Understanding and Reducing Disability in Older Adults Following Critical Illness*

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Objective: To review how disability can develop in older adults with critical illness and to explore ways to reduce long-term disability following critical illness.

Data Sources: We searched PubMed, CINAHL, Web of Science and Google Scholar for studies reporting disability outcomes (i.e., activities of daily living, instrumental activities of daily living, and mobility activities) and/or cognitive outcomes among patients treated in an ICU who were 65 years or older. We also reviewed the bibliographies of relevant citations to identify additional citations.

Study Selection: We identified 19 studies evaluating disability outcomes in critically ill patients who were 65 years and older.

Data Extraction: Descriptive epidemiologic data on disability after critical illness.

Data Synthesis: Newly acquired disability in activities of daily living, instrumental activities of daily living, and mobility activities was commonplace among older adults who survived a critical illness. Incident dementia and less severe cognitive impairment were also highly prevalent. Factors related to the acute critical illness, ICU practices, such as heavy sedation, physical restraints, and immobility, as well as aging physiology, and coexisting geriatric conditions can combine to result in these poor outcomes.

Conclusions: Older adults who survive critical illness have physical and cognitive declines resulting in disability at greater rates than hospitalized, noncritically ill and community dwelling older adults. Interventions derived from widely available geriatric care models in use outside of the ICU, which address modifiable risk factors including immobility and delirium, are associated with improved functional and cognitive outcomes and can be used to complement ICU-focused models such as the ABCDEs. (*Crit Care Med* 2015; 43:1265–1275)

Key Words: aging; critical illness; dementia; disability; elderly; older adults; outcomes; survivorship

For millions each year, surviving a critical illness represents a life-altering event punctuated by physical and cognitive impairments resulting in new-onset disability (1–8). Patients of all ages are affected (8–10). Older adults (i.e., those 65 years or older), however, bear the lion's share of this burden as the demographic most likely to become critically ill (11–14). Moreover, because the majority of patients with critical illness are older adults, the aging of the population in coming years is expected to drive a significant increase in the number of critical illness survivors with physical impairments, cognitive impairments, and disabilities (5, 7, 14, 15).

Regardless of age, critical illness survival implies resolution of the underlying illness, yet age may play an important role. In the case of respiratory failure, for example, older adults achieve physiologic recovery from their illness at least as fast as their younger counterparts (16, 17). After adjusting for potential confounders such as severity of illness, however, older adults are more likely to remain intubated and in the ICU (17). These data imply that ongoing and destructive processes—apart from those that resulted in the development of critical illness—may be responsible for poor physical and cognitive outcomes experienced by many older adults.

Critical illness survival also exists on a spectrum ranging from those who are free of disability to those who are severely disabled, a number of whom are "chronically critically ill" or "hospital dependent" (18–21). Why some patients "successfully" recover from critical illness, whereas others do not is unknown. Thus, a better understanding of the contributions to poor long-term physical and cognitive functioning that results in disability is needed to improve the lives of the growing number of older adults who survive a critical illness each year.

The disabling process results from the complex interrelationship between a patient's preillness vulnerability and the acute stress of a critical illness and treatment in an ICU (22). In older adults, the normal aging process, also known as senescence, in combination with systemic pathology from comorbid medical conditions, injuries, environmental, and epigenetic factors can reduce physiologic reserves and the ability to "bounce back" from an acute stressor (23–25). Thus, a highly vulnerable patient (e.g., one who is frail or physically or cognitively impaired before their illness) may develop disability following a less severe illness (e.g., urinary tract infection). Alternatively, a more robust patient who is less vulnerable will require a greater insult (e.g., septic shock with multiple organ failures) before developing disability.

This article, written by an interdisciplinary team of experts in critical care, geriatrics and gerontology, presents an integrative literature review of the epidemiology of disability in survivors of a critical illness; reviews how critical illness, in the setting of the physiology of aging, can result in disability following a critical illness; and, finally, presents expert opinion on steps that can be taken to make the ICU a more "friendly" place for older adults, with the ultimate goal of reducing the component of post-ICU suffering that is long-term disability.

