Influence of Aging and Environment on Presentation of Infection in Older Adults

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Disclosure: See at the last page.

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KEYWORDS

- Older adults
- Immunosenescence
- Frailty
- Thermoregulation
- Malnutrition

KEY POINTS

- Age-related physiologic changes affect several organ systems and contribute to increased vulnerability to infections.
- With aging comes immunosenescence, affecting both the adaptive and innate immune systems, and contributing to an increased risk of infection.
- Older adults experience a reduced febrile response caused by altered thermoregulation and a decrease in mean body temperature.
- Addressing malnutrition and dehydration among older adults may reduce their risk of infection.
- Knowledge of debilitated older adults’ functional and cognitive baseline may support early recognition of infection and discernment of conditions not related to infection.


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INTRODUCTION

The topic of human longevity has invited extensive scientific and philosophic debate. Haller, a prominent Swiss physiologist of the 18th century, thought that people ought to live to 200 years. Buffon, an 18th century French naturalist, was of the opinion that when someone did not die from some accident or disease they would reach 90 or 100 years. Nobel laureate Élie Metchnikoff, arguably the father of modern immunology and gerontology, found it “impossible to accept the view that the high mortality between the ages of 70 and 75 indicates a natural limit of human life.” In his 1907 book, *The Prolongation of Life*, he equated aging with a disease process that can be studied and possibly cured until death inevitably settles in from “natural causes.” He suggested that, similar to the instinct of sleep, there could be an instinct of death that is neither due to diseases nor accidents, but rather the result of age-related physiologic changes. He thought these changes were the result of self-digesting macrophages and poisoning by intestinal microbiota. Although this theory has been disproved, his contributions to immunology and gerontology were groundbreaking and continue to shape our understanding of infectious processes in older adults.

A testament to the contributions by these pioneers in the field of gerontology, people are living longer such that the number of older adults is rapidly increasing, both in the United States and globally. In 2015, approximately 617 million people were 65 years or older, representing 8.5% of the 7.3 billion people worldwide. Projections estimate that by 2050, approximately 1.6 billion people will be 65 years or older, with the proportion nearly doubling to 16.6% of the total world population. In the United States, the proportion of people projected to be 65 years or older by 2050 will constitute more than 20% of our total population. Bartels and Naslund famously described this demographic trend as the “silver tsunami.” Understanding the process of aging and how it influences the clinical presentation of diseases in general, and infectious diseases in particular, is a necessity for modern practitioners.

Aging changes the risk of and the clinical presentation of infection. This is due to factors intrinsic to individuals fortunate enough to age and to the environment in which they reside. Intrinsic factors include age-related physiologic changes, which can sometimes result in frailty, a pathologic state. Some age-related changes also influence the clinical manifestation of infection, presenting as alterations in temperature regulation, cognitive decline, and malnutrition. Environmental factors also play a role, particularly those related to the living situation (e.g., nursing home), and the health care setting to which older adults present. In combination, these factors make it difficult for health care workers to determine whether changes in clinical status are due to infection. This may contribute to a low threshold for prescribing systemic antimicrobials, which in turn increases older adults’ risk for acquiring multidrug-resistant organisms (MDRO) and *Clostridium difficile*.

Herein we review the age-related physiologic changes that may progress to frailty; these include both immune and organ-specific changes. We also address clinical factors that influence the manifestation of infections in older adults. Finally, we consider the influence of the external environment on the presentation and evaluation of infections in older adults, with consideration of the subjective roles and perspectives of caregivers within different settings.

PATHOPHYSIOLOGIC FACTORS INFLUENCING INFECTION RISK AND PRESENTATION IN OLDER ADULTS

With aging, physiologic changes occur that affect the immune system as well as various organ systems. Aging itself is not a disease, yet as time passes, the
accumulation of such changes can sometimes lead to a clinical condition in older adults known as frailty. In this section, we discuss these changes and introduce the concept of frailty.

**Age-related Immune Changes**

Gavazzi and Krause describe immunosenescence as “an age-related dysfunction of the immune system which leads to enhanced risk of infection.” This phenomenon is an area of active research and encompasses a large body of evidence. Globally, the total number of immune cells does not decrease with aging, but studies demonstrate a functional decline in both innate immunity and adaptive immunity that encompasses cell mediated and humoral immunity.

