

# The Burdens of Survivorship: An Approach to Thinking about Long-Term Outcomes after Critical Illness

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## Abstract

Internationally accepted approaches to the study of functioning and disability can inform critical care practitioners and scholars in their study of functional limitations, disability, and quality of life after critical illness and intensive care. Therefore this article provides an introduction to the World Health Organization's International Classification of Functioning, Disability and Health (ICF). The Institute of Medicine has also recommended this approach for the study of disability. This conceptual framework divides potential problems as follows: problems in body structure and tissue, limitations in activity (i.e., functional limitations as assessed in standardized environments), and restrictions in participation (i.e., the inability to fulfill a social role). The ICF draws attention to effect modifiers that can prevent problems at one level from progressing (or conversely can hasten their progression) to profound decrements in a patient's quality of life. It is particularly relevant for studies of long-term outcomes after critical illness and post-intensive care syndrome (PICS). This article provides a discussion of the ICF specific to the intensive care unit and the disablement process, with particular attention to new opportunities for intervention and their implications for cost and quality of life.

## Keywords

- ▶ critical illness
- ▶ post-intensive care syndrome (PICS)
- ▶ survivorship
- ▶ disability
- ▶ quality of life

The study of long-term outcomes of critical illness can be improved by placing the work and the data within the context of a broader research on disability. The National Heart Lung and Blood Institute of the National Institutes of Health recently published a position statement calling for a standardized approach to outcomes assessment, emphasizing the need for cross-study comparability.<sup>1</sup> This article introduces a framework for defining and studying disability using the World Health Organization's (WHO) International Classification of Functioning, Disability and Health (ICF).<sup>2</sup> The ICF builds on years of rigorous social, scientific, and epidemio-

logical study<sup>3,4</sup> and has been recommended by the US Institute of Medicine as a key conceptual framework.<sup>5,6</sup> Thinking about long-term outcomes in the context of the ICF is an opportunity to reconcile disparate findings and, more importantly, to consider new and unexplored interventions that may provide sustained improvements in the lives of survivors of critical illness.

The ICF divides the sequelae of acute illness into three nested categories: damage to body structures, limitations in activity, and restrictions in participation in social roles. This article applies this approach to critical illness survivorship

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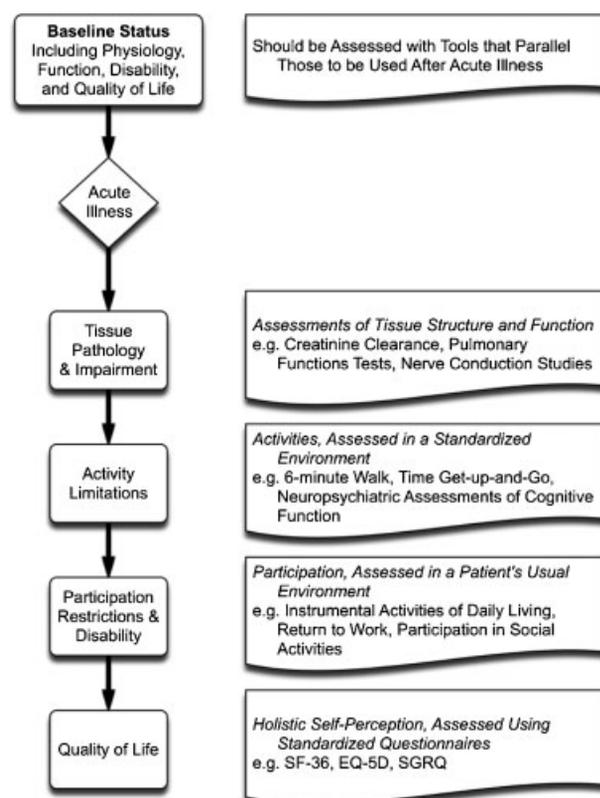
and follows recent scholars in adding a fourth category, quality of life. These categories can also be organized into a progression known as the disablement process, providing an approach to thinking about how tissue damage may lead to impaired quality of life.<sup>3</sup> Equally valuable, the ICF provides a framework for studying the social, psychological, and health care factors that act as effect modifiers, preventing or exacerbating progression of the disablement process in an individual patient. Each of these effect modifiers provides an opportunity for clinicians to help their patients.

In introducing the ICF, this article first explains the WHO classification system and the disablement process as it applies to critical illness. This is followed by a discussion of how nonmedical factors *modify the progression through the disablement process*, creating new measurement variables for researchers and new opportunities for clinicians and clinical researchers to develop tools for their armamentarium. Third, the text identifies actions in the intensive care unit (ICU) that prevent *progression through the disablement process*. Fourth, the discussion turns to the relationship between post-ICU functioning and health care costs. The article concludes by briefly discussing the implications of this approach for clinicians and researchers and introducing the accompanying two articles (Kress and Herridge, and Hopkins and Girard).

