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Functional Status of Patients Recovering from Severe COVID-19

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Abstract

Aims

The long-term impact of severe SARS-CoV-2 (COVID-19) on functional recovery remains unclear. This study examined and followed up patients admitted to an Irish Intensive Care Unit(ICU) between March 2020 and November 2021 to assess functional outcomes and respiratory symptoms.

Methods

Functionality was evaluated using the Katz Index and Karnofsky Performance Scale. Respiratory symptoms were assessed with the ATS Respiratory Questionnaire and the Modified Medical Research Council (mMRC) Dyspnoea Scale through telephone interviews.

Results

Among 101 ICU admissions, 43(42.5%) patients had died by follow-up. Of the 58 eligible survivors, 38(65.5%) participated. 27(71%) of patients regained full independence in basic activities of daily living (Katz score 6/6), and 32(84%) scored 5/6 or higher. However, 19(56%) of participants scored ≤70 on the Karnofsky scale, indicating ongoing functional limitation despite maintaining independence at home. Breathlessness (mMRC score ≥1) was reported by 27(71%)of patients, with 12(32%) experiencing severe dyspnoea after walking less than 100 meters (mMRC score 3).

Discussion

Most participants regained independence in basic daily activities, but significant functional limitations and respiratory symptoms persisted. Many patients had not returned to their pre-COVID baseline.

Introduction

The SARS-CoV-2 (COVID-19) pandemic profoundly impacted European healthcare systems beginning in early 2020, with significant consequences for mortality, healthcare delivery, and social functioning. Excess mortality, widespread lockdowns, and interruptions in routine care

strained resources and elevated demands on hospital and critical care services[1]. The most severe cases necessitated Intensive Care Unit (ICU) admission and the immediate focus was on their survival through medical care and mechanical ventilation. While vaccination efforts have mitigated the severity of acute cases, attention has shifted to the longer-term sequelae of COVID-19, collectively referred to as "Long COVID Syndrome.[2]" This encompasses a broad spectrum of persistent symptoms and disabilities.

The extent to which Long COVID Syndrome affects patients, particularly those with severe disease requiring ICU admission, remains incompletely understood. Moreover, its correlation with acute disease severity and response to intervention are still unclear. This study examined the recovery patterns of ICU patients with severe COVID-19 admitted during the first 18 months of the pandemic, with a focus on long-term functionality and disability. Patients were followed up over a year after discharge to assess persistent health issues and quality of life.

The survey we carried out utilized validated tools to measure current symptoms and functionality: the Katz Index, Karnofsky Performance Scale, ATS respiratory questionnaire, and Modified Medical Research Council (mMRC) Dyspnoea Scale(Appendix 1-3). The Katz Index and Karnofsky Performance Scale are both recommended tools for assessing functional outcomes in Critical Care populations[3]. These tools assessed basic daily living activities, advanced activities of daily living and disease impact on daily living, respiratory health, and breathlessness levels.

The Katz index was first developed to assess independence of older non-hospitalized adults within the general population[4]. It is a tool which assesses important basic activities of self-caring. It is scored from 0-6 based on dependence or independence when carrying out activities such bathing, eating and toileting. Although it is less sensitive to changes in more advanced activities of daily living than the Karnofsky scale it is useful in reflecting declining health status and loss of independence. Since its development it has been used in assessing patient independence and activities of daily living both within hospital[5] and after discharge from critical care[6,7].

The Karnofsky Performance status score is also a measure of functional status but gives an overall score between 0-100. The Karnofsky Performance status is a better functional screening tool to assess return to baseline function such as active living and employment. It has been used extensively in medical oncology for assessing suitability for treatment and prognosis over the past 70 years[8] but is also used regularly within ICU cohorts to assess functional outcomes[9,10].

We included the American Thoracic Society Respiratory Disease Questionnaire(ATS)[11] which is a standardised respiratory questionnaire which includes a wide range of questions investigating common respiratory symptoms including cough, shortness of breath, sputum, wheeze, recurrent chest infections and requirement for long term oxygen. While being useful

to identify the presence of symptoms, has been shown to correlate with reductions in lung function as identified by Spirometry[12].

