CHAPTER 72
Clinical Problems of Aging

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While an in-depth understanding of internal medicine serves as a foundation, proper care of older adults should be complemented by insight into the multidimensional effects of aging on disease manifestations, consequences and response to treatment. In younger adults, individual diseases tend to have a more distinct pathophysiology with well-defined risk factors; the same diseases in older persons may have a less distinct pathophysiology and are often the result of failed homeostatic mechanisms. Causes and clinical manifestations are less specific and can vary widely between individuals. Therefore, the care of older patients demands an understanding of the effects of aging on human physiology and a broader perspective that incorporates geriatric syndromes, disability, social contexts, and goals of care. For example, care planning for the older patient cannot ignore the influence of life expectancy. In fact, the expected remaining years of life can guide recommendations about appropriate preventive and other long-term interventions, and shape discussions about treatment alternatives.

Demography (see Chap. 79) Population aging emerged on a worldwide scale for the first time in its history within the last century. Since aging influences many facets of life, governments and societies now face new social and economic challenges that impact health care, as well as family and community responsibilities. Figure 72-1 highlights recent and projected changes in U.S. population structure. The overall number of children has remained relatively stable, but explosive growth has occurred among older populations. The percentage growth is particularly dramatic among the oldest old. For example, the 80-89-year-old group increased more than threefold between 1960 and 2010 and will increase almost tenfold between 2010 and 2050. Women already outlive men by many years and the sex discrepancy in longevity is projected to increase further in the future. Population aging occurs at different rates in varying geographical regions of the world. Over the last century, Europe, Australia, and North America have had the populations with the greatest proportions of older persons, but Asia and South America are aging rapidly, with a population structure that will resemble the "older" countries by around 2050 (Fig. 72-2). Among older persons, the oldest old (those older than age 80 years) are the fastest growing segment of the population (Fig. 72-3), and the pace of aging is projected to accelerate in most countries in the next 50 years. There is no evidence that the rate of population aging is decreasing.

Figure 72-1 Change in the structure of the U.S. population between 1960 and 2050. (From United Nations World Population Prospects: The 2008 Revision, http://esa.un.org/unpp.)
Population aging and health

Many chronic diseases increase in prevalence with age. It is not unusual for older persons to have multiple chronic diseases (Fig. 72-4) although some seem more susceptible to co-occurring problems compared to others. Functional problems with difficulty or need for help in performing basic activities of daily living (ADLs) (Table 72-1) increase with age and are more common in women than men. In recent decades, the age-specific prevalence of disability has declined, especially in the oldest old. Estimated rates are shown in Fig. 72-5 as the percentage of persons who reported severe difficulty or need for help in bathing, but data on other basic activities of daily living show similar trends. The rate of decline in disability is decreasing, but the magnitude of this decline is small compared to the overwhelming effect of population aging. Thus, the number of people with disability in the United States and other countries is rapidly expanding. Rate of cognitive impairments, such as memory problems, also increase with aging (Fig. 72-6). Chronic disease and disability lead to increased use of health care resources. Health care expenditures increase with age, increase more with disability, and are highest in the last year of life. However, new medical technologies and expensive medications are greater influences on health care costs than population aging alone. General practitioners and internists with little specific training in geriatric medicine provide the bulk of care for older persons.

Systemic effects of aging

Systemic consequences of aging are widespread but can be clustered into four main domains or processes (Fig. 72-7): (1) body composition; (2) balance between energy availability and energy demands; (3) signaling networks that maintain homeostasis; and (4) neurodegeneration. Each domain can be assessed using routine clinical tests, although more detailed research techniques are also available (Table 72-3).

Body composition: Profound changes in body composition may be the most evident and inescapable effect of aging (Fig. 72-8). Over the life span, body weight tends to increase through childhood, puberty, and adulthood until late middle age. Weight tends to decline in men between ages 65 and 70 years, and somewhat later in women. Lean body mass, composed predominantly of muscle and visceral organs, decreases steadily after the third decade. In muscle, this atrophy is greater in fast-twitch compared to slow-twitch fibers. Fat mass tends to increase in middle age and then declines in late life, reflecting the trajectory of weight change. Interestingly, waist circumference continues to increase across the life span, suggesting that visceral fat, which is responsible for most of the pathologic consequences of obesity, continues to accumulate. In some individuals, fat also accumulates inside muscle where it affects muscle quality and function. With age, fibroconnective tissue tends to increase in many organ systems. In muscle, fibroconnective tissue builds up also affects muscle quality and function. In combination, the loss of muscle mass and quality result in reduced muscle strength, with ultimate impact on functional capacity and mobility. Muscle strength declines with aging and does not affect functional status but is also a strong independent predictor of mortality (Fig. 72-9). Progressive denervation and architectural modification occurs in bone, resulting in a decline of bone strength. Loss of bone strength increases the risk of fracture. Sex differences in the effects of aging on bone mass are due to sex differences in peak bone mass and the effects of gonadal hormones on bone. Overall, compared to men, women tend to lose bone at an earlier age and more quickly reach the threshold of low bone strength that increases fracture risk. All of these changes in body composition can be attributed to disruptions in the links between synthesis, degradation, and repair that normally serve to remodel tissues. Body composition can be approximated in clinical practice using weight, height, body mass index (weight in kilograms divided by height in meters squared).

Figure 72-6 Rates of memory impairments in different age groups. The definition of "moderate or severe memory impairment" is 4 or fewer words recalled out of 20. (Source: Health and Retirement Survey.)

Figure 72-7 A unifying model of aging, frailty, and the geriatric syndromes.
### TABLE 72-2 Example of Assessment of the Different Domains of the Aging Phenotype

<table>
<thead>
<tr>
<th>Body Composition</th>
<th>Energetics</th>
<th>Homeostatic Regulation</th>
<th>Neurodegeneration</th>
</tr>
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</table>
| Anthropometrics (weight, height, BMI, waist circumference, arm and leg circumference, skin fold) | Self-reported questionnaires investigating physical activity, sense of fatigue/exhaustion, exercise tolerance | Baseline levels of biomarkers and hormones | Standard neurologic exam, including assessment of global cognition (Mini Mental State, Mooska... 
J) |
| Muscle strength testing (isometric and isokinetic) | Resting metabolic rate | Inflammatory markers (ESR, CRP, IL-6, TNF-alpha etc) | Objective assessment of gait, balance, reaction time, coordination. |
| Biomarkers (24-h creatinine or 3-methyl-histidine) | Performance-based tests of physical function | Nutritional biomarkers (vitamin, antioxidants, etc.) | Electromyography and electromyography |
| CT and MRI, dual-energy x-ray absorptiometry (DEXA) | Treadmill testing | Response to provocative tests, such as oral glucose tolerance test, dexaemethasone test, and others. | MRI, MRA, PET and other dynamic imaging techniques. |
| Hydrostatic weighting | Objective measures of physical activity (accelerometers, double labeled water) | Stress response | Endowed potentials. |

![Image 1](image1.png)

**Figure 72-8** Longitudinal changes of weight, body composition, and waist circumference over the life span in 1,167 participants of the Baltimore Longitudinal Study of Aging. "Lean Body Mass (LBM) and Fat Mass estimated with DEXA. (Source: The Baltimore Longitudinal study of Aging 2010 unpublished data)."

![Image 2](image2.png)

**Figure 72-9** Cross-sectional differences and longitudinal changes in muscle strength over a 27-year follow-up. Note that subjects who died during the follow-up had lower baseline muscle strength. (From K Naimark et al: Grip strength changes over 27 yr in Japanese-American Men. J Appl Physiol 82:2547, 1997)
and waist circumference, or more precisely using dual-energy X-ray absorptiometry (DEXA) or computed tomography.

