aged 80 years or older. J Am Geriatr Soc 2000;48:405-412.
14. Cheng KW, Wang CH, Ho RT, et al. Outcome of surgery and anesthesia in patients 80 years of age and older. Acta Anaesthesiol Sin 1994;32:37-43.
15. Djokovic JL, Hedley-Whyte J. Prediction of outcome of surgery and anesthesia in patients over 80. JAMA 1979;242:2301-2306.
16. Pedersen T. Complications and death following anaesthesia: a prospective study with special reference to the influence of patient-, anaesthesia-, and surgery-related risk factors. Dan Med Bull 1994;41:319-331.
17. Hamlet WP, Lieberman JR, Freedman EL, et al. Influence of health status and the timing of surgery on mortality in hip fracture patients. Am J Orthop 1997;26:621-627.
18. Zuckerman JD, Skovron ML, Koval KJ, et al. Postoperative complications and mortality associated with operative delay in older patients who have a fracture of the hip. J Bone Joint Surg Am 1995;77:1551-1556.
19. Ivanov J, Weisel RD, David TE, Naylor CD. Fifteen-year trends in risk severity and operative mortality in elderly patients undergoing coronary artery bypass graft surgery. Circulation 1998;97:673-680.
20. Calkins E. Care of older people in the hospital. In Calkins E, Wagner EH, Pacala JT (eds): New Ways to Care for Older People: Building Systems Based on Evidence. New York: Springer Publishing Company, 1999. p. 99-111.

21. Cohen YC, Rubin HR, Freedman L, Mozes B. Use of a clustered model to identify factors affecting hospital length of stay. J Clin Epidemiol 1999;52:1031-1036.
22. Shwartz M, Iezzoni LI, Ash AS, Mackiernan YD. Do severity measures explain differences in length of hospital stay? the case of hip fracture. Health Serv Res 1996;31:365-385.
23. Schwartz MH, Tartter PI. Decreased length of stay for patients with colorectal cancer: implications of DRG use. J Healthc Qual 1998;20:22-25.
24. Gardner TA, Bissonette EA, Petroni GR, et al. Surgical and postoperative factors affecting length of hospital stay after radical prostatectomy. Cancer 2000;89:424-430.
25. Neumayer LA, Smout RJ, Horn HG, Horn SD. Early and sufficient feeding reduces length of stay and charges in surgical patients. J Surg Res 2001;95:73-77.
26. Morse AR, Yatzkan E, Berberich B, Arons RR. Acute care hospital utilization by patients with visual impairment. Arch Ophthalmol 1999;117:943-949.
27. Yuen EJ, Zisselman MH, Louis DZ, Rovner BW. Sedative-hypnotic use by the elderly: effects on hospital length of stay and costs. J Ment Health Adm 1997;24:90-97.
28. Kalman PG, Johnston KW. Sociologic factors are major determinants of prolonged hospital stay after abdominal aneurysm repair. Surgery 1996;119:690-693.
29. Wong DT, Cheng DC, Kustra R, et al. Risk factors of delayed extubation, prolonged length of stay in the intensive care unit, and mortality in patients undergoing coronary artery bypass graft with fast-track cardiac anesthesia: a new cardiac risk score. Anesthesiology 1999;91:936-944.
30. Katz NM, Hannan RL, Hopkins RA, Wallace RB. Cardiac operations in patients aged 70 years and over: mortality, length of stay, and hospital charge. Ann Thorac Surg 1995;60:96-100; discussion 100-101.
31. Hirsch CH, Sommers L, Olsen A, et al. The natural history of functional morbidity in hospitalized older patients. J Am Geriatr Soc 1990;38:1296-1303.
32. Shah MR, Aharonoff GB, Wolinsky P, et al. Outcome after hip fracture in individuals ninety years of age and older. J Orthop Trauma 2001;15:34-39.
33. Granger CV, Hamilton BB. UDS report. The Uniform Data System for Medical Rehabilitation Report of First Admissions for 1990. Am J Phys Med Rehabil 1992;71:108-113.
34. Deutsch A, Fiedler RC, Granger CV, Russell CF. The Uniform Data System for Medical Rehabilitation report of patients discharged from comprehensive medical rehabilitation programs in 1999. Am J Phys Med Rehabil 2002;81:133-142.
35. Donabedian A. The quality of care. how can it be assessed? JAMA 1988;260:1743-1748.
36. Cleary PD, McNeil BJ. Patient satisfaction as an indicator of quality care. Inquiry 1988;25:25-36.
37. Ellwood PM, Jr., Lundberg GD. Managed care: a work in progress. JAMA 1996;276:1083-1086.
38. Laine C, Davidoff F. Patient-centered medicine: a professional evolution. JAMA 1996;275:152-156.
39. Kramer AM. Rehabilitation care and outcomes from the patient's perspective. Med Care 1997;35:JS48-JS57; discussion JS58-JS63.
40. Gerteis M, Edgman-Levitan S, Daley J, Delbanco TL. Medicine and health from the patient's perspective. In Gerteis M, Edgman-Levitan S, Daley J, Delbanco TL (eds): Through the Patient's Eyes: Understanding and Promoting Patient-Centered Care. San Francisco: Jossey-Bass, 1993. p. 1-18.
41. Ware JE, Davies AR, Stewart AL. The Measurement and Meaning of Patient Satisfaction: A Review of the Literature. Santa Monica, CA: RAND, 1977.
42. Cleary PD, Edgman-Levitan S, Roberts M, et al. Patients evaluate their hospital care: a national survey. Health Aff (Millwood) 1991;10:254-267.

43. Keith RA. Patient satisfaction and rehabilitation services. Arch Phys Med Rehabil 1998;79:1122-1128.
44. Anderson JG, Wixson RL, Tsai D, et al. Functional outcome and patient satisfaction in total knee patients over the age of 75. J Arthroplasty 1996;11:831-840.
45. Salmon P, Hall GM, Peerbhoy D, et al. Recovery from hip and knee arthroplasty: patients' perspective on pain, function, quality of life, and well-being up to 6 months postoperatively. Arch Phys Med Rehabil 2001;82:360-366.
46. Grissom SP, Dunagan L. Improved satisfaction during inpatient rehabilitation after hip and knee arthroplasty: a retrospective analysis. Am J Phys Med Rehabil 2001;80:798-803.
47. Ottenbacher KJ, Gonzales VA, Smith PM, et al. Satisfaction with medical rehabilitation in patients with cerebrovascular impairment. Am J Phys Med Rehabil 2001;80:876-884.

PREOPERATIVE RISK ASSESSMENT AND PREPARATION

Prior to undergoing an operative procedure, geriatric patients are often assumed to be at high risk for either bad outcomes or more severe complications. Assessing preoperative risk factors should allow for preoperative optimization when possible and provide a basis for appropriate perioperative intervention in urgent operations. (See also the section on age-related physiologic changes and preoperative care in Chapter 2, Geriatric Anesthesia.)

CARDIOPULMONARY FUNCTION

The large numbers of coronary artery bypass operations performed each year allow prospective evaluation of preoperative status with great statistical power. Such research includes the work by Elisheva et al (4835 patients),[1] John et al (19,224 patients),[2] Maharajah et al with 436 patients over 75 years of age,[3] Newman et al (2417 patients),[4] and Pederson et al (7305 patients).[5] Poor reserve with ST segment depression on exercise testing, prior history of myocardial infarction or cardiac operation, smoking, acute phase response with increased interleukin-6, and hypertension were associated with statistically greater complications with poor outcomes. Abnormal chest x-rays or decreased pulmonary function tests were associated with an increase in pulmonary complications following cardiac procedures.

In several studies, once risk had been identified, manipulations were used to determine the best method of reducing potential problems. In one study (Felding et al),[6] certain drugs were used to improve stress response, and in another (Kopp et al),[7] preemptive analgesia was implemented to modify postoperative pain response. Gotohda et al[8] applied a preoperative scoring system, and Newman et al[4] used a cluster scoring technique. Trzcieniecka-Green and Steptoe[9] attempted relaxation-based stress management for improvement in quality of life. Ashton et al[10] attempted self-hypnosis as a potential management strategy to reduce anxiety following bypass. (For further discussion of work on cardiac and pulmonary status preoperatively, see Chapter 2, Geriatric Anesthesia.)

NUTRITION

Himes reviewed the effects of poor nutrition on wound healing.[11] Protein-calorie malnutrition and involuntary weight loss continue to be prevalent among hospitalized and

long-term care patients. Studies on nutritional intervention have established a correlation between nutritional status, body weight, and rate of wound healing. Nutritional intervention, however, must be provided early enough to prevent a catabolic-induced decline in lean muscle mass, which can further impair wound healing. Chronic, nonhealing wounds are particularly difficult to treat and contribute to significant morbidity, mortality, and hospitalizations. More aggressive nutritional management and a greater understanding of the role of nutrition and weight gain in wound healing can result in more effective patient care. Azad et al, using a variety of survey instruments, evaluated elderly patients for malnutrition at the time of admission. [12] They found that 44% of the older patients were at moderate risk for malnutrition and that 15% were malnourished upon admission. All physicians should be aware of this staggering fact and be prepared to act as early as possible in the patient's hospital course; most concur that the elderly patients were suffering from malnutrition. Linn et al in 1988 [13] noted that the malnourished patients had the poorest surgical outcomes of any group. More specifically, Covinsky et al [14] found that such patients risk greater mortality, have later functional recovery, and have higher rates of nursing-home usage.

The most effective method for screening patients for nutritional status appears to be serum albumin concentration. [15] Unfortunately, the threshold danger level calculated by different investigators varies, from 2.8 to 3.5 g/dL. Other screening measurements include total lymphocyte counts, serum transferrin, C-reactive protein, anergy to Candida and mumps skin testing, and abnormal serum globulin. Baker et al [16] indicated that good nutritional histories and the use of brief nutritional assessment instruments and of physical measurements such as skin fold thickness or body mass index are effective in defining malnutrition. Avenell et al [17] noted that patients having urgent surgical care are at greater risk, since any nutritional deficiency cannot be corrected readily. Although most accept that optimal preoperative nutrition is beneficial, no consensus has emerged for the type of nutritional enhancement or the route of administration. It is equally unclear which vitamin or mineral supplementations are best suited for malnourished elderly patients. (See also discussion of nutrition in Chapter 11, section on postoperative outcome.)

FLUID MANAGEMENT

Zawada et al [18] assumed that geriatric patients who arrive for a procedure after the traditional fast are in negative fluid balance and become volume contracted. This assumption is not proven, but Seymour at al [19] developed a dehydration score for patients 70 years and older and found that it correlated significantly with altered mental status. Garrison et al [20] proposed preoperative saline loading to expand blood volume, but the results were marginal. Arieff [21] estimated blood or extracellular fluid volumes but was unable to predict preoperatively which patients would develop severe overhydration or pulmonary edema. Another area of concern is preoperative serum sodium. Miller [22] performed an extensive review of this problem. The causes included inadequate dietary sodium, increased sodium loss from diarrhea or vomiting, overhydration from either oral or intravenous administration, impaired water excretion, overdiuresis, adrenal insufficiency (rare), and inappropriate ADH secretion. The more important surgical syndromes are hyponatremia due either to dilutional hyponatremia or low blood volume electrolyte loss. The optimal type of intravenous fluid placement for older patients still is not determined.