THE DEVELOPMENT OF POSTCRITICAL ILLNESS DISABILITY

Optimizing long-term outcomes for survivors of critical illness must begin with a discussion of the disabling process in the setting of critical illness. This understanding will allow researchers and clinicians to communicate using the same terminology, to gain insights into how diseases and treatments may affect outcomes, to define better outcomes of importance to patients, and, eventually, to enhance clinical care.

Although different conceptual models exist to describe the disabling process, the framework originally proposed by Nagi (26), modified by Verbrugge and Jette (27), provides a robust, informative way to understand how critical illness may lead to disability. According to this model, diseases or injuries (*pathology*) result in dysfunction of body systems (*impairments*) leading to the inability to perform basic physical and cognitive functions (*functional limitations*) that alter the individual's capability to meet the demands of his or her environment (*disability*) (**Fig. 1**). Hence, disability, simply defined, represents the difference between a person's capabilities and the demands of a particular physical or social environment (27, 28).

To illustrate this process, let us explore a hypothetical case of Mrs. D, a 67-year-old widow who, prior to her illness, lived independently and was employed as an executive secretary (Fig. 1). She developed pneumococcal pneumonia and severe sepsis (*pathology*) and was mechanically ventilated in the ICU for 7 days. She was sedated and confined to bed for the first 5 days of her illness and suffered 6 days of delirium while in the ICU (*pathology*). Following extubation, the ICU physical therapist notes that Mrs. D has significant muscle atrophy and weakness that is attributed to ICU-acquired weakness (*impairment*). With her delirium now resolved, Mrs. D's daughter expresses concerns that her mother is having

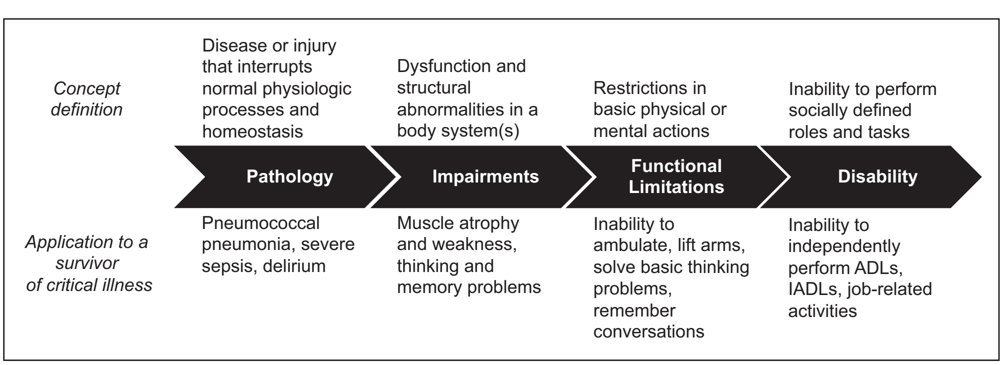

Figure 1. A conceptual model of the disablement process and its application to a survivor of a critical illness. This framework illustrates how diseases (pathology) result in body system dysfunction (impairments) that limits an individual's ability to perform basic actions (functional limitations) and prevent that individual from performing socially expected activities (disability). When applied to a hypothetical survivor of critical illness, the effects of critical illness alter the functioning of skeletal muscle and the brain to result in the inability to move one's arms and legs, as well as to remember and think clearly, preventing the patient from carrying out activities necessary to live independently such as basic activities of daily living (ADLs; dressing, bathing, walking across a room), instrumental ADLs (IADLs; managing money, cooking a meal), or to remain used. Adapted with permission from Verbrugge and Jette (1). Adaptations are themselves works protected by copyright. So in order to publish this adaptation, authorization must be obtained both from the owner of the copyright in the original work and from the owner of copyright in the translation or adaptation.

trouble thinking and remembering things (*impairment*). She notes that Mrs. D was "sharp as a tack" prior to her illness. After being transferred out of the ICU, Mrs. D continues to require assistance to ambulate and to lift her arms (*functional limitation*). She complains that she cannot complete crossword puzzles that she did easily before her illness and that she cannot recall the details of conversations with her family (*functional limitation*). As discharge planning progresses, Mrs. D's daughter is nervous that her mother will be unable to manage her medications and her finances (*disability in instrumental activities of daily living* [IADLs]). She continues to require assistance to bathe, dress, and transfer from the bed to a chair (*disability in basic activities of daily living* [ADLs]). As a result of these newly acquired disabilities, Mrs. D is discharged to a skilled nursing facility, where she still resides 1 year later. She is unable to return to work *(disability in employment*).