**Balance between energy availability and energy demand** Since most of the energy used by the body is generated through aerobic metabolism, energy consumption is usually estimated indirectly by oxygen consumption (indirect calorimetry). There is currently no method to measure true "fitness" which is the maximum energy that can be produced by an organism over extended time periods. Thus, fitness is estimated indirectly from peak oxygen consumption (VO₂peak) during a maximal treadmill test. Longitudinal studies have demonstrated that VO₂peak declines progressively with aging (Fig. 7-14), and the rate of decline is accelerated in those who are sedentary and in those affected by chronic diseases. A large portion of energy is consumed as the "resting metabolic rate" (RMR), the amount of energy expended at rest in a neutral temperature environment and in a postabsorptive state. In healthy individuals, RMR declines with aging, mostly due to a decline in the highly metabolically active tissues of lean body mass (Fig. 7-11). However, persons with unmeasurable mass due to illness require additional energy for compensatory mechanisms. Indeed, an inadequately high RMR is a marker of illness, is an independent risk factor for mortality, and may contribute to the weight loss that often accompanies severe illness. Finally, for reasons that are not yet completely clear, older age, pathology, and physical inactivity increase the energy cost of motor activities such as walking. Overall, older individuals with multiple chronic conditions have low available energy levels and require more energy both at rest and during physical activity. Thus, the sick older person may consume all of their available energy performing the most basic activities of daily living, leading to symptoms of fatigue and restriction to a sedentary existence. Energetic status can be assessed clinically by simply asking the patient about their perceived level of fatigue during daily activities such as walking or dressing.

**Energy capacity can be assessed more precisely by exercise tolerance during a walking test or a treadmill test coupled with spirometry.**

**Signaling networks that maintain homeostasis** The main signaling pathways that control homeostasis involve hormones, inflammatory mediators, and antioxidants; all are profoundly affected by aging. Sex hormone levels, such as testosterone, decrease with age in both men (Fig. 7-12) and women, while other hormone systems may change more subtly (Table 7-3). Most aging individuals, even those who remain healthy and fully functional, tend to develop a mild proinflammatory state characterized by high levels of proinflammatory markers, including IL-6 and CRP (Fig. 7-13). Aging is also thought to be associated with increased endoplasmic stress damage, either because the production of reactive oxygen species increases or because antioxidant buffers are less effective. Since hormones, inflammatory markers, and antioxidants are integrated into complex signaling networks, levels of individual biomarkers may well reflect adaptation within homeostatic feedback loops rather than true causative factors. Thus, the therapeutic strategy of single-molecule replacement may be ineffective or even counterproductive. The presence of such signaling networks and feedback loops may help explain why single-hormone "replacement therapy" for problems of aging has demonstrated little benefit. The focus of research in this area is now on multiple-hormonal dysregulation. For example, taking one at a time, levels of testosterone, dehydroepiandrosterone (DHEA), and IGF-1 do not predict mortality, but they do predict mortality when combined. This combined effect is especially strong in the setting of congestive heart failure. Similarly, several micronutrients, such as vitamins (especially vitamin D), minerals (zinc and magnesium), and antioxidan...
(Table 72-3) Hormones that decrease, remain stable and increase with aging.

![Table](Figure was redrawn. Please review.)

![Figure](72-10) Change in IL-6 and C-reactive protein with aging. Values are expressed as Z-scores to make them comparable. (From L. Ferrucci et al. The origins of age-related pro-inflammatory state. Blood 105:2294, 2005.)

(vitamin D and E), also regulate aspects of metabolism. Low levels of these micronutrients have been associated with accelerated aging and high risk of adverse outcomes. However, except for vitamin D, no clear evidence suggests that supplementation has positive effects on health. Unfortunately, no standard criteria exist that allow the detection and quantification of homeostatic dysregulation.

Neurodegeneration

Neurons stop reproducing shortly after birth and their number declines throughout life. Brain atrophy occurs with aging after the age of 60 years, with loss of both neurons and myelinated fibers. Atrophy proceeds at varying rates in different parts of the brain (Fig. 72-14) and is often accompanied by an inflammatory response and microglial activation. Age-associated brain atrophy may contribute to age-related decline in cognitive and motor function. Atrophy may also be a factor in some brain diseases that may occur with aging, such as Mild Cognitive Impairment (MCI), in which persons have mild but detectable impairments on tests of cognition but function well in daily life. In MCI, atrophy has been found in the prefrontal cortex and hippocampus, but these findings are not specific and their diagnostic utility is unclear.

(Fig. 72-15) Other neurophysiologic changes in the brain also frequently occur with aging and may contribute to cognitive decline. Functional imaging studies have shown that some older people have diminished coordination between the brain regions responsible for higher-order cognitive functions and that such diminished coordination is correlated with poor cognitive performance. In young healthy individuals, the brain activity associated with executive cognitive functions (e.g., problem solving, decision making) is very well localized while in healthy older individuals, the pattern of cortical activation is more diffuse. Brain pathology has typically been associated with specific disease states (amyloid plaques and neurofibrillary tangles are considered the pathologic hallmarks of Alzheimer's disease). However, these pathologic markers have not been found at autopsy in many older individuals who had cognitive testing in the year before death and were found to be normal. Taken together, trends in brain changes with aging suggest that some neurophysiologic manifestations are compensatory adaptations, rather than primary contributors to age-related decline. Because the brain is capable of reorganization and compensation, extensive neurodegeneration may not be clinically evident. Therefore, early detection requires careful testing. Clinically, cortical and subcortical changes are reflected in the high prevalence of "soft" nonspecific neurologic signs, often with slowly and unsteadily gait, poor balance, and slow reaction times. These movement changes can be elicited more overtly using "dual tasks" in which a cognitive and a motor task are performed simultaneously. In a simple version of a dual task, an older adult who has to stop walking in order to talk has been shown to predict increased risk of falls. Poor dual task performance has been interpreted as a marker of reduced overall capacity for central processing, so that simultaneous processing is more constrained. Beyond the brain, the spinal cord also experiences changes after age 60 years, including reduced numbers of motor neurons and damage to myelin. The motor neuron system that survives compensation by increased branching complexity, and by serving larger motor units. As motor units become larger, they decline in number at a rate of about 1% per year, starting after the third decade. These larger motor units contribute to reductions in fine-motor control and manual dexterity. Age-related changes also occur in the autonomic nervous system, affecting cardiovascular and splanchnic function.

System changes consist and affect each other: the phenotypes of aging to the final common pathway of this interaction. While age-related system changes were described individually, in reality these changes develop in parallel and affect each other through many feed-forward and feedback loops. Some system interactions are well understood, while others are under investigation. For example, body composition interacts with energy balance and signaling. Higher lean body mass increases energy consumption and improves insulin sensitivity and carbohydrate metabolism. Higher fat mass, especially visceral fat mass, is a culprit in the metabolic
syndrome and is associated with low testosterone, high SHBG, and increased levels of proinflammatory markers such as C-Reactive Protein and IL-6. Altered signaling can affect neurodegeneration; insulin resistance and adipokines such as leptin and adiponectin are associated with declines in cognitive function. A state of inflammation, reduced levels of testosterone and IGF-1, combined with loss of motor neurons and dysfunction of the motor unit have been linked to accelerated decline of muscle mass and strength. Normal neurotransmitter coordination is also affected by aging. The hypothalamus normally functions as a central regulator of metabolism and energy use and coordinates physiologic responses of the entire organism through hormonal signaling; aging-related changes in the hypothalamus alter this control. The central nervous system also controls adaptive sympathetic/parasympathetic activity, so that age-related CNS degeneration may have implications for autonomic function.