### Basic Conceptual Model: Distinguishing Impairment, Limitations, Restrictions, and Quality of Life

In pulmonary clinic, fellows are taught that a patient's shortness of breath is not fully determined by the forced expiratory volume in 1 second (FEV<sub>1</sub>). The distance covered during a 6-minute walk is not simply proportional to the FEV<sub>1</sub>; it is dependent on a complex interaction of extrapulmonary factors. Damage from an illness may occur at several levels that build on each other without manifesting a 1-to-1 correspondence. This insight forms the basis of the WHO ICF, which itself builds on seminal work by Verbrugge and Jette on the disablement process.<sup>3</sup>

The basic conceptual model is presented in ►**Fig. 1**. Patients may become critically ill in a body already suffering chronic problems. Critical illness may cause *impairments*—that is, the fundamental organ failures with which clinicians struggle daily. These impairments occur at the level of specific tissue damage and may be transient or permanent. These impairments may then cause *activity limitations* in functional activities. Limitations in physical and cognitive abilities may, in turn, lead to the *restrictions in participation* in social roles—that is, to *disability*. The ICF draws a distinction between what a person can do in a standardized testing environment (limitations) and what can be done in the patient's usual environment (disability). The perception of such disability and pursuant adaptation may impair *quality of life*. Consider the example of Mr. Jones, whose ICU-acquired weakness leads to atrophy of the quadriceps (an impairment), resulting in sit-to-stand inability (an activity limitation). Mr. Jones previously lived in a split-level ranch house with a master bedroom on the second floor. He can no longer climb the stairs to his



**Figure 1** A conceptual model for studying long-term outcomes after critical illness, rooted in the International Classification of Functioning, Disease and Health.

bedroom (a disability) and is unable to return home. This makes him profoundly unhappy (reduced quality of life).

The fundamental insight of contemporary disability research is the recognition that impairment, limitation, restriction, and quality of life are distinct aspects of response to a given illness. Different aspects require diverse approaches to assessment and will be differentially influenced by potential interventions. To grasp this model is to understand that a set of steps cumulates into a process eventually resulting in disablement. Disability is not foreordained but builds through layers. Continuing our example, whether Mr. Jones's atrophied quadriceps preclude his ability to return home—that is, the extent to which his ICU-acquired weakness will result in diminished quality of life—may depend on therapies he received in the hospital (e.g., neuromuscular blockade), whether he received early mobilization, and the resultant strength of his other muscles and their ability to compensate; his ability and willingness to learn new approaches to mobility; the design of his home and whether he can afford a stair-climber; and the availability and strength of caregivers at his home.

Intensivists are familiar with the measurement of *tissue impairment* after critical illness. Clinical assessment and research measurement of this aspect of survivorship typically requires direct examination of the patient's body, often with tissue sampling or noninvasive imaging. Examples include computed tomographic (CT) scans, creatinine clearance, and

muscle biopsies—the sorts of bedside tests familiar to clinical practitioners.

Assessments in a standardized environment are used to determine whether a patient has *limitations in abilities*. Cognitive assessments of executive function and memory tap this aspect of the disablement process. Motor function tests for limitation include the timed up-and-go and swallowing tests. There has been substantial effort in geriatrics and kinesiology research in this domain, with the development of strong measurement tools and a resultant deep understanding of conditions such as hip fracture and stroke. Limitations are distinguished from impairments by the focus on activity at a level recognizable to the patient.

Crucially, the linkage between tissue injury and limitation in abilities is often variable. Clinicians understand that a low cardiac ejection fraction or deconditioning may correspond to a wide range of 6-minute walk times,<sup>7,8</sup> and that the extent of ischemic damage on a head CT is only one predictor of functional deficits after stroke.<sup>9–11</sup> The mechanisms that drive this heterogeneity are a potentially rich area of study. For example, a recent review of stroke rehabilitation emphasized that there appears to be little recovery of damaged parts of the brain per se; however, the remarkable plasticity of the brain allows substantial compensation at the level of functional limitations rather than repair of the brain itself.<sup>12</sup> The variability between tissue damage and basic function points to important opportunities to improve function, even after tissue damage has been completed.

*Disability* is defined by the *restrictions in participation* through a given social role. The degree of disability depends on the complex interplay between the patient's functional limitations, the expectations placed upon them, and the social and technological environment in which this occurs. To give an example, many community-dwelling adults have poor distance vision. Without corrective devices, this would cause substantial disability, precluding them from driving or even enjoying a movie. With glasses, these individuals have no social disability despite precisely the same limitations in their ability. More generally, this distinction between functional limitations and disability crystallizes a common clinical insight among critical care physicians: that there are particular patients for whom seemingly innocuous functional deficits have a disproportionately negative impact on their lives. These patients could be the former athlete whose modestly diminished diffusing capacity, while still “in the normal range,” means that he can no longer compete, or the former executive for whom a small diminishment in the ability to concentrate has meant the loss of her once-prosperous small business. For these survivors, their social roles demand higher degrees of function, resulting in disability for them but perhaps not for others. Verbrugge and colleagues emphasized that, while functional limitations may be set by the biology of illness, the extent of social disability is fundamentally dependent on—and can be improved by—the social environment in which a patient lives.<sup>3,13</sup> Common measures of disability include assessments of the ability to return to work and of independence in performing activities of daily living and instrumental activities of daily living.