The portion of the ATS questionnaire that investigates breathlessness is closely aligned with the modified Medical Council Research Dyspnea Scale(mMRC). The mMRC grades breathlessness on a scale of 0-4. It has been shown to accurately reflect symptom burden and impaired quality of life in many different causes of lung disease[13,14]. We chose to include the mMRC numerical classification of dyspnea to try to better assess severity due to the debilitating nature of the symptom. For other respiratory symptoms such as chronic cough/wheeze we categorized as yes or no based on the continued presence or absence of symptoms.

Methods

This observational follow up study analysed functional outcomes among patients with severe COVID-19 who required ICU admission in Cork University Hospital. Ethical approval was obtained from the Clinical Research Ethics Committee (April 28, 2022). Data collection involved qualitative and quantitative approaches, with primary endpoints including functionality and disability assessments at least one year post-discharge.

Patient identification began using the IntelliSpace Critical Care and Anaesthesia (ICCA) database at Cork University Hospital, which recorded all ICU admissions. Eligible patients were those admitted to the ICU with COVID-19 as the primary diagnosis between March 2020 and November 2021. Survival to discharge was confirmed through medical records. Contact information was obtained from hospital records, and participants were invited via letter to participate in a telephone survey. Once they returned written consent for permission to contact, we conducted telephone interviews with patients to assess their current functional status.

The survey utilized validated tools to measure current symptoms and functionality: the Katz Index, Karnofsky Performance Scale, ATS respiratory questionnaire, and Modified Medical Research Council (mMRC) Dyspnoea Scale(Appendix 1-3). These tools assessed basic daily living activities, advanced activities of daily living and disease impact on daily living, respiratory health, and breathlessness levels. Data collection occurred in the last quarter of 2022, ensuring a minimum one-year follow-up period. Details collected from ICCA included Sex, Age, Length of ICU stay and if a patient had been intubated during their stay. Statistics were descriptive and performed using Excel.

Results

Cohort Overview

Of the 117 ICU admissions initially identified, 101 patients were eligible after excluding duplicates and transfers. At follow-up, 43 patients (42.5%) had died, leaving 58 survivors. Of these, 38 participated in the study (response rate: 65.5%). The cohort consisted of 16 males

and 22 females, with a mean age of 56 years (median: 67; range: 18–81). The median ICU length of stay was 7 days (range: 1–74 days).

15/38 (39%) of our cohort required intubation during their ICU admission, they had a mean length of stay of 28 days. 23/38(61%) of our cohort did not require intubation and had a mean length of stay of 5 days.

Mortality

Among the deceased, 24 patients (56%) died in the ICU, 16 (37%) in other hospital settings, and 3 (7%) post-discharge. The overall mortality rate was 42.5% at two years.

Functional Outcomes

Katz Index:

32 patients (84%) scored 5 or 6 on the Katz Index, reflecting near-full independence in basic ADLs. 2 patients (5%) scored 4, indicating moderate frailty, while 4 (11%) scored below 4, representing severe frailty or dependence. The distribution of Katz scores is depicted in *Figure 1.*