Changes in innate immunity include reduced phagocytic activity of neutrophils, macrophages, and natural killer cells. This is accompanied by upregulation of a number of proinflammatory cytokines, including interleukin (IL)-6, C-reactive protein, tumor-necrosis factor-α, and CXC chemokine ligand-10. This increase in cytokine and chemokine production results in a heightened chronic proinflammatory state in older adults that may contribute to the development of infection and other diseases (eg, atherosclerosis, arthritis, diabetes mellitus). Franceschi and Campisi referred to this chronic proinflammatory state as “inflammaging,” which can result in anorexia, nutritional compromise, muscle weakness, and weight loss, all of which could be presentations of infection in older adults, but also represent characteristics of frailty, as discussed elsewhere in this article. As such, the distinction between the clinical condition of frailty and presentation of infection becomes challenging, particularly for health care workers who encounter an individual patient for the first time in an acute care setting. Knowledge of older adults’ clinical baseline is, therefore, of great benefit when evaluating a suspected infectious process in this population.

One of the changes in cell-mediated immunity is the decline in the proportion of naïve T cells with aging. This occurs as a consequence of thymus involution and an increase in the proportion of circulating memory T cells in the setting of continued antigenic stimulation. This increase in the number of memory T cells is offset by their restricted clonal diversity. These changes in turn limit the antibody response to foreign antigens due to reduced regulatory control of T cells on B cells. Interestingly, Van Epps and colleagues recently demonstrated in vitro that although naïve T cells are reduced in number in older adults, they had enhanced functional ability, mainly the CD8 T cells. The clinical relevance of these findings is unclear at this time, but this increased functionality may also contribute, along with cytokine upregulation, to “inflammaging.” Some chronic infections also contribute to generalized chronic inflammation and through accumulation of damage to host cells, hasten the aging process. The best investigated example is human immunodeficiency virus (HIV), which results in accelerated aging. Gross and colleagues have demonstrated that HIV-infected individuals on sustained antiretroviral therapy have an epigenetic age about 5 years older than healthy controls. Smith and colleagues proposed that in addition to inflammation caused by HIV, adverse effects of antiretroviral drugs, specifically those that affect the mitochondria, also contribute to the accelerated aging of treated HIV-infected patients. Viruses other than HIV, namely cytomegalovirus and herpes simplex virus, also seem to correlate with premature immune aging. Given that most individuals do not receive antiviral therapy for these viruses, the implication is that these viral infections directly contribute to this phenomenon.

As a result of the changes to adaptive and innate immune responses, although the incidence of severe infections is higher in older adults, the protective effect elicited by vaccines is lower. This is the case for influenza, hepatitis B, and
pneumococcal vaccines, supporting the idea that vaccination in older adults is associated with modest clinical effectiveness.

Finally, it is important to appreciate that immunosenescence and chronic inflammation are gradual, relentless processes. Their clinical impact may not be fully apparent until progression to frailty. Coupled with other factors, such as comorbidities and declining functional status, frailty results in increased morbidity and mortality, including from infection.

**Age-related Organ-specific Physiologic Changes**

In addition to immunosenescence, aging also causes physiologic changes that affect nearly every organ system, independent of existing comorbidities and disease. This process is the result of a lifelong accumulation of molecular and cellular damage caused by a number of mechanisms regulated by a complex maintenance and repair network. Described in Table 1, these changes include structural transformations, altered anatomy, and decreased function in multiple physiologic systems, as well as loss of feedforward and feedback mechanisms between interacting systems.
The resulting constellation of physiologic changes results in progressive homeostatic dysregulation and may contribute to vulnerability to infections.\textsuperscript{6,25}

An example is the increased risk of pneumonia in older adults. The strength of respiratory muscles, compliance of the chest wall, and static elastic recoil all progressively decrease with aging, making the lungs less resistant to environmental insults, such as infectious agents and pollutants.\textsuperscript{26,27} Older adults are also at an increased risk of aspiration pneumonia. Aging is associated with a higher incidence