*Quality of life* is intended as a holistic measure of the extent to which a patient is satisfied with his or her life. Its measurement has deep roots in economics. For many clinical applications, scientists prefer the concept of “health-related quality of life,” which has been defined as “the relative desirability of measured or estimated health states.”<sup>14</sup> In principle, this allows rational and humanistic trade-offs, incorporating the choice by some that they would rather live for less time at a higher level of capacity. Health-related quality of life, particularly as embodied in the quality-adjusted life year, has been accepted as perhaps the dominant outcome for cost-effectiveness analysis in medicine. The assessment of quality of life requires a precise and structured approach; the optimal measurement is still debated and may hide contentious decisions about precisely whose point of view should be valued, but this discussion is outside the scope of this article.<sup>14–17</sup>

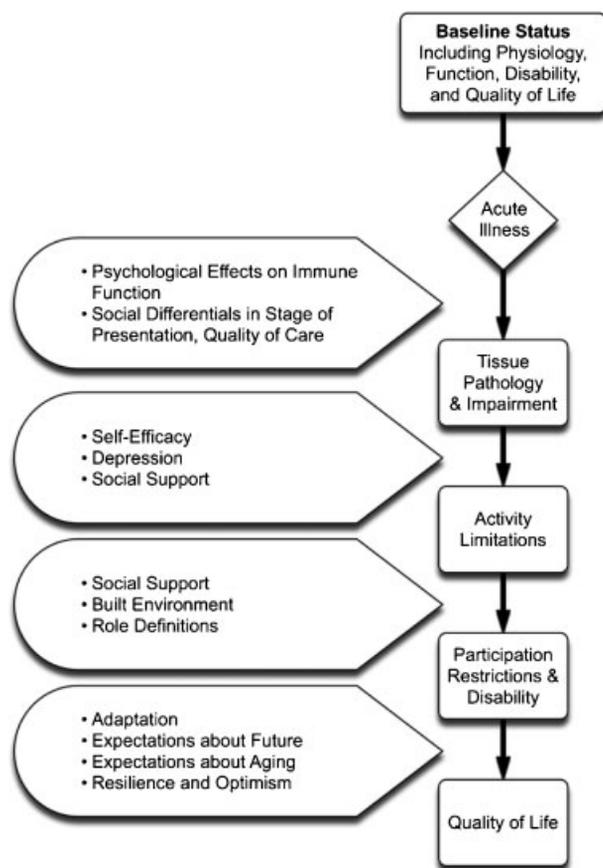
In summary, the ICF serves as a conceptual model for increasing our understanding of critical care survivorship. This model organizes the condition of survivors in terms of distinct phases, which can be understood as a disablement process: an acute injury modifying a baseline level, causing a pathology of injury that leads to tissue impairment, leading to functional activity limitations, which may lead to disability in the participation in social roles, and which may be associated with changes in quality of life. Such an approach is rooted in decades of geriatric and sociological study. Although the ICF and the theory of the disablement process continue as subjects of discussion and refinement,<sup>18–20</sup> they organize the facets of survivorship in ways allowing potentially productive analogies with long-standing work in related fields, such as geriatrics and stroke rehabilitation. They clarify potential sources of variability in the process and suggest ways this variability could be exploited to develop new interventions. This approach also offers a natural way to understand the complex process of patient care that may have important effects on the experience of survivorship.

## Effect Modification by Social and Psychological Factors during Disablement

A key insight of work on the disablement process—and the conceptual underpinning of the WHO ICF—is the recognition that the process by which functional limitations become restrictions on social participation is dependent on the social environment. This fact complicates the lives of ICU-based scientists because it requires them to conceptualize and measure aspects of patients' lives outside of their usual practice. But it can expand the armamentarium of clinicians committed to improving patients' lives.

In the realm of critical illness, there has been relatively little scientific study of the ways in which social and psychological factors explain variation in patients' progression through the disablement process. Thus this section draws on related literature to briefly sketch certain effect modifiers and the steps at which they may act. —**Figure 2** presents an overview.

There is reason to suspect effect modification even at the linkage between acute illness and tissue impairment. For



**Figure 2** The social environment and psychological makeup are crucial effect modifiers for progression through the disablement process.

example, there may be direct immunomodulatory effects of both psychological states (such as depression) and social support and social networks.<sup>21</sup> Patients with a more privileged social position (eg, race, greater wealth and education) may be more likely to present to the health care system earlier in the course of their disease. They may go to hospitals that provide better care<sup>22,23</sup>; certainly this is true on a global scale. Persistent and frustrating evidence suggests that differential care exists even within the same hospital,<sup>24,25</sup> which translates into social differentials in degrees of tissue impairment from the same apparent critical illness. As shown in the next section, hospitals may intervene during every step of the disablement process; therefore, social differentials in the choice of hospital may ramify at each level of that process.

