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Predicting Physical Function and Health Related Quality of Life Following Intensive Care

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Abstract

Objective: This study investigated how well the Functional Comorbity Index (FCI) predicts patient reported physical function compared with objective physical function measures, return to home and health related quality of life (HRQoL) of survivors of a general intensive care unit (ICU) cohort at 12 months post ICU discharge. This study also investigated how well ICU physiotherapists and physicians predict mortality, return to home and HRQoL of survivors at 12 months post ICU discharge.

Design: Prospective observational cohort study nested within a larger trial. FCI calculated at ICU admission and compared with patient reported physical function (SF36 version 2 Physical Component Score) and objective physical function measures (Six-Minute Walk Test, Timed Up and Go) at 12 months. ICU clinicians completed a four-item questionnaire at patient discharge from ICU predicting mortality, return to home and HRQoL and these were compared with 12-month patient outcomes.

Setting: 18-bed closed mixed medical/surgical, tertiary ICU in a university teaching hospital in Melbourne, Australia.

Participants: 34 ICU patients. 11 ICU clinicians (5 physicians and 6 physiotherapists) who were caring for the patients on day of discharge from ICU.

Results: The correlations between the FCI and 12-month objective measures of physical performance were small (6MWT rho 0. 02, TUG rho 0. 15). The FCI had a large correlation with patient reported physical function (SF36 version 2 rho -0. 60). The sensitivity of the physicians' predictions for mortality was the highest [83% (78-91%)], whilst the physiotherapists' predictions had the greatest specificity [100% (89-100%)]. All clinicians were comparable in their predictions of who would return home. Physicians were more accurate than physiotherapists in predicting future HRQoL (p=0. 04).

Conclusions: We conclude the FCI predicts patient reported physical function better than objective physical function measures. Intensive care physiotherapists and physicians have a variable ability to predict longer term outcomes for their patients and larger studies are needed to further evaluate this.

Keywords: Physical function; Health related quality of life

Introduction

Improved survival from critical illness has focused the attention of patients, families and clinicians on the importance of future health related quality of life (HRQoL) and functional outcome following an intensive care unit (ICU) admission [1,2]. Evaluating a patient's premorbid physical function and HRQoL status is important as it assists understanding of potential return to functional levels, independence and societal participation and can may be used as a predictor of outcome in for these important patient reported outcomes [3]. This information can assist ICU physicians and physiotherapists in establishing and directing the most appropriate level of medical and rehabilitative therapy to patients whilst in the ICU and after discharge. Survivors are reported to experience significant impairments in physical function and report a lower HRQoL prior to and following their ICU stay [4-7]. The provision of rehabilitation in intensive care may improve these outcomes [8,9]. However, health care resources are limited and not all patients may benefit from the provision of on-going rehabilitation [8], therefore identifying patients whose outcomes could be optimised by rehabilitation is important.

Establishing the premorbid physical function and HRQoL status of intensive care patients is difficult. Due to patient acuity and the intensive care environment, patients are often unable to speak for themselves. Clinicians are reliant on a variety of secondary information sources which may or may not accurately represent the patients' views of their premorbid status [10]. It is not possible to objectively measure physical function and HRQoL patients prior to their ICU admission. Premorbid HRQoL is commonly measured retrospectively once the

patient is awake in ICU, which may limit the validity of these measures [11,12]. The Functional Comorbidity Index (FCI) [13] may be a new approach to objectively predicting physical function and HRQoL outcomes following intensive care. The use of the FCI in ICU may assist physiotherapists in their clinical decision-making and promote targeted early rehabilitation.

The FCI was designed to predict physical function outcomes and can be used to adjust for the effect of comorbidity on physical function [13]. Measuring baseline comorbidity is important to evaluate the contribution of critical illness and subsequent interventions to the longer term health outcomes of patients [14]. It is also important at an individual patient level in establishing success of intensive care and rehabilitation therapies. The FCI has been validated against patient reported physical function measures using the physical component score (PCS) of the Short-Form 36 (SF-36) in Acute Respiratory Distress Syndrome (ARDS) [15] and Acute Lung Injury (ALI) populations [16].

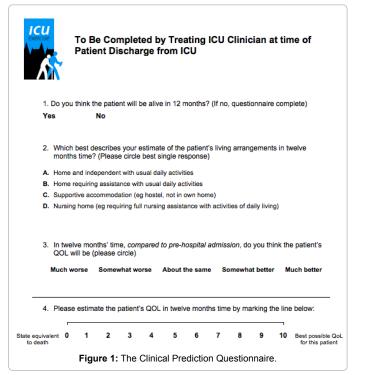The primary aim of this pilot study was to investigate how well

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Figure 1: The Clinical Prediction Questionnaire.

the FCI predicts patient reported physical function compared with objective performance measures of physical function, return to home and HRQoL of survivors of a general ICU cohort at 12 months post ICU discharge. The secondary aim was to investigate how well ICU physiotherapists and physicians predict mortality, return to home (as a surrogate of physical function) and HRQoL of survivors of ICU at 12 months post ICU discharge.