<table>
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<tr>
<th>Organ System</th>
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<td>Urinary</td>
<td>Mechanical changes: reduction in bladder capacity, uninhibited contractions, decreased urinary flow rate and postvoid residual volume</td>
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<td></td>
<td>Urothelial change: enhanced bacterial adherence</td>
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<td></td>
<td>Bladder prolapse in women and prostatic disease in men increase urinary stasis</td>
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<td>Diminished estrogen in postmenopausal women</td>
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<tr>
<td>Pulmonary</td>
<td>Blunting of cough and other reflexes that protect the airway</td>
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<td></td>
<td>Decreased mucociliary clearance, lung elasticity, chest compliance, and respiratory muscle strength</td>
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<td></td>
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<td>Skin and soft tissue</td>
<td>Loss of subcutaneous tissue</td>
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<td>Loss of collagen from the dermis and slower wound healing</td>
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<td>Reduction in the size of blood vessels in the dermis impairs delivery of immune cells</td>
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<td></td>
<td>Dry skin resulting from diminished water-binding capacity of the stratum corneum</td>
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<td>Flattened dermal–epidermal junctions and reduced dermal–epidermal adhesion</td>
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<tr>
<td>Gastrointestinal</td>
<td>Decreased saliva production and alterations in antimicrobial proteins in the saliva</td>
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<td>Decreased tongue strength and slower swallowing</td>
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<td></td>
<td>Decreased gastric acidity (mucosal gastric atrophy, proton pump inhibitors, surgery)</td>
</tr>
<tr>
<td></td>
<td>Decreased intestinal motility</td>
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<td></td>
<td>Modifications of resident intestinal flora (protective Bifidobacteria and anaerobes decrease, \textit{Enterobacteriaceae} increase)</td>
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<tr>
<td></td>
<td>Slow recovery of the gut microbiome following antimicrobial use in older adults</td>
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<tr>
<td>CNS</td>
<td>Structural and functional changes to microglial cells (resident immune cell population of the CNS and CNS equivalents of macrophages)</td>
</tr>
<tr>
<td>Endocrine system</td>
<td>Gradual increase in cortisol release with age and increased catabolism with resultant anorexia, weight loss, reduced energy expenditure, and decreased muscle mass (all components of frailty)</td>
</tr>
<tr>
<td>Musculoskeletal system</td>
<td>Sarcopenia (loss of skeletal muscle mass, often catabolism induced, after acute disease events) leads to decreased strength and functionality</td>
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</tbody>
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Abbreviation: CNS, central nervous system.  
Data from Refs. \textsuperscript{5,6,29,34,64,78}
of dysphagia, which can lead to aspiration as a result of misdirection of oropharyngeal secretions with a high bacterial load or gastric material into the lower respiratory tract. Decreased respiratory muscle strength and cough reflexes increase the risk of aspiration.

Skin and skin structure infections offer a second example of organ-specific changes contributing to an increase risk of infection. By age 70, about 70% of people have at least 1 underlying skin problem, such as keratoses, dermatitides, or pressure sores. Physiologic changes that occur with age contribute to skin fragility. Reduction in the size of blood vessels in the dermis impairs delivery of immune cells, and loss of collagen from the dermis results in thinner skin. Beyond these physiologic changes, older adults may also have pathologic conditions such as edema or trauma that further impair the integrity of the skin. All of these changes place older adults at a higher risk for skin and skin structure infections.

In summary, consideration of how age-related, organ-specific physiologic changes may alter the clinical presentation of infections may not only improve early recognition of infection in older adults, but may also help to discriminate conditions and changes not related to infection.

Frailty affects 13% to 28% of older adults and up to one-third of those 80 years and older. Fried and colleagues defined a frequently adopted phenotypic definition of frailty as the presence of 3 or more of the following readily identifiable characteristics: unintended weight loss, exhaustion, weakness, slow gait speed, and low physical activity. Other clinical features include falls, delirium, and fluctuating disability, all of which may overlap with presentation of infections in the older adults. Although several definitions of frailty exist, the criteria proposed by Fried and colleagues, which are based on phenotypic features, are the most feasible to assess clinically. That said, frailty extends beyond an apparent physical phenotype to include functional and cognitive statuses of the individual, as well as the setting in which they evolve or present. Additionally, continuous low-intensity inflammatory processes, detectable by moderately elevated levels of inflammatory cytokines, may also contribute to frailty.

Differentiation of the physiologic changes that accompany aging, the clinical entity of frailty, and the baseline clinical features of individual subjects may help to improve recognition of manifestations of infection in older adults. Notwithstanding the aging process and the resulting decline in various organ systems, these systems are resilient and do not immediately fail, owing to the gradual nature of that decline and to redundancy that provides for significant physiologic reserve. This reserve is unfortunately not inexhaustible, and a threshold is eventually reached beyond which vulnerability for subsequent morbidity and mortality becomes significant, triggered even by minor stressors. Fried and colleagues showed that the likelihood of frailty increases nonlinearly in relationship to the number of abnormal physiologic systems, and that the number of abnormal systems is more predictive of frailty than any of the individual affected systems. This aggregate loss results in frailty, which in turn is associated with increased morbidity and mortality.