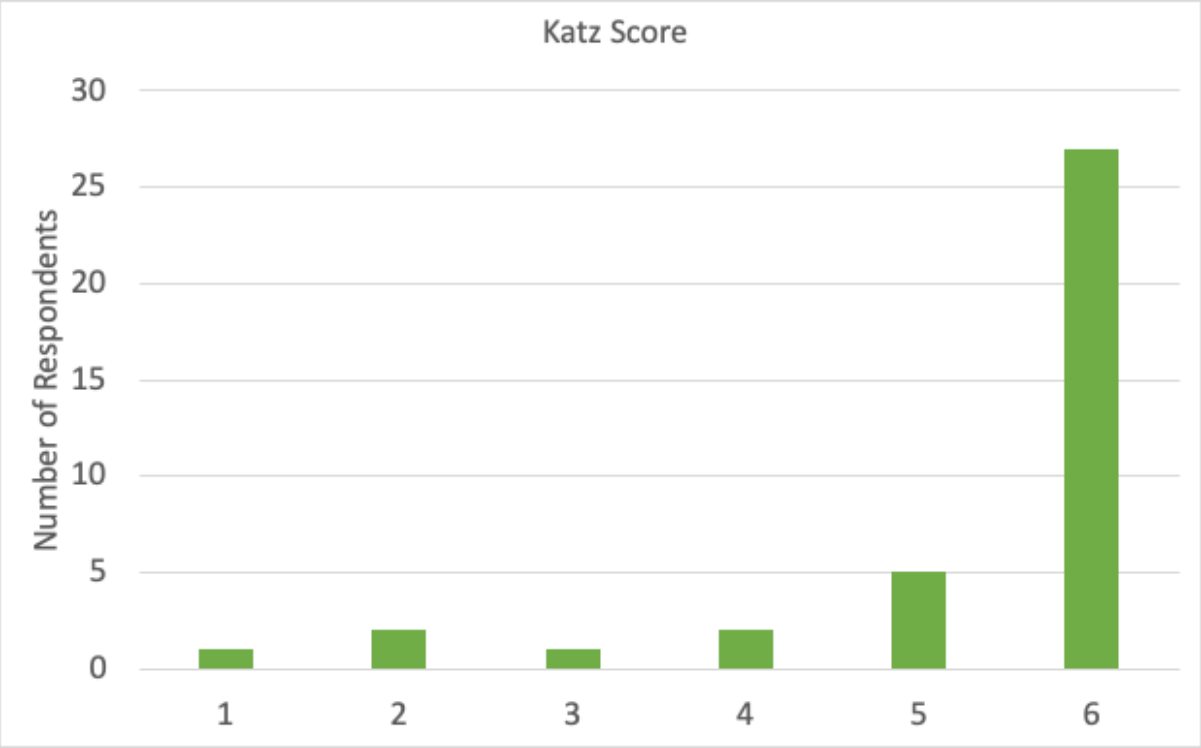

Figure 1: X axis denoting Katz Scoring 1-6 with Y axis showing number of respondents who attained that score.

Karnofsky Performance Scale:

On the Karnofsky Scale, 31(82%) participants scored between 60 and 80, suggesting reduced

capacity for active work and function below previous normal activity but adequate independence for self-care. 19 participants (56%) scored ≤70, reflecting limited functional capacity and inability to resume active work. Only 2 patients (5%) achieved a score of 100, signifying full recovery, while 4 (11%) scored ≤50, indicating severe disability requiring significant medical support. The distribution of Karnofsky scores is depicted in *Figure 2*.