Psychological factors may be particularly relevant in modifying the extent to which tissue impairment leads to functional limitations. Self-efficacy and depression have been associated with reduced physical activity and participation in rehabilitation.<sup>26</sup> Social support, here as at nearly every step, appears to be crucial. This is particularly concerning, given recent research showing that spouses and informal caregivers of the critically ill suffer depression and posttraumatic stress and its symptoms.<sup>27</sup> Directed support of family members during critical care<sup>28,29</sup> may yield important downstream benefits for patients, although this needs to be tested.

Because restrictions in social roles are defined in terms of the social environment, it is not surprising that there are many potential modifiers of the relationship between functional limitations (assessed in a standardized environment) and restrictions and disability (assessed in the patient's usual social context). A few broad domains stand out: (1) social support and social networks, (2) the built environment, and (3) role definitions.

1. **With regard to social support**, studies have shown that caregivers can buffer survivors from the impact of their limitations, serving as social assistive devices.<sup>30</sup> For example, caregivers can prevent patients from being moved to a nursing home (an extreme form of social disability) for patients with well-characterized dementia.<sup>31</sup> To our knowledge, equivalent data have not been collected after critical illness.

2. **The built environment** comprises "all buildings, spaces and products that are created or modified by people."<sup>32</sup> This architecture and the design of the spaces of our lives may have a profound impact on a patient's experience of them. This may be most familiar to many clinicians from ways in which grab bars and other bathroom modifications may allow patients to toilet themselves in an appropriate bathroom, despite the inability to do so in a conventional residential bathroom.<sup>33–35</sup> The Americans with Disability Act has led to the redesign of some public spaces to increase mobility and reduce disability, although barriers remain, particularly in private homes.<sup>36,37</sup>

An elegant study utilized self-reported measures of lower limb function and mobility disability and characterized street conditions outside of respondents' homes.<sup>38</sup> The investigators found that rates of mobility disability were much higher among those with lower body impairment who lived in an area with fair or poor streets compared with those living on well-maintained streets. This disparity persisted after extensive controls for potential confounders. That is, the relationship between functional limitations and social disability varies as a function of the local built environment, reinforcing the findings of several studies that used less granular data.<sup>32,39,40</sup> This suggests that the home and neighborhood environments where our patients live may be important determinants of the degree of social disability—but also that there might be powerful effects from modifications of those environments or the patient's ability to interact with them.

3. **Role definitions** are the set of social expectations and demands placed on us in each of the social roles we fill. In some cases, those role definitions may be binding, and any diminishment in function will result in the inability to fulfill the role. In other cases, there may be more slack, or even opportunities to redefine the role so that once seemingly essential characteristics are no longer so. At a global level, male gender was once considered an essential characteristic for a fire fighter or a law enforcement officer. At a local level, ramps and curb cuts mean that ambulation is no longer a requirement for participation in many aspects of urban life for otherwise mobility-impaired

people, ranging from those in wheelchairs to parents with strollers. At an individual level, a surgeon with new left-sided hemiparesis that precludes him or her from operating may redefine the job role by using analytic skills to mentor and teach.

In understanding survivorship, it is essential to understand that not all patients will evaluate the same degree of functional limitations and social disability equivalently in terms of their effect on their health-related quality of life. Psychological adaptation and other resources play a crucial role in mediating these relationships.<sup>41</sup> Furthermore, such adaptations can lead to substantial differences in the quality of life impact of a given degree of activity limitation. To highlight these challenges, consider an astute study by Smith and colleagues.<sup>42</sup> They identified 71 patients who had recently undergone either temporary or permanent colostomy or ileostomy at a major tertiary care center. At 1 week postdischarge, quality of life scores were indistinguishable between the groups. Over the next 6 months, the permanent ostomy group had steady and clinically and statistically significant improvements in their quality of life. In contrast, the temporary ostomy group had persistently low quality of life that did not improve. The authors posited that when patients were hopeful that a given disability was temporary they did not adapt to the situation and thus experienced poor quality of life. When the ostomies were clearly permanent, the patients adapted to the same disability with progressively improving quality of life. This emphasizes the variable, and perhaps unexpected, linkages between the functional limitations, disability, and quality of life of survivors of critical illness.<sup>43–45</sup> It further highlights that interventions which promote adaptation may offer intriguing benefits.

In sum then, the ICF organizes the potential challenges faced by survivors of critical illness and highlights the flexible interrelationships of those challenges. Social and psychological factors—many open to amelioration—may critically modify the extent to which a given tissue injury leads to social disability. These many effect modifiers suggest that the goal of care may then be to both minimize functional limitation and disability and to maximize the quality of life, but without the expectation that improvements in one will always correspond with improvements in the other.