**CLINICAL FACTORS INFLUENCING INFECTION RISK AND PRESENTATION IN OLDER ADULTS**

**Temperature Regulation**

The evidence suggesting a lower baseline temperature and fever suppression in older adults, albeit mitigated by concerns over measurement difficulties, is unanimous in
showing that mean body temperature decreases with age. A recent analysis of cross-sectional data from more than 18,000 adults shows a difference of 0.3°F between the oldest and youngest groups after controlling for sex, body mass index, and white blood cell count. This is commensurate with the adage, “the older, the colder.”

Fever, or at least an increase in temperature over baseline, occurs in most cases of infection in older adults. In a landmark study of mostly male veteran nursing home residents, Castle and colleagues showed that a single temperature reading of 101°F (38.3°C) had a sensitivity of 40% for predicting infection, compared with 70% when lowered to 100°F (37.8°C), while maintaining a specificity of 90%. Studies of specific syndromes confirm this observation and show a blunted fever response in older compared with younger adults in the contexts of bloodstream infections, endocarditis, meningitis, intraabdominal infection, nosocomial infections, and tuberculosis. It is important to recognize that a robust fever of 38.3°C or higher in a geriatric patient is indicative of a serious infection and needs to be promptly addressed.

The definition of fever is relative and depends in part on the population for which it is intended (Box 1), making its recognition challenging for caregivers. One of the criteria offered by the Infectious Disease Society of America is an increase in temperature of greater than 2°F (1.1°C) over the baseline temperature. The relative temperature change indicative of infection varies among individuals. Accordingly, knowledge of an older adult’s baseline temperature, such as might be available in electronic health records, may help caregivers to ascertain if a change in temperature truly indicates a fever.

Reasons for decreased body temperature in older adults reflect thermoregulatory changes in cutaneous vasomotor and sudomotor responses. Other physiologic mechanisms responsible for temperature variations in older adults remain unclear. Previous studies indicate that they experience alterations in the circadian temperature rhythms, with flatter and earlier phased rhythms. In the context of infection, animal data show that quantitative and qualitative abnormalities occur in the production and response to peripheral endogenous mediators, such as IL-1, IL-6 and tumor necrosis

<table>
<thead>
<tr>
<th>Box 1</th>
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<td>Fever definitions by the Infectious Diseases Society of America</td>
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</table>

Fever in patients with neutropenia (one of the following):
- Oral temperature measurement of greater than 101°F (38.3°C).
- Temperature of greater than 100.4°F (38.0°C) sustained over a 1-hour period.

Fever in older adult residents of long-term care facilities (one of the following):
- Single oral temperature greater than 100°F (>37.8°C)
- Repeated oral temperatures greater than 99°F (>37.2°C) or rectal temperatures greater than 99.5°F (>37.5°C), or
- An increase in temperature of greater than 2°F (1.1°C) over the baseline temperature.

factor-$\alpha$, induced by bacterial products, such as lipopolysaccharide.\textsuperscript{33,45–47} Furthermore, peripheral endogenous mediators are unable to cross the blood–brain barrier to exert their effect on the central nervous system,\textsuperscript{33,46} resulting in a blunted fever response in older adults.

Finally, some evidence suggests that lower body temperature might confer a survival advantage in humans. Analysis from the Baltimore Longitudinal Study of Aging over 25 years of follow-up showed that men with body temperatures below the median had significantly higher survival rates than those with body temperatures above the median temperature.\textsuperscript{37,48} Nonetheless, mounting a fever in the context of infection is part of overall health defense and the absence of fever in response to a serious infection is a poor prognostic sign.\textsuperscript{34,49,50}

### Cognitive Decline

Cognitive decline in older adults encompasses a clinical spectrum ranging from mild cognitive impairment to overt dementia. Memory deficits but intact activities of daily living and preserved general cognitive function characterize mild cognitive impairment. Overt dementia is manifested by progressive deterioration in cognitive ability and in capacity for independent living.\textsuperscript{51,52} Here we focus on overt dementia, because infections are often exceptionally difficult to ascertain in this population.