EPIDEMIOLOGY OF DISABILITY FOLLOWING CRITICAL ILLNESS

The declines in Mrs. D's physical and cognitive functioning represent a common scenario for the estimated 1.4 million older adults in the United States (and many more worldwide) who survive a critical illness each year (6). We searched PubMed, CINAHL, Web of Science, and Google Scholar for studies reporting disability outcomes (i.e., ADLs, instrumental ADL [IADLs], and mobility activities) and/or cognitive outcomes among patients treated in an ICU who were 65 years or older. We also reviewed the bibliographies of relevant citations to identify additional citations. Overall, 19 studies met these criteria (2, 3, 29–45): 17 studies reported disability outcomes (2, 29–38, 40–42, 44), two studies reported cognitive outcomes (3, 45), and two studies reported both (39, 43).

Of the studies that reported disability outcomes (**Table S1**, Supplemental Digital Content 1, http://links.lww.com/CCM/B223), 13 were single-center cohorts and 12 enrolled fewer than 300 patients. Patients were enrolled from mixed (medical and surgical) ICUs in 11 studies, from medical ICUs in four studies, and from surgical ICUs in two studies. The mean age of patients enrolled in the studies ranged from 69 to 89 years. Most (10 of 14) of the studies that assessed ADL function used the Katz ADL (46), two studies used the Barthel Index (47), and two other studies used other measures. All four studies that assessed IADLs used the Lawton Index (48). Of the three studies that assessed mobility status (2, 35, 44), each used different scoring measures (35, 49, 50). Most studies assessed outcomes less than 12 months following critical illness.

Disability in ADLs was highly prevalent after a critical illness and was present in 33% to 58% of patients when follow-up occurred less than 3 months after the index illness and 12% to 97% for follow-up time points occurring more than 6 months after the index illness. Among the nine studies that reported baseline (preillness) ADL function, new-onset or worsened ADL disability was present in 10% to 63% of patients assessed less than 1 year after their critical illness and in 22% to 37% of patients assessed at 1 year or later (29, 31, 34–37, 40–43). New or worsened IADL disability was also common and reported in 22% to 45% of patients evaluated 3 months to 2 years following the index illness (34, 38, 43). A single study where a number of patients were disabled in ADLs and IADLs at baseline (43% and 60%, respectively) reported no change in disability at 3-month follow-up (42). Finally, disability in mobility activities (i.e., moving around one's home, walking half a mile, walking up and down stairs) was present in 14% to 87% of patients assessed during the first year following their index illness.

Of the four studies that assessed cognitive outcomes, two were single-center cohorts. Each study used a different outcome measure and assessed cognition at time points ranging from 3 months to 8 years following the index illness (Table S2, Supplemental Digital Content 1, http://links.lww.com/CCM/B223) (3, 39, 43, 45). Three of four studies assessed preillness cognitive functioning and reported newly developed (i.e., incident) dementia in 12% to 18% of patients who were assessed between 1 and 8 years after their illness (3, 39, 45). Prevalent dementia (i.e., preillness dementia status was unknown) was reported in 15% of patients at hospital discharge and in 10% at 1-year follow-up (43). In addition to the prevalence of dementia, one study also reported newly acquired mild to moderate cognitive impairment was present in 56% of patients, yielding an overall proportion of cognitive impairment plus dementia of 73% of patients 4 years after critical illness (39).

