

## Clinical Implications of Normal Aging

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### OBJECTIVES

Upon completion of this chapter, the reader will be able to:

- Describe the major biologic theories of aging and their effects on observed phenomena of human aging.

- Discuss and give examples of the following principles of aging: frailty, functional reserve, and the distinction between usual and successful aging.
- Identify and discuss common changes that occur with age in the following systems: musculoskeletal, skin, cardiovascular, respiratory, gastrointestinal, central nervous, special senses, and endocrine.

### PRETEST

1. Which one of the following signs of aging occurs earliest in most adults?
  - a. Difficulty reading fine print without glasses
  - b. Inability to stay up all night and work the next day
  - c. Radiologic evidence of osteoarthritis of the spine
  - d. Intense awareness that life is limited (“midlife crisis”)
  - e. Fixed wrinkling around the mouth
2. Which of the following statements is true about individuals at age 80 years?
  - a. Vibratory sensation is equally reduced in distal and proximal joints.
  - b. More than half of older persons report trouble sleeping at night.
  - c. Renal perfusion is 75% to 80% of its value at age 30 years.
  - d. Fewer than half of couples have been affected by death or disability of one or both spouses.
3. Which one of the following symptoms referable to the urogenital system is commonly reported by older women?
  - a. Increased vaginal mucus
  - b. Reduced urinary frequency
  - c. Vaginal bleeding
  - d. Incontinence

Aging is a process of gradual and spontaneous change, resulting in maturation through childhood, puberty, and young adulthood and then decline through middle and late age. Senescence is the process by which the capacity for cell division, growth, and function is lost over time, ultimately leading to an incompatibility with life; that is, the process of senescence terminates in death. Aging has both the positive element of development and the negative element of decline. Senescence refers only to the degenerative processes that ultimately make continued life impossible.

In both aging and senescence, many physiologic functions deteriorate, but normal decline is not usually considered the same as ailment. Mild cognitive changes do occur with progressive aging and are considered normal; however, cognitive decline consistent with dementia, although usual in late life, is considered an illness.

### Martha Hilliard Robinson (Part I)

#### CHILDHOOD AND YOUNG ADULTHOOD

*Martha Hilliard Robinson was born on January 10, 1898, in the small rural community of Tarboro in eastern North Carolina. She had three older brothers, and her father owned a hog farm. Taking unusually well to “book learning,” she was the first member of her family to complete high school. After graduation, Martha persuaded her father to allow her to attend Roth School of Nursing in Durham, North Carolina.*

*In the wave of patriotism after war was declared, Martha enlisted as an army nurse. She was sent to Base Hospital Number 165, north of*

Paris. There she met her first husband, Gerald Anthony Hilliard, a 27-year-old army physician from Raleigh who “had a gift for putting anyone at ease.” Martha and Dr. Hilliard fell in love in France but decided to postpone marriage. Martha did not want to anger her father, who was furious that she had enlisted in the army without his permission.

In 1918 Martha returned to Roth to complete her nursing education, and Dr. Hilliard resumed his appointment at Rex Hospital in Raleigh. They were married in 1920. Martha then worked for a private physician in Raleigh until she had a child, Gerald Junior. Thirteen months later, Jeremiah was born, and 2 years later, Martha had a third child, Rachel. Understandably, she did not consider returning to work. Her primary job was that of wife and homemaker, and wives of prominent physicians were expected to stay at home to care for the family.

Martha’s life changed suddenly when Gerald Anthony Hilliard was killed on a rainy night in 1932. He had been returning home from the hospital when his car collided with a milk wagon, killing him instantly. Martha was 35 years old with three school-age children. Her father insisted that she move back to the family homestead in Tarboro, where she remained for 4 years. With her mother available to help care for the children, Martha resumed her nursing career by taking a part-time job in a local physician’s office.

In 1936 Martha applied for a staff nurse position at Roth Hospital because she “believed in what Roth was doing.” Roth provided nearly three fourths of all free bed-care furnished to the destitute sick white citizens of Durham County (there was a separate black hospital at that time). Three months after Martha began working at Roth, her children joined her.

During 1936 Martha met her second husband, Benjamin Robinson, III, an attorney. She had retained his services because of a problem with her first husband’s death benefit. She was determined that the government not reduce her widow’s pension, especially because she had three dependent children. She and Benjamin Robinson were married in 1939 and remained together until his death in 1981, when Martha was 83.