The phenotype that results from the aging process is characterized by increased susceptibility to diseases, high risk of multiple coexisting diseases, impaired response to stress (including limited ability to heal or recover after an acute disease), emergence of "geriatric syndromes" (characterized by stereotyped clinical manifestations but multifactorial causes), altered response to treatment, high risk of disability, and loss of personal autonomy with all its psychological and social consequences. In addition, these two aging processes may interfere with the typical pathophysiology of specific diseases, thereby altering expected clinical manifestations and confounding diagnosis. Clinically, patients may present with obvious problems within only one of the domains, but when these two processes interact, all four main domains should be evaluated and considered potential therapeutic targets. When patients present with obvious problems in multiple main systems affected by aging, they tend to extreme degrees of susceptibility and loss of resilience, a condition that is globally referred to as "frailty."

**Frailty**

Frailty has been described as a physiologic syndrome characterized by decreased reserve and diminished resistance to stressors, resulting from cumulative decline across multiple physiologic systems, causing vulnerability to adverse outcomes and high risk of death. A proposed definition characterized by weight loss, fatigue, impaired grip strength, diminished physical activity and slow gait has shown good internal consistency and strong predictive validity, and has been used in many clinical and epidemiologic studies. However, alternative schools of thought have different diagnostic criteria. For example, frailty has been suggested to be a random accumulation of multiple impairments with aging; and, therefore, no standard criteria for diagnosis can be developed. Regardless of the definition, an extensive literature shows that older persons who are considered frail by any definition have overt changes in the same four main processes—body composition, hemodynamic dysregulation, energetic failure, and neurodegeneration, the characteristics of the aging "phenotype." A classic clinical case would be an older woman with sarcopenic obesity characterized by increased body fat and decreased muscle (body composition changes); extremely low exercise tolerance and extreme fatigue (energetic failure); high insulin; low IGF-1; inadequate intake of calories; low vitamin D, E, and corticosteroids (signal dysregulation); and memory problems, slow gait and unstable balance (neurodegeneration). This woman is likely to show all the manifestations of frailty, including high risk of multiple diseases, disability, urinary incontinence, falls, delirium, depression and other geriatric syndromes. Conceptualizing frailty through the four main underlying processes stems from accumulated evidence and recognizes the heterogeneity and dynamic nature of the aging phenotype. Aging is universal but proceeds at highly variable rates, with wide heterogeneity in the emergence of the aging phenotype. Thus, the question is not whether an older patient is frail, but rather whether the severity of frailty is beyond the threshold of clinical and behavioral relevance. Understanding
frailty through the lens of four interacting underlying processes also provides an interface with diseases that, like aging itself, affect the "aging phenotype." For example, congeuous heart failure is associated with low energy availability, multiple hormonal derangements, and a premorbid state, thereby contributing to frailty severity. Parkinson disease is an example of neurodegeneration that, in an advanced state, affects body composition, energy metabolism, and hormone signaling, resulting in a syndrome that closely resembles frailty. Diabetes is especially important to aging and frailty because it harms body composition, energy metabolism, and hormone signaling, and neuromuscular integrity. Accordingly, a number of studies have found that type 2 diabetes is a strong risk factor for frailty and for many of its consequences. The disease and aging interact, careful and appropriate treatment of disease is critical to prevent or reduce frailty.

Consequences of Aging Processes, the Aging Phenotype, and Frailty

While the physiopathology of frailty is still being elucidated, its consequences have been well characterized in prospective studies. Four main consequences are important for clinical practice: (1) ineffective or incomplete homeostatic response to stress, (2) multiple coexisting diseases (multimorbidity) and polypharmacy, (3) physical disability, and (4) the so-called geriatric syndromes. We will briefly address each one of them.

Low resistance to stress. Frailty can be considered a progressive loss of reserve in multiple physiologic functions. At an early stage and in the absence of stress, mildly frail older individuals may appear to be normal. However, they have reduced ability to cope with challenges, such as acute diseases, trauma, surgical procedures, or chemotherapy. Acute illness involving a hospital stay is associated with undernutrition and inactivity, which sometimes may be of such magnitude that the residual muscle mass fails to meet the minimal requirement for walking. Even when nutrition is restored, energy reserves may be insufficient to adequately rebuild muscle mass. Older persons have a reduced ability to tolerate infections, in part because they are less able to build a dynamic inflammatory response to vaccination or infectious exposure, so that infections are more likely to become severe and systemic and resolve more slowly. In the context of tolerance to stress, assessing aspects of frailty can help estimate ability to withstand the rigors of aggressive treatments, to respond to interventions aimed at infection, to anticipate and prevent complications of hospitalization, and generally to estimate prognosis. Accordingly, treatment plans may be adjusted to improve tolerance and safety; bed rest and hospitalization should be used sparingly; and infections should be prevented, anticipated, and managed assertively.

Concomitance and polypharmacy. Older age is associated with high rates of many chronic diseases (Fig. 72-4). Thus, not unexpectedly, the percentage of individuals affected by multiple medical conditions (co- or multimorbidity) also increases with age. In frail older individuals, concomitance occurs at higher rates than would be expected from the combined probability of the component conditions. It is likely that frailty and concomitance affect each other, so that multiple diseases contribute to frailty and frailty increases susceptibility to diseases. Clinically, patients with multiple conditions present unique diagnostic and treatment challenges. Standard diagnostic criteria may not be informative because there are additional confounding signs and symptoms. A classical example is the coexistence of iron and vitamin B12 deficiency, creating an apparently normocytic anemia. The risk/benefit ratio for many medical and surgical treatment options may be reduced in the face of other diseases. Drug treatment planning is made more complex because comorbid diseases may affect the absorption, volume of distribution, protein binding, and, especially, elimination of many drugs, leading to fluctuation in therapeutic levels and increased risk of under- or overdosing. Drug excretion is affected by renal and liver changes with aging that may not be detectable with usual clinical tests. Formulas for estimating glomerular filtration rate in older patients are available while estimating changes in hepatic excretion is still a challenge. Patients with many diseases are usually prescribed multiple drugs, especially when they are cared for by multiple specialists who do not communicate. The risk of adverse drug reactions, drug-drug interactions, and poor compliance increase geometrically with the number of drugs prescribed and with the severity of frailty. Some general rules minimize the chances of adverse drug events as follows: (a) always ask patients to bring in all medications, including prescription, over-the-counter, vitamins supplements, and herbal preparations (the "brown bug test"); (b) screen for unnecessary drugs—those without a clear indication should be stopped; (c) simplify the regimen in terms of number of agents and schedules, try to avoid frequent changes and use single daily dosage regimen whenever possible; (d) avoid drugs that are expensive or not covered by insurance whenever possible; (e) minimize the number of drugs to those that are absolutely essential and always check for possible interactions; (f) make sure that the patient or an available caregiver understands the administration regimen and provide legible written instructions; and (g) schedule periodic medication reviews.

