Pearls and Pitfalls in the Crashing Geriatric Patient

David P. Yamane, MD[a,b,*]

KEYWORDS

• Geriatric • Emergency clinician • Critical care • Intensive care

KEY POINTS

- The geriatric population is growing and is the largest utilizer of emergency and critical care services; the emergency clinician should be comfortable in the management of the acutely ill geriatric patient.
- There are important physiologic changes in geriatric patients, which alters their clinical presentation and management.
- Age alone should not determine the prognosis for elderly patients. Premorbid functional status, frailty, and severity of illness should be considered carefully for the geriatric population.
- Emergency clinicians should have honest conversations about goals of care based not only a patient's clinical presentation but also the patient's values.

INTRODUCTION

The definition of "old" varies greatly. The most common definition of the geriatric patient, including that of the World Health Organization, is an adult greater than or equal to age 65 years.[1] Within the United States, this population increased 1000%, from 3.1 million (1 in every 25 persons) in 1900 to more than 35 million people (1 in every 8 persons) in 2000. The geriatric population is the largest growing age group, accounting for more than 13% of the population, with an expected increase to 70 million, or 16% to 25% of the population, by 2050. The oldest-old group ($\geq$85 years) is the fastest growing, with an expected climb from 1% to 5% of the population (1 in 20 Americans) by 2050.[2,3]

One in 4 older adults visits the emergency department (ED) each year, and ED care is one of the highest utilized health resources by this population. Geriatric patients account for approximately 15% of ED visits and utilize ambulances 38% more than any other age group. These patients have higher disease acuity and higher probability of needing hospital admission.[4] This growing population is also increasingly utilizing critical care services. Over the past 20 years, admissions to the intensive care unit (ICU)

[a] Emergency Medicine, George Washington University, Washington, DC, USA; [b] Anesthesiology and Critical Care Medicine, George Washington University, Washington, DC, USA
* 2120 L street NW, suite 400, Washington DC 20037, USA
E-mail address: dyamane@email.gwu.edu
Twitter: @donth8intubate (D.P.Y.)

Emerg Med Clin N Am 38 (2020) 919–930
https://doi.org/10.1016/j.emc.2020.06.011
emed.theclinics.com

have increased for the geriatric population, with those for the greater than 80-year-old cohort increasing at the fastest rate. Geriatric ICU admission accounts for 25% to 50% of all ICU admissions and the geriatric population stays longer in the ICU, accounting for 60% of total ICU days.[1,3,5–7] This growing population requiring critical care resources is projected to lead to a severe shortage of ICU beds. This shortage will require emergency physicians to care for critically ill geriatric patients for longer periods and be ready to respond to their specific needs if they deteriorate.

GERIATRIC PATIENTS ARE NOT JUST OLD ADULTS: PHYSIOLOGIC CHANGES IN THE GERIATRIC POPULATION

The geriatric population has a loss of physiologic reserve due to the aging process, making them vulnerable to stressors, such as infection and injury.[2] The exact mechanism of the aging process is not well understood, involving an interplay of genetic, oxidative free radical, and cellular-level changes.[7] The geriatric patient has specific physiologic changes that the emergency clinician must be attuned to (**Table 1**).

Neurologic Changes

The aging brain decreases in size, with a decrease in functional neurons resulting in loss of cognitive function, motor function, hearing vision, and memory. The decrease in size with the adherence of the dura to the skull bases places the strain on the bridging vessels, increasing the risk for subdural hematomas in response to even minor traumas. The geriatric brain also has baseline decreased cerebral perfusion; declines in perfusion pressure from critical illnesses (eg septic shock) may result in concomitant neurologic insults.[8] The geriatric patient also is less sensitive to pain, which may result in later-stage presentations of illness.[9] The clinician should be attuned that the lack of pain cannot rule out serious illness.