The global burden of dementia in adults 60 years of age or older is estimated at 5% to 7% in most world regions and at 6.8% in the United States.\textsuperscript{52} In 2010, the United States had the second largest estimated number of people living with dementia (3.9 million), surpassed only by China (5.4 million). Nursing home residents with advanced dementia have significant functional impairment and may be effectively mute. In a retrospective study of 148 hospitalized older adults with pneumonia, Johnson and colleagues\textsuperscript{53} compared nonspecific presenting symptoms, with the exception of delirium, between older (>65 years) and younger adults (<65 years). When subjects with dementia were excluded, nonspecific symptoms (eg, generalized weakness, decreased appetite, falls, and delirium) were similar in both groups. They found that the presence of dementia, not age, explained the difference in the clinical presentation of pneumonia in their cohort.

Estimating the exact contribution of dementia to the clinical presentation of infection in older adults is difficult. Misdiagnosis of infection, and frequent and inappropriate antimicrobial use are common in older adults, particularly nursing home residents, contributing to increasing antimicrobial resistance in this setting.\textsuperscript{54,55} In a prospective cohort of 362 nursing home residents with advanced dementia, Mitchell and colleagues\textsuperscript{55} showed that 66% of residents experienced at least 1 suspected infection over 12 months. They defined advanced dementia in this study as a nurse-measured Global Deterioration Scale score of 7 of 7 (manifested as profound memory deficits, severely curtailed verbal ability with command of <5 words, incontinence, and inability to walk). The most commonly observed infections in these residents were respiratory tract infections, followed by urinary tract and skin infections. More than 90% of skin infections met treatment criteria, compared with only 19% of urinary tract infections.\textsuperscript{55} The authors attributed this discrepancy to the fact that objective changes support the diagnosis of skin infections, whereas subjective symptoms obtained from nursing homes residents or observed from health care workers may trigger a concern for a urinary tract infection.

Just as cognitive decline may influence presentation of infection, chronic infection and inflammation are linked with cognitive decline.\textsuperscript{56–60} As discussed, chronic infections such as HIV contribute to the aging process through chronic inflammation. Infection causes immune activation in the form of cytokines, chemokines, adhesion
molecules, and matrix metalloproteinases that in turn activate microvascular endothelial cells, facilitating vascular leukocyte adhesion and dissolving the basement membrane. Vessel leakage, microbleeds, and inflammatory progression of cerebrovascular lesions ensue, precipitating cognitive decline. Support for this theory comes from the Honolulu Aging Study, which linked elevated C-reactive protein to all cause dementia. A subset of the Northern Manhattan Study also suggests that the accumulation of infectious burden (measured as an index based on serum titers of antibodies against 5 common viruses and bacteria) correlates with cognitive decline. Other clinical data suggest an association between hospitalization with pneumonia and increased risk of dementia, as well as an association between *Helicobacter pylori* infection and dementia.

**Malnutrition**

After retiring to his country estate in 44 BC, the Roman philosopher and politician Marcus Cicero wrote a short treatise on the subject of old age, *De Senectute*, which offers the earliest known account of malnutrition of aging. Malnutrition affects 20% to 30% of older adults and is more prevalent in institutionalized and hospitalized individuals. It is the result of the interplay of multiple factors: socio-economic, psychological (eg, depression, stress), and biological (eg, decreased senses of smell and taste, dental problems, increased proinflammatory cytokines associated with excess catabolism, and alterations in the production of appetite-regulating peptides and hormones). Dehydration is also a common problem in older adults, specifically during a febrile illness. Reasons include poor oral intake and impaired vasopressin responses in older adults, manifested as decreased thirst. Polypharmacy may also be a factor leading to malnutrition and dehydration in older adults.

Malnutrition contributes to immune dysregulation in older adults and results in increased susceptibility to infections. It is also a significant predictor of mortality in this group. For example, in a study of 188 nursing home residents with physical and cognitive impairment, urinary tract infection during the preceding year was independently associated with poor nutritional status. Similar to the association between frailty and infection, there is a 2-way association between malnutrition and infection, as well as between dehydration and infection. In contrast with frailty, however, age-related immune and organ-specific changes that occur in older adults, malnutrition and dehydration both respond to intervention. For example, Langkamp-Henken and colleagues studied EXP, an experimental nutritional formula, and found that it enhanced immune function in nursing home residents older than 65 years of age, indicated by increased influenza vaccine response and lymphocyte activation, less fever, and fewer newly prescribed antimicrobials compared with those consuming a standard ready-to-drink nutritional supplement.