### Health Care as Modifier and as Outcome of the Disablement Process

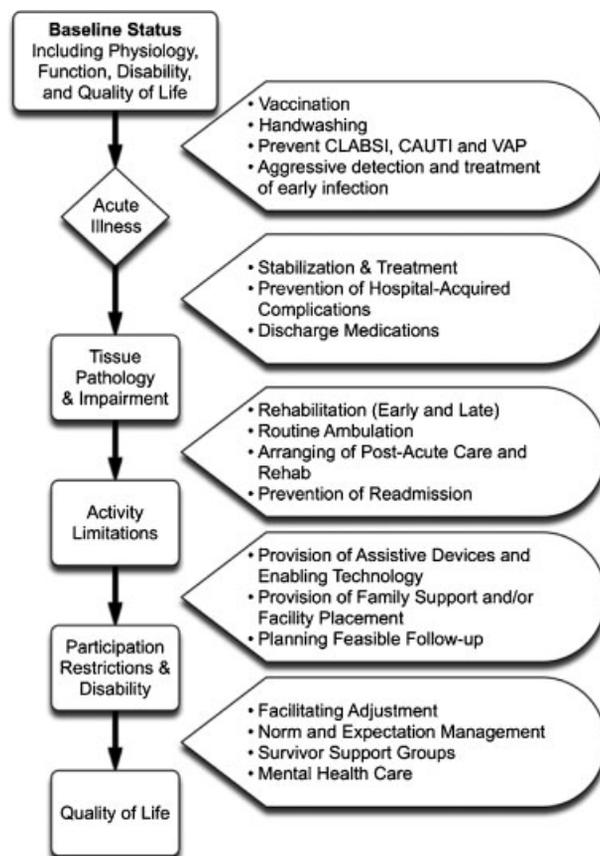
A patient's health care needs and utilization have an interactive relationship with the disablement process. On the one hand, an important goal of much care is to prevent or ameliorate disablement. Yet impairments, limitations, and restrictions may also lead to both a greater need for health care and greater use of services. It is useful to consider these separately. Let us first look at the ways in which care during the acute illness can potentially interrupt disablement. We will then consider health care needs and use.

### Current ICU Practices That May Influence Survivorship and the Disablement Process

The traditional view of survivorship is that it is an issue to be addressed after the acute illness is completed. But recent work in mechanically ventilated patients—and current practice with stroke, trauma, and cardiac surgery patients—suggests that targeted care during the acute setting can improve long-term survivorship. Rapid postoperative extubation may speed coronary artery bypass surgery patients off mechanical ventilation in hours after leaving the operating room.<sup>46–51</sup> Stroke rehabilitation begins in the ICU.<sup>52–54</sup> In the medical ICU, current excitement focuses on the dramatic gains resulting from rehabilitation during the ICU stay.<sup>55–58</sup> A host of current practices influence various transitions between the steps of functioning, disability, and quality of life. —Figure 3 provides a comprehensive list; the focus here is on action in the ICU.

Preventing long-term adverse outcomes from critical illness can begin with preventing critical illness. This suggests that existing patient safety efforts to reduce infection<sup>59–61</sup> and acute lung injury<sup>62</sup> may have an important role in preventing post-critical illness disability when considered at the population health level.

Much of critical care is devoted to the prevention of tissue damage and organ failure. However, far less attention has been directed toward rigorously evaluating the impact of our



**Figure 3** Current routine practices by acute care hospitals that may have effects on the disablement process.

therapies on long-term outcomes. Fascinating 1-year mortality and cognition data are available for the pairing of a spontaneous awakening trial and spontaneous breath trial, the Awakening and Breathing Controlled (ABC) trial,<sup>63</sup> and a follow-up evaluated some of the patients in the Fluids and Catheter Treatment Trial (FACTT).<sup>64,65</sup> But these trials are notable also for how unusual the collection of these outcomes was. Meaningful long-term outcomes are not yet routinely collected in randomized, controlled trials nor required by the Food and Drug Administration for approval.<sup>66,67</sup> It seems a reasonable extrapolation that other advances in contemporary critical care, such as early goal-directed resuscitation and low tidal volume mechanical ventilation, will also offer benefits in terms of survivorship. But it must be emphasized that there is painfully little proof that these fundamental therapies *do* improve long-term outcomes. Getting such proof would be of substantial scientific merit<sup>66</sup> and may help clarify the mechanisms leading to various aspects of survivorship. Particularly, such data might provide insight into the extent to which the general ICU environment (possibly including existing care practices), as opposed to specific pathophysiological pathways, causes the components of disability.