Preoperative low serum potassiums predicts serious postoperative arrhythmias. Wahr et al [23] and Bartholaw et al [24] noted that blood pressure measurement, spot urine chlorides, and serum renin and aldosterone measurements help to clarify hypokalemia and metabolic alkalosis. Kudoh et al [25] noted that concentrations of aldosterone and atrial natriuretic hormone in elderly patients with hyperkalemia are unresponsive to surgical stress and volume expansion. Antonelli et al [26] assessed 180 patients from admission to discharge or death and concluded that postoperative electrolyte imbalance is a marker for very frail medical status and a risk factor for poor outcome among elderly patients.

ETHICAL ISSUES

The most comprehensive research on ethics, advance directives, communication with medical patients and families, and informed consent is the Study to Understand Prognoses and Preferences for Outcomes and Risks of Treatment (SUPPORT), along with Hospitalized Elderly Longitudinal Project (HELP). [27] SUPPORT and HELP constituted a two-phase study. The observational phase was designed to describe patient preferences for care and to develop prognostic models. HELP was a supplemental study that enrolled patients aged 80 years and older.

Sixty-seven articles from the project were in print at the time our literature search was conducted. SUPPORT described a number of problems: physicians misunderstood patients' preferences, do-not resuscitate (DNR) orders were written shortly before death, the majority of patients died in intensive care units, and patients had substantial levels of pain during the hospital stay. The SUPPORT and HELP investigators produced a prognostic model for functional outcome in older patients [28] and survival in all patients. [29]

The SUPPORT intervention to change physician behavior was not successful. Lynn et al [30] reviewed reasons for the failure and concluded that individual physician instruction was insufficient and that a system-level intervention of innovation and quality improvement in routine care might be appropriate. The SUPPORT and HELP studies focused on severely ill patients and made little mention of surgical patients. Hamel et al [31] reported older age to be associated with higher rates of decisions to withhold an operation, ventilator support, and dialysis. This was found to be true even after adjustment for patients' prognoses and preferences.

Observational studies of surgical patients have described some of the processes studied by SUPPORT investigators. Brett and Rosenberg reviewed records of patients with gastrostomy tubes. [32] They reported that the patient's competence was documented only for two thirds of patients. A discussion with the patient about alternatives to the tube was charted in only one patient. Surrogates gave consent for over 90% of patients even though over 20% of patients were competent to give their own consent. In another record review, Trunkey et al [33] reported that 67% of geriatric trauma patients who died had documentation indicating that a decision had been made to withdraw therapy and that an early decision to provide comfort care had been made for only 10 patients. Llovera et al reported that older patients presenting to the emergency department are more likely than younger patients to have an advance directive, with an increase in the odds ratio of 0.03 for each year of age. [34] These researchers did not present the absolute frequency of advance directives for the elderly patients.

Outcomes of Surgical Management

A deficiency of data on outcomes for the elderly surgical patient limit the surgeon's ability to obtain informed consent. Most studies reporting surgical outcomes in older patients are case series that report the results of operations in patients above a specified age. [35] Geriatric patients in surgical case series are likely to be healthier than all patients with the disease, including some who do not have an operation. The selection bias introduced into descriptive studies by clinical decisions should be adjusted or described in future literature to yield more applicable information for surgeon-patient communication about surgical risks and benefits. Functional status and other severity-of-illness variables should be reported to allow the surgeon to determine when outcome data apply to an individual patient. [36] Often, geriatric patients are excluded from trials of new surgical procedures, again creating uncertainty about whether outcomes data are applicable to this population.

Conversely, there is insufficient literature available about the outcome of forgoing an operation, a choice that is more likely in the frail elderly population than in most other age groups. Frail older patients may refuse surgery or receive a recommendation against surgery when the physician believes that its risks outweigh potential benefits. [37] Outcomes for treatment and control groups of geriatric patients are rarely reported, despite their importance to informed decision making. Small studies have reported on the outcomes of nonoperative management of hip fractures in geriatric patients. [38,39] The results were uniformly poor.

Geriatric patients have shorter life expectancies than younger patients and therefore may value certain outcomes to a greater extent. An older patient may fear a permanently disabling stroke after cardiac bypass grafting more than he or she fears a lethal arrhythmia. Surgical outcomes studies should be expanded to include functional status and to consider other relevant outcome measures, such as residence in a nursing home, experience of delirium, and quality of life after surgery. [40,41]

Outcomes data on surgical versus nonsurgical management of common diseases have the potential to change ethical decision making at a societal level. Surgical management may be more costly than nonsurgical management, and the principle of distributive justice argues against the use of health care resources for minimal benefit.

Informed Consent

Although the ethics literature provides guidance about the ideal conduct of the consent process, [42] controversies remain concerning the normative requirements for decisional capacity, disclosure, comprehension, and voluntary choice. The clinical practice of informed consent for surgical procedures does not always achieve these ideals, particularly for older and more poorly educated patients. [32,43,44]

A prominent reality of informed consent for elderly patients is the prevalence of cognitive impairment. [45] Although there has been a great deal of research regarding advance directives for life-sustaining treatments, there has been virtually no research exploring advance directives for other types of treatment. Few living wills include preferences for or against major procedures, although frail older patients often elect to forgo surgical treatment. For surgical decisions for geriatric patients who have lost decisional capacity, appointing formal surrogate decision makers, for example, choosing someone to have a health care power of attorney or to be a legal surrogate under state law, may be more flexible and useful than relying on a living will. Morrison et al, for example, studied

patients with end-stage dementia who nonetheless had surgery for hip fractures and found them to have a 6-month mortality rate of nearly 50%. [46] The problem is not only that demented patients have a short life expectancy but also that the surgery adds considerable expense, does little to enhance their quality of life since they cannot participate effectively in rehabilitation and thus do not walk, and also exposes them to potential prosthetic infection.

The Conduct of the Operation

One of the key ethical questions that arises once an operation is planned pertains to do-not-resuscitate orders in the operating room. [47,48] Practice guidelines from the American College of Surgeons and the American Society of Anesthesiologists recommend discussion of this issue prior to operation. Patients may feel strongly that they do not wish to receive life-sustaining treatments, regardless of the cause of the cardiac or respiratory arrest. Surgeons and anesthesiologists often feel ethically bound to treat an arrest or complication they perceive to be iatrogenic. Compromises concerning conduct of care should be reached before the patient goes to the operating room.

Postoperative Care

A critical postoperative ethical issue is the physician's obligation to ensure access to adequate rehabilitative care. Postoperative care can make a difference in the functional outcome of the surgical patient. [49] When prospective payment was linked to shorter length of hospital stay, it was found that hip fracture patients received less physical therapy, more frequent transfers to nursing homes, and fewer discharges to home, with more limited functional recovery. [50] Research shows that patients with more comprehensive insurance, better personal financial resources, and who receive intensive rehabilitative care do not suffer the adverse effects of early hospital discharge. [51]

PREOPERATIVE EDUCATION

Educating patients and their families improves outcomes and postoperative satisfaction. Patients and their families make the best advocates for the patient. Most patients want to take responsibility for playing their part in trying to optimize the outcome of their surgery, but many are frustrated by lack of information and support to allow them to fulfill this role to their satisfaction. Having patients as honorary members of the health care team may facilitate the development of a framework within which the potential contribution of patients to their own care could be valued and supported more effectively. [52] This would help optimize patient outcomes and increase patient satisfaction with care.

Implementing such a plan has significant problems. When questioned, patients have expressed pronounced individual preferences. Beresford et al found that three groups of patients having cardiac procedures emerged: those requesting little or no risk information, those requesting information about major risks, and those requesting full risk disclosure. [53] The patients were not generally concerned about the specific probabilities of any risk. These researchers concluded that clinicians counseling patients before operation should routinely discuss patient preferences before risk disclosure, distinguishing among a preference for "no risk information," "all potentially relevant risks," and "those risks considered significant or likely to occur." The fact of individual patient preferences may undermine

the concept of the "reasonable patient" in determination of the legal requirements for risk disclosure. (A reasonable individual would be one who is well informed, and withholding information on preference would introduce bias.) In another study conducted by Stanley et al, patients undergoing femoral popliteal bypass or carotid surgery were randomized to obtain either routine consent only or consent after active participation by the patient in the consent process, with the patient receiving two forms of information, oral and written. [54] The authors found that additional written or verbal information did not improve a patient's understanding of the procedure or its risks and complications. Patients' anxiety levels were unaltered by the increase in the information they were given.

Some patients and families seek information on their own, hoping to expand on what the surgeon provides, often with no additional success. Publicly released performance reports ("report cards"), now available for cardiac surgery, are expected to foster competition on the basis of quality. Proponents frequently cite the need to inform a patient's choice of physicians and hospitals as a central element of this strategy. In a study by Schneider and Epstein, only 12% of patients surveyed reported awareness of a widely publicized report on cardiac surgery mortality before undergoing cardiac surgery. [55] Less than 1% knew the correct rating of their surgeon or hospital, and most reported that the data had only a moderate or minor impact on their selection of provider. Efforts to aid patient decision making with performance reports are unlikely to succeed without a tailored and intensive program for dissemination and patient education.

If the education of patients is to improve, they themselves must participate in the process of establishing the information used in the preoperative education. Taylor and Norton asked patients postoperatively what information they felt was required to help prepare someone for their experience (major bowel surgery). [56] The participants identified many issues that would not have been considered important by the surgeon. A survey concerning the preanesthetic visit showed that the general public considers anesthetic assessment prior to surgery to be an important part of preoperative preparation. [57] Fears of brain damage, death, and intraoperative awareness associated with general anesthesia remain prevalent, suggesting that preoperative education of patients should address these concerns. The general population was less concerned about realistic fears such as nausea, vomiting, and postoperative discomfort. Many surgeons and surgical groups develop materials on their own, some with good results. Extensive preoperative patient and family education with ample time for questions and follow-up calls should be provided by the surgeon's office. Trovar et al developed a clinical pathway that is based on patient education. [58]

> *CCI 24 (Level B)*: **Although the ASA-PS risk assessment has helped to stratify patients, more detailed work is needed to allow for better preoperative preparation. Large databases should be used to identify the age-specific risks in major surgical procedures. Stratification of the risk factors will help to determine the threshold for the elderly patient (as distinguished from the younger adult) for developing a poor outcome following major surgical procedure.**

> *CCI 25 (Level B)*: **A simplified, easily applied scoring system for an aggregate value as well as by specific outcome needs to be developed and validated to offer a predictor of both survival and postoperative function following major surgery.**

CCI 26 (Levels, B, A): **On the basis of risk-factor identification (see CCI 24), we need to develop candidate preventive and therapeutic methods for elderly surgical patients and then test the most promising ones in controlled trials.**

CCI 27 (Level B): **We must anticipate common complications of major surgery for older patients—for example, stroke—and develop standard procedures to immediately limit damage.**

CCI 28 (Level A): **Antidelirium strategies for elderly patients undergoing operations need to be tested, using an approach analogous that that used by Inouye et al in older medical inpatients.**

CCI 29 (Level B): **Preoperative interventions designed to speed postoperative recovery and enhance functional outcomes for older surgical patients need to be developed and validated.**

CCI 30 (Level B): **We need to use available literature and new ideas to establish a preferred screening method for malnutrition and to plan nutritional supplementation for elderly patients who will have elective surgery.**

CCI 31 (Levels B, A): **A program of "preventive nutrition" for patients who are at high risk to need urgent surgical intervention should be studied in cohort studies and ultimately in randomized controlled trials.**

CCI 32 (Level B): **Cohort studies are needed to try to identify surgical patients who are especially likely to develop fluid and electrolyte problems.**

CCI 33 (Levels, B, A): **Having identified risk factors for fluid and electrolyte problems (see CCI 32), we should first perform cohort studies and ultimately randomized controlled trials wherein patients at high risk would receive various regimens of intensive fluid and electrolyte management to determine which are most effective.**

CCI 34 (Level B): **Observational studies are needed to describe older patients' preferences with regard to surgery, consent for resuscitation, and advance directives.**

CCI 35 (Level B): **Research is needed to provide more useful outcome measures to inform decisions about the advisability of surgery for the geriatric population. Studies of surgical and nonsurgical management should include data on comparative costs, in addition to data on patient-level outcomes such as survival duration, function, quality of life, and complication rates.**

CCI 36 (Level B): **Cohort studies are needed to determine what benefits would outweigh the risks of pain, aspiration, and delirium that often accompany major surgery for elderly patients with dementia.**

CCI 37 (Level B): **Studies are needed to examine the effect on outcomes and satisfaction of preoperative discussions of patients' or surro-**

gates' preferences regarding resuscitation in the operating room in general and specifically resuscitation for complications thought to be iatrogenic.