Materials and Methods

Design and setting

This prospective observational cohort study was nested within a larger randomised controlled trial (RCT) [17] which investigated the efficacy of a comprehensive rehabilitation intervention on HRQoL and physical function. The RCT was conducted in a closed 18 bed medical/surgical, quaternary ICU in a teaching hospital in Melbourne, Australia, between May 2007-August 2010. This nested study used the last thirty-four patients from the RCT as a sample of convenience, commencing in January 2009 with recruitment of Participant 118 and finishing in August 2009 at Participant 151, upon completion of recruitment for the larger RCT. Ethical approval was gained from the Institutional Human Research Ethics Committee for the current study. Written informed consent was gained from participants.

Participants

There were two participant groups for this study – the patients from the larger RCT and the ICU clinicians.

The eligible patients recruited for the RCT met the follow inclusion criteria: i) age >18 years, ii) ICU length of stay>5 days, iii) able to understand written and spoken English, iv) reside in greater Melbourne defined as within a radius of 50 km from Austin Health in Heidelberg (as they were required to attend outpatient rehabilitation following hospital discharge) and v) the intensive care specialist agrees to their participation. An ICU length of stay >5 days was deemed to represent patients with a 'prolonged ICU stay' [17].

Eligible participants in the current study comprised ICU physiotherapists and physicians who were caring for the patients in the original study at the time of ICU discharge. Physicians were included for the purposes of comparison with physiotherapist as the physicians are ultimately responsible for decision making with regard to ICU care. There were no specific exclusion criteria for clinicians.

Procedure

Once the patient was recruited into the RCT, patient demographic and comorbidity data were collected by the investigator using the patient's medical history admission notes. The FCI score was calculated using the collected comorbidity data and scored as originally described where the score is the sum of all comorbidities according to the index [13].

On the day of patient discharge from ICU, the current study was explained to the ICU physician and physiotherapist caring for the patient and they were invited to participate. The Clinician Prediction Questionnaire (detailed below) which asked the clinicians to predict mortality, discharge destination and HRQoL, were distributed to the clinicians in the ICU and returned via mail. Consent was assumed if the questionnaire was completed. To ensure the integrity of the data, all participants completed the questionnaire independently.

Outcome Measures

The Clinician Prediction Questionnaire: A four item prediction questionnaire (Figure 1) was initially developed by the investigators who were a team of experienced ICU clinician researchers. The questionnaire was sent to other ICU physicians and physiotherapists for review at our institution and their feedback was incorporated to ensure the questionnaire was easily understood and feasible to complete at the patient bed-side. The questionnaire was then piloted by two physicians and two physiotherapists in the ICU [18,19]. Clinician The questionnaire included aspects of outcome measures previously validated in ICU populations [20,21] where possible but was primarily designed to assess the subjective predictions made by the clinicians.

Item one asked clinicians to predict whether they thought the patient would be alive or deceased at one year post ICU discharge. If they predicted the patient would be deceased the questionnaire was completed.

Item two asked clinicians to predict the whether the patient would return home independently or require assisted living at one year post ICU discharge based upon their assessment of the patient during ICU. This question was devised as a surrogate for physical function to assist clinicians (particularly the physicians) in conceptualising levels of physical function required for various levels of independent or assisted living.

Item three asked clinicians to estimate (on a Likert scale), the patient's predicted one year HRQoL compared to their pre-morbid HRQoL. This was based upon the health transition item, the second question of the SF-36 v2(20).

Item four asked clinicians to mark on a visual analogue scale (range 0-10) their prediction of the patient's future HRQoL at one year post ICU discharge. This was based upon the utility score of the AQoL.