## STUDY QUESTION

1. How would knowledge of Mrs. Robinson’s early life history have assisted a physician in providing sensitive, appropriate care for an acute illness at age 90 years?

There is increasing evidence that the black box we have referred to as “biologic aging” is composed of genetic factors and many types of environmental exposures. Some of the most potentially modifiable elements are those attributable to disuse or insufficient exposure to certain kinds or intensities of physical stressors during the course of the life span. Preventive actions targeting community-dwelling frail older people will be increasingly important with the growing number of very old and, thereby also frail, people.

Traditionally, the aging process, including the development of physical frailty toward the end of life, has been considered to be physiological and inevitable. Recently, it has become evident that stereotypes of aging as an irreversible process of decline and loss are not correct. The overarching goal should be “an increase in years of healthy life with a full range of functional capacity at each stage of life” (Table 2-1). Such a compression of morbidity can often be achieved through lifestyle measures, but a number of aspects of the aging process invite the development of “routine” medical intervention programs in order to setback the aging process and to permit us to live for a longer period in a relatively intact state.

● Functional problems in the elderly often have multiple causes.

**Table 2-1** Life Expectancy and Number of Remaining Years Free of Dependency in Activities of Daily Living

Age, Years	Life Expectancy <sup>a</sup> , Average		Disability-Free Years Remaining	
	Men	Women	Men	Women
65-69	13	20	9	11
70-74	12	16	8	8
75-79	10	13	7	7
80-84	7	10	5	5
≥85	7	8	3	3

<sup>a</sup>For independent noninstitutionalized elderly men and women in Massachusetts. Longevity and disability-free longevity are surprisingly long and must be incorporated into treatment decisions. All figures rounded to nearest year.

From Katz S, Branch LG, Branson MH, et al: Active life expectancy, *N Engl J Med* 309:1218-1824, 1983.

**Case Discussion**

*A physician seeing Mrs. Robinson for an episode of pneumonia or diverticulitis at age 92 years might not immediately appreciate the independence and self-reliance that she has demonstrated through her earlier life experiences. Her background in nursing, if known by her physician, would call for a more sophisticated level of communication about her illness than would be used with a poorly educated former laborer, for example.*

**Martha Hilliard Robinson (Part II)**

*At age 46, Martha Robinson told her new family physician, Dr. Hensley, that she was worried about “getting decrepit.” Dr. Hensley took each complaint seriously; Mrs. Robinson liked that. When his evaluation was complete, he explained each concern in language she understood, reassured her that her general health was excellent, and told her what she could do to stay healthy.*

*He explained that the bright red spots on her abdomen, which had become prominent over the past 10 years, were benign cherry angiomata clumps of blood vessels that commonly arise when a patient is in his or her 30s or 40s. He explained that the wrinkles around her eyes were normal by age 40; he called them “smile marks.” He advised her, however, to avoid sun exposure, which accelerates wrinkling. He explained that her occasional right knee pain was osteoarthritis that had set in early because that knee had been injured playing baseball as a teenager. Finally, he explained that her problems reading fine print were also normal and caused by the lens of each eye losing its ability to change shape. He advised her to be fitted for reading glasses.*

**USUAL VERSUS SUCCESSFUL AGING**

There is substantial disparity in the effects of aging on healthy individuals, with some persons exhibiting extensive alteration in physiological functions with age and others little or none. It has been suggested that it might be useful to differentiate between *usual* and *successful* patterns of aging.<sup>1</sup> Genetic factors, lifestyle, and societal investments in a safe and healthful environment are important aspects of successful aging. Normal aging includes the collective set of diseases

and impairments that characterize aging for many of the elderly. Successful (healthy) aging refers to a process by which deleterious effects are minimized, preserving function until senescence makes continued life impossible. The concept of successful aging is that aging is not necessarily accompanied by debilitating disease and disability. For example, the elderly may be able to avoid the complications of vascular disease, even while the circulatory system continues to age, by controlling blood glucose levels and body fat percentage.

Centenarians are persons who have escaped major common diseases, cancers included, and have reached the extreme limits of the human life span. Thus, they are the best example of successful aging. Demographic and epidemiological studies indicate that frequency and mortality for cancer level off at around 85 to 90 years of age, followed by a plateau, or even a decline, in the last decades of life. It is reasonable to infer that centenarians are people endowed with an atypical resistance to cancer. The genetic basis of this situation is poorly understood.