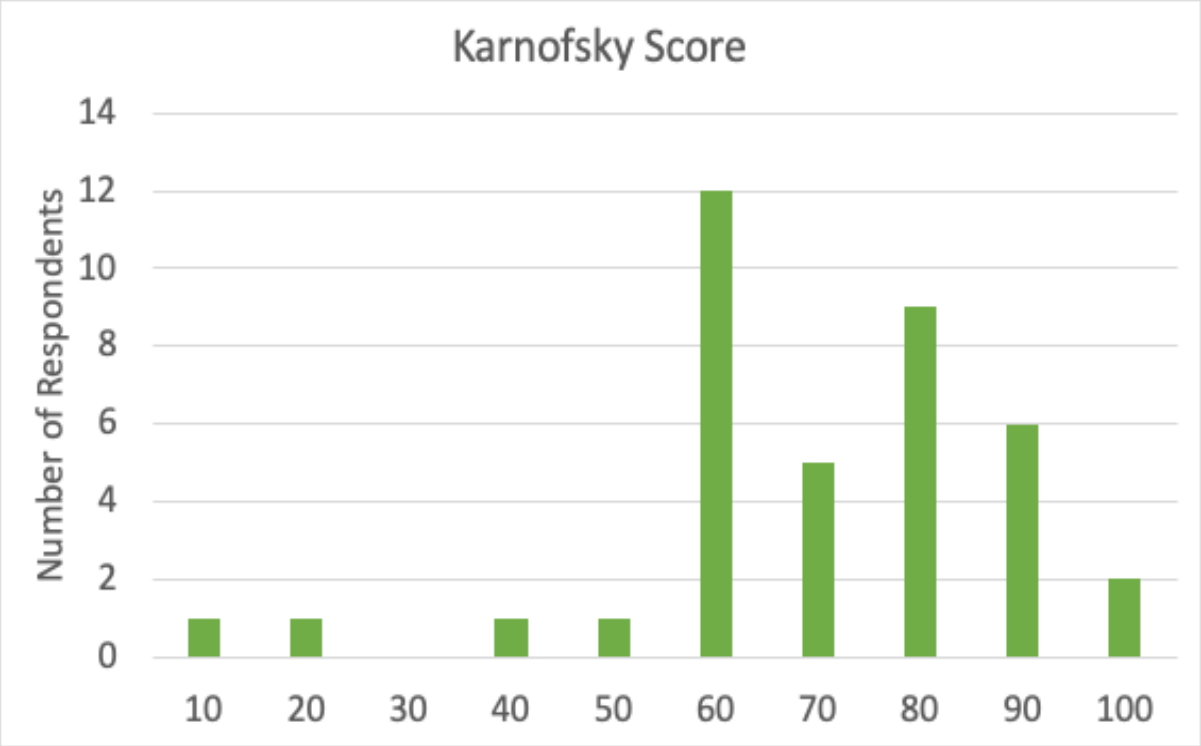

Figure 2: X axis denoting Karnofsky scoring 10-100. Y axis denoting number of respondents who attained that score.

Respiratory Symptoms

We used a simplified version of the ATS Respiratory Questionnaire to assess burden of respiratory symptoms including cough/wheeze/recurrent chest infections and requirement for long term oxygen. Respiratory dysfunction was prominent. Chronic cough affected 20 participants(52%), while 17(45%) experienced chronic wheeze. Recurrent chest infections were reported by 9 participants(24%). 1 patient required long-term oxygen therapy. Persistent breathlessness, assessed via the mMRC Dyspnoea Scale, was reported by 27(71%) participants. 12 patients (32%) had a dyspnoea score of 3, indicating breathlessness after walking less than 100 meters on flat ground. 8 participants (21%) reported breathlessness only during strenuous exercise (score 0), and 3 (8%) were too breathless to leave their house (score 4). The distribution of mMRC Dyspnoea Scale scores is illustrated in *Figure 3*.