Cardiovascular Changes

The geriatric patient population is at increased risk for cardiovascular ischemia. More than 40% of deaths in the geriatric population stem from cardiovascular disease, and silent myocardial infarctions occur in over 40% of patients older than 75 years.[7,10,11] In addition the geriatric population is at increased risk to arrhythmias, including sick sinus syndrome, atrial arrhythmias, ventricular arrhythmias, and bundle branch blocks, as a result of connective tissue and fat replacing the autonomic tissues. Atrial fibrillation is common in the elderly, with a prevalence of 10% in patients over 80 years old.[2,7,10,12]

Both systolic and diastolic heart failure are common in the elderly population, and several effects of aging contribute to the high prevalence.[13] With age, the cardiac myocytes are replaced by fibrous tissue, reducing the ejection fraction and overall cardiac output. In addition, the decrease in elasticity of the aorta increases cardiac afterload and hypertension. In response to the increased cardiac afterload, there is left ventricular hypertrophy decreasing the cardiac compliance placing these patients at risk for diastolic dysfunction. The geriatric heart responds to demands of increased cardiac output by increasing ventricular filling and stroke volume. The geriatric patient is in a preload dependent state, very susceptible to even minor changes in volume status.[2]

At rest, cardiac output can be maintained; however, the aging heart has a blunted response to sympathetic stimulation (hyposympathetic state) and is unable to respond to increased demands by increasing the heart rate. Geriatric patients suffering from hypovolemia may not mount the tachycardic response clinicians expect. Similarly,

Table 1
Summary of physiologic and functional changes in the geriatric population

Physiologic Changes	Functional Changes
Neurologic	
Decreased brain size Decreased cerebral perfusion	Decline in cognitive function Increased risk for additional neurologic insult
Cardiovascular	
Increased fibrosis of the myocardium and autonomic tissue Increase aortic wall thickness and decreased elasticity	Increased arrhythmia risk Decreased cardiac output Increased afterload
Pulmonary	
Decreased chest wall compliance Decreased alveolar surface area, surfactant, ciliary clearance Increased residual volume	Decreased maximal inspiratory and expiratory force, forced expiratory volume in the first second of expiration Decreased cough, increased pneumonia risk Increased ventilation/perfusion mismatch
Gastrointestinal	
Decreased motility and delayed gastric emptying Decreased in nutritional absorption Decreased gastric acid secretion and mucous production	Increased aspiration risk Increased malnutrition risk Increased risk of gastrointestinal bleeds and bacterial translocation
Renal	
Decrease renal size Decrease renal blood flow Increase sclerosis of nephrons	Decreased GFR Increased risk of acute renal failure
Musculoskeletal	
Decrease in lean muscle mass	Increased risk of falls and injury
Integumentary	
Decrease subcutaneous adipose Decreased epidermal skin layer Decease dermal vasculature	Increased risk of infection Increased risk of decubitus ulcers Poor wound healing

normotensive geriatric patients may be masking inadequate perfusion, and these changes make shock insidious in the geriatric patient. Emergency clinicians must be vigilant for changes in mental status, oliguria, and clammy skin as evidence of shock. During resuscitation, the clinician must carefully balance the need to maintain adequate preload with the increased risks of pulmonary edema from heart failure.

Airway Changes

Airway management and intubation in the elderly population can be challenging. Bag-valve masking a patient can be a challenge with the loss of muscular facial and pharyngeal support, and edentulousness can make a mask seal challenging. Mouth opening, mandibular protrusion, thyromental distance, neck mobility, and submandibular compliance decrease with age, while the Mallampati score increases. The emergency clinician, therefore, should be prepared for a potentially difficult airway when intubating a geriatric patient.[14]

Pulmonary Changes

The geriatric patient has many changes in the pulmonary system. Structural changes, such as kyphosis, vertebral compression fractures, increased chest wall stiffness, and increased anteroposterior diameter, result in decreases in chest wall compliance. The chest wall compliance decreases by 10% after age 50,[15] and lungs have a loss of elastic recoil. Along with a 25% decline in respiratory muscle strength, these changes lead to a decrease of the maximal inspiratory and expiratory forces of up to 50%.[3,16]

Geriatric patients have a reduction in total lung capacity, vital capacity, and forced expiratory volume in the first second of expiration, with increases in functional residual capacity and residual volume.[3] Alveolar surface area decreases from 70 m^2 at age 20 to approximately 60 m^2 at age 70, for a reduced gas exchange area leading to a decline in Pa_{O_2} of 0.3 mm Hg/y after age 30.[17] There are no changes in the Pa_{CO_2} with age, however.[18]

The physiologic response to hypoxia decreases by 50% and hypercapnia by 40%, making the geriatric patient less able to respond to changes.[7] With the decrement in elastic recoil, there is subsequent airway narrowing and collapse, which may lead to ventilation-perfusion mismatch. These physiologic changes result in higher rates of mechanical ventilation and longer ventilation needs in the geriatric patient population.[3] Additionally, they are at risk for higher rates of ventilator-associated pneumonia and failure to wean from the ventilator. Noninvasive ventilation should be considered to avoid intubation when possible.