**Case Discussion**

*Relatively early in Mrs. Robinson’s adulthood, occasional osteoarthritic pain developed in her right knee, which had been injured when she was a teenager. That joint became an important source of physical impairment later in life.*

**Frailty**

Age-related disability is characterized by generalized weakness, impaired mobility and balance, and poor endurance (Box 2-1). In the oldest old, this state is

<b>BOX 2-1 Frailty Syndrome</b>	
<b>Outcomes</b>	
Prolonged or repeated hospitalizations	Prolonged or limited recoveries
<b>Proximate causes</b>	
Multiple comorbid conditions	Falls/fractures
<b>Intermediate causes</b>	
Loss of organ system reserve	Prolonged reaction time
	Loss of strength
Polypharmacy	Poor vision
	Osteoporosis
<b>Initial causes</b>	
Changes in endocrine function	

called physical frailty, which is defined as a state of reduced physiological reserves associated with increased susceptibility to disability. Clinical correlates of physical frailty include falls, fractures, impairment in activities of daily living, and loss of independence. It is hypothesized that a rapid decline of functional condition may follow even minor perturbations of physiological homeostasis in frail persons. The same perturbation would cause only negligible or transient illness in a healthy person. Interventions for disability prevention are considered most likely to be cost-effective when targeted to frail older persons.

Loss of muscle strength is a significant factor in the process of frailty. Muscle weakness can be caused by aging of muscle fibers and their innervation, osteoarthritis, and chronic debilitating diseases. A sedentary way of life and decreased physical activity and disuse are also important determinants of the decline in muscle strength. In a study of 100 frail nursing home residents (average age, 87 years), lower-extremity muscle mass and strength were closely related. Supervised resistance exercise training (for 45 minutes three times per week for 10 weeks) doubled muscle strength and significantly increased gait velocity and stair-climbing power.<sup>2</sup> This demonstrates that frailty in the elderly is not an irreversible effect of aging and disease but can be reduced and perhaps even prevented. Prevention of frailty can be achieved by exercise.

● The organ system usually associated with a particular symptom is less likely to be the source of that symptom in older individuals than in younger ones.

### Martha Hilliard Robinson (Part III)

*Mrs. Robinson was at the peak of her professional career at age 60. She had moved to Raleigh to become dean of the College of Nursing at Mercy Hospital. She recognized that her stamina had diminished, however, and she became fatigued particularly during out-of-town business trips. Routines had become important to maintain her energy. She exercised daily, and she was always in bed by 9:30 p.m. She also noticed trouble reading in dim light and was frequently bothered by knee pain, especially when walking long distances or on stairs.*

*During the decade that followed, Mrs. Robinson's knee continued to be her biggest health problem. She stopped using the stairs, moved to a one-story house, changed her evening walks to avoid a downward*

*grade, and frequently had pain at night. She took increasing doses of acetaminophen, occasionally with codeine, for pain. She began using a cane whenever she went outside the house. Her daily walks were replaced by swimming three times a week at the neighborhood pool.*

*At age 68, Mrs. Robinson saw Dr. Hensley because of vaginal bleeding after intercourse. He prescribed an estrogen cream, and the problem soon resolved. She was now retired and traveled frequently with her husband, Benjamin.*

*At age 72, she was placed on a diuretic for elevated blood pressure, which she attributed in part to her husband's heart attack the previous year.*

## STUDY QUESTIONS

1. To what extent are the above changes noted by Mrs. Robinson likely to be attributed to normal aging?
2. To what extent are the above changes noted by Mrs. Robinson likely to be attributed to disease?
3. To what extent are the above changes noted by Mrs. Robinson likely to be attributed to disuse or deconditioning?
4. List 10 environmental adjustments that may enhance the independence of an older person with severe osteoarthritis of the knee.

## MAINTENANCE OF HOMEOSTASIS

Because of decreased physiological reserve, older patients frequently develop symptoms at an earlier stage of their disease. Homeostatic strain caused by onset of a new disease often leads to symptoms associated with a different organ system, compromised by subclinical disease. For example, heart failure may be precipitated by mild hyperthyroidism, cognitive dysfunction by urinary tract infection, and nonketotic hyperosmolar coma by mild glucose intolerance.