Disability and impaired recovery from acute-onset disability. The prevalence of disability in self-care and home management increases steeply with aging and tends to be higher in women than in men (Fig. 72-3). Physical and cognitive function in older persons reflects overall health status, and predicts health care utilization, institutionalization, and mortality more accurately than any other known biomedical measure. Thus, assessing function and disability and predicting the risk of disability are cornerstones of geriatric medicine. Frailty, regardless of the criteria used for its definition, is a robust and powerful risk factor for disability.Because of this strong relationship, measures of physical function and mobility have been proposed as standard criteria for frailty. However, disability occurs late in the frailty process, after reserve and compensation are exhausted. Early in the development of frailty, body composition changes, reduced fitness, hemodynamic derangement, and neurodegeneration can begin without impact on daily function. As opposed to disability in younger persons, where the rule is to look for a clear dominant cause, disability in frail older persons is almost always multifactorial. Multiple disrupted aging processes are usually involved, even when the precipitating cause seems unique. Excess fat mass, poor muscle strength, reduced lean body mass, poor fitness, reduced energy efficiency, poor nutritional intake, low circulating levels of antioxidants micronutrients, high levels of proinflammatory markers, objective signs of autonomic dysfunction, and cognitive impairment all contribute to disability. The multifactorial nature of disability in frail older persons reduces the capacity for compensation and interferes with functional recovery. For example, a small lacunar stroke that causes problems with balance in a young hypertensive individual can be overcome by standing and walking with the feet further apart, a strategy that requires the brain to adapt, strong muscles, and lots of energy capacity. The same small, lacunar stroke may cause catastrophic disability in an older person already affected by neurodegeneration and weakness who is less able to compensate. As a consequence, interventions aimed at preventing and reducing disability in older persons should have a dual focus on both the precipitating cause and the systems needed for compensation. In the case of the lacunar stroke, interventions to promote mobility function might include stroke prevention, balance rehabilitation, and strength training. As a rule of thumb, the assessment of contributing causes and the design of
intervention strategies for disability in older persons should always consider the four main aging processes that contribute to disability. One of the most popular approaches to disability measurement is a modification of the International Classification of Impairments, Disabilities and Handicaps (World Health Organization, 1980) proposed by the Institute of Medicine (IOM, 1992). This classification infers a causal pathway in four steps: pathology (disease), impairment (the physical manifestation of diseases), functional limitation (global functions such as walking, grasping, climbing stairs) and disability (ability to fulfill social roles in the environment). In practice, the assessment of functional limitations and disability is performed either by: 1) self-reported questionnaires concerning the degree of ability to perform basic self-care or more complex activities of daily living; 2) performance-based measures of physical function that assess specific domains, such as balance, gait, manual dexterity, coordination, flexibility, and endurance. A concise list of standard tools that can be used to assess physical function in older persons is reported in Table 72-4. In 2001, the WHO officially endorsed a new classification system, the International Classification of Functioning, Disability and Health, known more commonly as ICF. In the ICF, health measures are classified from body, individual, and societal perspectives by means of two lists: a

### Table 72-4: Tools for Functional Assessment in Older Patients

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Domain</th>
<th>Description</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barthel Index</td>
<td>Professionally evaluated</td>
<td>Independence and need for help in feeding, transferring from bed to chair and back, grooming, transferring to and from toilet, bathing, walking, stairs, dressing, continence. Tarlov AR et al. Functional Evaluation: The Barthel Index. Mil State Med J. 1965</td>
<td>Administered by trained health professionals.</td>
</tr>
<tr>
<td>Mobility Questionnaire</td>
<td>Self-reported</td>
<td>Severe difficulty walking 1/4 mile and/or climbing stairs</td>
<td>Short and simple</td>
</tr>
<tr>
<td>Walking Speed</td>
<td>Objective performance</td>
<td>Measure walking speed over a 4 m course. Studenski S. Brachypedias is gait speed ready for clinical care? J Nutr Health Aging. 2003</td>
<td>Simple and powerful but limited to patients who can walk.</td>
</tr>
<tr>
<td>Long Distance Corridor Walk (400 m)</td>
<td>Objective performance-based</td>
<td>Time to walk 400 m. Nurenberg AD et al. Association of long-distance corridor walk performance with mortality, cardiovascular disease, mobility limitation, and disability. JAMA. 2006</td>
<td>More challenging than the 6-min walk.</td>
</tr>
</tbody>
</table>
list of body functions and structure, and a list of domains of activity and participation. Since an individual’s functioning and disability occurs in a context, the ICF also includes a list of environmental factors. A detailed list of codes that allow the classification of body functions, activities, and participation is being developed. The ICF system is widely implemented in Europe and is gaining popularity in the United States.

Impaired cognition is a very important cause of disability but is treated in detail in Chap. 371.

**Geriatric syndromes**

The term **geriatric syndrome** is used to capture clinical conditions that are frequently encountered in older persons, have a deleterious impact on function and quality of life, have multifactorial pathophysiology, often involving systems unrelated to the apparent chief complaint, and are manifested by stereotypical clinical presentations. The list of geriatric syndromes includes incontinence, delirium, falls, pressure ulcers, sleep disorders, problems with eating or feeding, pain, and depressed mood. Dementia and physical disability are also sometimes considered to be geriatric syndromes. Using the term syndrome is somewhat misleading since this term is normally used to describe a pattern of symptoms and signs that have a single underlying cause. Geriatric syndromes, by contrast, refer to "multifactorial health conditions that occur when the accumulated effects of impairments in multiple systems render an older person vulnerable to situational challenges." According to this definition, geriatric syndromes reflect the complex interactions between an individual’s vulnerabilities and exposure to stressors or challenges. This definition aligns well with the concept that geriatric syndromes should be considered as phenotypic consequences of frailty and that a limited number of shared risk factors contribute to their etiology. Indeed, in various combinations and frequencies, virtually all geriatric syndromes are characterized by body composition changes, energy gaps, signaling disarray, and neurodegeneration. For example, decreased (bladder) underactivity is a multifactorial geriatric condition that contributes to urinary retention in the frail elderly. It is characterized by detrusor muscle loss, fibrosis, and animal degeneration. A postinflammatory state, and a lack of estrogen signaling, cause bladder muscle loss and detrusor underactivity while a chronic urinary infection may cause detrusor hyperactivity, all factors that may contribute to urinary incontinence.

Due to limited space, only delirium, falls, incontinence, and chronic pain are addressed here. Interested readers are encouraged to consult the references at the end of the chapter for details on other geriatric syndromes.

**Delirium** (see Chap. 25)

Delirium is an acute disorder of disturbed attention that fluctuates with time. It affects between 15 and 35% of hospitalized older patients and is associated with high in-hospital mortality and sometimes with permanent brain damage. Figure 72-16 shows brief guidelines for assessment and management of delirium in hospitalized older patients. The clinical presentation of delirium is heterogeneous, but frequent features are (a) rapid decline in level of consciousness with difficulty focusing, sitting up, or sustaining attention; (b) cognitive change (ranging from incoherent speech, memory gaps, disorientation, hallucinations) not explained by dementia and (c) medical history suggestive of preexisting cognitive impairment, frailty, and comorbidity. The strongest predisposing factors for delirium are dementia, any other condition associated with chronic or transient neurologic dysfunction (neurologic diseases, dehydration, alcohol consumption, psychotropic drugs) and sensory (visual and hearing) deprivation, suggesting that delirium is a condition of brain functions susceptibility (neurodegeneration or transient neuroimpaired) that cannot avoid decompensation when hit by a stressful event. Many comorbid conditions have been implicated as precipitating factors, including surgery, anesthesia, persistent pain, opiates, narcotics, anticholinergics, sleep deprivation, immobilization, hypoxia, malnutrition, and metabolic and electrolyte degradations. Delirium, both onset and severity, can be reduced by anticipatory screening and preventive strategies aimed at reducing precipitating causes. The Confusion Assessment Method (CAM) is a validated tool for screening in the hospital setting. Immediate identification and treatment of precipitating factors, withdrawal of drugs that may have facilitated the emergence of delirium, and supportive care (management of hypoxia, hydration and nutrition, mobilization and environmental modifications) are the three pillars of treatment. Whether patients in special Delirium Units have better outcomes is still in question. Physical restraints should be avoided because they tend to increase agitation and injury. Whenever possible, drug treatment should be avoided because it may prolong or aggregate delirium in some cases. The treatment of choice is low-dose haloperidol.