CCI 38 (Level B): **Large surveys of patients' biases and preferences for information are needed to help clinicians determine the appropriate material to present in the preoperative preparation of patients and their families.**

CCI 39 (Level B): **Unbiased, procedure-specific, and age-specific data need to be generated with public input through each of the surgical specialty societies to give patients a reliable source of preoperative data.**

References

1. Elisheva S, Noya G, Yana ZG, et al. Sequential logistic models for 30 days mortality after CABG: pre-operative, intra-operative and post-operative experience–The Israeli CABG study (ISCAB): three models for early mortality after CABG. Eur J Epidemiol 2000;16:543-555.
2. John R, Choudhri AF, Weinberg AD, et al. Multicenter review of preoperative risk factors for stroke after coronary artery bypass grafting. Ann Thorac Surg 2000;69:30-35; discussion 35-36.
3. Maharajh GS, Masters RG, Keon WJ. Cardiac operations in the elderly: who is at risk? Ann Thorac Surg 1998;66:1670-1673.
4. Newman MF, Wolman R, Kanchuger M, et al. Multicenter preoperative stroke risk index for patients undergoing coronary artery bypass graft surgery. Multicenter Study of Perioperative Ischemia (McSPI) Research Group. Circulation 1996;94:II 74-80.
5. Pedersen T, Eliasen K, Henriksen E. A prospective study of mortality associated with anaesthesia and surgery: risk indicators of mortality in hospital. Acta Anaesthesiol Scand 1990;34:176-182.
6. Felding C, Mikkelsen AL, Clausen HV, et al. Preoperative treatment with oestradiol in women scheduled for vaginal operation for genital prolapse: a randomised, double-blind trial. Maturitas 1992;15:241-249.
7. Kopp A, Wachauer D, Hoerauf KH, et al. Effect of pre-emptive hydromorphone administration on postoperative pain relief–a randomized controlled trial. Wien Klin Wochenschr 2000;112:1002-1006.
8. Gotohda N, Iwagaki H, Itano S, et al. Can POSSUM, a scoring system for perioperative surgical risk, predict postoperative clinical course? Acta Med Okayama 1998;52:325-329.
9. Trzcieniecka-Green A, Steptoe A. Stress management in cardiac patients: a preliminary study of the predictors of improvement in quality of life. J Psychosom Res 1994;38:267-280.
10. Ashton C, Whitworth GC, Seldomridge JA, et al. Self-hypnosis reduces anxiety following coronary artery bypass surgery: a prospective, randomized trial. J Cardiovasc Surg (Torino) 1997;38:69-75.
11. Himes D. Protein-calorie malnutrition and involuntary weight loss: the role of aggressive nutritional intervention in wound healing. Ostomy Wound Manage 1999;45:46-51, 54-45.
12. Azad N, Murphy J, Amos SS, Toppan J. Nutrition survey in an elderly population following admission to a tertiary care hospital. CMAJ 1999;161:511-515.
13. Linn BS, Robinson DS, Klimas NG. Effects of age and nutritional status on surgical outcomes in head and neck cancer. Ann Surg 1988;207:267-273.

14. Covinsky KE, Martin GE, Beyth RJ, et al. The relationship between clinical assessments of nutritional status and adverse outcomes in older hospitalized medical patients. J Am Geriatr Soc 1999;47:532-538.

15. Kung SP, Tang GJ, Wu CW, Lui WY. Serum albumin concentration as a prognostic indicator for acute surgical patients. Chung Hua I Hsueh Tsa Chih (Taipei) 1999;62:61-67.

16. Baker JP, Detsky AS, Wesson DE, et al. Nutritional assessment: a comparison of clinical judgement and objective measurements. N Engl J Med 1982;306:969-972.

17. Avenell A, Handoll HH. Nutritional supplementation for hip fracture aftercare in the elderly. Cochrane Database Syst Rev 2000:CD001880.

18. Zawada ET, Horning JR, Jr., Salem AG. Renal, fluid, electrolyte, and acid-base problems during surgery in the elderly. In Katlic MR (ed): Geriatric Surgery. Comprehensive Care of the Elderly Patient. Baltimore: Urban & Schwarzenberg, Inc., 1990. p. 85-96.

19. Seymour DG, Henschke PJ, Cape RD, Campbell AJ. Acute confusional states and dementia in the elderly: the role of dehydration/volume depletion, physical illness and age. Age Ageing 1980;9:137-146.

20. Garrison RN, Wilson MA, Matheson PJ, Spain DA. Preoperative saline loading improves outcome after elective, noncardiac surgical procedures. Am Surg 1996;62:223-231.

21. Arieff AI. Fatal postoperative pulmonary edema: pathogenesis and literature review. Chest 1999;115:1371-1377.

22. Miller M. Fluid and electrolyte balance in the elderly. Geriatrics 1987;42:65-68, 71, 75-66.

23. Wahr JA, Parks R, Boisvert D, et al. Preoperative serum potassium levels and perioperative outcomes in cardiac surgery patients. Multicenter Study of Perioperative Ischemia Research Group. JAMA 1999;281:2203-2210.

24. Bartholow C, Whittier FC, Rutecki GW. Hypokalemia and metabolic alkalosis: algorithms for combined clinical problem solving. Compr Ther 2000;26:114-120.

25. Kudoh A, Sakai T, Ishihara H, Matsuki A. Renin-aldosterone in elderly patients with hyperkalaemia under anaesthesia. Eur J Anaesthesiol 1999;16:231-235.

26. Antonelli Incalzi R, Gemma A, Capparella O, et al. Post-operative electrolyte imbalance: its incidence and prognostic implications for elderly orthopaedic patients. Age Ageing 1993;22:325-331.

27. Phillips RS, Hamel MB, Covinsky KE, Lynn J. Findings from SUPPORT and HELP: an introduction. Study to Understand Prognoses and Preferences for Outcomes and Risks of Treatment. Hospitalized Elderly Longitudinal Project. J Am Geriatr Soc 2000;48:S1-S5.

28. Wu AW, Yasui Y, Alzola C, et al. Predicting functional status outcomes in hospitalized patients aged 80 years and older. J Am Geriatr Soc 2000;48:S6-S15.

29. Knaus WA, Harrell FE, Jr., Lynn J, et al. The SUPPORT prognostic model: objective estimates of survival for seriously ill hospitalized adults. Study to Understand Prognoses and Preferences for Outcomes and Risks of Treatment. Ann Intern Med 1995;122:191-203.

30. Lynn J, Arkes HR, Stevens M, et al. Rethinking fundamental assumptions: SUPPORT's implications for future reform. Study to Understand Prognoses and Preferences for Outcomes and Risks of Treatment. J Am Geriatr Soc 2000;48:S214-S221.

31. Hamel MB, Teno JM, Goldman L, et al. Patient age and decisions to withhold life-sustaining treatments from seriously ill, hospitalized adults. SUPPORT Investigators. Study to Understand Prognoses and Preferences for Outcomes and Risks of Treatment. Ann Intern Med 1999;130:116-125.

32. Brett AS, Rosenberg JC. The adequacy of informed consent for placement of gastrostomy tubes. Arch Intern Med 2001;161:745-748.

33. Trunkey DD, Cahn RM, Lenfesty B, Mullins R. Management of the geriatric trauma patient at risk of death: therapy withdrawal decision making. Arch Surg 2000;135:34-38.

34. Llovera I, Mandel FS, Ryan JG, et al. Are emergency department patients thinking about advance directives? Acad Emerg Med 1997;4:976-980.

35. Edmunds LH, Jr., Stephenson LW, Edie RN, Ratcliffe MB. Open-heart surgery in octogenarians. N Engl J Med 1988;319:131-136.

36. Concato J, Horwitz RI, Feinstein AR, et al. Problems of comorbidity in mortality after prostatectomy. JAMA 1992;267:1077-1082.

37. King SB, 3rd, Ullyot DJ, Basta L, et al. Task force 2: application of medical and surgical interventions near the end of life. J Am Coll Cardiol 1998;31:933-942.

38. Lyon LJ, Nevins MA. Management of hip fractures in nursing home patients: to treat or not to treat? J Am Geriatr Soc 1984;32:391-395.

39. Winter WG. Nonoperative treatment of proximal femoral fractures in the demented, nonambulatory patient. Clin Orthop 1987;(218):97-103.

40. Hannan EL, Magaziner J, Wang JJ, et al. Mortality and locomotion 6 months after hospitalization for hip fracture: risk factors and risk-adjusted hospital outcomes. JAMA 2001;285:2736-2742.

41. Marottoli RA, Berkman LF, Leo-Summers L, Cooney LM, Jr. Predictors of mortality and institutionalization after hip fracture: the New Haven EPESE cohort. Established Populations for Epidemiologic Studies of the Elderly. Am J Public Health 1994;84:1807-1812.

42. Seidman MD, Shapiro DP, Shirwany NA. Ethical issues for otolaryngology and surgery in the elderly. Ear Nose Throat J 1999;78:422, 424-426, 428.

43. Wenger NS, Lieberman JR. An assessment of orthopaedic surgeons' knowledge of medical ethics. J Bone Joint Surg Am 1998;80:198-206.

44. Sugarman J, McCrory DC, Hubal RC. Getting meaningful informed consent from older adults: a structured literature review of empirical research. J Am Geriatr Soc 1998;46:517-524.

45. Wenger NS, Lieberman JR. Achieving informed consent when patients appear to lack capacity and surrogates. Clin Orthop 2000;(378):78-82.

46. Morrison RS, Siu AL. Survival in end-stage dementia following acute illness. JAMA 2000;284:47-52.

47. Hoehner PJ. Ethical decisions in perioperative elder care. Anesthesiol Clin North America 2000;18:159-181, vii-viii.

48. Wenger NS, Greengold NL, Oye RK, et al. Patients with DNR orders in the operating room: surgery, resuscitation, and outcomes. SUPPORT Investigators. Study to Understand Prognoses and Preferences for Outcomes and Risks of Treatment. J Clin Ethics 1997;8:250-257.

49. Gerety MB, Soderholm-Difatte V, Winograd CH. Impact of prospective payment and discharge location on the outcome of hip fracture. J Gen Intern Med 1989;4:388-391.