Renal Changes

The kidneys decrease in size up to 30% and blood flow up to 50% by age 80. By age 85%, 40% of the nephrons become sclerotic, while the remaining nephrons hypertrophy to compensate. This loss of physiologic reserve places geriatric patients at high risk of acute renal failure from even minor perfusion changes. Diminished renal function leads to an inability to concentrate urine, conserve sodium, and excrete hydrogen, making the geriatric patient susceptible to dehydration and sodium and acid-base imbalances. Clinicians should be cautious because a loss of up to 50% of a functioning glomerular filtration rate (GFR) may not be reflected in the creatinine because patients' lean body mass also decreases over this time period.[6,7,12]

AGE IS JUST A NUMBER: BEYOND CHRONOLOGIC AGE

The common adage, "age is just a number," often is incorporated into documentation when it is stated that a patient "appears younger (or older) than stated age." There are more scientific approaches to classifying geriatric patients, however. As with pediatrics, there are phases in geriatrics, including the young-old, middle-old, and oldest-old. The young-old typically represents patients 65 to 75 years old, the middle-old 75 to 85 years old, and the oldest-old greater than or equal to 85 years old.[8,19] Geriatric patients often progress from being healthy independent individuals in the first category to progressive dependence on others for performing their instrumental activities of daily living (IADLs), which include operating a phone, shopping, food preparation, housekeeping, and laundry, and for help with activities of daily living (ADLs), including bathing, dressing, toileting, transfers, and feeding. Although these stages help frame thinking of the geriatric patients, not all patients age at the same rate. Physiologic changes vary between individuals due to genetics, lifestyle, and environment, and a patient's physiologic age may not align with chronologic age.[7,8]

Although the mortality of the geriatric patient is higher than that of the younger population, age alone does not predict mortality from critical illness.[3,4,20] Severity

of presenting illness, admission from a chronic care facility, comorbid illness, prior health, and functional status have shown to correlate more strongly with mortality. Patients 65 to 84 years old have on average 2.6 ± 2.2 comorbid conditions, and those greater than 85 years old have 3.6 ± 2.3 comorbid conditions.[1] Comorbid conditions associated with worse outcomes include degenerative brain disease, cerebrovascular disease, congestive heart failure, chronic pulmonary disease, diabetes mellitus, and malnutrition.[20] Mechanical ventilation and longer ICU stays also are associated with higher mortality in the geriatric patient.[4,21] In cases of out-of-hospital cardiac arrest, time to cardiopulmonary resuscitation and clinical characteristics, including a shockable rhythm, a lactate less than 5 mg/dL, and a lower cumulative dose of epinephrine, correlate with mortality and neurologic outcomes better than age does.[9]

Frailty

More important than chronologic age is the concept of frailty, a syndrome of reduced physical, physiologic, and cognitive reserve. Frailty is characterized by decreased mobility, muscle mass, weakness, poor nutritional status, and diminished cognitive function, making individuals more susceptible to extrinsic stressors. Frailty and comorbid conditions are more common in the geriatric population, but advanced age is not synonymous with either frailty or comorbidity. Frail geriatric patients account for 25% of the population over the age of 65% and 50% over the age of 85.[22–24] Frailty has been linked to increases in both in-hospital and long-term mortality. More meaningful to the geriatric population, however, is that frailty has been linked to a reduced chance of returning home, functional disability, and decreased quality of life.[25–27] There are multiple validated screening tools to quantify frailty; however, many are cumbersome and too complex to complete in ED setting, with up to 30 to 70 items assessed.[25,26,28] One well-studied, simple tool is the Clinical Frailty Scale, which is a 9-level assessment, with levels 1 to 4 being nonfrail, 5 to 6 mildly to moderately frail, and greater than or equal to 7 severely frail (**Table 2**).[24,29,30] This scale has been proved to be reliably performed by emergency clinicians.[31] Increases in the Clinical Frailty Scale are associated with higher mortality.[1,24] The identification of frailty and its impact may help guide emergency clinicians in management decisions or discussions of goals of care in the critically ill.