On the other end of the spectrum, obesity is also problematic in older adults. Along with diabetes, it is a recognized cause of accelerated aging triggered by increased inflammation resulting from macrophage infiltration of the adipose tissue, which in turn increases cytokine levels (eg, tumor necrosis factor-α and IL-6). That said, obesity in older adults is a controversial topic. Some data suggest that it correlates with an increased risk of morbidity in older adults, whereas other studies found that it may confer a protective effect in older adults.

In summary, recognizing and addressing nutritional concerns may help to mitigate some complications in older adults, while recognizing that only some aspects of poor oral intake may be remediable.
THE INFLUENCE OF THE LIVING ENVIRONMENT ON INFECTION RISK AND PRESENTATION IN OLDER ADULTS

Older adults reside in a variety of settings (eg, home, nursing homes, assisted living facilities) and may also come to medical attention in a number of different settings (eg, physician’s office, nursing homes, emergency departments [ED] or hospitals). Currently in the United States, approximately 1.4 million people reside in 15,600 nursing homes.69 Despite ongoing efforts to help people “age in place,”70 as our population ages, the need for postacute and long-term care will continue to increase.

Nursing home residents share dining, recreation and therapeutic facilities. They are also highly dependent upon health care workers for assistance with activities of daily living, namely bathing, toileting, dressing, eating, and mobility.69 Hospitals are closely linked to nursing homes with frequent patient transfers between the 2 types of facilities and as many opportunities for the spread of MDROs and C difficile from one setting to the other. During hospitalization, older adults may acquire drug-resistant pathogens and, upon transfer to a nursing home, become a reservoir and source of transmission to others.

In addition, inappropriate antimicrobial use has been shown to be a significant problem in nursing homes, with as many as 25% to 75% of antimicrobial prescriptions in nursing homes being inappropriate.71 The magnitude of the antimicrobial resistance problem in nursing homes is potentially substantial knowing that by 2030, 70 million US residents will be aged 65 years or older and that 3.5% are nursing home residents.71 Fear of infection in long-term care residents with cognitive decline may promote injudicious antimicrobial use, MDRO selection, and C difficile infection. In the study by Mitchell and colleagues,55 most nursing home residents with suspected infections received antimicrobials (72%) and the cumulative incidence of MDRO acquisition was 48%; acquisition was independently associated with exposure to antimicrobials. Other contributing factors include lack of time and reimbursement, and the fact that nursing home practitioners are often family or internal medicine physicians without specialty training in geriatrics or infectious diseases. As such, their expertise in addressing complicated infections in the absence of further support might be limited.4,71,72 Antimicrobial stewardship programs in nursing homes, made mandatory by the Centers for Medicare and Medicaid Services starting 2017, might aid practitioners and help reduce antimicrobial misuse and the prevalence of MDROs.73

In an attempt to assist in the diagnosis of infection and the initiation of antimicrobials in residents of long-term care facility, the Society for Healthcare Epidemiology of America convened a consensus conference that established minimum criteria for initiating antimicrobials in this population. The conference elaborated criteria for the most common infectious syndromes in residents of long-term care facility, namely respiratory tract infections, urinary tract infections, skin and soft tissue infections, and fever where the focus of infection is unknown.54 These criteria, commonly referred to as the Loeb minimum criteria and detailed in Table 2, can facilitate the diagnosis of infection in long-term care facility residents as well as in older adults with advanced dementia.