50. Fitzgerald JF, Moore PS, Dittus RS. The care of elderly patients with hip fracture: changes since implementation of the prospective payment system. N Engl J Med 1988;319:1392-1397.

51. Palmer RM, Saywell RM, Jr., Zollinger TW, et al. The impact of the prospective payment system on the treatment of hip fractures in the elderly. Arch Intern Med 1989;149:2237-2241.

52. Edwards C. A proposal that patients be considered honorary members of the healthcare team. J Clin Nurs 2002;11:340-348.

53. Beresford N, Seymour L, Vincent C, Moat N. Risks of elective cardiac surgery: what do patients want to know? Heart 2001;86:626-631.

54. Stanley BM, Walters DJ, Maddern GJ. Informed consent: how much information is enough? Aust N Z J Surg 1998;68:788-791.

55. Schneider EC, Epstein AM. Use of public performance reports: a survey of patients undergoing cardiac surgery. JAMA 1998;279:1638-1642.

56. Taylor C, Norton C. Information booklets for patients with major bowel resection. Br J Nurs 2000;9:785-791.

57. Matthey P, Finucane BT, Finegan BA. The attitude of the general public towards preoperative assessment and risks associated with general anesthesia. Can J Anaesth 2001;48:333-339.
58. Tovar EA, Roethe RA, Weissig MD, et al. One-day admission for lung lobectomy: an incidental result of a clinical pathway. Ann Thorac Surg 1998;65:803-806.

PERIOPERATIVE CLINICAL PATHWAYS

Many common perioperative problems lend themselves to management by algorithms established through a consensus process. Although older patients may have conditions that alter the timing of diagnosis or require a deviation from the treatment protocol, the uniform application of standard management schemas permit the staff caring for these complex patients to remember to track and treat commonly occurring perioperative problems.

VENOUS THROMBOEMBOLISM

The diagnosis and treatment of deep-vein thrombosis (DVT) is relatively straightforward, but the prevention of DVT remains a controversial topic, particularly with regard to the elderly surgical patient. A well-designed clinical study to determine if any type of DVT prophylaxis is effective in decreasing the risk of fatal pulmonary embolism in elderly patients would require approximately 100,000 patients. To date, the largest studies have included fewer than 4000 patients.

The incidence of DVT in geriatric patients undergoing hip or knee replacement or hip fracture surgery varies, from 40% to 70%. Among those who do not have routine prophylaxis, fatal pulmonary embolism occurs in 0.37% to 3.3%. [1,2] Both mechanical and pharmacologic methods are used. Mechanical methods of prophylaxis include early mobilization, sequential compression stocking devices, foot pumps, and support stockings. Mechanical aids with or without pharmacologic methods decrease the incidence of DVT by approximately 50%. [3–5] Patients' tolerance of the mechanical devices, however, varies, and a patient who has decreased grip strength secondary to arthritis will find that support stockings are difficult to apply. Pharmacologic measures include aspirin, subcutaneous heparin, warfarin, dextran, and fractionated heparins. In a meta-analysis, Westrich et al found the best prophylactic method for safety and efficacy to be pneumatic compression and the least effective to be low-dose heparin. [6] For all of the pharmacologic agents, significant risks of bleeding complications occur, particularly with low-molecular-weight heparins and low-dose heparin. [7,8] Although promising, these agents may pose a significant risk in elderly patients. In joint-replacement patients, hematoma formation with the potential for infection can be a devastating complication.

Few studies actually demonstrate convincingly that any type of DVT prophylaxis decreases the rate of fatal pulmonary embolism. Ansari reported a risk of fatal pulmonary embolism following total knee replacement of 0.4% and suggested that prophylaxis was not warranted in patients undergoing unilateral total knee replacement. [9] Fender et al, utilizing a regional hip registry in England, found that the use of chemical prophylaxis did not seem to alter the very low rates of fatal pulmonary embolism. [10] Neither study had adequate power to rule out an effect.

The length of time of DVT prophylaxis also remains controversial. Several studies have shown that there are two peaks of increased incidence following an operation. The first peak of proximal DVT occurs at 7 days postoperatively (2.4%) and the second spike

occurs at approximately 1 month (8.2%). [11–13] Current recommendations include continued prophylaxis for up to 6 weeks postoperatively.

For further discussion of DVT, see the section on joint replacement surgery in Chapter 11, Geriatric Orthopedics. Very little DVT research has focused on nonorthopedic surgical procedures.

POSTOPERATIVE DELIRIUM

Best described as an acute confusional state, delirium is a transient, often devastating phenomenon that may require months to disappear. Diagnosis can be based on the Confusion Assessment Method (CAM). [14] It requires the presence of an acute change in mental status with fluctuating course, inattention, and either disorganized thinking or an altered level of consciousness. Hallucinations may be present. Other guidelines exist. [15] It is also important to recognize that delirium may be the initial presentation of some systemic illness. It is essential to evaluate mental status preoperatively, not only to facilitate the subsequent diagnosis of delirium, but also because pre-existing dementia is the most potent predisposing factor for the development of delirium. This is most often done by means of the Mini–Mental State Examination. [16]

In hospitalized medical patients, the incidence of delirium runs between 15% and 50%. Among surgical patients, the incidence is highly dependent on procedure: only 1% to 3% after cataract procedures, 10% to 15% after general surgery, and 30% to 60% after major orthopedic procedures. [17-19] These rates are from studies designed to detect delirium. In clinical practice, physicians often miss the diagnosis. [19]

The enormous consequences of postoperative delirium include functional decline, increased length of hospital stay, increased need for nursing-home placement, and a several-fold increase in mortality. [17,20,21] The economic impact to the United States is estimated at $4 billion annually. [17] Effects on the family and friends have not been quantified.

The variety of predisposing and precipitating factors for delirium suggests that medical science has a long way to go before discovering the underlying mechanism. [22] All factors involve some degree of stress on the brain. Usually, multiple factors play a role. Important predisposing factors are pre-existing dementia, any severe illness (acute or chronic), major depression, poor social supports, vision impairment, and dehydration (high BUN-to-creatinine ratio). Precipitating factors include the stress of surgery, sleep and sensory deprivation, an unfamiliar environment, immobilization, metabolic derangements, malnutrition, pain, and perhaps most of all, psychoactive medications, especially those with anticholinergic effects and opioids and benzodiazepines. [23] Age is a nonmodifiable risk factor, and another risk factor, pre-existing dementia, is usually untreatable.

No study has ever demonstrated that the choice of anesthesia affects the incidence of delirium except for the first few hours after the operation. Smaller differences occur between general and regional anesthesia if sedation is utilized during the regional anesthetic. [18,24] (For further discussion of anesthesia and delirium, see Chapter 2, Geriatric Anesthesia.)

Since the cause of delirium is protean, there is no single treatment. Prevention and treatment require that all predisposing and precipitating factors be addressed, if possible. In an important study of prevention in one nonsurgical population, one ward received standard care and in another ward special efforts were made to maintain orientation,

prevent sleep deprivation, encourage ambulation, manage visual and hearing impairment, and prevent dehydration. The incidence of new-onset delirium was 15% in the control ward and 10% in the other ward, a significant decrease. [25] When delirium did occur, however, its severity and duration were not different between the two groups. As encouraging as this study was, it was not possible to identify which parts of the intervention were effective and which were not. In a study of surgical patients with femoral neck fractures, the incidence of delirium was reduced by applying a program of geriatric consultation, subcutaneous heparin, supplemental oxygen, opiate analgesic, and aggressive treatment of hypotension and congestive heart failure. [26] The current trend of performing more and more procedures on an outpatient basis, even in elderly patients, may provide the unexpected benefit of decreasing the incidence of delirium. By getting back to a familiar environment quickly, the outpatient may not have time to suffer enough cumulative insults to make delirium likely.

In addition to delirium, an operation may also be associated with decrements in cognition. Building on anecdotal reports dating from the middle of the last century, new data confirm that some patients undergoing an operation under general anesthesia suffer permanent decrements in measurable cognition in comparison with nonhospitalized volunteers. [17,27] Significant cognitive decline was discovered in 10% of the patients 3 months after a procedure in comparison with only 3% of the volunteers 3 months after baseline measurement. Cognitive decline was associated with a higher degree of functional decline. Subject age was the only significant risk factor for cognitive decline at 3 months following a surgical procedure. (See also Chapter 2, Geriatric Anesthesia.)

POSTOPERATIVE DEPRESSION

Holmes and House summarized what little information is available on prevalence of postoperative depression. [28] Most studies from 1985 to 1996 were in patients following hip fracture. In the immediate postoperative period, an average of 13% of patients had evidence of a depressive disorder, although it is not known if they were depressed prior to having surgery.

Without testing for the presence of depression preoperatively, it is impossible to evaluate the impact of surgery on affect. One of the few studies with preoperative data on elderly patients having cataract extraction showed little evidence for increased depression postoperatively unless the patient was depressed preoperatively or had a poor outcome with respect to vision. [29]

FALLS PREVENTION

Instability and falls are important warning symptoms of underlying serious illness among elderly persons. Falls are a major source of injury in elderly people. Falls cause 90% of hip fractures. The current cost of hip fractures in the United States is estimated to be about 10 billion dollars. [30] The somatosensory, vestibular, and visual systems, which contribute to the maintenance of balance, deteriorate with age. These changes, coupled with age-related changes in muscles and bones, contribute to an increased risk of falls by elderly persons. The integrated rehabilitation-based model of risk factors for falls suggests that there are multiple opportunities for interventions that might reduce the risks. Little research exists on postsurgical patients, so inferences must be made from studies on

community-dwelling older persons and older medical patients. (See also Chapter 11, Geriatric Orthopedics, for further discussion of issues related to falls.)

In the community, the incidence of falls can be reduced by a repeated campaign to alert older persons to the risk of falling. Assantachai et al used a leaflet for seniors containing information on important risk factors for falls within their community. [31] They noted a decreased fall rate with the educational efforts. It was found to be a cost-effective way to prevent falls by healthy elderly persons in the community.

Several studies have demonstrated that patients at risk of falls can be identified. Gunter et al used two scales to identify fallers: the "Get Up and Go" (a test involving lower-extremity strength and power, and mobility) and the Tandem Gait tests. [32] Those patients who were slow to get up were more likely to fall, which suggests that prevention strategies should concentrate on strength and mobility. In an analysis by Frels et al of falls among hospitalized elderly patients, most fallers were identified for risk of falling by ward staff. [33] Falls were least likely to occur during visiting hours, and peak incidence occurred during nighttime. Most significantly, these researchers observed that benzodiazepines were implicated in many of the falls, with an odds ratio of 5.6.

In the acute-care setting, Lane identified four risk factors for falls: age 60 and over, impaired memory, muscle weakness, and need of ambulatory assistance. [34] However, prevention strategies did not change the rate of falling. In a meta-analysis, Hill-Westmoreland et al found in 12 studies that intervention reduced risk of falling by only 4%. [35] At least one other evaluation shows better rates. [36] (See also Chapter 11, section on bone insufficiency and falls.)