DANGER DRUGS: CRITICAL CARE PHARMACOLOGY IN THE GERIATRIC PATIENT

The critically ill geriatric patient is at an increased risk of adverse drug reactions,[32,33] due to changes in physiology, metabolism, and polypharmacy. Diminished first-pass effect and decreased gastric motility may increase the availability in the systemic circulation, but this may be offset some by the decreased absorption of the geriatric gastrointestinal system. The geriatric patient has an increased proportion of body fat content of 15% to 30% and decreases in total body water of 12% to 15%, affecting volume of distribution.[34] For lipophilic drugs, there is an increased volume of distribution with a prolonged half-life, whereas water-soluble drugs have a decreased volume of distribution. Protein bound drugs, like warfarin, phenytoin, and digoxin, may have a reduced binding capacity in elderly patients with higher concentration of unbound (active) drug[2] (**Table 3**).

Drug excretion also is altered in the geriatric patient. Due to the physiologic decline in GFR in the geriatric population, there is a decrease in renal excretion of drugs. The hepatic clearance of drugs is slowed but the clinical significance in the geriatric population is unknown.[3]

Table 2
Clinical Frailty Scale

Level	Description
1. Very fit	Robust, active, energetic, well-motivated, fit; exercise regularly; fittest for their age
2. Well	No active disease symptoms, less fit than group 1; active occasionally (eg seasonally)
3. Managing well	Medical problems are well controlled; no regular activity beyond routine walking
4. Apparently vulnerable	Not frankly dependent, disease symptoms limit activity; commonly complain of feeling "slow" or being tired during the day
5. Mildly frail	More evident slowing; limited dependence on high-order IADLs (finances, transportation, heavy housework, and medications)
6. Moderately frail	Need help in in both IADLs and ADLs, such as all outside activities and keeping house; often have problems with stairs and need help with bathing
7. Severely frail	Completely dependent on others for ADLs; stable and not at risk of dying (<6 mo)
8. Very severely frail	Completely dependent; approaching end of life; could not recover from minor illness
9. Terminally ill	Life expectancy <6 mo who otherwise are not evidently frail

Data from Rockwood K, Song X, Macknight C, et al. A global clinical measure of fitness and frailty in elderly people. CMAJ. 2005;173(5):489-95 and Juma S, Taabazuing MM, Montero-odasso M. Clinical Frailty Scale in an Acute Medicine Unit: a Simple Tool That Predicts Length of Stay. Can Geriatr J. 2016;19(2):34-9.

Polypharmacy is associated with adverse outcomes and should be avoided. In the critical care setting, this may be impossible, but efforts should be made to minimize the number of medications a geriatric patient receives.[7]

Drugs and Delirium: A Doubly Dangerous Combination

Delirium is an acute-onset disorder characterized by fluctuations of attention and global cognitive function.[35] Delirium is nearly ubiquitous in the geriatric critical care population, with rates greater than or equal to 70%,[36,37] and serious consequences.

Table 3
Commonly prescribed drugs in the critical care setting[3]

Drug	Route of Elimination	Volume of Distribution	Half-Life	Dose Adjustment
Midazolam	Hepatic (CYP3a)	Unchanged	Increased	Decrease
Lorazepam	Hepatic	Decreased	Unchanged	Decrease
Diazepam	Hepatic (CYP3a)	Increased	Increased	Decrease
Digoxin	Renal	Decreased	Increased	Decrease
Furosemide	Hepatic, Renal	Decreased	Increased	Decrease
Propofol	Renal	Decreased	Increased	Decrease
Morphine	Renal	Decreased	Increased	Decrease

Delirium may result in inadvertent removal of life-support devices, requirement of physical restraints, and prolonged mechanical ventilation. Delirium has been linked to increased morbidity, mortality, ICU length of stay, and hospital length of stay, and, specific to the geriatric population, loss of cognitive function, nursing home placement, and loss of independence.[4,35,38,39]