Drug side effects can occur in older adults with drugs and drug doses unlikely to produce side effects in younger people. For instance, a sedating antihistamine (e.g., diphenhydramine) may cause confusion, digoxin may induce depression, and over-the-counter sympathomimetics may precipitate urinary retention in men with mild prostatic obstruction.

The predisposition to develop symptoms at an earlier stage of disease or with medication use is often offset by two factors. First, symptoms may present soon after if there is functional inadequacy in another system. Ischemic heart disease or congestive heart failure may not cause symptoms as early in patients whose

mobility is compromised by arthritis. Second, because debility is accepted as normal for our older population and disability and illness are accepted as normal consequences of aging, the elderly are less likely to seek attention until symptoms become disabling. Therefore, any symptom, particularly with a change in functionality, must be taken seriously and evaluated swiftly.

- Drug side effects can occur with drugs and drug doses unlikely to produce side effects in younger people.

## THEORIES OF BIOLOGIC AGING

Aging clearly occurs at dissimilar rates for different species and at different rates among individuals. By inference it appears that aging must be genetically controlled, at least to some extent. Both within and between species, lifestyle and exposures may alter the aging progression. Most gerontologists consider senescence as a group of degenerative entropic processes linked only by the fact that they occur over time. Some theories of aging address what controls these processes and why the controls exist as they do. Other theories of aging focus on the issues of whether senescence is more programmed, rather than random entropy, thus offering some advantage for a species. For instance, senescence may have evolved to increase the rate at which adaptive mutations are introduced.

### *Cellular and Molecular Aging*

Cells lose their capacity to divide over time unless they become cancerous. This limit to cellular replicative competence (Hayflick's limit or phenomenon) can be demonstrated in fibroblasts removed from the umbilical cord of newborns and cultured in vitro. Fibroblasts removed from aged persons tend to divide a lesser number of times. Telomeres are stretches of DNA at the end of chromosomes that act as handles by which chromosomes are moved in the course of the telophase of meiosis. Telomeres are irrevocably shortened each time a cell divides. When the telomeres become too short, the cell can no longer divide. In transformed (e.g., cancerous) cells, the enzyme telomerase lengthens telomeres after telophase. The telomeres of transformed cells do not shorten after each division, and thus, the cells become immortal, dividing far beyond Hayflick's limit.

### *Necrosis and apoptosis*

Cell death may occur by necrosis or apoptosis. Necrosis is due to physical or chemical insults (e.g., metabolic inhibition, ischemia) that overwhelm normal cellular progression and make the cell nonviable. In necrosis, loss of ion gradients across the cell membrane leads to

an incursion of calcium and other ions, which initiates proteolysis and break down of the organelle membranes. Necrosis is an entirely entropic event due to loss of the cell's capacity to transform external energy.

In contrast, apoptosis is a decidedly regulated, orderly process by which a cell in effect commits suicide. The stimulus for apoptosis is a physiologic sign or a very mild insult. A significant feature of apoptosis is the fragmentation of the cell's DNA, produced by a regulated activation of deoxyribonuclease. However, numerous other biochemical processes that also lead to cell death are concurrently induced. Apoptosis is vital for normal growth and remodeling. Apoptosis has been thought to contribute to several age-related ailments, including Alzheimer's disease. Whether age-related cell death is due primarily to necrosis or to apoptosis affects whether aging is considered the outcome of entropic processes (if due primarily to necrosis) or of comparatively simpler, more regulated processes.

Three theories of aging that remain actively investigated, include<sup>3</sup>:

### *“Free Radical” Theory*

This theory proposes that an entropy-producing agent—free radicals—gradually disrupts cellular macromolecular constituents. Theoretically, free radicals, generated during oxidative phosphorylation, can variously alter macromolecules, mainly through oxidation. Evidence suggests that oxidative injury increases with age. Certain oxidized derivatives of nucleotides from DNA amplify in frequency.

### *“Glycosylation” Theory*

This theory proposes that glycosylation can create modified proteins that accumulate and cause dysfunction with aging. Experimental evidence that rats on low calorie diets have lower blood glucose levels, accumulate fewer proteins, and may live longer lends some theoretical support for this theory.

### *Ultraviolet Light–Induced DNA Damage*

This theory proposes that the ability to repair ultraviolet (UV) light damage to DNA may be related to life span.