PRESSURE ULCER PREVENTION

In 1992, the Agency for Health Care Policy and Research released a guideline on the prevention of pressure ulcers. [37] Although this was a seminal work, at the time there was very little evidence-based data available to its authors. Of the 26 recommendations made by the panel, only six (23%) had sufficient research data to warrant an A or B strength of evidence rating. [38] It was essentially an expert panel document. However, the guideline did provide physicians with five specific steps that can be used to prevent pressure ulcers in their patients:

- perform a risk assessment on all bed- and chair-bound patients,

- keep the pressure off the bony prominences of at-risk patients by using a turning schedule,

- use a pressure-reducing mattress in the treatment of all at-risk patients,

- avoid massage of bony prominences,

- encourage the development of institutional educational programs or skin care teams for the prevention and treatment of pressure ulcers.

Among medical patients, assessment at the time of admission identified that patients who were confused on arrival developed significantly more pressure ulcers than patients who were orientated to time and place. [39] However, there is limited information about pressure ulcer risk in the preoperative, intraoperative, and postoperative periods. Because the surgical period is defined temporally, in contrast to the protracted course of the chroni-

cally ill patient, the development of pressure ulcers must be examined using a time-based evaluation. Stotts called for the Agency for Health Care Policy and Research guideline for pressure ulcer prevention to be tested in surgical patients. [40] Surgical patients present a unique challenge in preventing pressure ulcers because the problem begins while the patients are immobile and unable to perceive the discomfort of prolonged pressure. Although the pathophysiology and etiology of pressure ulcers are well documented by years of research, the operating room as an etiologic factor is largely undefined. [41] The emphasis on the effect of intraoperative events on pressure ulcer occurrence has led to a quest for predictors of pressure ulcers in surgical patients. [42]

The prevention of pressure ulcers continues in the intensive care unit and on the ward. Few research studies address pressure ulcer prevention in the critical-care setting. Level of risk needs to be linked with intervention to assist the caregivers in managing the pressure-relief options that are available. While studies revolve around testing beds and other products, the prevention of pressure ulcers in critical care patients will continue to require vigilance and the best use of available knowledge in the field. [43]

CCI 40 (Level A): **To determine if deep-vein thrombosis prophylaxis should be instituted in all geriatric surgical patients or just a select few having certain procedures, a randomized controlled trial must be designed to determine for each common procedure what the likelihood is of getting deep-vein thrombosis, with or without prophylaxis.**

CCI 41 (Levels B, A): **The risks and complications of using vena cava filters in elderly patients to prevent pulmonary embolism as an alternative to other therapies should be evaluated by cohort studies and ultimately by a randomized controlled trial.**

CCI 42 (Level B): **Cohort studies are needed to determine if predisposing and precipitating factors for delirium in the older hospitalized surgical patient are the same as in the older hospitalized nonsurgical patient.**

CCI 43 (Level A): **Proof is needed that prevention of a given factor will lower the risk, or that treating a factor once delirium develops will lessen the adverse outcomes associated with delirium; this will require controlled, probably nonrandomized trials.**

CCI 44 (Level B): **Ultimately, the biochemical basis for delirium needs to be delineated in the hope that drug therapy will prove useful and cost-effective, not only for treatment but perhaps for prophylaxis as well.**

CCI 45 (Level A): **The likelihood of delirium after outpatient surgery needs to be compared by randomized controlled trials with that of inpatient surgery of comparable stress rating.**

CCI 46 (Level B): **In order to improve studies of postoperative cognitive decline, attempts should be made at developing methods of measuring cognition that can be applied serially and are sensitive to modest degrees of cognitive decline.**

CCi 47 (Level B): **After development of improved measures of cognitive decline (see CCI 46), prospective cohort studies of surgical patients receiving general anesthesia should be designed that will assess the impact of postoperative cognitive decline on functional status and other long-term outcomes.**

CCI 48 (Level B): **The causal relationship between delirium and cognitive decline, if any, needs to be determined by longitudinal cohort studies.**

CCI 49 (Levels B, A): **The effect of successful versus unsuccessful outcomes of surgery on the incidence and ability to treat postoperative depression should be investigated by longitudinal cohort studies followed by case-control studies.**

CCI 50 (Levels B, A): **Treatment protocols that include behavioral and pharmacologic modalities should be developed for older patients who develop postoperative depression, and they should be tested first in cohort studies, followed ultimately by randomized controlled trials.**

CCI 51 (Level A:) **Simple, easily applied protocols have been validated to identify preoperatively those older patients who are at risk for falling. High-risk patients should be studied in randomized controlled trials to determine if an intervention program could significantly decrease the number of falls in the postoperative period. Cost analysis should accompany these studies.**

CCI 52 (Levels B, A): **Cohort studies are needed to determine the causative factors for pressure ulcers that occur in the operating room. Longitudinal evaluations are needed to determine if prevention strategies begun in the operating room make a difference in the incidence and severity of pressure ulcers in the elderly surgical population.**

References

1. Wakefield TW, Proctor MC. Current status of pulmonary embolism and venous thrombosis prophylaxis. Semin Vasc Surg 2000;13:171-181.
2. White RH, Gettner S, Newman JM, et al. Predictors of rehospitalization for symptomatic venous thromboembolism after total hip arthroplasty. N Engl J Med 2000;343:1758-1764.
3. Donat R, Mancey-Jones B. Incidence of thromboembolism after transurethral resection of the prostate (TURP)—a study on TED stocking prophylaxis and literature review. Scand J Urol Nephrol 2002;36:119-123.
4. Warwick D, Harrison J, Whitehouse S, et al. A randomised comparison of a foot pump and low-molecular-weight heparin in the prevention of deep-vein thrombosis after total knee replacement. J Bone Joint Surg Br 2002;84:344-350.
5. Robertson KA, Bertot AJ, Wolfe MW, Barrack RL. Patient compliance and satisfaction with mechanical devices for preventing deep venous thrombosis after joint replacement. J South Orthop Assoc 2000;9:182-186.
6. Westrich GH, Haas SB, Mosca P, Peterson M. Meta-analysis of thromboembolic prophylaxis after total knee arthroplasty. J Bone Joint Surg Br 2000;82:795-800.

7.   Palareti G, Leali N, Coccheri S, et al. Bleeding complications of oral anticoagulant treatment: an inception-cohort, prospective collaborative study (ISCOAT). Italian Study on Complications of Oral Anticoagulant Therapy. Lancet 1996;348:423-428.

8.   Kakkar VV, Kakkar S, Sanderson RM, Peers CE. Efficacy and safety of two regimens of low molecular weight heparin fragment (Fragmin) in preventing postoperative venous thrombolism. Haemostasis 1986;16 Suppl 2:19-24.

9.   Ansari S, Warwick D, Ackroyd CE, Newman JH. Incidence of fatal pulmonary embolism after 1,390 knee arthroplasties without routine prophylactic anticoagulation, except in high-risk cases. J Arthroplasty 1997;12:599-602.

10. Fender D, Harper WM, Thompson JR, Gregg PJ. Mortality and fatal pulmonary embolism after primary total hip replacement: results from a regional hip register. J Bone Joint Surg Br 1997;79:896-899.

11. Prandoni P, Bruchi O, Sabbion P, et al. Prolonged thromboprophylaxis with oral anticoagulants after total hip arthroplasty: a prospective controlled randomized study. Arch Intern Med 2002;162:1966-1971.

12. Kibel AS, Creager MA, Goldhaber SZ, et al. Late venous thromboembolic disease after radical prostatectomy: effect of risk factors, warfarin and early discharge. J Urol 1997;158:2211-2215.

13. Ricotta S, Iorio A, Parise P, et al. Post discharge clinically overt venous thromboembolism in orthopaedic surgery patients with negative venography–an overview analysis. Thromb Haemost 1996;76:887-892.

14. Inouye SK, van Dyck CH, Alessi CA, et al. Clarifying confusion: the confusion assessment method: a new method for detection of delirium. Ann Intern Med 1990;113:941-948.

15. O'Keeffe ST, Ni Chonchubhair A. Postoperative delirium in the elderly. Br J Anaesth 1994;73:673-687.

16. Folstein MF, Folstein SE, McHugh PR. ''Mini-mental state'': a practical method for grading the cognitive state of patients for the clinician. J Psychiatr Res 1975;12:189-198.

17. Ni Chonchubhair A, Valacio R, Kelly J, O'Keefe S. Use of the abbreviated mental test to detect postoperative delirium in elderly people. Br J Anaesth 1995;75:481-482.

18. Parikh SS, Chung F. Postoperative delirium in the elderly. Anesth Analg 1995;80:1223-1232.

19. Flacker JM, Marcantonio ER. Delirium in the elderly: optimal management. Drugs Aging 1998;13:119-130.

20. Inouye SK, Bogardus ST, Jr., Charpentier PA, et al. A multicomponent intervention to prevent delirium in hospitalized older patients. N Engl J Med 1999;340:669-676.

21. Marcantonio ER, Flacker JM, Michaels M, Resnick NM. Delirium is independently associated with poor functional recovery after hip fracture. J Am Geriatr Soc 2000;48:618-624.

22. Inouye SK. Delirium in hospitalized older patients. Clin Geriatr Med 1998;14:745-764.

23. Marcantonio ER, Juarez G, Goldman L, et al. The relationship of postoperative delirium with psychoactive medications. JAMA 1994;272:1518-1522.

24. Williams-Russo P, Urquhart BL, Sharrock NE, Charlson ME. Post-operative delirium: predictors and prognosis in elderly orthopedic patients. J Am Geriatr Soc 1992;40:759-767.

25. Inouye SK, Schlesinger MJ, Lydon TJ. Delirium: a symptom of how hospital care is failing older persons and a window to improve quality of hospital care. Am J Med 1999;106:565-573.

26. Gustafson Y, Brannstrom B, Berggren D, et al. A geriatric-anesthesiologic program to reduce acute confusional states in elderly patients treated for femoral neck fractures. J Am Geriatr Soc 1991;39:655-662.

27. Moller JT, Cluitmans P, Rasmussen LS, et al. Long-term postoperative cognitive dysfunction in the elderly ISPOCD1 study. ISPOCD investigators. International Study of Post-Operative Cognitive Dysfunction. Lancet 1998;351:857-861.

28. Holmes J, House A. Psychiatric illness predicts poor outcome after surgery for hip fracture: a prospective cohort study. Psychol Med 2000;30:921-929.