Drugs associated with delirium are digoxin, antihistamines, opiates, antiparkinsonian medications, antipsychotics, antidepressants, and sedative or analgesic medications, especially benzodiazepines.[7,9,40] To treat the symptoms of delirium, pharmacologic agents like antipsychotics, such as haloperidol or olanzapine, can be considered.[7] Because antipsychotics treat only the symptoms of delirium and not delirium itself, their use should be limited and discontinued as soon as possible. Antipsychotics have been linked to long-term mortality and are discouraged by the American Geriatrics Society.[1,9] Benzodiazepines should be avoided in the geriatric patient population at all costs, because their use has been associated with increased delirium.[1,9]

DO NOT RESUSCITATE/DO NOT INTUBATE DOES NOT MEAN DO NOT PROVIDE CRITICAL CARE: ESTABLISHING GOALS OF CARE AND TRIAGING CRITICAL CARE INTERVENTIONS

Many geriatric patients have set limits to their care. These limits may have clear definitions like “do not resuscitate” whereas others may be more nebulous and individualized. Even though patients may have limitations to their treatment plans, that does not exclude them the benefit of critical care interventions.

In all geriatric patients presenting with critical illness, clearly establishing goals of care is important. This often can be a challenge while resuscitating an acutely ill geriatric patient because time and information are limited. Often geriatric patients have advanced directives in place, which can guide the emergency clinician; these wishes should be confirmed with the patient or surrogate. if possible. When no advanced directives are available, patients should be asked directly about their wishes. When patients are unable to speak for themselves, a surrogate must be sought. This may require a phone call to a patient’s home, facility, or next of kin. When none of these is available, the emergency clinician should default to resuscitation.[14]

There is a great degree of uncertainty with critical care, even more so with the geriatric patient. Often, it is uncertain if a patient would benefit from critical care interventions, and patients may be unsure about their goals of care or the options for critical care support. For those who cannot express their wishes, surrogates may not truly understand a patient’s preferences or may not be able to consider how acute changes in clinical prognosis would alter the patient’s beliefs.

With so much uncertainty around prognosis, clinicians are challenged with triaging who would benefit from critical care. In 1 series, only 30% to 50% of all geriatric patients with definitive need for ICU admission (abnormal vital signs or high-intensity condition or diagnoses) were admitted to the ICU.[3] There often is a high refusal rate of admission to the ICU for the elderly, up to 73% for patients greater than or equal to 80 years old, critical care providers citing either being too well (28%) or too sick (44%) to benefit from ICU admission.[41] The population of “too sick” patients, however, had a mortality less than 100%, and those “too well” patients a mortality greater than 0%, representing a potential underutilization of critical care admission.[41] Life-sustaining therapies often are denied to the geriatric population, with less likelihood of having renal replacement, vasopressors, tube feeding, major surgical interventions, and mechanical interventions.[21]

Although geriatric patients are more likely to place limitations on care, poor physician-patient communications often underestimate the geriatric patient's desire for aggressiveness of care and pursuit of life-sustaining interventions.[1,27,42] Chronologic age should not be used to discriminate against patients who potentially may benefit from critical interventions. Factors shown to better predict outcomes, including frailty, physiologic reserve, comorbid illnesses, severity of illness, and premorbid functional status, should be considered, along with the patient's goals of care and treatment limitations.[7,21] Decisions to withhold critical care interventions should be based on a patient's values and the those predictors, not based on age alone.

For geriatric patients with an unclear benefit of resuscitation or an unsure surrogate, a "trial of ICU" may be offered. A trial of ICU is a time-limited trial with pursuit of specified ICU interventions and a specified goal of recovery. If a patient deteriorates over this time period, the patient should be transitioned to comfort measures, and, if the patient improves, directed therapy should continue. If uncertainty remains after the trial of ICU, another trial may be initiated. This trial must have a predefined period of care, after which clinicians and the family re-evaluate the clinical situation. There are no strict guidelines on how long this time period should be, but many recommend at least 24 hours to 72 hours, up to 10 days to 12 days for patients with lower rates of organ failure. Worsening clinical status within 3 days to 5 days of initiating a trial of ICU, however, can serve as a reliable endpoint. The directed therapies and limitations of care should be agreed on. The clinician care team should guide the recommendations to ensure they are internally consistent with the stated goals.[27,43]