**Falls and balance disorders**

Unstable gait and falls are serious concerns in the older adult because they lead not only to injury but also to restricted activity, increased health care utilization, and even death. Like all geriatric syndromes, problems with balance and falls tend to be multifactorial and are strongly connected with the disrupted aging systems that contribute to frailty. Poor muscle strength, neural damage in the basal ganglia and cerebellum, diabetes, and peripheral neuropathy are all recognized risk factors for falls. Therefore, evaluation and management require a structured multidisciplinary approach that spans the entire frailty spectrum and beyond. Accordingly, interventions to prevent or reduce instability and falls usually require a mix of medical, rehabilitative, and environmental modification approaches. Guidelines for the evaluation and management of falls, released by the American Geriatrics Society, recommend asking all older adults about falls and perceived gait instability (Fig. 73-17). Patients with a positive history of multiple falls, in addition to persons who have sustained one or more injurious falls, should undergo an evaluation of gait and balance...
as well as a targeted history and physical examination to detect sensory, nervous system, brain, cardiovascular, and musculoskeletal contributors. Interventions depend on the factors identified but often include medication adjustment, physical therapy, and behavioral modifications. Meta-analyses of falls prevention strategies have found that multifactorial risk assessment and management, as well as individually targeted therapeutic exercises, are effective in reducing falls. Supplementation with vitamin D at 800 IU daily may help reduce falls, especially in older persons with reduced levels.

**Persistent pain**

Pain from multiple sources is the most common symptoms of older adults in primary care settings and is also common in acute care, long-term care, and palliative care settings. Acute pain and cancer pain problems are beyond the scope of this chapter. Persistent pain results in restricted activity, depression, sleep disorders, social isolation, and increases the risk of medication adverse events. The most common causes of persistent pain are musculoskeletal problems, but neuropathic and ischemic pain occur frequently, and multiple concurrent causes are often found. Alterations in mechanical and structural elements of the skeleton commonly lead to secondary problems in other parts of the body, especially to soft tissue or myofascial components. A structured history should obtain information about the quality, severity, and temporal patterns of pain. Physical examination should focus on back and joints as well as trigger points and dermatomal areas, as well as evidence of radicular neurologic patterns and peripheral vascular disease. Pharmacologic management should follow standard recommendations as recommended by the World Health Organization (Chap. 41), but risk of side effects to the central nervous system are more likely and must be monitored. For persistent pain, regular antalgic medications and strategies schedules are appropriate and should be combined with nonpharmacologic approaches such as splints, physical exercise, heat, and other modalities. A variety of adjuvant analgesics such as antidepressants and anticonvulsants may be used, but again, effects on reaction time and alertness may be dose limiting, especially in older persons with cognitive impairment. Joint or soft tissue injuries may be helpful. Patient education and shared goal setting are important since pain is usually not fully eliminated, but rather controlled to a tolerable level that maximizes function while minimizing adverse effects.

**Urinary incontinence**

Urinary incontinence (UI), the involuntary leakage of urine, is highly prevalent in older persons, especially in older women, and has a profound negative impact on quality of life. Approximately 50% of American women will suffer from some form of UI over a lifetime. Increasing age, white race, childbirth, obesity, and medical comorbidity are all risk factors for UI. The three main clinical forms of UI are as follows: (a) Stress incontinence is the failure of the sphincteric mechanism to remain closed when there is a sudden increase in intraabdominal pressure,
such as a cough or sneeze. In women, this condition is due to insufficient mobility of the pelvic floor musculature, while in men it is almost exclusively secondary to prostate surgery. (b) Urge inconti-
nence is the loss of urine accompanied by a sudden sensation of need to void and is due to decreased muscle excitability (lack of inhibition) due to loss of neurogenic control or local irritation. (c) Overflow incontinence is characterized by urinary dribbling, either constantly or for some period after urination. This condition is due to impaired detrusor contractility (due usually to denervation, for example in diabetes) or bladder outlet obstruction (prostate hyper-
trophy in men and cystocele in women). Thus, not surprisingly, the pathogenesis of urinary incontinence is connected to the disrupted aging systems that contribute to frailty, body composition changes (atrophy of the bladder and pelvic floor muscle), and neurodegen-
eration (both central and peripheral nervous systems). Frailty is a strong risk factor for urinary incontinence. Indeed, older women are more likely to have mixed (urge-stress) incontinence than any pure form (Fig. 72-18). In analogy with the other geriatric syndromes, UI derives from a predisposing condition superimposed on a stressful, precipitating factor. Accordingly, treatment of UI should address both. The first line of treatment is bladder training associated with pelvic muscle exercise (Kegel exercise) that sometimes should be associated with electrical stimulation. Those with possible vaginal or urethral prolapse should be referred to a specialist. Urinary infec-
tions should be investigated and eventually treated. A long list of medications can precipitate urinary incontinence, including diuretics, antihypertensive, antidepressant, diuretics, adrenergic agonists or blockers, anticholinergic and calcium channel blockers. Whenever possible, those medications should be discontinued. Until recently, it was believed that estrogen oral or local treatments improved the UI symptoms in postmenopausal women, but this notion is now controverted. Antimuscarinic drugs such as tolterodine, darifenac-
olate, and fesoterodine are modestly effective for mixed incontinence, but no long-term studies are available and so must be used with caution and careful follow-up monitoring of cognitive status. In some cases, surgical treatment should be considered. Chronic catheterization has many adverse effects and should be used only in chronic urinary retention that cannot be managed in any other way. Bacteriuria always occurs and should be treated only if symptomatic.

Undernutrition and anemia Normal aging is associated with a decline in food intake that is more marked in men than in women. To some extent, food intake is reduced because energy demand declines as a result of a combination of lower physical activity, decline in lean body mass, and slowed rates of protein turnover. Other contributors to decreased food intake include losses of taste sensation, reduced stomach compliance, higher circulating levels of cholecystokinin, and, in men, testosterone levels associated with increased leptin. When food intake decreases to a level below the reduced energy demand, severe and multiple precipitating causes. In addition, many older individuals tend to consume a monotonous diet that lacks sufficient fresh fruit, vegetables, and starchy carbohydrates. Inadequate intake of important nutrients is inadequate. Undernutrition in older people is associated with multiple adverse health consequences, including impaired muscle function, decreased bone mass, immune dysregulation, anorexia, reduced cognitive function, poor wound healing, delayed recovery from surgery, and increased risk of falls, disability, and mortality. Despite these serious consequences, undernutrition often remains unrecognized until it is very advanced because weight loss tends to be ignored by both patients and physicians. Muscle wasting is a frequent feature of weight loss and malnutrition, often associated with loss of subcutaneous fat. The main causes of weight loss are anorexia, cachexia, sarcopenia, malabsorption, hypermetabolism, and delirium, almost always in various combinations. Many of these causes can be detected and corrected. Cancer accounts for only 10–15% of cases of weight loss and anemia in older people. Other important causes include a recent move to a long-term care setting, acute illness (often with inflammation), hospitalization with bed rest for as little as 1–3 days, depression, drugs that cause anorexia and nausea, increased loss of caloric intake associated with reduced access to food. Weight loss may also result from dehydration, possibly related to excess sweating, diarrhea, vomiting, or reduced intake. Early identification is paramount and requires careful weight monitoring. Patients or caregivers should be taught to record weight regularly at home, the patient should be weighed at each clinical encounter, and a record of serial weights should be maintained in the medical record. If malnutrition is suspected, formal assessment should begin with a standardized screening instrument such as the Mini Nutritional Assessment (MNA), the Malnutrition Universal Screening Tool, or the Simplified Nutritional Appetite Questionnaire. The MNA includes questions on appetite, timing of eating, and frequency of meals and taste, and has sensitivity and specificity >75% for future weight loss of 35% in older people. Many nutritional supplementations are available and should be initiated early to prevent more severe weight loss and its consequences. When an older patient has malnu-
trition, the diet should be liberalized and dietary restrictions should be lifted as much as possible. Nutritional supplementations should be given between meals to avoid interference with food intake at mealtime. Limited evidence supports the use of any phar-
macologic intervention to treat weight loss. The two anorexogenic drugs most often prescribed in older persons are megestrol and dronabinol. Both can increase weight, although the gain is mostly fat not muscle, and both have serious side effects. Dronabinol is an excellent drug in the palliative care setting. There is little evidence that intentional weight loss in overweight, older people prolongs life. Weight loss after the age of 70 should probably be limited to those with extreme obesity and should always be medi-
cally supervised.