The findings of this review indicate that disability in ADLs, IADLs, and mobility is common among older adults who survive a critical illness. They also highlight the substantial burden of newly acquired cognitive impairment and dementia following critical illness. Nevertheless, several limitations of these studies are worthy of mention. First, few studies have reported data on these important patient-centered outcomes after critical illness. Second, the majority of these studies are small, single-center cohorts that used heterogeneous assessment methods with follow-up time points that varied widely. Third, although some studies reported data on patients' preillness disability, physical, and/or cognitive functioning, the majority did not. Thus, the lack of information on the trajectories of preillness disability and cognitive functioning may bias the results and the true effect of critical illness on these outcomes remains unclear (51). Nevertheless, the rates of postcritical illness disability reported in these studies are substantially higher than community dwelling persons (52–54) and older adults who are hospitalized without critical illness (55, 56). Finally, because disability and dementia are associated with mortality in older adults, the results of these studies likely underestimate the true burdens of these conditions following critical illness due to the large number of patients who were not included in follow-up assessments due to the competing risk of death.

INTERSECTIONS OF AGING PHYSIOLOGY AND CRITICAL ILLNESS

Some older adults who carry a low-burden of aging-related disease and disability remain highly functional, and can be thought of as aging "successfully" (57, 58). For the vast majority, however, "normal" aging is characterized by a progressive accumulation of molecular and cellular damage due to illness, injury, environmental, and epigenetic factors that lead to physiologic impairments of organ systems and an increased risk of disease, disability, and death (23, 24). The rate of this decline of organ systems is controlled by homeostatic maintenance and repair mechanisms (23). Over time, maintenance and repair functions lose complexity, and maladaptive stress responses alter the body's ability to maintain homeostasis. The degree to which these functions are altered varies from person to person and from organ system to organ system and may explain, in part, variations in the speed of aging (23). Accelerated decline of homeostatic mechanisms, which often characterizes the geriatric condition known as frailty, is present in up to one third of all older adults and leads to a state of increased vulnerability and disproportionate changes in functional and cognitive status following an acute stressor, such as critical illness (59–64).

Although aging-related alterations to homeostatic mechanisms occur in nearly all organ systems, in the context of critical illness, changes to the structure and function of skeletal muscle and/or the brain place older patients at increased risk of developing newly acquired and/or worsened disability. The effects of critical illness on other organ systems, such as the aging cardiovascular, pulmonary, and renal systems, have been described elsewhere (65–67).

Aging Skeletal Muscles in Critical Illness

Roughly half of persons who are 65 years or older have clinically significant diminished skeletal muscle mass and strength due to age-related changes known as sarcopenia (68). The causes of sarcopenia are multifactorial and include disuse atrophy, changes in endocrine function, inflammation, and nutritional deficiencies (68, 69). Sarcopenia is characterized by a decrease in the size, number, and composition of muscle fibers, remodeling of motor units, increased intramuscular lipid concentration, inflammation, oxidative stress, and loss of anabolic stimuli (70, 71). The end result of sarcopenia is reduced muscle power and strength, progressive weakness, fatigue, slow gait speeds, and difficulty ambulating long distances (68, 70, 72). Sarcopenia is associated with a variety of poor clinical outcomes including increased length of hospital stay, hospital readmission, and death (73–76).

During critical illness, inflammation alters the atrophy-hypertrophy-signaling pathways within skeletal muscle, resulting in acute muscle wasting in the first few days of illness, particularly among those with multiple organ failures (77–79). This imbalance between muscle breakdown and recovery represents an additional degenerative insult that cannot be appropriately countered in aging muscle and may, in part, explain the higher prevalence of ICU-acquired weakness among older patients (78, 80).

Immobility, even among patients who were ambulatory prior to their illness, is common during hospitalization (81–83). For patients of all ages, bed rest results in losses in muscle mass, strength, and aerobic capacity (84); yet, these losses are accelerated by roughly a factor of three among older adults (85). In noncritically ill older patients, even short periods (e.g., 1–2 d) of reduced activity or bed rest can result in disability and nursing home admission (86, 87).

Thus, the skeletal muscles of older adults in the ICU face the concurrent insults of inflammation and bed rest, which are intensified by both the severity and the duration of the underlying critical illness. The end result is muscle atrophy, weakness, and diminished aerobic capacity, contributing to the inability to perform basic self-care activities (i.e., disability) following critical illness.