FATE FAR WORSE THAN DEATH: NAVIGATING END-OF-LIFE AND GOALS-OF-CARE DISCUSSIONS

The mortality of the critically ill geriatric patient is high; 30% of older adults are admitted to the ICU in the last 30 days of their life,[27] and 14% of patients greater than 85 years old die during the ICU admission.[21] Many patients are admitted to the ICU in the terminal portion of their illness, and more than 40% of these patients die in the ICU, accounting for 25% of Medicare expenditures.[7]

Although many studies focus on mortality outcomes, most geriatric patients have an understanding of the inevitability of death, and mortality may not be the most important outcome for them. Many focus on the quality of life remaining, valuing maintaining function and returning to their previous functional state.[44,45] Many geriatric patients rate conditions like ventilator dependence and bowel or bladder incontinence worse than death. The geriatric patient may be uninterested in care if the result is an unacceptable quality of life.[27]

Geriatric survivors of sepsis have a 50% risk of developing a new or worsening disability and only 25% of patients greater than 80 years old ever return to their prefunctional status after ICU admission.[27] Hospitalized geriatric patients who required mechanical ventilation had worse disability scores compared with those who were not hospitalized, with a greater decline in functioning in the year after hospitalization. ICU admission in the elderly is associated with 2.3 times the risk of developing dementia. At 12 months after a critical illness, 25% of geriatric patients had cognitive impairment similar to Alzheimer disease and a third were impaired to the level of a moderate traumatic brain injury.[46] Although patients may survive their acute critical illness, they may go on to develop chronic critical illness, with prolonged organ failures and mechanical ventilation dependence.[4] In patients with acute respiratory failure, age is associated with longer duration of mechanical ventilation and ICU length of stay. Patients greater than or equal to 80 years old are more likely to be discharged to a long-

term care facility than are younger cohorts, and those discharged to a long-term facility had a higher long-term mortality[7,21]; 20% of all patients admitted to a longer-term care facility require readmission to the hospital within 30 days, decreasing their chances of ever returning home.[27] To a geriatric patient who values independence and quality of life, chronic dependence on mechanical support without hope of return to previous function can be a fate worse than death.

Clinicians should have frank conversations with geriatric patients and their families about their goals of care and prognosis. Discussions should occur with every geriatric patient, ideally before a patient needs resuscitation, to ensure provision of care respectful of the patient's values and goals. These conversations should consider the patient's premorbid functional status, frailty, severity of illness, and expected prognosis. It is crucial to inform patients and their loved ones of poor expected outcomes so they may make informed decisions about their goals of care.

PHONE A FRIEND: ROLES OF GERIATRICS AND PALLIATIVE CARE CONSULTATION

Both geriatrics and palliative care medicine have important roles in the care of the critically ill geriatric patients. Clinicians may specialize in either or both specialties.

Geriatricians provide a specialized approach to geriatric patients and their unique challenges, focusing on prevention of functional decline and restoration of independent functioning in acutely ill patients. They provide a complete approach to the geriatric patient's care, integrating social work, dietitians, and physical and occupational therapists. They address issues, such as polypharmacy, delirium, dementia, failure to thrive, elder abuse/neglect, malnutrition, and depression.[4] Geriatricians have been shown improve outcomes, including delirium treatment and discharge to home.[47]

Palliative care medicine follows the principles of improving quality of life for patients with serious illness through pain and symptom management, providing psychosocial support and facilitating conversation about patients' preferences and complex medical decision making. Despite these benefits, palliative care consults are underutilized and often initiated late in the clinical course. This likely is due to the misconception that consulting palliative care is inconsistent with continued medical care or is the same as hospice care. Palliative care consultation has shown improvements with increased advanced directives, decreases in nonbeneficial ICU treatments, and reductions in ICU length of stay and ICU readmissions.[4]

SUMMARY

The geriatric population is the largest growing age group, accounting for more than 13% of the population, with an expected increase to 70 million, or 16% to 25% of the population, by 2050. The oldest-old group ($\geq$85 years) is the fastest growing, with an expected climb from 1% to 5% of the population by 2050 (1 in 20 Americans). The geriatric population has a loss of physiologic reserve due to the aging process, making them vulnerable to stressors, such as infection and injury. All organ systems undergo significant changes in the aging process, and understanding these changes is imperative for emergency clinicians who are resuscitating geriatric patients. Although age correlates with frailty and comorbidities, frailty is a more important marker of outcomes than age alone. Clinicians should discuss goals of care with all geriatric patients but should not assume that patients will not benefit from critical care interventions. When the goals are in flux, a clearly defined trial of critical care may be in order. Both geriatricians and palliative care clinicians can be invaluable in assisting in the care of older patients.