### **Martha Hilliard Robinson** *(Part IV)*

*Two months after her 78th birthday, Mrs. Robinson fell and broke her right wrist. She had been taking the garbage out to the compost pile in her backyard (a habit from her childhood days*

on the farm). It was dark, and she did not notice a piece of gravel on the uneven ground. “My ankle twisted, and I wasn’t able to catch myself,” she explained. Thinking back, she remembered that she had tripped several other times in the backyard since purchasing the house 14 years before, but this was the first time she had fallen.

Dr. Hensley felt that the accident might be a result of normal aging changes, but he followed up the incident with a thorough health evaluation. He noted that Mrs. Robinson had difficulty performing tandem gait but could maintain a standing position with her eyes closed (Romberg’s test). Her heart, lungs, and kidneys were fine. Her right knee was considerably larger than the left knee, without an effusion, and a 10-degree flexion contracture was evident. Quadriceps, hip abductors, and hip extensors were all weak on the right side.

Laboratory test results included a hematocrit of 41%, a blood urea nitrogen of 14 mg/dl, a creatinine of 1.1 mg/dl, and a cholesterol level of 234 mg/dl. Radiograph of her right wrist showed moderate osteoporosis and a displaced Colles’ fracture. Her audiogram showed bilateral high-frequency hearing loss, consistent with presbycusis.

Although he could not be certain that her severe knee osteoarthritis had caused Mrs. Robinson’s fall, Dr. Hensley believed that it was the major treatable contributing factor. He arranged for her to see an orthopedic surgeon about a knee replacement. Several months later, Mrs. Robinson had the surgery. She worked hard to regain her strength and mobility during postoperative rehabilitation. By 6 months after surgery, her knee mobility and strength were markedly improved and she was pain free.

## STUDY QUESTION

1. When an elderly patient is noted to have a functional problem such as weakness, recurrent falls, incontinence, or confusion, what general approach should the physician use to identify the relative contributions of disease, disuse, and normal aging to the problem?

## COMMON LABORATORY TESTS AND AGING

Distinguishing true physiologic effects of aging from disease and disuse has also proven difficult in the area of laboratory testing. It appears, however, that most labo-

ratory values change little, if at all, in normal healthy elderly. These include hematocrit, white cell count, electrolytes, calcium, thyroxine ( $T_4$ ), and thyroid-stimulating hormone (TSH). Notable exceptions are postprandial blood sugar, serum cholesterol in women, sedimentation rate, and serum tri-iodothyronine, or  $T_3$  (because peripheral thyroxine [or  $T_4$ ] is converted at lower rates in the elderly). Brain natriuretic peptide (BNP) level is a relatively new laboratory test used primarily in management of congestive heart failure. BNP tends to have higher levels in the elderly primarily owing to underlying renal insufficiency. Renal adjustments for several frequently used laboratory tests need to be adjusted at higher baseline levels owing to age-related renal function decline seen in the elderly.<sup>4</sup>

## ORGAN SYSTEM CHANGES WITH AGING

Table 2-2 summarizes selected age-related changes and their physiologic consequences.

### Skin Changes

The most visible signs of aging consist of changes in the skin and hair. Wrinkling, sagging of subcutaneous support, hair loss and graying, and a variety of benign and malignant skin conditions increase with frequency as individuals age. Many such changes occur more rapidly in fair-skinned persons and are accelerated by sun exposure.<sup>5</sup> Although the pace varies, the sequence of changes is relatively uniform: sagging of lateral aspects of the eyebrows, wrinkling of the forehead, horizontal skin lines at the lateral canthus of the eye, sagging of the tip of the nose, perioral wrinkling, and fat absorption of the buccal and temporal areas. Microscopic changes visible in aged skin include epidermal thinning, degeneration of the elastic fibers providing dermal support, thickening of collagen fibers in the dermis (often with pseudoscar formation), reduction in the numbers of sweat and sebaceous glands, and reduction in skin flow because of diminished vascularity.