Figure 72-18 Rates of urge, stress, and mixed incontinence by age group in a sample of 3,552 women. Based on a sample of 3,553 participants. (From A. M. Mehrotra et al: Urinary incontinence in US women: A population-based study. Arch Intern Med 165:537, 2005.)
How the Phenotypes of Aging Affect Disease Presentation

Common diseases in older adults may have unexpected and atypical clinical features. Most age-related changes in clinical presentation, evolution, and response to treatment are due to the interactions between the pathophysiology of disease and the development of age-related systemic dysregulations. Some diseases directly impact aging systems and, therefore, have a devastating impact on frailty and its consequences. Parkinson disease (PD) and diabetes are described as examples.

Parkinson disease (see Chap. 37) Most cases of PD begin after age 60 years, and incidence increases up to about age 80 years. Brain aging and PD have long been thought to be related. The nigrostriatal model posits that PD is caused by death of several dopamine-producing cells. Parkinson disease, like other age-related motor and cognitive manifestations of PD tend to be more amenable to levodopa or dopaminergic replacement therapy, especially in older persons. Interestingly, age at presentation does not correlate with the severity and progression of other clinical PD symptoms such as tremor, rigidity, and bradykinesia, and it does not affect response of these symptoms to levodopa. The pattern of PD features in older persons suggests that late-life PD may reflect a failure of the normal cellular compensatory mechanisms in vulnerable brain regions, and this vulnerability is increased by age-related neurodegeneration, making PD symptoms particularly resistant to levodopa treatment. In addition to the motor symptoms, older PD patients tend to have reduced muscle mass (sarcopenia), eating disorders, and poor levels of fitness. Accordingly, PD is a powerful risk factor for frailty and its consequences, including disability, comorbidity, falls, incontinence, chronic pain, and delirium. Use of levodopa and dopaminergic agents in older PD patients requires careful dosing regimens and therefore slow-release preparations should be preferred. Both dopaminergic and anticholinergic agents increase the risk of confusion and hallucinations. Use of anticholinergic agents should generally be avoided. For dopaminergic agents, cognitive side effects can be dose-limiting.

Diabetes (see Chap. 34) Both the incidence and prevalence of diabetes mellitus increase with aging. Among persons age 65 years and older, the prevalence is about 12%, and is higher in African Americans and Hispanics, reflecting the effects of population aging and the obesity epidemic. Diabetes affects all four main aging systems that contribute to frailty. Obesity, especially visceral obesity, is a strong risk factor for diabetes. Diabetes is associated with both reduced muscle mass and accelerated rates of muscle wasting. Diabetic patients have a higher BMI and poor fitness. Diabetes is associated with multiple hormone dysregulations, including insufficiency, cardiovascular risk factors, and elevated inflammatory markers. Diabetic patients have a higher risk of developing physical disability, depression, delirium, cognitive impairment, urinary incontinence, and sepsis. In older adults, diabetes is an independent risk factor for development of new disability during a long-term follow-up, and is associated with higher mortality. Thus, the assessment of older diabetic patients should always include screening and risk factor evaluation for these conditions. In younger and adult patients, the main treatment goal has been tight glycemic control aimed at bringing the hemoglobin A1c to below normal values. However, the risk benefit ratio is optimized by using less aggressive glycemic targets. In fact, in the context of a randomized clinical trial, strict glycemic control was associated with higher mortality. Thus, a more reasonable goal for A1c in 7% or slightly below. Treatment goals are altered further in frail older adults who have high risk of complications of hyperglycemia and a life expectancy of less than 5 years. In these cases, an even less strict target such as 7-8% should be considered, with A1c monitored every 6 or 12 months. Hyperglycemia is particularly difficult to identify in older diabetic patients because autonomic and nervous system symptoms occur at a lower blood sugar level compared to younger diabetics, although the metabolic reactions and neurologic injury effects are similar in young and older diabetics. The silent symptoms of hyperglycemia are often missed by healthcare providers. Frail older adults are at even higher risk for serious hyperglycemia than are healthier, higher functioning older adults. In older patients with type 2 diabetes, a history of severe hyperglycemic episodes is associated with higher mortality, more severe microvascular complications, and greater risk of dementia. Thus, patients with suspected or documented episodes of hyperglycemia, especially those who are frail or disabled, need more liberal glucose control goals, careful education about hyperglycemia, and close follow-up with the health provider, possibly accompanied by a caregiver. Chlorpropamide has a prolonged half-life, particularly in older adults, and should be avoided because it is associated with high risk for hyperglycemia. Metformin should be used with caution and only in patients free of severe renal insufficiency. Renal insufficiency should be assessed by calculated glomerular filtration rate, or in very old patients who have reduced muscle mass, by a direct measure of creatinine clearance from a 24-hour urine collection. Lifestyle changes in diet and exercise and losing a little weight can prevent or delay diabetes in high-risk individuals. Risk of type 2 diabetes decreased by 58% in a study of diet and exercise and this effect was similar in all ages and all ethnic groups. For comparison, the risk reduction with renin inhibitor plus losartan was 31%.

Approach to the Care of Older Persons

Organization of health care for older adults. The complex underlying physiology of aging leads to multiple coexisting medical problems and functional consequences that are often chronic with recurrent exacerbations and remissions. Combined with social consequences of aging such as widowhood and lack of an available caregiver, older adults must sometimes use nonmedical services to meet functional needs. The goal of all these medical, functional, and social factors is that older adults use many health care and social support services and settings. Thus it is incumbent on the internist, whether a generalist or specialist, to be familiar with the scope of settings and services that are used by their patients. For many settings, Medicare reimbursement requires a medical order based on specific indications, so the hospitalist or referring physician must be familiar with eligibility requirements. Table 72-5 summarizes the types of services and payment sources for common settings of care. Older adults who have experienced new disability during a hospitalization are eligible for rehabilitation services. Inpatient rehabilitation requires at least 3 h per day of active rehabilitation and is limited to specific diagnoses. More and more rehabilitative services are provided in postacute settings, where the required intensity of service is less stringent. Postacute settings are also used for complex nursing services such as supervision and supervision of long-term parental medications or wound care. Under current policy, Medicare covers postacute care if there is an eligible medical, nursing, or rehabilitation service. Otherwise, nursing home care is not covered by Medicare and must be paid for by expending personal assets until resources are consumed, at which time Medicare coverage becomes available. Medicaid is a state- or federal partnership whose greatest single cost is nursing home care. Thus the need for chronic daily assistance with personal care in a nursing home consumes a large part of most state Medicaid budgets as well as personal assets. Therefore, alternatives to chronic nursing home care are of great interest to states, patients, and families.
TABLE 72.5 Models of Care Setting for Older Patients