REFERENCES

1. Guidet B, Vallet H, Boddaert J, et al. Caring for the critically ill patients over 80: a narrative review. Ann Intensive Care 2018;8(1):114.
2. Pisani MA. Considerations in caring for the critically ill older patient. J Intensive Care Med 2009;24(2):83–95.
3. Nagappan R, Parkin G. Geriatric critical care. Crit Care Clin 2003;19(2):253–70.
4. Hazzard WR. Principles of geriatric medicine and gerontology. New York: McGraw-Hill; 2003.
5. Angus DC, Kelley MA, Schmitz RJ, et al. Caring for the critically ill patient. Current and projected workforce requirements for care of the critically ill and patients with pulmonary disease: can we meet the requirements of an aging population? JAMA 2000;284:2762–70.
6. Menaker J, Scalea TM. Geriatric care in the surgical intensive care unit. Crit Care Med 2010;28(9):S452–9.
7. Marik PE. Management of the critically ill geriatric patient. Crit Care Med 2006; 34(9):s176–82.
8. Walker M, Spivak M, Sebastian M. The impact of aging physiology in critical care. Crit Care Nurs Clin North Am 2014;26(1):7–14.
9. Joyce MF, Reich JA. Critical care issues of the geriatric patient. Anesthesiol Clin 2015;33(3):551–61.
10. The GUSTO investigators. An international randomized trial comparing four thrombolytic strategies for acute myocardial infarction. N Engl J Med 1993;329: 673–82.
11. The International Study Group. In-hospital mortality and clinical course of 20 891 patients with suspected acute myocardial infarction Older ICU Patients/randomised between alteplase and streptokinase with or without heparin. Lancet 1990;336:71–5.
12. Boss GR, Seegmiller JE. Age-related physiological changes and their clinical significance. West J Med 1981;135(6):434–40.
13. Crispell KA. Common cardiovascular issues encountered in geriatric critical care. Crit Care Clin 2003;19:677–91.
14. Perera T, Cortijo-brown A. Geriatric Resuscitation. Emerg Med Clin North Am 2016;34(3):453–67.
15. Anthonisen NR. Tests of mechanical function. Bethesda (MD): American Physiologic Society; 1986.
16. Chen HI, Kuo CS. Relationship between respiratory muscle function and age, sex, and other factors. J Appl Physiol (1985) 1989;66:943–8.
17. Brandstetter RD, Kazemi H. Aging and the respiratory system. Med Clin North Am 1983;67:419–31.
18. Sorbini CA, Grassi V, Solinas E, et al. Arterial oxygen tension in relation to age in healthy subjects. Respiration 1968;25:3–13.
19. Aronson L. Elderhood, redefining aging, transforming medicine, reimagining life. New York: Bloomsbury Publishing; 2019.
20. Chelluri L, Pinsky MR, Donahoe MP, et al. Long-term outcome of critically ill elderly patients requiring intensive care. JAMA 1993;269(24):3119–23.
21. Bagshaw SM, Webb SA, Delaney A, et al. Very old patients admitted to intensive care in Australia and New Zealand: a multi-centre cohort analysis. Crit Care 2009; 13(2):R45.
22. Clegg A, Young J, Iliffe S, Rikkert MO, Rockwood K. Frailty in elderly people. Lancet 2013;381(9868):752–62.