In the ICU, explicit interventions to prevent functional limitations typically rely on physical and occupational therapy. Enacting such therapy broadly requires not only dedicated time with highly skilled therapists but also core nursing tasks, including sedation minimization, that allow patients to engage in as much self-care as possible, and frequent time out of bed.<sup>68</sup> Hospital variations in physical therapy practices may be marked.<sup>69</sup> Mobility-related activities have been called the most common “error of omission” by nursing care on general floors,<sup>70,71</sup> and there are few reasons to think this is better in the ICU. Although there are promising data about new interventions to improve cognition after critical illness<sup>72</sup> and there is useful evidence from other related fields,<sup>12,73–75</sup> such interventions are not yet well integrated into ICU care.

Other ICU interventions not directly targeted to improving functional status may also have critical “side-effects” in this step in the disablement process.<sup>68</sup> The interdependence of sedation, delirium, and patient activity has been increasingly evident since Kress et al’s ground-breaking study.<sup>76</sup> Sedation minimization makes possible active patient participation for many hours a day, from the crucial muscular activity of maintaining posture in a chair to playing video games.<sup>77,78</sup> Delirium prevention may improve the long-term outcomes of both mortality and cognition.<sup>79–81</sup> Conversely, other initiatives intended to improve patient safety may have deleterious effects. Inouye and colleagues have pointed out that the labeling of in-hospital falls as never-events may lead instead to immobilization and unnecessary loss of functional capacity.<sup>68</sup> As we consider the mobilization of hospitalized patients, we should remember that the mortality benefits of paired spontaneous breathing and awakening trials<sup>63</sup> are comparable to those of low tidal volume ventilation.<sup>82</sup>

It is easy to overlook the potential for ICU-based interventions to prevent given functional limitations from becoming social disability. Occupational therapy (OT) plays a role, teaching patients to compensate for physical limitations to

avoid disability.<sup>83,84</sup> Although their efforts are often overlooked, the trial by Schweickert et al randomized patients to treatment by a physical therapy/occupational therapy (PT/OT) team, not just PT.<sup>58</sup> One might speculate that OT care should begin in the ICU, and arranging appropriate care transitions is essential.<sup>85</sup> It is likely hospitals vary in other processes that effect social disability and quality of life, holding constant functional limitations; identifying these is an important area for our study of long-term outcomes.

Further, it is our suspicion—as of yet unproven—that ICU efforts to support spouses and families may offer substantial possibilities in preventing disability. Spouses have been proven to be a crucial determinant of whether cognitive decline leads to nursing home use.<sup>31</sup> The health benefits that flow from social support in general, and families in particular, are well documented and appear to be causal, not just associated.<sup>30</sup> Families provide enormous hours of uncompensated but crucial informal care after many conditions.<sup>86–94</sup> Yet the families of ICU patients leave our care with substantial burdens, including depression, anxiety, and learned helplessness.<sup>28,29,86,95–103</sup> As Kress and Herridge suggest in their article in this volume, interventions supporting families during their loved ones’ ICU stay could empower these families to provide high-quality, personalized support in the post-ICU period. This “social reserve”—analogous to physiological reserve—may be heedlessly diminished by current ICU practice that is rarely optimized for the families’ needs.

In sum, many current ICU practices and systems influence steps of the disablement process after critical illness. However, most of this activity occurs in an information vacuum. Little high-quality evidence links specific interventions to specific aspects of survivorship. This research knowledge deficit is exacerbated by the fragmentation of post-critical illness care,<sup>85</sup> which obstructs the ability of clinicians to receive meaningful feedback on the results of their efforts. Quality improvement systems rarely track the long-term outcomes necessary to provide closed-loop feedback. Although this lack of standardization causes pervasive deficits, it is also an opportunity to examine these diverse and independently developed programs to identify areas of particular effectiveness.

### Health Care Needs and Health Care Use as Outcomes of Care

Although health care may help prevent the development of impairments, limitations, and restrictions, it is also true that impairments, limitations, and restrictions increase health care needs. The dearth of robust literature precludes a comprehensive review of the ways in which critical illness-induced disability increases health care costs. However, there are some clear initial findings.

Survivors of critical illness have substantial and ongoing health care needs. For example, Weycker et al noted mean charges of \$78,500 (in year 2000 US\$) among patients with severe sepsis, a surprisingly large fraction of which was unrelated to the initial admission.<sup>104</sup> Dramatic heterogeneity existed across age groups, with younger patients having

much higher subsequent mean charges. Lee et al noted more modest costs among sepsis survivors from Alberta ICUs, with postdischarge 1 year mean costs of CAN\$20,855 (in year 2001 CAN\$, where CAN\$1 = US\$0.68).<sup>105</sup> Importantly, this Canadian report showed a highly skewed distribution of cost. High cost outliers (>CAN\$100,000) were common, so estimates of the mean or of the total population burden will be quite sensitive to how these high cost outliers are detected and handled.<sup>106,107</sup> Further, with this distribution, mean costs (although important administratively), may be poor predictors of what any individual patient will face.<sup>108</sup> Detailed cohort analyses of acute respiratory distress syndrome (ARDS) survivors from Toronto likewise show ongoing costs. After average costs of CAN\$22,309 (2009 CAN\$) in the first year after discharge with ARDS, and CAN\$9,885 in the second, their average ongoing costs of care were CAN\$5,566 in the fifth year. But survivors with two or more comorbidities at baseline had greater costs than those with better pre-ARDS health—accruing mean total costs of almost CAN\$90,000 in 5 years.<sup>109,110</sup>