The Aging Brain in Critical Illness

Aging results in a variable trajectory of declines in cognitive abilities, particularly in working memory, short-term memory, and processing speed (88–90). In the aging brain, oxidative stress, epigenetic factors, diminished autophagy, decreased insulin/insulin-like growth factor-1 signaling, impaired stress responses and clearance of toxic proteins in combination alter hormonal and immunologic feedback mechanisms (89, 91–95). Loss of these feedback mechanisms can result in exuberant inflammatory responses to acute stress, resulting in neurodegeneration, which then drives additional inflammation. Thus, the aging brain can be caught in a vicious cycle that, over time, results in neuronal loss and clinically significant cognitive decline.

The acute stress of critical illness and age-related changes to the brain makes critically ill older adults particularly susceptible to developing delirium (96). Delirium results from the complex interaction of a patient's underlying vulnerability, neurotransmitter imbalances, inflammatory responses, oxidative stress, physiologic stressors, and metabolic derangements that result in the large-scale disruption of neural networks, resulting in fluctuating acute confusion, altered consciousness, inattention, and disorganized thinking (96–100).

In some cases, delirium may resolve without long-term consequences. Nevertheless, evidence now supports an association between delirium and long-term cognitive sequelae, including dementia and accelerated cognitive decline (8, 101–103). In critically ill patients, delirium duration is one of the strongest independent predictors of significant cognitive deficits after critical illness (8, 104). Although the precise mechanisms are unclear, it is hypothesized that delirium, triggered by an acute insult, initiates or exacerbates the pathologic age-related structural, immune, neurochemical, and neurohormonal brain changes, resulting in a cycle of neuroinflammation and neurodegeneration leading to cognitive impairment (95, 105, 106).

REDUCING POSTCRITICAL ILLNESS DISABILITY

Postcritical illness disability results from the interaction of a patient's baseline health status and vulnerability to the acute stress of critical illness with the effects of the acute illness itself and treatment practices during and after the ICU admission (55, 107, 108). Thus, because it is not (yet) possible to prevent aging, to reverse vulnerability in the setting of critical illness which is most often an unplanned event, or to completely avoid critical illness–related organ system impairments, the focus of preventing disabilities should lie with the identification of critically ill patients who are at risk for developing/exacerbating disabilities and in addressing specific iatrogenic contributors to postcritical illness disability.

Identifying High-Risk Older Patients

Outside the ICU, several tools exist to identify patients at risk for posthospital disability (109–112). Although the content of these tools differs slightly, each incorporates the patient's preillness functional and cognitive status, highlighting the important contribution of baseline status to posthospital outcomes. Despite an association with improved survival and ability to reside in their own home following a hospitalization (113), few hospitalized older adults undergo functional and cognitive status assessments during hospitalization (114). This practice is even less common in the ICU, where few clinicians have training in assessment techniques. Additional barriers to functional and cognitive status assessment in critically ill patients include the inability of many patients to communicate directly due to endotracheal tubes, sedation, and/or delirium, as well as time constrains of the busy ICU workflow. These barriers, however, may be overcome using a pragmatic functional and cognitive assessment adapted for the unique needs of critically ill patients (**Table 1**).

Addressing Modifiable Risk Factors for Disability

Two of the most common and modifiable risk factors for subsequent functional and cognitive decline are immobility and

TABLE 1. Pragmatic Functional and Cognitive Assessment for Older Adults With Critical Illness