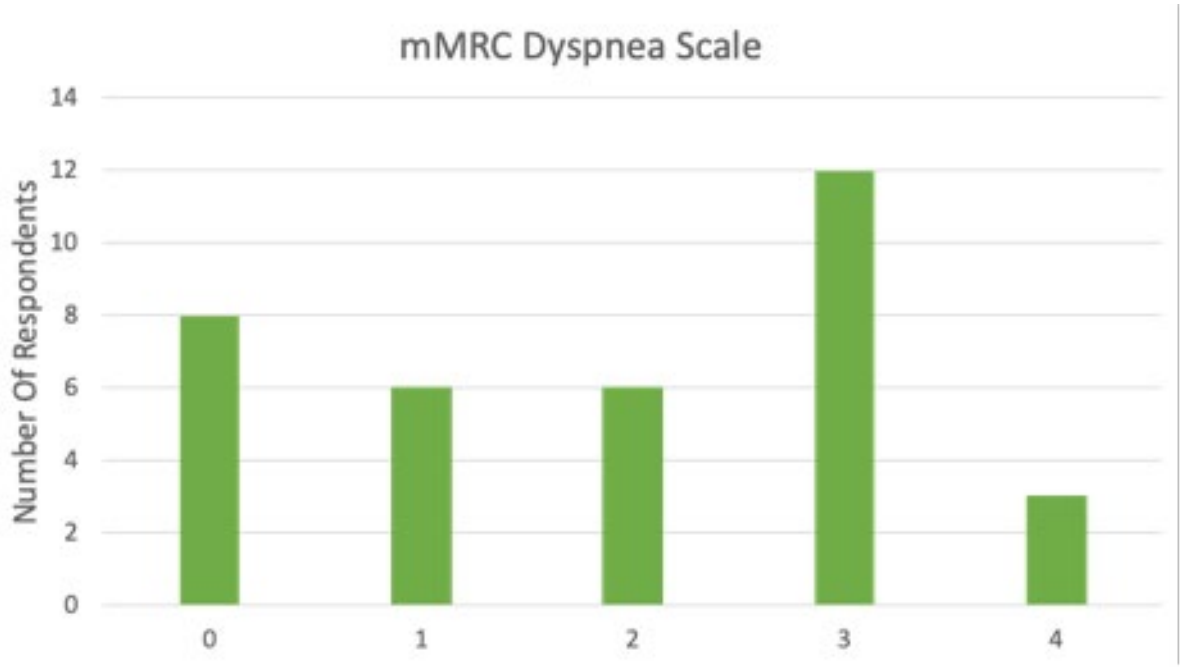

Figure 3: X axis denoting mMRC Dyspnoea Grading 0-4. Y axis denoting number of participants who attained that score.

Other Symptoms

Participants frequently reported additional symptoms, including fatigue, cognitive dysfunction ("brain fog"), neuropathic pain, and gastrointestinal issues. Many described sensory impairments, such as hearing or vision loss. Fatigue was nearly universal, significantly impacting daily routines. Several participants self-reported diagnoses of Long COVID Syndrome by their general practitioners or independently identified with the term.

Discussion

This study evaluated long-term functionality and disability in ICU survivors admitted during the COVID-19 pandemic. While many regained independence in basic activities of daily living (ADLs), a significant proportion exhibited persistent impairments in advanced ADLs, such as active work and exercise, up to two years after discharge. Fatigue and respiratory symptoms, especially breathlessness, were prevalent, with 71% of participants reporting dyspnoea. Cognitive dysfunction ("brain fog"), neuropathic pain, and gastrointestinal disturbances were also frequently noted, and many participants self-identified as having Long COVID Syndrome. These findings underscore the severe and enduring burden of critical illness and its post-recovery sequelae, emphasizing the importance of structured follow-up and rehabilitation for ICU survivors.

Functional recovery after ICU admission is increasingly recognized as a critical component of patient outcomes, particularly as ICU mortality has declined in recent decades[15]. Longitudinal studies consistently show that ICU survivors experience a reduced quality of life (QOL) compared to the general population, with impairments persisting for many years[16,17]. Many of these studies were performed prior to the arrival of COVID-19 pandemic. We believe it is important to attempt to quantify the functional outcomes of the large cohort of patients who were treated for severe COVID-19 in Intensive Care Units worldwide. This data may allow us to make comparisons to previous data carried out on general Intensive Care populations or compare to well researched Intensive Care sub-groups such as patients treated for Acute Respiratory Distress Syndrome(ARDS).

In our study, 84% of participants achieved near-full independence in basic ADLs, yet 56% remained unable to resume active work or engage in higher-level functional activities at follow-up. This finding aligns with previous research by Kamdar et al., which reported that 66% of ICU survivors were unable to return to work three months after discharge, and 33% were still out of work five years later[18]. The functional limitations observed in our cohort, which have been echoed in similar studies investigating severe Covid-19 infection, highlight the prolonged nature of recovery for survivors[19,20].
The physical and functional impairments observed in our cohort reflect the complex interplay of factors that contribute to post-ICU morbidity.
Post-Intensive Care Syndrome (PICS), a constellation of physical, cognitive, and psychological deficits that often persist after ICU discharge, has been extensively described in the literature[21]. While PICS is not unique to COVID-19, the pathophysiological effects of SARS-CoV-2, including prolonged systemic inflammation, microvascular injury/microthrombi and direct organ damage, may exacerbate its severity. COVID-19-specific PICS could represent a distinct subgroup due to the unique impact of the virus on the pulmonary, neurological, and cardiovascular systems. Moreover, the sheer number of ICU admissions during the pandemic presents an unprecedented challenge for healthcare systems to address the long-term needs of this population.

Respiratory symptoms, including chronic cough (52%), wheeze (45%), and dyspnoea, were highly prevalent in this study. Breathlessness was often debilitating, with 32% of participants reporting a modified Medical Research Council (mMRC) Dyspnoea Scale score of 3, indicating breathlessness after walking less than 100 meters, and 8% reporting a score of 4, indicating severe dyspnoea that limited them to their homes. Zheng et al noted up to 41% of patients were found to have some degree of persistent breathlessness, when using the mMRC scale, in a recently published systematic review of COVID-19 patients which included non-hospitalized populations[22].