From a prognostic standpoint, these studies imply high (and heterogeneous) ongoing costs for survivors of critical illness. Unfortunately, these studies lacked rigorously described comparator arms allowing us to specify the economically relevant counterfactual (i.e., the extent to which these high costs are *caused* by the various critical illnesses, as opposed to the extent to which patients with poorer baseline health then become critically ill). (Possible counterfactuals include the patient's own pre-ICU costs, costs for matched patients who were hospitalized but did not require ICU care, or costs for matched patients who had some non-ICU serious illness—each of which implies a distinct scientific question that has advantages and disadvantages which should be explicitly stated.) Further, these studies have not always distinguished between the costs attributable to living as a survivor of critical illness, and the costs attributable to the increased ongoing risk of death of survivors of critical illness.<sup>111</sup> Because health care costs spike dramatically in the months prior to death, the fact that survivors of critical illness have an increased risk of death could lead to artifactually higher costs in aggregate. In oncology, a so-called phases of disease model has been used to distinguish the costs of living with a diagnosis from the analytically distinct costs of dying after a diagnosis.<sup>112</sup> Such work is needed in critical care as well.

Research in the area is only just beginning. There are several key deficits that need to be corrected before the full economic impact of post-critical illness disability can be assessed. First, the formal health care needs of survivors of critical illness may well be equaled by unmeasured informal care needs. Such is the case in dementia.<sup>89,113</sup> Further, declines in function impose substantial burdens on informal caregivers.<sup>27,88,89,114–116</sup> For example, the onset of moderate cognitive impairments is associated with families spending *an additional* 17.4 hours per week in informal care per patient.<sup>89</sup> Second, none of these landmark critical care studies stratified costs by disability. The onset of disability is associated with worsened mortality<sup>117,118</sup> and a \$10,000 increase

in medical costs in the next 2 years.<sup>119</sup> This is a particularly important problem because disability is a major driver of the crises of public health care costs and US state and federal budget deficits. In the United States, patients eligible for Medicaid by reason of disability account for only 15% of Medicaid enrollees but 43% of Medicaid expenditures.<sup>120</sup> Third, health care use and health care needs are not synonymous. Any evaluation of health care use or needs must be careful to specify measurement approaches and attempts to determine the extent to which local system norms and availability might influence their results.<sup>121</sup>

Nonetheless, a reasonable body of evidence suggests that survivors of critical illness cost “a lot” of money. There are plausible arguments that some, perhaps much, of this cost is increased relative to appropriate comparators and may be *caused* by the critical illness itself. Given that the assessment of causation is incomplete for the “cost” and for the “effectiveness” of long-term outcomes for critical illness, we can offer no scientific measurement of value. Beyond these difficult questions, the implications of labeling care as “low value” or “not cost-effective” are challenging, particularly when it is difficult to identify such patients a priori. At this point in time, with so little research on the extent to which post-critical illness functional limitation, disability and quality of life might be amenable to improvements, we hesitate to use such labels.

## Implications

The framework outlined here has several implications, for both practicing intensivists and researchers. Although we can make few definitive conclusions, we can offer some tentative suggestions.

### Toward an Approach for the Practicing Intensivist

There are limited data upon which to build an evidence-based approach to prognosticating and preemptively managing the burdens of survivorship among our patients. Although scattered post-ICU clinics have been established, they have yet to be organized to conduct large-scale tests of randomized interventions, nor regular data sharing to allow collective learning by doing. As such, we can offer seven recommendations that are necessarily tentative, summarized in ► **Table 1**. We, as a specialty, are at the beginning stages of learning how to optimize our care based on patients' baseline limitations and disability and their risk for worsening functional outcomes. The key message is to consider that there are multiple domains in which adverse outcomes could occur—the ICF is useful for this—and to attempt to assess and improve potential effect modifiers relevant to each particular patient.

### Pragmatic Suggestions to Advance Research

Our suggestions for clinicians are necessarily hesitant given the lack of an evidence base, but we can make four recommendations for advancing research on long-term outcomes. We begin with those in which we are most confident.