### Case Discussion

*Mrs. Robinson’s fall illustrates the principle that functional problems in the elderly tend to have multiple causes. Physiologic studies demonstrate that dark adaptation declines with age, so Mrs. Robinson’s vision was somewhat impaired as she walked to the compost pile. Furthermore, reaction times are slower, so she probably had more difficulty righting herself when she lost her balance. In addition, a disease process, osteoarthritis of the knee, had caused further impairment, leading to*

**Table 2-2** Selected Age-Related Changes and their consequences

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*localized muscle atrophy and a mild contracture. One other physiologic factor certainly contributed to her injury: reduced bone mass in the wrist from osteoporosis. Despite all these physiologic limitations, Mrs. Robinson did well until an environmental factor, a stone on uneven ground, created a challenge to her physiologic reserves. Because of the multiple factors just cited and probably because of others as well, Mrs. Robinson was unable to prevent an injurious fall.*

### *Aging and the Heart*

In the resting aging heart, there are largely no alterations of systolic function, with preserved ejection fraction and stroke volume. The resting heart rate is unchanged or only minimally reduced with aging; cardiac output is also preserved. Aging alters cardiac responsiveness to  $\beta$ -adrenergic stimuli. Both the catecholamine- or exercise-induced increases in heart rate and myocardial contractility are definitely blunted in elderly subjects. Thus, for cardiac output to be increased in proportion to the body's metabolic needs

despite inadequate contractile and chronotropic reserves, the aging left ventricle mainly engages the Frank-Starling mechanism.<sup>6</sup> It has been suggested that the heart of the elderly behaves like a younger heart subjected to beta-blocker treatment.

Several cardiovascular features of the elderly most likely depend on aging, but often impaired performance also results from various combinations of sub-clinical cardiovascular or noncardiovascular illnesses, for example, thyroid dysfunction, diabetes, and borderline hypertension. The situation is further complicated because age-related changes by no means consist of a uniform and generalized structural degeneration.

### *Aging and the Lung*

A variety of physiologic changes in the lung with normal aging can lead to a decline in forced expiratory volume (FEV) and forced expiratory vital capacity (FVC), as well as an increase in residual volume. These changes result from reduced elasticity, decreased lung mass, chest wall stiffness, and decreased respiratory muscle strength. Airway ciliary action and the cough are less effective, increasing the risk for pulmonary infection.

#### **Case Discussion**

*Of the laboratory values obtained by Mrs. Robinson's physician, the hematocrit is clearly normal and should not change with age. The creatinine is in the high-normal range for that laboratory test. The test value probably represents significant reduction in creatinine clearance because creatinine clearance generally needs to be reduced by about half before the creatinine rises. Mrs. Robinson's serum cholesterol of 234 mg/dl is probably normal, given the rise in median cholesterol with age seen in healthy women. The relative importance of cholesterol values in older adults, particularly women, remains controversial.*

### *Aging and the Kidney*

In cross-sectional studies, creatinine clearance declines at a rate of 10 ml per decade. However, longitudinal studies have demonstrated that this decline is highly variable within older subgroups.<sup>7</sup> The use of medications with primary renal excretion requires caution in the very old. The older kidney demonstrates decreased sodium excretion and conservation, as well as decreased concentrating capacity.

### *Aging and the Gastrointestinal System*

The older stomach has mild decrease in stomach acid production. Colonic contractions are less effective and contribute to symptoms of constipation. The liver size is decreased, as is liver blood flow. The CYP3A sub-family of the cytochrome P450 system is critical to the hepatic metabolism of many medications (e.g., calcium channel blockers, statins, benzodiazepines). CYP3A activity may be reduced by up to 50% in some older adults. These changes may lead to clinically significant changes in drug metabolism.

#### **Martha Hilliard Robinson**

*(Part V)*

*During her annual physical examination at age 84 by Dr. Hensley, Mrs. Robinson expressed concern about not being able to sleep. "I'm in bed by 9:00 p.m., read until 10:00 p.m., and generally fall asleep," she said. "But by 2:30 a.m. I'm likely to be awake. Often, but not always, I go to the bathroom. Then, if I fall asleep, I wake up again at 4:30 or 5:00 a.m. If only I could get a complete night's sleep!" With probing, Dr. Hensley was able to get Martha to talk about her husband's death of a stroke 8 months earlier. After determining that she was undergoing a normal adjustment to loss of a spouse, Dr. Hensley reassured her. He discussed the normal pattern of responses after losing a spouse. He also reviewed the physiology of sleep and emphasized that her sleep pattern was normal.*

*At a later visit, Mrs. Robinson expressed concerns about her memory. "I can't remember the names of people I ought to know—people I just met; people in church," she stated. "I find myself writing notes to remember what to buy, even if I'm only going to the store for three or four items. I'm worried I might have Alzheimer's disease. What do you think, doctor?"*

#### **STUDY QUESTIONS**

1. How can a primary care physician effectively differentiate between benign forgetfulness and early dementia?
2. Is sleep disturbance normal or abnormal in older persons?