<table>
<thead>
<tr>
<th>Setting</th>
<th>Services</th>
<th>Payment Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hospital acute care</td>
<td>Medical, surgical and psychiatric services that cannot be provided in less complex settings</td>
<td>Medicare, Medicaid, and private insurance</td>
</tr>
<tr>
<td>Emergency room</td>
<td>Research, rescue, stabilization, triage, disposition</td>
<td>Medicare, Medicaid, and private insurance</td>
</tr>
<tr>
<td>Inpatient rehabilitation</td>
<td>Hospital-based residential program providing team-based, physician-supervised, intensive therapeutic rehabilitation for specific diagnoses</td>
<td>Medicare, Medicaid, and private insurance</td>
</tr>
<tr>
<td>Outpatient clinic</td>
<td>Chronic, urgent and preventive services</td>
<td>Medicare, Medicaid, and private insurance</td>
</tr>
<tr>
<td>Postacute care</td>
<td>Medical, nursing and rehabilitative services after hospitalization, often based in hospitals or nursing homes</td>
<td>Medicare up to 100 days with eligibility requirements</td>
</tr>
<tr>
<td>Long-term care</td>
<td>Residential program with daily nursing and aide care for persons who are dependent in self-care</td>
<td>Medicaid, private pay, long term care insurance</td>
</tr>
<tr>
<td>Assisted living</td>
<td>Residential program with daily aide care and housing for persons who are dependent in household management</td>
<td>Private pay</td>
</tr>
<tr>
<td>Home health care</td>
<td>Nursing and rehabilitative services for episodes of care provided to persons in the community</td>
<td>Medicare, Medicaid</td>
</tr>
<tr>
<td>Day programs</td>
<td>Supervised settings providing nursing and aide care for scheduled hours</td>
<td>Private pay, Medicaid</td>
</tr>
</tbody>
</table>

Some states have developed Medicaid-funded day care programs, sometimes based on the Programs for All Inclusive Care of the Elderly (PACE) model. In this situation, older adults who are eligible for both Medicare and Medicaid, and otherwise eligible for chronic nursing home care, can receive coordinated medical and functional services along with a day care setting. For most older adults, a caregiver must be available to provide assistance on week nights and weekends. Home health services under current policy do not provide chronic functional assistance in the home, but rather are targeted at episodes of care for medical or rehabilitative services for older adults who are considered home bound. Within the past decade, there has been tremendous growth in a broad spectrum of assisted living settings. Such settings do not provide the degree of 24-h nursing supervision or personal aide care that is provided in traditional nursing homes, although distinctions are becoming blurred. Most assisted living settings provide meals, medication supervision, and homemaker services but often require that residents be capable of transporting themselves to a congregate meal site. Most of these settings accept only private pay from residents and their families and thus are hard to access for older adults with limited resources. Some states are expediting coverage for lower-cost residential care services such as family care homes. Some community agencies, whether private or public, can provide home maker and home aide services to assist the home-based older adult with functional needs, but may be income requirements or need for expensive private payment.

Models of care coordination

The complexity and fragmentation of care for complex older adults results in both increased costs and increased risk of intradomiciliary complications, further worsening of function and even death. These serious consequences have led to a strong interest in care coordination through teams of providers, with the goal to reduce unnecessary costs and prevent adverse events. Table 72.6 lists examples of evidence-based models of care coordination that were recommended in a recent Institute of Medicine report. While not mentioned as a specific type of team care, modern information technology has substantial promise to provide consistent readily available information across settings. All such team programs are targeted at prevention and management of chronic and complex problems. Each model has demonstrated evidence for benefit in clinical trials or quasi-experimental studies, and some have sufficient findings to support meta-analyses. The evidence for benefit is not always consistent between studies or types of care, but includes some support for improved quality of care, quality of life, function, survival, and health care costs and use. Some models of care care are disease-specific and focus on common chronic conditions such as diabetes mellitus, congestive heart failure, chronic obstructive pulmonary disease, or stroke. One challenge to these models is that a majority of older adults will have multiple simultaneous conditions, and thus need services from multiple programs that may not communicate among themselves.

Most models of care are difficult to implement in today’s health care system because non-physician services are not reimbursed, nor is physician effort that it not incorporated into “face to face” time. Thus several models have largely been developed in the Department of Veterans Affairs Health Care system, Medicare Managed Care providers, or other sponsoring agencies. Medicare has developed a series of demonstration projects that can help further build the evidence base and serve policy makers.

SCREENING AND PREVENTION IN OLDER PERSONS

In older adults, prevention tests and interventions are less consistently recommended for all asymptomatic patients. The guidelines fail to address the influence of health status and life expectancy on recommendations, although the benefit of prevention are clearly affected by life expectancy. For example, in most types of cancer, screening provides no benefit in patients with a life expectancy of 5 years or less. More research is needed to build an appropriate evidence base for age- and life expectancy–adapted preventive services. Health behavior modification, especially increasing physical activity and improving nutrition, are probably the two interventions with the highest potential to promote healthy aging.

Screening tests

- Osteoporosis: Bone mineral density (BMD) at least once after the age of 65 years. There is little evidence that regular monitoring of BMD improves the prediction of fractures. However, because of limitations in the precision of DEXA, the minimal interval between evaluations should be 2–3 years.
<table>
<thead>
<tr>
<th>Model</th>
<th>Team Members</th>
<th>Services</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interdisciplinary primary care “Medical Home”</td>
<td>Primary care physician plus social worker, nurse, nurse practitioner, or other care coordinators</td>
<td>Coordinate medical and social needs across settings</td>
</tr>
<tr>
<td>Case management</td>
<td>Nurse or social worker</td>
<td>Provide education and information to patients and families, may communicate with providers and settings</td>
</tr>
<tr>
<td>Disease management</td>
<td>Nurse</td>
<td>Health education and follow-up support for specific chronic diseases</td>
</tr>
<tr>
<td>Preventive home visits</td>
<td>Physician, nurse, social worker, and others</td>
<td>Structured assessment of physical, mental, functional, and social status in the home setting, with recommendations for care and prevention</td>
</tr>
<tr>
<td>Comprehensive outpatient geriatric assessment and management</td>
<td>Physician, nurse, social worker, plus sometimes others such as pharmacist, rehabilitation therapists, psychologist</td>
<td>Structured assessment of physical, mental, functional, and social status in the outpatient setting, with recommendations for care and prevention</td>
</tr>
<tr>
<td>Pharmaceutical care management</td>
<td>Pharmacist</td>
<td>Review and recommendations regarding the total medication regimen, provided in any setting</td>
</tr>
<tr>
<td>Chronic disease self-management</td>
<td>Nurse, health educator, or other health professional</td>
<td>Health education and coaching for specific chronic conditions</td>
</tr>
<tr>
<td>Prevention rehabilitation</td>
<td>Rehabilitation therapist</td>
<td>Anticipatory guidance, therapeutic exercise, and assistive technology in the home or outpatient setting for older adults with physical disability</td>
</tr>
<tr>
<td>Caregiver services</td>
<td>Social worker, psychologist, or other health professional</td>
<td>Education, counseling, and resource referral for caregivers of older adults with chronic functional and mental health problems</td>
</tr>
<tr>
<td>Hospital discharge/transition coordination</td>
<td>Nurse, nurse practitioner</td>
<td>Care planning and education for patient and family before and after hospital discharge</td>
</tr>
<tr>
<td>Hospital at home</td>
<td>Physician, nurse, pharmacist</td>
<td>Diagnostic testing and medical treatments that can replace hospitalization or reduce length of stay for target conditions</td>
</tr>
<tr>
<td>Nursing home care coordination</td>
<td>Nurse practitioner or physician assistant</td>
<td>Scheduled assessment and care planning, as well as education for health workers in chronic care settings</td>
</tr>
<tr>
<td>Hospital delirium comprehensive care</td>
<td>Physician, nurse</td>
<td>Prevention, screening, and management of delirium in the hospital setting</td>
</tr>
<tr>
<td>Comprehensive inpatient geriatric assessment and management</td>
<td>Physician, nurse, social worker plus sometimes others such as pharmacist, rehabilitation therapists, psychologist</td>
<td>Specialized inpatient settings such as acute care of the elderly (ACE) unit or neurosciences teams that provide evaluation and recommendations for medical, mental, health, functional, and social needs. ACE units and some teams take responsibility for implementation of recommendations</td>
</tr>
</tbody>
</table>

- **Hypertension:** Blood pressure at least once a year, more often in patients with hypertension.
- **Diabetes:** Serum glucose and hemoglobin A1c every 3 years, more often in patients who are obese or hypertensive.
- **Lipid disorders:** Lipid panel every 5 years, more often in patients with diabetes or any cardiovascular disease.
- **Colorectal cancer:** Fecal occult blood test, sigmoidoscopy or colonoscopy, regular schedule up to age 75 years. No consensus guidelines after age 75 years.
- **Breast cancer:** Mammography every 2 years between ages 50 and 74 years. No consensus guidelines after age 75 years.
- **Cervical cancer:** Pap smear every 3 years up to age 65 years.