29. Billig N, Stockton P, Cohen-Mansfield J. Cognitive and affective changes after cataract surgery in an elderly population. Am J Geriatr Psychiatry 1996;4:29-38.
30. Carter ND, Kannus P, Khan KM. Exercise in the prevention of falls in older people: a systematic literature review examining the rationale and the evidence. Sports Med 2001;31:427-438.
31. Assantachai P, Chatthanawaree W, Thamlikitkul V, et al. Strategy to prevent falls in the Thai elderly: a controlled study integrated health research program for the Thai elderly. J Med Assoc Thai 2002;85:215-222.
32. Gunter KB, White KN, Hayes WC, Snow CM. Functional mobility discriminates nonfallers from one-time and frequent fallers. J Gerontol A Biol Sci Med Sci 2000;55:M672-M676.
33. Frels C, Williams P, Narayanan S, Gariballa SE. Iatrogenic causes of falls in hospitalised elderly patients: a case-control study. Postgrad Med J 2002;78:487-489.
34. Lane AJ. Evaluation of the fall prevention program in an acute care setting. Orthop Nurs 1999;18:37-43.
35. Hill-Westmoreland EE, Soeken K, Spellbring AM. A meta-analysis of fall prevention programs for the elderly: how effective are they? Nurs Res 2002;51:1-8.
36. Robertson MC, Campbell AJ, Gardner MM, Devlin N. Preventing injuries in older people by preventing falls: a meta-analysis of individual-level data. J Am Geriatr Soc 2002;50:905-911.
37. Agency for Health Care Policy and Research. Pressure ulcers in adults: prediction and prevention. Rockville, MD: U.S. Department of Health and Human Services, Public Health Service. AHCPR Publication No. 92-0050, 1992.
38. Xakellis GC. Guidelines for the prediction and prevention of pressure ulcers. The Agency for Health Care Policy and Research. J Am Board Fam Pract 1993;6:269-278.
39. Gunningberg L, Lindholm C, Carlsson M, Sjoden PO. Implementation of risk assessment and classification of pressure ulcers as quality indicators for patients with hip fractures. J Clin Nurs 1999;8:396-406.
40. Stotts NA. Risk of pressure ulcer development in surgical patients: a review of the literature. Adv Wound Care 1999;12:127-136.
41. Armstrong D, Bortz P. An integrative review of pressure relief in surgical patients. AORN J 2001;73:645-648, 650-643, 656-647 passim.
42. Byers PH, Carta SG, Mayrovitz HN. Pressure ulcer research issues in surgical patients. Adv Skin Wound Care 2000;13:115-121.
43. Glavis C, Barbour S. Pressure ulcer prevention in critical care: state of the art. AACN Clin Issues Crit Care Nurs 1990;1:602-613.

HEALTH-RELATED QUALITY OF LIFE

The Centers for Disease Control and Prevention defines HRQOL as a person's or group's perceived physical and mental health over time. Medical interest in measuring quality of life has evolved from the realization that "prolonging life may be a mixed blessing: patients want to live, not merely survive." [1]

Heyland et al in 1998 described a clear conceptual framework. [2] Only those domains of health status measurement that overlap with the quality-of-life domains constitute health-related quality of life. They include physical, psychologic, and social functioning. One of the most widely used measures is the Medical Outcomes Study Short Form 36-item health survey (SF–36), which has been validated in many chronic diseases. [3,4] The Sickness Impact Profile is another, but longer, general health questionnaire. Both of these measures were designed to apply generically, to any type of illness. However, measurement of outcomes for some interventions, for example, surgery, may require more disease-specific tools.

Despite the value of these general tools, new measurement tools have been developed. These new surveys can answer questions about speed and nature of recovery from surgical procedures for a group of patients. However, health status survey questions are designed to change practice over time and may not specifically help individual patients. [5]

Questions continue about the suitability of generic measures like the SF-36 in specific populations. [5–7] HRQOL may be affected by highly specific domain-sensitive criteria. For example, Terrell et al found that HRQOL after head and neck dissection for cancer depended greatly on whether cranial nerves V or XI were dissected, and that dissection of one or the other nerve produced different degrees of deterioration in HRQOL. [8]

Many older persons who have cognitive impairments from dementia are unable to answer questions relating to quality of life, but Brod et al suggest that persons with mild to moderate dementia can be considered good informants of their own subjective states. [9]

FUNCTIONAL PROBLEMS

Since the ability to perform daily functions changes one's perception of the quality of life, investigations have concentrated on common functions.

Sensory Disorders

The prevalence of sensory disorders in adults aged 70 years and older include 18% with self-reported vision impairments (4.4 million persons) and 33% (about 7 million) with hearing impairments; 8.6% report both vision and hearing impairments. [10] Numerous studies document the function-specific problems these patients experience. Because they have a variety of problems, some persons with severe vision problems and many with hearing problems do not get successful rehabilitation management. [11–14] Nonetheless, these services have proven benefits in specific populations. [14–16] (See also Chapter 7, Geriatric Ophthalmology, for a more detailed review of impaired vision, and Chapter 8, Geriatric Otolaryngology, for more a detailed review of impaired hearing.)

Sleep Problems

The NIH Consensus Conference on sleep disorders in 1990 mentions nothing about the sleep patterns of the surgical patient after operative intervention or during a stay in an intensive care unit (ICU). [17] Only two basic sleep problems were defined: obstructive sleep apnea and insomnia. Although postoperative pain clearly interferes with sleep, it may not be the only factor interfering with sleep after surgery or ICU experiences. Inouye et al included sleep enhancement in their overall Hospital Elder Life Program, but their intervention studies did not include postsurgical patients. [18]

Mobility

Many studies point to the fact that multiple factors contribute to decreased mobility in older adults. Immobility forms the third part of the triangle of evaluation of the elderly patient suggested by Katz. [19] (The other sides of the triangle are activities of daily living and instrumental activities of daily living.) Acute hospitalizations are associated with decreased independence in mobility and activities of daily living. [20] Some studies have shown that changes in acute hospital care systems may help improve functional outcomes. [21]

Most physicians and surgeons believe that early ambulation postoperatively is beneficial to patients, but proof is scarce. In one randomized controlled trial, 64 patients undergoing laparotomy and intestinal or rectal resection were randomized to usual care or to controlled rehabilitation with early ambulation and diet. The experimental group did better in time to discharge, complication and readmission rates, pain, and quality of life and patient satisfaction. Patients 70 years of age and over benefited from early ambulation but not quite as much as did patients younger than 70.[22] Other trials have confirmed benefit from accelerated rehabilitation but have not drawn distinctions that are based on age, usually because the number of patients in those trials was too small.[23]

Falls

Few studies have actually measured the HRQOL of older persons who fall in comparison with those who do not fall. Many risk factors for falls have been identified. Both vigorous and frail elderly persons are at risk for injurious falls.[24] Certain body characteristics such as underweight and osteoporosis clearly place one at increased risk of serious injury from falls. No studies specifically examined the risk for older adults of falling around the time of operation.

Sexuality

In a population survey, male erectile dysfunction was found to be significantly correlated with increasing age but to be less correlated with geographical location and to be independent of ethnicity.[25] Prostatic operations commonly interfere with erectile function.[26–28] Litwin noted that other types of procedures such as colon resection may affect erectile function. For cardiothoracic surgery, little information is available on postoperative sexual function. Litwin incorporated in his surveys of quality of life several "new" domains (sexual, urinary, and bowel). His survey instrument included measures of sexual function that had been excluded from many other measurement tools, for example, the Nottingham Health Survey[29] or the EuroQol measure.[30] Research on postoperative sexual dysfunction in women is almost nonexistent.

Urinary Incontinence

Many older adults alter their lives greatly to adjust to the problems of urinary incontinence. Women become incontinent more commonly than men do, and they most often respond by having less social interaction, especially with their families.[31] When incontinence occurs in women under age 60, they suffer greater deterioration of HRQOL than do older women.[32] In one group of women aged 70 years or more, 18% reported incontinence. They also reported more depressive feelings and a sense of decreased freedom of activity when incontinence hampers their lives.[33]

Pain

Chronic pain is common in older persons. Operations generally create acute pain on top of existing pain syndromes. Little literature specifically studies pain as a cause for or result of an operation in the elderly patient. Alteration of baseline pain and management of acute postoperative pain is a difficult problem in older patients, particularly because of the narrowing therapeutic range, which increases with age.

The relief of pain and suffering is a primary aim of medicine. Many geriatric patients fear the pain of surgery. Older patients can tolerate opioid medications with proper dosing and attention to side effects. In the postoperative setting, one of the pressing clinical issues is the need to balance adequate pain medication with the risks of delirium and excessive immobility. Assessment of pain in many patients with dementia is possible, but geriatric patients who are delirious or less verbal may not be asked about pain.

For further discussion of the management of acute and chronic pain along with research agenda items, see Chapter 2, Geriatric Anesthesia.

Procedure-Specific HRQOL

Some HRQOL assessments in cardiac, prostate, and cataract surgery demonstrate that many patients assess their results as worse than their preoperative states.[2] A sizable number of patients after cataract procedures do not show improved self-rated quality of life.[34] However, for larger operations such as coronary artery bypass, quality of life has been shown to generally improve.

Barriers to the Application of HRQOL Results

Newer types of outcomes measurements suggest that further research in HRQOL will provide useful data. However, barriers to studying HRQOL outcomes still persist. Clinicians often feel that HRQOL studies based on large patient databases do not reflect the unique problems of their own frail elderly patients. Results may point to unexpected outcomes that may suggest that certain procedures should not be performed on elderly patients or that physicians change their long-established behaviors. Despite the fact that value has been shown for some vision and incontinence rehabilitation programs, patients are not always referred for these services.

> *CCI 53 (Level B)*: **Generic health surveys to measure outcomes may not be adequate for use in the surgical population. However, disease- or syndrome-specific surveys have not been validated for this group. It is not known if health-related quality of life is domain-specific. Research therefore is needed to determine whether current measures require modification or new measures of health-related quality of life need to be developed.**

> *CCI 54 (Level B)*: **An instrument such as that for quality of life in dementia may help surgeons to make decisions about offering surgery to elderly demented patients, but such use requires validation.**

> *CCI 55 (Level B)*: **Measures of vision and hearing and of the effects of visual and auditory rehabilitation should be tested in the elderly surgical population by longitudinal cohort studies.**

> *CCI 56 (Level B)*: **The incidence, etiology, and severity of sleep disturbance in elderly postoperative patients should be evaluated, and longitudinal cohort studies should be performed to look for their temporary or long-lasting effects on health-related quality of life.**

> *CCI 57 (Level B)*: **Questions about sexuality should be included in all instruments used to measure health-related quality of life of elderly surgical patients.**

CCI 58 (Level B): **When instruments that include questions about sexuality become available (see CCI 57), then the ability to evaluate the effects of different operative procedures on the sexual aspects of quality of life should be tested and validated.**

CCI 59 (Level B): **Cohort studies or case-control studies should be performed to determine to what degree improvements or cure of incontinence improve health-related quality of life even in the presence of other negative quality-of-life factors, such as decreased mobility, chronic illness, or sleep disorders.**

CCI 60 (Level B): **It is necessary to continue to develop condition-specific instruments that will allow us to compare the health-related quality-of-life outcomes in operative and nonoperative therapies for the older population.**

References

1.   Grunfeld E, Glossop R, McDowell I, Danbrook C. Caring for elderly people at home: the consequences to caregivers. CMAJ 1997;157:1101-1105.
2.   Heyland DK, Guyatt G, Cook DJ, et al. Frequency and methodologic rigor of quality-of-life assessments in the critical care literature. Crit Care Med 1998;26:591-598.
3.   Ware JE, Jr., Sherbourne CD. The MOS 36-item short-form health survey (SF-36): I. conceptual framework and item selection. Med Care 1992;30:473-483.
4.   McHorney CA, Ware JE, Jr., Raczek AE. The MOS 36-Item Short-Form Health Survey (SF-36): II. psychometric and clinical tests of validity in measuring physical and mental health constructs. Med Care 1993;31:247-263.
5.   Stadnyk K, Calder J, Rockwood K. Testing the measurement properties of the Short Form-36 Health Survey in a frail elderly population. J Clin Epidemiol 1998;51:827-835.
6.   Hayes V, Morris J, Wolfe C, Morgan M. The SF-36 health survey questionnaire: is it suitable for use with older adults? Age Ageing 1995;24:120-125.
7.   Dorman PJ, Waddell F, Slattery J, et al. Is the EuroQol a valid measure of health-related quality of life after stroke? Stroke 1997;28:1876-1882.
8.   Terrell JE, Welsh DE, Bradford CR, et al. Pain, quality of life, and spinal accessory nerve status after neck dissection. Laryngoscope 2000;110:620-626.
9.   Brod M, Stewart AL, Sands L, Walton P. Conceptualization and measurement of quality of life in dementia: the dementia quality of life instrument (DQoL). Gerontologist 1999;39:25-35.
10. Campbell VA, Crews JE, Moriarty DG, et al. Surveillance for sensory impairment, activity limitation, and health-related quality of life among older adults—United States, 1993-1997. MMWR CDC Surveill Summ 1999;48:131-156.
11. Rubin GS, Roche KB, Prasada-Rao P, Fried LP. Visual impairment and disability in older adults. Optom Vis Sci 1994;71:750-760.
12. Massof RW, Rubin GS. Visual function assessment questionnaires. Surv Ophthalmol 2001;45:531-548.
13. Parrish RK, Gedde SJ, Scott IU, et al. Visual function and quality of life among patients with glaucoma. Arch Ophthalmol 1997;115:1447-1455.
14. Scott IU, Smiddy WE, Schiffman J, et al. Quality of life of low-vision patients and the impact of low-vision services. Am J Ophthalmol 1999;128:54-62.
15. Swagerty DL. The impact of age-related visual impairment on functional independence in the elderly. Kans Med 1995;96:24-26.