	Domain Assessed		
	Activities of Daily Living	Mobility	Cognition
As soon as possible after ICU admission (use surrogate to obtain information, as needed)	Katz ADL Index (46)[a]: Is assistance required to 1) Bathe or shower 2) Get dressed 3) Get to the restroom 4) Transfer from bed to chair 5) Control bladder or bowels 6) Eat a meal Consider high risk for postcritical illness disability if requires assistance to complete any ADL	Sit → stand → walk Assess patient's ability to 1) Sit up in bed 2) Stand at edge of bed 3) Walk a few feet (using assistive devices if needed) Consider high risk for postcritical illness disability if unable to get out of bed and stand	If patient alert and nondelirious: mini-Cog or if patient comatose or delirious: IQCODE (perform with surrogate) Mini-Cog (158): 1) Three-item recall (e.g., banana, sunrise, and chair) 2) ask patient to draw a clock face showing the time as 11:10 (patient should draw circle, numbers, and hands at appropriate time) 3) ask patient to recall three words (one point for each correct word, two points for correct clock) *Consider high risk for postcritical illness disability if scores < 2 points* IQCODE (159)[a]: 16-question tool comparing current cognitive functioning to 10 years ago (supplementary materials, Supplemental Digital Content 1, http://links.lww.com/CCM/B223) for IQCODE questionnaire. (Scores range from 1 to 5, where 1 indicates much improved functioning, 5 indicates much worse functioning, and 3 indicates no change) Consider high risk for postcritical illness disability if scores 3.44 or greater
Daily while in ICU	Have patient perform ADLs. Directly observe or obtain information from patient's family, bedside nurses, physical, or occupational therapists. Consider high risk for postcritical illness disability if requires assistance to complete any ADL	Sit → stand → walk Directly observe or obtain information from patient's family, bedside nurses, physical, or occupational therapists. Consider high risk for postcritical illness disability if requires assistance to get out of bed and stand	Delirium screening Use Confusion Assessment Method for the ICU or Intensive Care Delirium Screening Checklist Each day of delirium increases risk for postcritical illness disability

ADL = activities of daily living, IQCODE = Informant Questionnaire on Cognitive Decline in the Elderly

[a]The complete Katz Index of Activities of Daily Living instrument and the Informant Questionnaire on Cognitive Decline in the Elderly instrument are available in the supplementary materials (Supplemental Digital Content 1, http://links.lww.com/CCM/B223).

delirium. Immobility is an "under-recognized epidemic" among hospitalized older adults with deleterious effects on subsequent physical and cognitive function (62, 87, 115, 116). Delirium, present in up to 80% of all mechanically ventilated patients, is among the strongest predictors of subsequent cognitive impairment and also contributes to long-term disability in ADLs (8, 104, 117, 118). Both immobility and delirium exacerbate underlying age-related physiologic changes; thus, efforts to shorten their duration (or prevent their occurrence all together) can have substantial impacts on postcritical illness outcomes (116, 119, 120).

For over half a century, the untoward effects of immobility and delirium have been the focus of clinicians caring for hospitalized older adults outside of the ICU, yet only recently has become the focus of those caring for the critically ill (108, 121–128). Thus, geriatricians have had a significant head start in preventing and managing immobility and delirium through interdisciplinary "geriatric care models" (119, 129–132). Within the past decade, however, ICU-focused interdisciplinary strategies, such as the "ABCDE bundle," have been described and implemented (133–138). Using a synthesis of the literature and expert opinion, we now will discuss how components of geriatric care models can be used to complement the ABCDE bundle and other "best practices" of ICU care.

Recommended Interventions to Improve Functional and Cognitive Outcomes

Members of the ICU team should assess a patient's functional and cognitive status as soon as possible after admission either through direct patient evaluation or from the patient's surrogate, to identify patients at high risk for postcritical illness disability. In addition, because functional and cognitive status can fluctuate during a hospitalization, daily monitoring should be performed to alert clinicians to potential changes.

The ABCDE bundle is advocated by a number of professional societies including the Society for Critical Care Medicine and combines evidence-based strategies to reduce the harms associated with sedation, mechanical ventilation, delirium, and immobility in critically ill patients of all ages. Although a complete description of each of the components of the ABCDE bundle is beyond the scope of this review, excellent resources that detail the specific components of the ABCDE bundle and the evidence behind them are available at both http://www.iculiberation.org and http://www.icudelirium.org. Briefly, the ABCDE bundle includes daily spontaneous *A*wakening and spontaneous *B*reathing trial *C*oordination ("ABC"), *C*hoosing to sedate patients only when necessary and to "lighter" levels ("C"), screening for *D*elirium ("D"), and the *E*arly mobilization/physical and occupational therapy ("E"). Implementation of the ABCDE bundle is independently associated with a doubling of the odds of a patient being mobilized out of bed and a 45% decrease in the odds of developing delirium (139). In addition, individual components of the ABCDEs are associated with improved functional status at hospital discharge and decreased mortality following critical illness (116, 140).