**Preventive Interventions**
- **Influenza:** Immunization annually.
- **Shingles:** Herpes zoster immunization once after age 50 years.
- **Pneumonia:** Pneumococcal immunization once at age 65 years.
- **Myocardial Infarction:** Daily aspirin in patients with prevalent cardiovascular disease or with poor cardiovascular risk profile.
- **Osteoporotic Calcium:** 1200 mg daily and vitamin D at least 800 IU daily.

**EXERCISE**
Rate of regular physical activity decreases with age and are lowest in older persons. This is unfortunate because physical activity has clear benefits in aging. In older adults, increased physical activity improves physical function, muscle strength, mood, sleep, and metabolic risk profile. Some studies suggest that exercise can improve cognition and prevent dementia, but this is still controversial. Exercise programs, both aerobic and strength training, are feasible and beneficial even in very old and frail individuals. Regular, moderate-intensity exercise can reduce the rate of age-associated decline in physical function. The U.S. Centers for Disease Control and Prevention recommend that older persons should have at least 150 min per week of moderate-intensity aerobic activity (such as brisk walking) and muscle-strengthening activities that work all major muscle groups (legs, hips, back, abdomen, chest, shoulders, and arms) on 2 or more days a week. In the absence of contraindications, more intense and
PART 5
Aging

prolonged physical activity provides higher benefits. Frail and seden-
tary persons may need supervision, at least at the start of the exercise
program, to avoid falls and exercise-related injuries.

NUTRITION
Older persons are particularly vulnerable to malnutrition and many
problems that affect older patients can be addressed by dietary modi-
fication. In spite of this, evidence-based guidelines for individualized
dietary modifications in the elderly are lacking and older people tend to
be poorly compliant with dietary recommendations. Basic principles of
a healthy diet that are also valid for older persons are as follows:

- Encourage consumption of fruits and vegetables. They are rich in
  micronutrients, minerals, and fibers. Whole grains are also a good
  source of fiber. Keep in mind that some of these foods are costly
  and thus less accessible to low-income persons.
- Good hydration is essential. Fluid intake should be at least 1000 ml
daily.
- Encourage the use of fat-free and low-fat dairy products, legumes,
poultry, and lean meats. Encourage consumption of fish at least
once a week.
- Match intake of energy (calories) to overall energy needs in order
to maintain a healthy weight and body mass index (BMI) 20–27.
If BMI ≥27, implement a 5–10% calorie restriction.
- Limit consumption of foods with high calorie density, high sugar,
  and high salt content (less than 6 g per day).
- Limit the intake of foods with a high content of saturated fatty
  acids and cholesterol.
- Limit alcohol consumption (1 drink per day or less).
- Older persons who have little exposure to UV radiation are at
  risk of vitamin D insufficiency. Thus, vitamin D–fortified foods
  and/or vitamin D supplements should be introduced in the diet.
- Make sure that the diet includes adequate food-related intake of
  magnesium, vitamin A, and vitamin B12.
- For constipation: increase dietary fiber to 10–25 g and fluid
  intake to 1500 ml daily. A bulk laxative (Methylcellulose or
  Pylolax) can be added.

MOBILE INTERVENTIONS TO MODIFY AGING PROCESSES
Aging is a complex process with multiple manifestations at the
molecular, cellular, organ, and whole organism level. The nature
of the aging process is still not fully understood, but aging and its effects
may be modulated by appropriate interventions. Dietary and genetic
alterations can increase healthy life spans and prevent the development
of dysregulated systems and the aging phenotype in laboratory models
organisms. The mechanisms responsible for life span expansion are
“food” sensors typically activated in situations of food shortages, such as
IGF-1 (insulin-like growth factor) and TOR (target of rapamycin)
pathways. Accordingly, a reduction in food intake without
malnutrition, extends the life span by 10–50% in diverse organisms,
from yeast to thymus monocytes. Mechanisms that modulate the effects
of calorie restriction are under intensive study because they are poten-
tially useful for interventions aimed at countering the emergence
of the aging phenotype and its deleterious effects in humans. For
example, resveratrol, a natural compound found in grape skin that
minimizes some of the effects of dietary restriction, increases longevity
and improves health, when fed to mice on a high fat diet but has little
effect in mice on a standard diet. Other compounds that potentially
mitigate caloric restriction are currently in development and testing. A
high prevalence of IGF-1 receptor gene mutation has been found in
Adolescent Crohn’s colectomies and in long-lived individuals, sugges-
ting that the downregulation of IGF-1 signaling may promote human
longevity. A 20-year 30% dietary restriction applied to adult thymus
monocytes was shown to be associated with reduced cardiovascular and
cancer morbidity, reduced signs of aging and higher longevity, through
a second such study did not find increased longevity. In humans,
dietary restriction is effective against obesity and reduces including
insulin resistance, inflammation, blood pressure, C-reactive protein
and intima-media thickness of the carotid arteries. However, the benefi-
cial effects of dietary restriction in humans are still controversial,
and some potential negative effects have not been sufficiently studied.
An interesting effect of calorie restriction in humans is mitochondrial
biogenesis. Mitochondrial dysfunction has emerged as a potentially
important underlying contributor to aging. Reduced expression of
mitochondrial genes in a strongly conserved feature of aging across
different species. Interestingly, mitochondria are the machinery for
chemical energy production, and lysosomes and macrophages are particularly
important in the secretion of mitochondrial dysfunction. Thus, declining mito-
chondrial function may be a direct cause of at least three of the main
dysregulated systems contributing to the phenotype of aging.

OTHER ASPECTS OF AGING
This chapter touched on some of the fundamental aspects of human
aging, focusing mostly on those that are relevant to the care of older
patients. Many aspects of geriatric medicine could not be addressed
due to space limitations. Valuable topics had to be left out, includ-
ing details of comprehensive geriatric assessment, depression and
anxiety, hypertension, orthostatic hypotension, dementia, vision
and hearing impairment, osteoporosis, palliative care, prostate dis-
orders, foot problems, and women’s health. Some of these topics are
treated extensively elsewhere in this text, sometimes with comments
on age-specific issues. The interested reader can find resources for
further information at the end of this chapter.

CONCLUSIONS
The universal process of aging is becoming better understood. There
appear to be shared underlying cellular and molecular processes that
induce widespread dysregulation in key systems. This dysregula-
tion contributes to clinical manifestations of a frailty phenotype and
can be used to understand how to evaluate and manage the older
patient.

ACKNOWLEDGMENT
We would like to thank our colleagues who provided critical and
suggestions for improvement of this chapter. We are particularly
indebted to Dr. John Marley for his valuable suggestions on the
"Amenities-Malnutrition“ section.

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