16. Watson GR. Low vision in the geriatric population: rehabilitation and management. J Am Geriatr Soc 2001;49:317-330.

17. Drugs and insomnia. NIH Consensus Development Conference. Natl Inst Health Consens Dev Conf Summ 1984;4:1-9.

18. Inouye SK, Bogardus ST, Jr., Baker DI, et al. The Hospital Elder Life Program: a model of care to prevent cognitive and functional decline in older hospitalized patients. Hospital Elder Life Program. J Am Geriatr Soc 2000;48:1697-1706.

19. Katz S. Assessing self-maintenance: activities of daily living, mobility, and instrumental activities of daily living. J Am Geriatr Soc 1983;31:721-727.

20. Mahoney JE, Sager MA, Jalaluddin M. Use of an ambulation assistive device predicts functional decline associated with hospitalization. J Gerontol A Biol Sci Med Sci 1999;54:M83-M88.

21. Iezzoni LI, McCarthy EP, Davis RB, Siebens H. Mobility impairments and use of screening and preventive services. Am J Public Health 2000;90:955-961.

22. Delaney CP, Zutshi M, Senagore AJ, et al. Prospective, randomized, controlled trial between a pathway of controlled rehabilitation with early ambulation and diet and traditional postoperative care after laparotomy and intestinal resection. Dis Colon Rectum 2003;46:851-859.

23. Basse L, Raskov HH, Hjort Jakobsen D, et al. Accelerated postoperative recovery programme after colonic resection improves physical performance, pulmonary function and body composition. Br J Surg 2002;89:446-453.

24. Speechley M, Tinetti M. Falls and injuries in frail and vigorous community elderly persons. J Am Geriatr Soc 1991;39:46-52.

25. Jonler M, Moon T, Brannan W, et al. The effect of age, ethnicity and geographical location on impotence and quality of life. Br J Urol 1995;75:651-655.

26. Litwin MS. Health related quality of life in older men without prostate cancer. J Urol 1999;161:1180-1184.

27. Litwin MS. Measuring quality of life after prostate cancer treatment. Cancer J Sci Am 1999;5:211-213.

28. Schover LR, Fouladi RT, Warneke CL, et al. Defining sexual outcomes after treatment for localized prostate carcinoma. Cancer 2002;95:1773-1785.

29. Lukkarinen H, Hentinen M. Assessment of quality of life with the Nottingham Health Profile among patients with coronary heart disease. J Adv Nurs 1997;26:73-84.

30. EuroQol—a new facility for the measurement of health-related quality of life. The EuroQol Group. Health Policy 1990;16:199-208.

31. Bernstein I, Sejr T, Able I, et al. Assessment of lower urinary tract symptoms in women by a self-administered questionnaire: test-retest reliability. Int Urogynecol J Pelvic Floor Dysfunct 1996;7:37-47.

32. Dugan E, Cohen SJ, Robinson D, et al. The quality of life of older adults with urinary incontinence: determining generic and condition-specific predictors. Qual Life Res 1998;7:337-344.

33. Kutner NG, Schechtman KB, Ory MG, Baker DI. Older adults' perceptions of their health and functioning in relation to sleep disturbance, falling, and urinary incontinence. FICSIT Group. J Am Geriatr Soc 1994;42:757-762.

34. Lundstrom M, Stenevi U, Thorburn W. Quality of life after first- and second-eye cataract surgery: five-year data collected by the Swedish National Cataract Register. J Cataract Refract Surg 2001;27:1553-1559.

MODELS OF CARE DELIVERY

Most older patients receiving surgical and rehabilitation care are living with one or, commonly, several chronic illnesses. Improving care for these complicated patients involves interventions aimed at the multiple components of the health care system, described by Donabedian as care by practitioners and other providers, patient- and family-initiated care, and community services. [1]

Comorbidities often impede older persons from helping themselves to heal. Arthritis and immobility make them vulnerable to additional postoperative complications and prevent them from properly caring for their wounds. Boynton suggests that systems will be necessary to assist them to take appropriate steps in the healing process. [2] This is true even in the ICU, where resources must be brought together to assist the older patient through the period of maximum vulnerability. [3]

INTERDISCIPLINARY TEAMS AND PROCESS OF CARE

Teamwork and interdisciplinary care play important roles in the care of older patients. [4,5] A large Veterans Affairs study of more than 1600 stroke patients demonstrated that some measures of team function predict patient recovery and decreased length of stay. [6] Continence improvement correlated with the attributes of team organization, order, and quality management. [7] Another approach in health care emphasizes teamwork by applying W. Edwards Deming's management principles; Deming espoused collaborative work environments that used the skill and knowledge of all workers. This approach was found to lead to improved patient outcomes and decreased health care costs when applied to ICU care. [8] Team or collaborative care leads to improved outcomes in outpatient management of chronic illnesses like diabetes mellitus. [9] These approaches often involve changes in care processes using personnel already involved in patient care but may require additional team members. Such team behavior is not necessarily an intrinsic skill of health care professionals. [10] Methods are available to teach and measure interdisciplinary team building with specific application to the care of older patients. [11,12]

THE FAMILY'S CONTRIBUTION TO CARE

Family and caregiver health can be adversely affected by many illnesses like dementia, stroke, and hip fracture. The psychologic and financial burdens families face when patients survive with severe chronic disability are huge and a source of significant animosity toward the health care system. [13–16] Some studies point to unmet needs identified by families. [17] Little is known about the effects of different types of caregiving on patients' outcomes from surgical and rehabilitation treatments. Some studies suggest that, in the setting of chronic disease, training family and friends in methods of assisting patients improves patient outcomes and prevents caregiver burnout. [18–20] The types and goals of family interventions are subjects of ongoing research. [21,22]

SYSTEMS INTERVENTIONS TO IMPROVE QUALITY

There exists a mismatch between the health needs of older patients and the way health care systems are organized to deliver care. Research has identified elements of care needed to promote improved health outcomes. For example, in the Chronic Care Model,

productive interactions between physicians and patients requires decision support, clinical information systems, self-management support for patients, delivery system redesign, and linkages to community services, all operating within a health system supportive of these objectives. [23]

Quality Improvement Methodologies

Physicians and health systems require tools and methods to improve patient outcomes and the quality of care. Quality improvement efforts may be conducted to offer new ways to gain knowledge relevant to the care of older adults. [24] Methods used in industrial quality improvement are applicable to specific problems in health care delivery. [25–27] Through close collaboration of clinicians, the Northern New England Cardiovascular Disease Study Group improved outcomes and reduced mortality among patients undergoing coronary artery bypass grafting. [28] For years, surgeons have analyzed individual complications through surgical morbidity and mortality conferences. [29] In the past, these conferences focused on clinical decisions alone, but including analysis of process and systems issues in the conferences could clarify other sources of error in hospital care. [30–32]

Evidence-Based Medicine

Applications of evidence-based medicine for older patients is another approach that may improve outcomes. [33,34] Practicing evidence-based medicine requires the acquisition of new skills by physicians. [35] However, many studies lack inclusion of older subjects, thereby limiting the amount of evidence available to guide clinical decisions regarding the care of older patients. Wenger at al summarized the literature on many of the clinical conditions where data are available for the management of the vulnerable elderly. [36] Difficulties in conducting research to produce adequate evidence may include conflicts of interest, ethical contraindications to including older patients in clinical research, the presence of many comorbidities, and interference by medications for chronic illnesses. [37]

Postoperative Planning and Coordination

Inefficiencies in discharge planning may play a role in longer lengths of stay since some, but not all, studies with targeted discharge planning processes have reduced hospital lengths of stay. [38] Rigorous use of evidence-based clinical pathways in hip fracture patients did reduce length of stay by 1 day for nursing-home patients but not for other patients. [39] This lack of reduction in average length of stay after hip fracture was found in another study in which care managers were used for "low-risk" patients. [40] This latter study did achieve decreased lengths of stay for total hip and knee replacement cases without significant changes in patient outcomes but may have just shifted the cost of health care, because more short-stay total hip replacement patients went to nursing homes or rehabilitation facilities. Total cost of care may actually have been increased through such transfers rather than having patients remain 1 or 2 more days in the acute-care hospital. For ICUs, decreased lengths of stay were achieved through team care and implementation of protocols. [41]

Settings for Post-Hospital Care

An increasing number of studies have evaluated the most appropriate settings for post-hospital care and rehabilitation. Many of these suggest that care of older adults can

be improved by changes in how care is organized and delivered. [42] One study evaluated patient satisfaction and functional outcomes by following elective hip and knee replacement patients after a 7-day surgical hospitalization. Patients were discharged to either an inpatient rehabilitation stay or home, primarily on the basis of patient preference. There were no differences in outcomes. [43] In a study of high-risk individuals after these elective joint procedures, patients were found to do better if they were transferred to a rehabilitation facility on postoperative day 3 rather than 7. [44] Another large national study showed better functional outcomes at 6 months for stroke survivors but no difference in hip fracture outcomes for patients treated in acute rehabilitation hospitals rather than in skilled nursing facilities. [45] Tinetti et al examined a multicomponent home-based rehabilitation program for older persons after hip fracture, comparing it with usual care, and found no differences in final outcomes. [46]

Continuity of Care

A single older patient may receive care for a single illness event, like stroke or complicated surgical procedure, from many different treatment teams, including ones in an acute-care hospital, a rehabilitation hospital, a subacute-care facility, then an outpatient rehabilitation facility and their physicians' offices. If patients have suboptimal function after a rehabilitation hospital stay, they may go to a nursing facility or may use home health services as well as services offered by their primary care physician.