23. Hoover M, Rotermann M, Sanmartin C, et al. Validation of an index to estimate the prevalence of frailty among community-dwelling seniors. Health Rep 2013; 24(9):10–7.
24. Rockwood K, Song X, Macknight C, et al. A global clinical measure of fitness and frailty in elderly people. CMAJ 2005;173(5):489–95.
25. Darvall JN, Gregorevic KJ, Story DA, et al. Frailty indexes in perioperative and critical care: A systematic review. Arch Gerontol Geriatr 2018;79:88–96.
26. Muscedere J, Waters B, Varambally A, et al. The impact of frailty on intensive care unit outcomes: a systematic review and meta-analysis. Intensive Care Med 2017; 43(8):1105–22.
27. Mittel A, Hua M. Supporting the geriatric critical care patient: decision making, understanding outcomes, and the role of palliative care. Anesthesiol Clin 2019; 37(3):537–46.
28. De vries NM, Staal JB, Van ravensberg CD, et al. Outcome instruments to measure frailty: a systematic review. Ageing Res Rev 2011;10(1):104–14.
29. Juma S, Taabazuing MM, Montero-odasso M. Clinical frailty scale in an acute medicine unit: a simple tool that predicts length of stay. Can Geriatr J 2016; 19(2):34–9.
30. Islam A, Muir-Hunter S, Speechley M, et al. Facilitating frailty identification: comparison of two methods among community-dwelling older adults. J Frailty Aging 2014;3(4):216–21.
31. Ringer T, Thompson C, Mcleod S, et al. Inter-rater agreement between self-rated and staff-rated clinical frailty scale scores in older emergency department patients: a prospective observational study. Acad Emerg Med 2019;27(5):419–22.
32. Lazarou J, Pomeranz BH, Corey PN. Incidence of adverse drug reactions in hospitalized patients: a meta-analysis of prospective studies. JAMA 1998;279: 1200–5.
33. Onder G, Pedone C, Landi F, et al. Adverse drug reactions as cause of hospital admissions: results from the Italian Group of Pharmacoepidemiology in the Elderly (GIFA). J Am Geriatr Soc 2002;50:1962–8.
34. Shock NW, Watkin DM, Yiengst MJ, et al. Age differences in the water content of the body as related to basal oxygen consumption in males. J Gerontol 1963; 18:1–8.
35. Inouye SK. Delirium in older persons. N Engl J Med 2006;354:1157–65.
36. McNicoll L, Pisani MA, Zhang Y, et al. Delirium in the intensive care unit: occurrence and clinical course in older patients. J Am Geriatr Soc 2003;51:591–8.
37. Pisani MA, Murphy TE, Van Ness PH, et al. Characteristics associated with delirium in older patients in a medical intensive care unit. Arch Intern Med 2007;167:1629–34.
38. Ely EW, Gautam S, Margolin R, et al. The impact of delirium in the intensive care unit on hospital length of stay. Intensive Care Med 2001;27:1892–900.
39. Milbrandt EB, Deppen S, Harrison PL, et al. Costs associated with delirium in mechanically ventilated patients. Crit Care Med 2004;32:955–62.
40. Dubois MJ, Bergeron N, Dumont M, et al. Delirium in an intensive care unit: a study of risk factors. Intensive Care Med 2001;27:1297–304.
41. Garrouste-orgeas M, Timsit JF, Montuclard L, et al. Decision-making process, outcome, and 1-year quality of life of octogenarians referred for intensive care unit admission. Intensive Care Med 2006;32(7):1045–51.
42. Fowler RA, Sabur N, Li P, et al. Sex-and age-based differences in the delivery and outcomes of critical care. CMAJ 2007;177(12):1513–9.

43. Vink EE, Azoulay E, Caplan A, et al. Time-limited trial of intensive care treatment: an overview of current literature. Intensive Care Med 2018;44(9):1369–77.
44. Cosgriff JA, Pisani M, Bradley EH, et al. The association between treatment preferences and trajectories of care at the end-of-life. J Gen Intern Med 2007;22:1566–71.
45. Fried TR, Bradley EH, Towle VR, et al. Understanding the treatment preferences of seriously ill patients. N Engl J Med 2002;346:1061–6.
46. Pandharipande PP, Girard TD, Jackson JC, et al. Long-term cognitive impairment after critical illness. N Engl J Med 2013;369:1306–16.
47. Brooks SE, Peetz AB. Evidence-based care of geriatric trauma patients. Surg Clin North Am 2017;97(5):1157–74.