Older adults, however, face additional risk factors for poor functional and cognitive outcomes not addressed by the ABCDE bundle, including social isolation, enforced dependence in ADLs, restraints, poor nutrition, polypharmacy, and unnecessary medical tests and procedures (119, 129, 132). To address these risk factors, three widely implemented "geriatric care models"—The Acute Care for Elders model, the Hospital Elder Life Program, and the Nurses Improving Care for Healthsystem Elders—were developed (119, 129, 132). The specific interventions contained in these programs differ; yet, each addresses the risk factors faced more commonly by older adults. In general, each care model reduces falls, prevents functional decline, decreases the proportion of patients who develop delirium, shortens hospital length of stay, and increases the likelihood of being discharged to home (130, 141). Whether these same outcomes can be achieved in older adults who are critically ill is an area in need of further research.

Nevertheless, given their association with improved outcomes in less-severely ill older adults, we propose a group of evidence-based interventions that can be used to complement existing ICU best-practices and care bundles to reduce functional and cognitive decline among older adults with critical illness (**Fig. 2**). Because ICUs differ with regard to the specifics by which patient care is delivered, there is no one-size-fits-all approach to implementing these suggested interventions. Yet, because one common thread running through modern ICU practice is close, collaborative interdisciplinary patient care, the ICU serves as an ideal environment to adapt and implement components of these geriatric care models. For example, preventing inappropriate medication use requires cooperation between physicians, pharmacists, and bedside nurses each of whom contribute to the process of ordering, dispensing and administering medications, and communicating these changes to the next level of care. Technologies ranging from simple checklists, to electronic medical records, computerized dashboards, and telemedicine have been used to augment therapeutic intervention delivery in severe sepsis and prevent iatrogenic harms such as central line infections and thus could serve as a model for implementing the proposed interventions (142–145).

The aforementioned assessment tools and interventions are intended to be a pragmatic approach to caring for critically ill older adults; thus, they are far from comprehensive. To address the specific age-related issues that affect over half of all ICU patients better (1), critical care clinicians are encouraged to further their knowledge of clinical geriatrics and to seek help from experts trained in the care of older adults. Several educational resources are available both in print (e.g., American Geriatrics Society's *Geriatrics at your Fingertips*) (146) and online (e.g., the Portal of Geriatrics Online Education [www.pogoe.org] and the Hartford Institute for Geriatric Nursing's "Try This" series [www.hartfording.org/practice/try_this]). ICU clinicians and educators seeking to develop even greater expertise in the care of older adults may be eligible for "mini-fellowships" in geriatrics sponsored by the Donald W. Reynolds Foundation, which provide intensive courses in geriatrics and geriatrics education as well as follow-up support to enhance these endeavors (147). In the future, the development of collaborative training programs between critical care medicine and geriatrics, two specialties that already share a number of overlapping "Entrustable Professional

Suggested enhancements to make the ICU more 'friendly' for older adults with critical illness

Environment

Risk Factor	ICU Intervention
Sensory Deprivation	• Vision aids (eye glasses & magnifying glasses) • Hearing aids (portable amplifying devices & hearing aids)
Disorientation	• Clocks with large numbers • Single date calendar or day/date visible on white board • Names of care team visible on white board • Frequent orientation to surroundings
Sleep disruption	• Reduce nighttime noise and light (pagers on vibrate, quite hallways, dim lights, turn off TVs) • Adjust care schedules to allow sleep (reschedule medications & procedures)

Medical Care

Risk Factor	ICU Intervention
Polypharmacy/ psychoactive medications	• Avoid potentially inappropriate medications, particularly sedative-hypnotics • See http://www.americangeriatrics.org/files/documents/beers/2012BeersCriteria_JAGS.pdf
Unnecessary tests and procedures	• Consider need for routine labs/blood draws, central lines, bladder catheters, iv fluids, iv medications, supplemental oxygen • Avoid procedures and tests that will not alter management
Unclear patient wishes/ goals of care	• Have frequent and ongoing discussions regarding patient wishes/ goals of care • Establish thresholds for continuation/ discontinuation of medical therapies