First, measure outcomes over relevant time scales. Several studies have now shown that recovery after critical illness

**Table 1** Seven Tentative Recommendations for Improving Long-Term Outcomes

1. <i>Provide high-quality acute intensive care.</i> This should include resuscitation and initial stabilization but also evidence-based ventilator and sedation management, minimizing duration of mechanical ventilation.
2. <i>Involve rehabilitation experts as early as possible in the ICU course.</i> Such experts include physical therapists, occupational therapists, social workers, physical medicine, and geriatrics.
3. <i>Consider structured assessment of limitations and restrictions/disabilities.</i> Impressionistic assessments of cognitive and physical limitations have been quite poor in sensitivity and specificity, <sup>124,125</sup> but rapid, user-friendly systematic assessments of functional limitations and disabilities are well developed, such as so-called comprehensive geriatric assessment. <sup>126</sup>
4. <i>Mobilize the patient's social resources and provide the patient with enabling equipment.</i>
5. <i>Arrange close follow-up, and work to avoid fragmentation of care by structured, routine hand-offs to both hospitalists and outpatient providers.</i>
6. <i>Patients cannot do it by themselves: learn from PRaCTICaL.*</i>
Patients sent home with instructions for physical therapy and self-reporting their progress to nurses do no better than patients simply sent home; greater levels of support seem necessary, although we do not yet have proof as to the best way to provide that support.
7. <i>Find a way to get feedback on your patients' long-term outcomes so you can learn from them.</i>

\*The PRaCTICaL study of nurse led, intensive care follow-up programmes for improving long term outcomes from critical illness: a pragmatic randomised controlled trial.<sup>127</sup>

takes at least 12 to 24 months.<sup>110,117,122</sup> Long-term outcome studies should certainly last at least 1 to 2 years and should often strive for at least 5 years of follow-up.<sup>123</sup> Studies with shorter time scales have the onus of proving that they are demonstrating a new steady state, not simply an arbitrary point in the midst of recovery.

Second, measure and report select key social and psychological modifiers of the disablement process. Our short list of essential variables would include the following: (1) marital status, (2) social support, (3) education, (4) wealth (not just income), and (5) a measure of psychological resiliency. For brief assessments, it may be particularly valuable to use standardized question elements that allow comparability with some accepted reference standard, such as with the nationally representative, NIH-funded Health and Retirement Study (HRS). The HRS has been harmonized with an international series of ongoing studies, with carefully translated equivalent scales. Using HRS-based instruments allows easy comparability and a ready defense for why one instrument was chosen rather than another. Questionnaires are freely available at <http://hrsonline.isr.umich.edu>. Consistent reporting of such key variables will support hypothesis generation in the likely event of inconsistent findings across studies, particularly for smaller studies.

Third, we recommend reporting one's findings in terms of the aspects of the ICF. Studies of tissue pathology, activity limitation, restrictions in participation (i.e., disability), and quality of life are all important, but as we have argued here, they are not equivalent or interchangeable. It would take but a few words for researchers to clearly state which aspects of the ICF their outcome variables assess. Doing so makes it easier for readers to integrate findings and to draw parallels from the other fields dedicated to preventing disability and improving post-illness quality of life. Critical illness, particularly with its natural focus on adaptation and accommodation,<sup>18</sup> may also contribute to ongoing discussions of the best way to study disability itself.<sup>18–20</sup>

Fourth, we recommend using this framework when designing randomized, controlled trials to test interventions. This recommendation implies that testing for changes in outcomes at the level of functional limitations and social disability as well as using standardized instruments for quality of life.<sup>1</sup> We favor simple disability metrics like return to work (if appropriate), and basic and instrumental activities of daily living. Furthermore, this framework suggests that many factors outside the ICU may matter and may add variance to the outcome measurement. If an individual randomized, controlled trial cannot be powered to look for effect modification by itself, certainly it should measure the handful of key variables outlined here to allow post hoc examination for effect modification across multiple studies.

### Moving Forward

The present volume of *Seminars in Respiratory and Critical Care Medicine* has two closely linked articles. Kress and Herridge focus on the effect of critical illness on many domains of physical disability. They have a particular interest in the current state of research on potential effect modifiers that lead to greater or lesser disability, and the usefulness of such modifiers for risk stratification and targeting of interventions. Hopkins and Girard identify the substantial cognitive and psychiatric problems under which survivors of critical illness labor. They critically and forthrightly review the level of evidence for causal linkages between critical illness and these problems and explore the interplay between the neurobiology and clinical aspects of care. The terminology of the ICF is not used in these articles, perhaps reflecting its low visibility in the ICU community. However, both articles carefully review core findings on survivorship. It is our hope that, by considering survivorship data through the prism of this disablement model, readers can more fully appreciate what is known and what needs to be investigated to better understand and intervene to attenuate disability following critical illness.

## Conclusion

A major challenge for critical care is to understand and then improve the long-term functioning, disability, and quality of life of the ever-growing group of patients surviving critical illness. Because looking at the substantial burdens of survivors may make some feel that ICU care is a waste, offering little real benefit, we face the challenge to prove our benefit for long-term, patient-centered outcomes. Furthermore, little scientific attention has been devoted to developing and assessing interventions to improve survivorship and developing systems that effectively transition from the ICU setting to several years of integrated patient-centered (evolving) follow-up. We now have a tremendous opportunity to fundamentally rethink our approach to the care of critically ill patients and to make core contributions to improving their lives.

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