### *Aging and the Musculoskeletal System*

Without regular physical exercise, usual aging will result in a loss of muscle fibers and a decrease in mus-



cle mass. Decreasing bone mass occurs in both men and women. Osteoarthritis is associated with age, and by age 40 years, many adults have osteoarthritic changes visible in radiographs of the cervical spine. However, not every older person is equally affected, and in individuals not every joint is equally affected. Age-related physiologic changes combine with other factors to determine the extent of symptomatic disease.

- Functionally significant aging changes are especially common in the urinary, musculoskeletal, and neurologic systems and in the special senses.

### *Aging and the Endocrine System*

Postprandial glucose tolerance is impaired with age (increased by 10 mg/dl per decade). Nocturnal growth hormone peaks are lost, and there is a marked decrease in dehydroepiandrosterone (DHEA). Aging of women starts with slow decreases of ovarian steroid production, followed by unexpected and almost complete termination of sex hormone production at menopause. Men do not experience universal absolute gonadal failure. Testicular androgen production declines gradually, with significant individual variability along with the aging course. There are multiple factors influencing testosterone levels in elderly men: genetics, environment, and socioeconomic state (diet, hygiene). Older men will experience a prolonged refractory period for erections. Men and women will experience reduced intensity of orgasms.

### *Aging and the Immune System*

Aging is associated with a decline in cell-mediated immunity. The thymus gland atrophies with a loss of thymic hormones. These changes result in more non-responders to vaccines and decreased delayed-type hypersensitivity. There is a decreased production of antibodies to specific antigens by B cells.<sup>8</sup>

#### **Martha Hilliard Robinson (Part VI)**

*For her 90th birthday, Mrs. Robinson was interviewed for a feature by a reporter from the Durham Morning Star. An independently wealthy widow, Mrs. Robinson had donated an undisclosed sum of money to the Roth School of Nursing. At the interview her white hair was pulled back into a thin, neat bun; her posture was stooped; and she walked with the assistance of a four-pronged cane. She wore a hearing aid and an*

*eye bandage, having recently undergone laser surgery on her left eye. Nevertheless, she continued to live alone in her one-story home, receiving home-maker services 3 hours a day. Her daughter, 15 miles away, assisted with transportation and shopping. A visiting nurse was coming daily to check on her eye but would discontinue services soon. The interviewer, a journalism graduate student from a local small college, had gone to considerable length to prepare for the interview. She had learned that Mrs. Robinson was somewhat hard of hearing and bothered by bright lights. She also knew that Mrs. Robinson preferred a morning interview, generally taking a nap and then visiting with friends in the afternoon.*

*“Based on your own experience,” the interviewer asked, “is it better to let things go or to keep as active as possible?”*

*“A little of both, I guess,” responded Mrs. Robinson. “I’m not as active as I used to be, but I still do as much as I feel able. I guess I’d say I pace myself. I’m an early riser; take my pills, do a few exercises, and have breakfast. Morning is my work time for shopping, writing letters, paying bills, seeing the doctor, or being interviewed by you. Two mornings a week I go to the senior center, where I’m in a bridge group. We use large-print playing cards.”*

### *Aging and the Nervous System*

There is small decrease in brain mass with age, with an associated loss of neurons. Normal aging is associated with scattered neurofibrillary tangles and senile plaques, but in smaller numbers than seen in Alzheimer’s disease. There is some slowing of central processing and reaction time, resulting in more difficulty recalling facts. In the peripheral nervous system, there is a decrease in vibratory sensation, especially in the feet. Changes in autonomic regulation result in a decrease in sweat production, resulting in an increased core temperature required to start sweating.<sup>9</sup>

### *Sensory Changes*

#### **VISION**

Beginning in early adulthood, the ability of the lens to accommodate for near-vision gradually diminishes. Eventually the eye is no longer able to change the shape of the lens enough to focus on near objects, such

as fine print. This gradual loss of lens elasticity, which is the most common age-related eye problem, is called presbyopia. By their 40s, most adults require reading glasses. By age 55 nearly all persons have great difficulty focusing on close objects without glasses.<sup>10</sup>

## HEARING

Hearing loss is the third most common chronic condition in older adults. High-frequency hearing loss (presbycusis) is the most common form in this population. This type of hearing loss decreases the ability to interpret speech, which can lead to communication difficulties, increased isolation, and depression. Although most hearing loss in older adults is sensorineural, cerumen impaction and chronic otitis media may be present in up to 30% of this population.