Caregivers are important in establishing a baseline description of the clinical status of long-term care residents under their care. It is therefore important, during history taking, to obtain a detailed account of baseline clinical features from caregivers, including patients’ relatives and friends. This includes knowledge of residents’ baseline frailty, temperature as well as their cognitive, functional, and psychological status. A good understanding of these baseline parameters will significantly aid in discerning clinical changes that might be related to infection or other new stressors. This
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<th>Infection/Site</th>
<th>Criteria</th>
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<tr>
<td><strong>Urine tract infection</strong>&lt;br&gt;in resident without catheter</td>
<td>Acute dysuria alone or Fever (&gt;37.9°C [100°F] or 1.5°C [2.4°F] increase above baseline temperature) and at least one of the following: suprapubic pain, gross hematuria, costovertebral angle tenderness, or new or worsening urgency, frequency or urinary incontinence</td>
<td>Foul smelling or cloudy urine is not a valid indication for initiating antibiotics. Asymptomatic bacteriuria should not be treated with antibiotics.</td>
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<tr>
<td><strong>Urine tract infection</strong>&lt;br&gt;in resident with catheter</td>
<td>Presence of at least one of the following: Fever (&gt;37.9°C [100°F] or 1.5°C [2.4°F] increase above baseline temperature) New costovertebral tenderness Rigors (shaking chills) with or without identified cause New onset of delirium</td>
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<td><strong>Respiratory Infections in the febrile patients</strong>&lt;br&gt;If temperature &gt;38.9°C [102°F]: Respiratory rate &gt;25 breaths per minute or productive cough</td>
<td>Episodic setting (eg, influenza outbreak) in interpreting clinical features is essential.</td>
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<td><strong>Respiratory infections in the afebrile patients</strong>&lt;br&gt;Afebrile residents with COPD</td>
<td>New or increased cough with purulent sputum production.</td>
<td>Congestive heart failure must be considered within the differential diagnosis of residents with acute respiratory symptoms and signs.</td>
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<tr>
<td>Afebrile residents with no COPD</td>
<td>New cough with purulent sputum production and at least one of the following: Respiratory rate &gt;25 breaths per minute or delirium</td>
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<tr>
<td><strong>Skin and soft-tissue infections</strong>&lt;br&gt;New or increasing purulent drainage at a wound, skin, or soft-tissue site or At least two of the following: Fever (temperature &gt;37.9°C [100°F] or an increase of 1.5°C [2.4°F] above baseline temperatures taken at any site) Redness Tenderness Warmth Swelling that was new or increasing at the affected site</td>
<td>Erythema alone is not adequate as a minimum criterion for initiating antibiotics. Deeper infections, such as olecranon bursitis, may present with similar symptoms. Thromboembolic disease should be considered with an erythematous or swollen leg. Gout can be mistaken for cellulitis.</td>
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Abbreviation: COPD, chronic obstructive pulmonary disease.

contributes, in turn, to improving diagnostic accuracy, which supports reducing inap-
propriate and unnecessary antimicrobial use.

Although it is possible for caregivers in nursing homes to observe and understand
the baseline clinical features of their residents, this is not usually possible for care-
givers in other settings. Older adults account for 12% to 24% of all ED visits with pneu-
monia (25%), urinary tract infection (22%), and sepsis and bacteremia (18%)
representing the most frequently cited infections. They also visit the ED more
frequently than younger adults, arrive more often by ambulance, have a higher level
of medical acuity, higher rates of test use, longer durations of ED stays, higher rates
of hospital admission, and more serious medical illnesses. Absent detailed commu-
nication with nursing home staff or other caregivers accompanying older adults, ED
personnel have no reference while evaluating geriatric patients. As a result, these pa-
tients are more likely to be misdiagnosed, and more frequently discharged with unrec-
ognized health problems. A common scenario is an older adult with a change in
mental status who receives treatment for a urinary tract infection based on the results
of a urinalysis. This may not only expose them to unnecessary antimicrobials, but also
overlook more common and treatable causes for a mental status change, such as
dehydration, pain, recent change in medications, or sleep deprivation.

Although several risk assessment and screening tools are available for use by ED
personnel in caring for older adults, there is a need for more guidance in optimizing
the evaluation of older adults in the ED setting. Comprehensive geriatric evaluation
of older adults in the ED by trained specialized nurses or interdisciplinary teams is
effective. Coupled with risk assessment and screening tools, it helps in detecting geri-
atric syndromes and other missed diagnoses, increasing community referrals, and
avoiding hospital admission on the ED index visit.

SUMMARY

We have summarized the pathophysiologic, clinical, and environmental influences on
the presentation of infections in older adults. Health care professionals should under-
stand those changes and the specific features that affect presentation of illness in
older adults, especially at a time when the increasing geriatric population is referred
to as the “geriatric demographic imperative” or the “silver tsunami.” Pope John
XXIII once joked that, “Men are like wine - some turn to vinegar, but the best improve
with age.” Recognition of age-related changes as well as their treatable effects will
aid in the prevention, early diagnosis, and treatment of infections and other illnesses,
ultimately improving clinical outcomes in this population.

DISCLOSURE

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