Many of our patients had severe hypoxic respiratory failure characterised by prolonged inflammatory reactions causing diffuse lung damage. They often required prolonged periods of ventilation or Non-Invasive ventilation in poorly compliant lungs contributing to further inflammation and Ventilator induced Lung Injury(VILI). On follow up of survivors of previous Coronavirus epidemics including SARS(Severe Acute Respiratory Syndrome) and MERS(Middle East Respiratory Syndrome) pulmonary functions tests have shown reduced diffusion capacity and vital capacity, findings consistent with fibrotic changes[23]. We believe our cohort likely has some degree of ongoing interstitial lung disease contributing to the level of dyspnoea observed. With the large number of patients that required hospitalisation or Intensive Care during the years of the pandemic in Ireland, we hypothesise that there may be a large number of patients with unrecognised interstitial lung disease that may present acutely in the future.

Cognitive and psychological impairments were also prominent in our cohort, with many participants reporting cognitive dysfunction, fatigue, and symptoms consistent with PICS. These findings align with prior research documenting persistent neurocognitive deficits among ICU survivors[20]. Cognitive impairments, colloquially referred to as "brain fog," may result from multiple factors, including hypoxia, systemic inflammation, and direct effects of SARS-CoV-2 on the central nervous system. Fatigue, which was nearly universal among our participants, further compounded the burden of disability, limiting patients' ability to engage in daily activities and hindering recovery. This aligns with reports from other studies, which have highlighted the pervasive and multifactorial nature of fatigue in COVID-19 survivors[21]. Addressing these deficits requires a multidisciplinary approach, integrating physical therapy, cognitive training, and psychological support to optimize outcomes.

A significant gap in follow-up care was evident in this study, with many participants lacking engagement with post-discharge healthcare services. Guidelines from the British Thoracic Society recommend routine follow-up for survivors of severe COVID-19, including imaging and pulmonary function tests at three months. This aims to help identify and manage complications such as pulmonary fibrosis, thromboembolic disease, or respiratory insufficiency[24]. Enhanced care pathways and better coordination between primary care providers, specialists, and rehabilitation teams are essential to ensuring timely diagnosis and management of these complications. In our cohort, delayed follow-up or lack of engagement likely contributed to the persistence of untreated symptoms, emphasizing the need for robust systems of post-ICU care which currently do not exist nationally.

The importance of structured rehabilitation programs cannot be overstated. Rehabilitation should address the physical, respiratory, and cognitive impairments that commonly affect ICU survivors. Structured respiratory rehabilitation programs, which include breathing exercises, physical activity, and education, have demonstrated efficacy in improving dyspnoea and overall quality of life across a range of conditions, including post-COVID-19 syndrome[22]. For patients with significant cognitive or psychological impairments, integrating cognitive training

and psychological support into rehabilitation programs is critical to addressing the multifaceted needs of this population. Multidisciplinary rehabilitation programs, tailored to the specific deficits of each patient, represent the best approach to improving long-term outcomes in ICU survivors.

Our findings also underscore the need for further research to better understand the long-term effects of severe COVID-19 and the mechanisms underlying persistent symptoms. For instance, the role of SARS-CoV-2 in inducing long-term systemic inflammation, its effects on neurocognitive function, and its contributions to respiratory dysfunction warrant further investigation

Although the severity of illness associated with COVID-19 has greatly reduced with the introduction of widespread vaccination and less virulent strains we believe follow up studies such as our own can help us learn information for future pandemics. Although survival is an important outcome, large studies which analyse specific interventions among different sub-groups and then compare them with functional outcomes can give us huge amounts of valuable information for improving patients quality of life post ICU admission. We believe this information will be useful not only for COVID-19 but for other diseases commonly treated in Intensive Care.

We highlight the local burden of ongoing chronic lung disease which may be prevalent within survivors of severe COVID-19. We believe this information may be informative for clinicians who may encounter these patients presenting acutely in the future as the knowledge of underlying interstitial lung disease may have a beneficial role in both management and prognostication.

This study had several limitations. Difficulties in recruiting adequate numbers of participants limited us to basic descriptive statistics and inability to quantify or analyse sub groups within our cohort. Patients were also assessed at different time periods from ICU discharge depending on time of admission so evolution over time may have improved functionality scores in some participants.