## SMELL AND THIRST

Smell detection decreases by 50%, resulting in changes in taste as well. Older adults retain the taste of sweetness but report a decline in the detection of saltiness. There is a decrease in the recognition of thirst.

### Case Discussion

*Healthy aging, as exemplified by Martha Hilliard Robinson, involved preparation, adaptation, and good fortune. Mrs. Robinson prepared for a healthy old age by adopting good health habits early in life. She did not overeat, did not smoke, exercised regularly, got plenty of sleep, married, and raised a family. Her lifestyle during older years involved routines of exercise, eating, rest, productive work, and socializing. All of these factors have been linked to longevity. Furthermore, she managed to enter old age relatively well off economically; the well-to-do live longer and remain healthier than the impoverished.*

*Despite entering old age with superior health habits and economic resources, Mrs. Robinson needed to adjust successfully to a variety of losses. She retired, her husband became ill and died, and she suffered from osteoarthritis, osteoporosis, and hearing impairment. In her case, successful adaptation involved being able to give up some activities and continue others. Thus she was able to continue to find meaning in life despite limitations and losses. She maintained a strong faith in God and a close attachment to her family, drawing strength from these in difficult times.*

## STUDY QUESTION

1. Mrs. Robinson had many advantages that helped her age gracefully. Identify some of the problems that a less advantaged person might face and what physicians can do to provide assistance in addressing each.

● Death and dying are a normal part of aging.

### Martha Hilliard Robinson (Part VII)

*At age 92, Mrs. Robinson suffered a stroke, which left her aphasic and unable to use her right hand. After rehabilitation, she was able to walk with a cane. She moved in with her daughter, whose care was supplemented by home health nursing. She died of pneumonia at age 94.*

## CASE DISCUSSION

*Those like Mrs. Robinson, who have led a long, full life, often face death unafraid. Indeed, it is the period of dependency and disability that often accompanies the final years that older persons most often fear because it is often a difficult time for the older person and his or her family. Mrs. Robinson was fortunate to have a supportive daughter and physician and to die in relative comfort at home.*

## SUMMARY

Older Americans are not straightforwardly categorized. Their requirements and preferences are diverse and becoming more dissimilar. A useful appraisal of this population need not take an inordinate amount of time or occur as a single event to effectively prevent, or at least delay, many of their major causes of morbidity and mortality. Most functional loss later in life is related to specific disease processes and not to aging itself. Greater stress on disease prevention, as opposed to disease management, through appropriate screening, immunization, and healthy behaviors and lifestyle choices can significantly retard disability and death.

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## POSTTEST

1. Which of the following normal aging changes contributes to impaired night driving skills among 80-year-old individuals?
  - a. Reduced dark adaptation
  - b. 19% decrease in foot reaction time compared with young adults
  - c. 70% reduction in light reaching the retina
  - d. Reduced ability to hear approaching sirens
  - e. All of the above
2. Which one of the following statements is false about individuals aged 65 to 70 years?
  - a. Reported happiness is greater than at any other age.
  - b. Percentage of body fat is greater than at age 20.
  - c. They report less independence and more financial worries than do younger adults.
  - d. Sexual activity is correlated with physical health.
3. All of the following are true about normal aging except which one?
  - a. Established routines often constitute a helpful adjustment to aging.
  - b. Sensory impairments limit many older persons' ability to make friends.
  - c. Major disability is uncommon among older persons.
  - d. Worrying about memory loss is more often a symptom of normal aging than of Alzheimer's disease.
4. Mr. Carter, an 80-year-old retired engineer, is active in a bridge club, the local church, and a daily exercise class. His wife, on the other hand, spends the majority of her time either watching television (during cold days) or sitting on the front porch (during warm days). Which one of the following is false about this couple?
  - a. Mrs. Carter exemplifies the disengagement theory of successful aging.
  - b. Mr. Carter exemplifies the activity theory of successful aging.
  - c. Mr. Carter is likely to live longer than Mrs. Carter.
  - d. The continuity theory could apply to either spouse.

## PRETEST ANSWERS

1. b
2. b
3. d

## POSTTEST ANSWERS

1. b
2. c
3. c
4. c