Patients are at increased risk when information that is transferred from one institution to another is not complete or correct. [47] Receiving teams are known to repeat tests and procedures. [48] Quality indicators for continuity of care have been suggested to improve continuity as well as to integrate quality assurance across settings of care. [36,49] The Domain Management Model and the use of patient care notebooks kept by patients and families are possible tools to standardize information transfer among sites of care. [50,51]

Measuring and Improving Access to Necessary Care

Barriers in access to care and disparities in health care quality can lead to poorer health outcomes among vulnerable subgroups of older people, such as those with lower socioeconomic status, from racial and ethnic minority groups, or those with disabilities. Administrative databases can provide critical information about Medicare patient access to well-defined and appropriate services. [52,53] Asch et al studied 345,253 randomly selected elderly Medicare beneficiaries in 1994–1996. [52] They examined 26 indicators for necessary care and documented that these patients in fact were receiving that care. However, using 16 different indicators, Hannan found that fewer than 66% of beneficiaries were receiving the care. [53] In this study, patients in poverty areas were found to have poorer access. Among the first steps for improving quality of care for older surgical and rehabilitation patients is the assessment of access to care. [54]

> *CCI 61 (Level B)*: **Observational studies are needed to learn where errors occur and where established evidence for best practice improves perioperative care.**

> *CCI 62 (Level A)*: **Interventional studies are needed to test methods to improve outcomes by reducing errors and applying relevant evidence for best practices.**

CCI 63 (Level B): **Observational studies are needed to suggest which components of post-hospital care are associated with better outcomes.**

CCI 64 (Level A): **Interventional trials of different post-hospital care treatments and management strategies are needed to test hypotheses of ways to improve outcomes.**

CCI 65 (Level B): **Observational studies are needed to document specific problems in communication among settings of care that lead to medical errors, duplication of staff work, and patient and family confusion and lack of compliance.**

CCI 66 (Level A): **Interventional studies are needed to assess the effectiveness of strategies that foster communication and coordination among settings of care.**

CCI 67 (Level B): **Observational studies are needed to identify specific barriers to and disparities in the quality of care for vulnerable elderly subgroups.**

CCI 68 (Level A): **Interventional studies are needed to assess the effectiveness of specific targeted interventions designed to reduce barriers to and disparities in quality of care for older persons.**

CCI 69 (Level B): **Descriptive studies are needed to assess the relationship of team function and organizational characteristics to outcomes in older surgical patients.**

CCI 70 (Level A): **Interventional studies are needed to determine the optimal composition and structure of interdisciplinary teams as well as to determine how to improve team function to economically improve outcomes for elderly surgical patients in different care settings.**

CCI 71 (Level B): **Prospective studies are needed to assess the effects of various types of family caregiving on the outcomes for older patients who require surgery, emergency department visits, and rehabilitation care.**

CCI 72 (Level B): **Observational studies are needed to assess family or caregivers' identification of unfulfilled needs during the course of an elderly patient's recovery.**

CCI 73 (Level A): **Interventional trials will ultimately be needed to determine if patient and caregiver outcomes can be improved with targeted interventions.**

References

1. Donabedian A. The quality of care: how can it be assessed? JAMA 1988;260:1743-1748.
2. Boynton PR, Jaworski D, Paustian C. Meeting the challenges of healing chronic wounds in older adults. Nurs Clin North Am 1999;34:921-932, vii.
3. Tullmann DF, Dracup K. Creating a healing environment for elders. AACN Clin Issues 2000;11:34-50; quiz 153-154.

4. Counsell SR, Kennedy RD, Szwabo P, et al. Curriculum recommendations for Resident Training in Geriatrics Interdisciplinary Team Care. J Am Geriatr Soc 1999;47:1145-1148.
5. Keith RA. The comprehensive treatment team in rehabilitation. Arch Phys Med Rehabil 1991;72:269-274.
6. Strasser DC, Falconer JA, Herrin J, Bowen SE. Team functioning and patient outcomes in stroke rehabilitation in VA hospitals (poster). Arch Phys Med Rehabil 2000;81:1291.
7. Strasser DC, Falconer JA, Herrin J, Bowen SE. The relation of rehabilitation team functioning and urinary continence for Veterans Administration stroke patients (abstract). Arch Phys Med Rehabil 2001;82:1491.
8. Clemmer TP, Spuhler VJ, Oniki TA, Horn SD. Results of a collaborative quality improvement program on outcomes and costs in a tertiary critical care unit. Crit Care Med 1999;27: 1768-1774.
9. Wagner EH. More than a case manager. Ann Intern Med 1998;129:654-656.
10. Fulmer T. Curriculum recommendations for Resident Training in Geriatrics Interdisciplinary Team Care. J Am Geriatr Soc 1999;47:1149-1150.
11. Hyer K, Fairchild S, Abraham I, et al. Measuring attitudes related to interdisciplinary training: revisiting the Heinemann, Schmitt and Farrell ′attitudes toward health care teams' scale. J Interprof Care 2000;14:249-258.
12. Siegler EL, Hyer K, Fulmer T, Mezey M (eds): Geriatric Interdisciplinary Team Training. New York: Springer Publishing Company, 1998.
13. Levine C. The loneliness of the long-term care giver. N Engl J Med 1999;340:1587-1590.
14. Somers AR. Long-term care at home (letter). N Engl J Med 1999;341:1005.
15. Levine C. Long-term care at home (reply). N Engl J Med 1999;341:1005.
16. Covinsky KE, Goldman L, Cook EF, et al. The impact of serious illness on patients' families. SUPPORT Investigators. Study to Understand Prognoses and Preferences for Outcomes and Risks of Treatment. JAMA 1994;272:1839-1844.
17. Greveson G, James O. Improving long-term outcome after stroke—the views of patients and carers. Health Trends 1991;23:161-162.
18. Von Korff M, Gruman J, Schaefer J, et al. Collaborative management of chronic illness. Ann Intern Med 1997;127:1097-1102.
19. Evans RL, Matlock AL, Bishop DS, et al. Family intervention after stroke: does counseling or education help? Stroke 1988;19:1243-1249.
20. Evans RL, Connis RT, Bishop DS, et al. Stroke: a family dilemma. Disabil Rehabil 1994;16:110-118.
21. Glass TA, Dym B, Greenberg S, et al. Psychosocial intervention in stroke: Families in Recovery from Stroke Trial (FIRST). Am J Orthopsychiatry 2000;70:169-181.
22. Lenz ER, Perkins S. Coronary artery bypass graft surgery patients and their family member caregivers: outcomes of a family-focused staged psychoeducational intervention. Appl Nurs Res 2000;13:142-150.
23. Wagner EH, Austin BT, Von Korff M. Improving outcomes in chronic illness. Manag Care Q 1996;4:12-25.
24. Casarett D, Karlawish JH, Sugarman J. Determining when quality improvement initiatives should be considered research: proposed criteria and potential implications. JAMA 2000;283: 2275-2280.
25. Berwick DM. Continuous improvement as an ideal in health care. N Engl J Med 1989;320: 53-56.
26. Berwick DM. Developing and testing changes in delivery of care. Ann Intern Med 1998;128: 651-656.
27. Langley G. The Improvement Guide: A Practical Approach to Enhancing Organizational Performance. San Francisco: Jossey-Bass, 1996.

28. O'Connor GT, Plume SK, Olmstead EM, et al. A regional intervention to improve the hospital mortality associated with coronary artery bypass graft surgery. The Northern New England Cardiovascular Disease Study Group. JAMA 1996;275:841-846.
29. Gordon L. Gordon's Guide to the Surgical Morbidity and Mortality Conference. Philadelphia: Hanley & Belfus Inc., 1994. p. 1-88.
30. Feldman SE, Roblin DW. Medical accidents in hospital care: applications of failure analysis to hospital quality appraisal. Jt Comm J Qual Improv 1997;23:567-580.
31. Pearse RM, Dana EC, Lanigan CJ, Pook JA. Organisational failures in urgent and emergency surgery: a potential peri-operative risk factor. Anaesthesia 2001;56:684-689.
32. Neale G, Woloshynowych M, Vincent C. Exploring the causes of adverse events in NHS hospital practice. J R Soc Med 2001;94:322-330.
33. Sackett DL, Straus SE, Richardson WS, et al. (eds): Evidence-based Medicine: How to Practice and Teach EBM, 2nd ed. Edinburgh: Churchill Livingstone, 2000.
34. Duncan PW, Horner RD, Reker DM, et al. Adherence to postacute rehabilitation guidelines is associated with functional recovery in stroke. Stroke 2002;33:167-177.
35. Cabana MD, Rand CS, Powe NR, et al. Why don't physicians follow clinical practice guidelines? a framework for improvement. JAMA 1999;282:1458-1465.
36. Wenger NS, Rosenfeld K. Quality indicators for end-of-life care in vulnerable elders. Ann Intern Med 2001;135:677-685.
37. Rosenstock L, Lee LJ. Attacks on science: the risks to evidence-based policy. Am J Public Health 2002;92:14-18.
38. Heseltine D. Community outreach rehabilitation. Age Ageing 2001;30 Suppl 3:40-42.
39. March LM, Cameron ID, Cumming RG, et al. Mortality and morbidity after hip fracture: can evidence based clinical pathways make a difference? J Rheumatol 2000;27:2227-2231.
40. Weingarten S, Riedinger MS, Sandhu M, et al. Can practice guidelines safely reduce hospital length of stay? results from a multicenter interventional study. Am J Med 1998;105:33-40.
41. Young MP, Gooder VJ, Oltermann MH, et al. The impact of a multidisciplinary approach on caring for ventilator-dependent patients. Int J Qual Health Care 1998;10:15-26.
42. Calkins E, Boult C, Wagner EH, Pacala JT (eds): New Ways to Care for Older People: Building Systems Based on Evidence. New York: Springer Publishing Company, 1999.
43. Mahomed NN, Koo Seen Lin MJ, Levesque J, et al. Determinants and outcomes of inpatient versus home based rehabilitation following elective hip and knee replacement. J Rheumatol 2000;27:1753-1758.
44. Munin MC, Rudy TE, Glynn NW, et al. Early inpatient rehabilitation after elective hip and knee arthroplasty. JAMA 1998;279:847-852.
45. Kramer AM, Steiner JF, Schlenker RE, et al. Outcomes and costs after hip fracture and stroke: a comparison of rehabilitation settings. JAMA 1997;277:396-404.
46. Tinetti ME, Baker DI, Gottschalk M, et al. Home-based multicomponent rehabilitation program for older persons after hip fracture: a randomized trial. Arch Phys Med Rehabil 1999;80:916-922.
47. Byington M. Ensuring patient safety from care site to care site. Harvard Risk Manage Found Forum 1997;18:12-13.
48. Boult C, Pacala JT. Integrating care. In Calkins E, Boult C, Wagner EH, Pacala JT (eds): New Ways to Care for Older People: Building Systems Based on Evidence. New York: Springer Publishing Company, 1999. p. 196-209.
49. Coleman EA, Besdine RW. Integrating quality assurance across sites of geriatric care. In Calkins E, Boult C, Wagner EH, Pacala JT (eds): New Ways to Care for Older People: Building Systems Based on Evidence. New York: Springer Publishing Company, 1999. p. 185-195.
50. Siebens H. Applying the domain management model in treating patients with chronic diseases. Jt Comm J Qual Improv 2001;27:302-314.

51. Siebens H, Weston H, Parry D, et al. The Patient Care Notebook: quality improvement on a rehabilitation unit. Jt Comm J Qual Improv 2001;27:555-567.
52. Asch SM, Sloss EM, Hogan C, et al. Measuring underuse of necessary care among elderly Medicare beneficiaries using inpatient and outpatient claims. JAMA 2000;284:2325-2333.
53. Hannan EL. The continuing quest for measuring and improving access to necessary care. JAMA 2000;284:2374-2376.
54. Bierman AS, Magari ES, Jette AM, et al. Assessing access as a first step toward improving the quality of care for very old adults. J Ambulatory Care Manage 1998;21:17-26.