Severe COVID-19 resulted in high mortality and substantial long-term impairments among ICU survivors. At least one year post-discharge, many patients continued to experience significant physical, respiratory, and cognitive limitations, with fatigue and breathlessness being the most prominent complaints. Structured follow-up and multidisciplinary rehabilitation are critical to addressing these persistent effects and improving long-term outcomes.

Declarations of Conflicts of Interest:

None declared.

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Appendix

1. Katz Index of Independence in Activities of Daily Living

Katz Index of Independence in Activities of Daily Living

Activities Points (1 or 0)	**Independence** (1 Point) **NO** supervision, direction or personal assistance.	**Dependence** (0 Points) **WITH** supervision, direction, personal assistance or total care.
BATHING Points: _____	**(1 POINT)** Bathes self completely or needs help in bathing only a single part of the body such as the back, genital area or disabled extremity.	**(0 POINTS)** Need help with bathing more than one part of the body, getting in or out of the tub or shower. Requires total bathing
DRESSING Points: _____	**(1 POINT)** Get clothes from closets and drawers and puts on clothes and outer garments complete with fasteners. May have help tying shoes.	**(0 POINTS)** Needs help with dressing self or needs to be completely dressed.
TOILETING Points: _____	**(1 POINT)** Goes to toilet, gets on and off, arranges clothes, cleans genital area without help.	**(0 POINTS)** Needs help transferring to the toilet, cleaning self or uses bedpan or commode.
TRANSFERRING Points: _____	**(1 POINT)** Moves in and out of bed or chair unassisted. Mechanical transfer aids are acceptable	**(0 POINTS)** Needs help in moving from bed to chair or requires a complete transfer.
CONTINENCE Points:	**(1 POINT)** Exercises complete self control over urination and defecation.	**(0 POINTS)** Is partially or totally incontinent of bowel or bladder
FEEDING Points: _____	**(1 POINT)** Gets food from plate into mouth without help. Preparation of food may be done by another person.	**(0 POINTS)** Needs partial or total help with feeding or requires parenteral feeding.
TOTAL POINTS: _____	**SCORING:** 6 = High (*patient independent*)	0 = Low (*patient very dependent*

Source: The Hartford Institute for Geriatric Nursing, New York University, College of Nursing

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2. The Karnofsky Performance Status Scale

Performance status		
Definition	**%**	**Criteria**
Able to carry on normal activity and to work. No special care is needed.	100	Normal; no complaints; no evidence of disease
	90	Able to carry on normal activity; minor signs or symptoms of disease.
	80	Normal activity with effort; some signs or symptoms of disease.
Unable to work. Able to live at home, care for most personal needs. A varying amount of assistance is needed.	70	Cares for self. Unable to carry on normal activity or to do active work.
	60	Requires occasional assistance, but is able to care for most of his needs.
	50	Requires considerable assistance and frequent medical care.
Unable to care for self. Requires equivalent of institutional or hospital care. Disease may be progressing rapidly.	40	Disabled; requires special care and assistance.
	30	Severely disabled; hospitalisation is indicated although death not imminent.
	20	Very sick; hospitalisation necessary; active supportive treatment necessary.
	10	Moribund; fatal processes progressing rapidly.
	0	Dead.

Source: Timmermann C. 'Just give me the best quality of life questionnaire': the Karnofsky scale and the history of quality of life measurements in cancer trials.

3. Modified Medical research Council Dyspnoea Scale

The modified MRC Scale

Description	Grade
I only get breathless with strenuous exercise	0
I get short of breath when hurrying on level ground or walking up a slight hill	1
On level ground, I walk slower than people of my age because of breathlessness, or I have to stop for breath when walking at my own pace on the level	2
I stop for breath after walking about 100 yards or after a few minutes on level ground	3
I am too breathless to leave the house or I am breathless when dressing/undressing	4

Source: Mahler DA, Wells CK. Evaluation of clinical methods for rating dyspnea. Chest 1988; 93: 580-58
https://www.pcrs-uk.org/sites/default/files/resources/MRC-Score.pdf