Patient-centered care

Risk Factor	ICU Intervention
Social Isolation	• Encourage family/partner/friend visitation, including overnight visitation • Cognitive stimulating activities (discuss current events, structured reminiscence, word games)
Reduced mobility/ encouraged dependence	• Avoid 'bed rest' orders • Have patients perform ADLs, as able • Ensure prosthetics/assistive devices available • Early PT/OT within 72 hours of admission
Undernutrition/ dehydration	• Meet daily caloric and fluid needs • Ensure dentures/dental appliances available • Avoid NPO, • Start enteral feeding within 48 of admission
Sleep deprivation	• Warm milk/herbal tea, relaxation music, massage • Avoid pharmacologic sleep agents

Post-hospital care planning

Risk Factor	ICU Intervention
No planning for return to home	• Focus on 'planning for home' • Assess what is needed to return home throughout ICU stay • Include social workers and home health nurses in assessment, if indicated • Transfer to specialized geriatric unit such as ACE or GEM unit, if available
Chronic critical illness	• Utilize prognostic scores such as ProVent (*Crit Care Med* 2012:40;1171-1176) to guide goals of care discussions with patients and proxy decision makers for patients with chronic critical illness (mechanically ventilated for ≥21 days or new tracheostomy)
Unclear patient wishes/goals of care	• Substantial mortality in the first year after a critical illness warrants ongoing goals of care discussions.

Figure 2. Interventions adapted for the ICU from geriatric care models may be used to improve care for older adults with critical illness. PT/OT = physical and occupational therapy, ACE = acute care for elders, GEM = geriatric evaluation and management.

Activities" (148–150), will enable trainees to face the important challenges of caring for older adults with critical illness better.

Finally, co-management strategies, such as the hip fracture "Orthogeriatric" model (i.e., co-management by both the orthopedic surgeon and a geriatrician) have been used to improve outcomes, including reductions in delirium and length of stay, improve functional status and mortality among older adults could serve as a potential care model for older adults in the ICU (151–154).

DIRECTIONS FOR FUTURE RESEARCH

Today, older adults who survive a critical illness are having the burdens of disability, physical, and/or cognitive impairments that previous generations did not face due to death and effective interventions are needed to aid this growing segment of the population. The central role that hospitalization for a critical illness plays in the development of disability afterward is becoming clear. Nevertheless, additional research is needed to understand how the trajectory of a patient's preillness functional status, as well as factors relating to the patient's critical illness, and ICU treatment result in postcritical illness disabilities better. In addition, deeper knowledge of the unique contributions of post-ICU physical and cognitive dysfunction and mental health impairments to the disabling process should be sought. Interventions that can be implemented throughout the continuum of critical illness from the earliest days in the ICU to a variety of post-ICU settings (e.g., hospital ward, rehabilitation facilities, nursing facilities, and home) to prevent, treat, and rehabilitate disabilities in this vulnerable and growing segment of the population should be studied and implemented. Although in need of testing in survivors of critical illness, physical exercise, resistance training, and nutritional supplementation, which are effective in improving physical functioning among those with aging-related muscle loss (e.g., sarcopenia) (155) as well as cognitive rehabilitation that is associated with improve cognitive functioning in patients with acquired brain injuries (e.g., traumatic brain injury and stroke) (156, 157), may serve as readily available platforms by which to reduce disability after critical illness.

CONCLUSIONS

For the 1.4 million older adults in the United States (and many more worldwide) who survive a critical illness each year, the subsequent months and years are fraught with significant declines in functional and cognitive status, resulting in long-term disability for as many as two of every three patients. We argue that aging physiology, complications of critical illness, and common ICU practices contribute significantly to the development of postcritical illness disability.

Interventions derived from widely available geriatric care models in use outside of the ICU, which address modifiable risk factors including immobility and delirium, are associated with improved functional and cognitive outcomes and can be used to complement ICU-focused models such as the ABCDEs.

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