The Functional Comorbidity Index: The FCI is an 18 item, diagnosis based index containing co-morbid diseases such as depression and arthritis, where one point is given for each diagnosis and the final score is the sum of the items [13] (Table 1). The FCI was developed with physical function as the outcome of interest as previous comorbidity

	Items
1	Arthritis
2	Osteoporosis
3	Asthma
4	COPD, ARDS
5	Angina
6	Congestive heart failure or heart disease
7	Heart attack
8	Neurological disease
9	Stroke/TIA
10	Diabetes types 1 and 2
11	Peripheral vascular disease
12	Upper gastrointestinal disease
13	Depression
14	Anxiety or panic disorders
15	Visual impairment
16	Hearing impairment
17	Degenerative disc disease
18	Obesity and/or BMI of >30kg/m2

Table 1: The Functional Comorbidity Index(13).

indices such as the Charlson Comorbidity Index (CCI) have been designed to predict 12 month mortality and include diagnoses more relevant to mortality and less relevant to physical function outcomes. The FCI has been compared with the CCI in an Adult Respiratory Distress Syndrome (ARDS) population finding the FCI was moderately correlated with the SF36 PCS up to 12 months whereas the CCI score was not. The FCI is completed when the patient is admitted to ICU using the comorbidity diagnoses documented in their medical chart/record [13,15].

Physical Function: Physical function was measured as part of the larger RCT (17) at baseline (when patient was first able to complete in ICU), 3, 6 and 12 months post ICU discharge. For the purposes of this study we elected to make comparisons with short term (baseline in ICU) and long term (12 months) performance based physical outcome measures. The following short term objective tests used for comparison were the Physical Function in Intensive care Test (PFIT) [22] and the Medical Research Council Manual Muscle test (MRC). The longer term tests used for comparison were the six minute walk test (6MWT) [23] and Timed Up and Go test (TUG) [24]. Patient reported physical function was measured using the Physical Component Score of the Short Form 36 version 2 (SF36 v2) [20] (detailed below) which comprises of 10 items asking the patient to rate their ability to perform physical tasks such as walking varied distances, climbing stairs, carrying groceries, bathing and dressing.

Health Related Quality of Life: HRQoL was measured as part of the larger RCT [17] at baseline (as a "then" test), 3, 6 and 12 months post ICU discharge using the Short Form-36 v2 (SF36 v2) and Assessment of Quality of Life (AQoL). For the purposes of this study, we used the 12 month outcome measures of HRQoL for comparison with the FCI as this was the time point we were asking the clinicians to make their predictions for HRQoL. The SF36 v2 is a generic HRQoL instrument with 8 subscales (physical functioning, role physical, bodily pain, general health, vitality, social functioning, role emotional, mental health) and is a reliable and valid measure of health related quality of life in survivors of ICU [20,25]. The AQoL is a generic health, multi-attribute utility instrument comprising of fifteen items in 5 dimensions (illness, independent living, social relationships, physical senses, psychological well-being) giving a score between 0 and 1 where 0 is a death equivalent state and 1 represents best possible quality of life [21].

Other patient outcomes: Patient demographics and return to home/independent living status at 12 months post ICU were also collected in the larger study [17].

Statistical analyses

Correlation of the FCI with physical function (measured using the MRC, PFIT, 6MWT, TUG and PCS of the SF-36 v2) and HRQoL (AQoL utility score) was tested using Spearman's rho and the strength of correlation was considered according to Cohen: r=0.10-0.29 small, r=0.30-0.49 moderate, r=0.50-1.0 large [26]. The prediction success of categorical variables such as mortality (Item 1 of the questionnaire) and discharge destination (Item 2 of the questionnaire), were analysed using the McNemar-Bowker test. The Wilcoxon Signed Ranks Test was used to analyse health transition and change over time for quality of life, using the SF-36 v2 health transition score [1,20] and AQoL utility score [21] (Item 3 and 4 of the questionnaire). Imputation of missing data was undertaken using the last observation carried forward method [27]. Statistical analysis was performed using IBM® SPSS® Statistics, Version 20 (Chicago, Illinois, USA). Data are reported as median [IQR] unless otherwise specified. Tests were two tailed and statistical significance was accepted at $p < 0.05$.

Results

Patient demographics

Thirty four patients were included in this study and their demographics are presented in Table 2. Briefly, the patients had a median [IQR] age of 62.5 (47-77), were mostly male, were moderately unwell as represented by the Acute Physiology and Chronic Health Evaluation (APACHE) II score and most were still receiving mechanical ventilation at day five of their admission. The median [IQR] for the FCI (score out of 18 where low is better) was 2.5 (1-4).

Clinician demographics

Five senior intensive care physicians and six physiotherapists participated in the study. The physicians individually had more than 10 years' experience and the physiotherapists had four months to three years' experience (except one who had seven years' experience). The intensive care physicians were all male, the physiotherapists all female. The levels of experience of physiotherapists were reflective of current ICU staff demographics for physiotherapists in the public hospital sector in Australia [28].

A total of 61 questionnaires were completed by clinicians out of a possible 68 (90%). Twenty-nine questionnaires were completed by the physicians and 32 by the physiotherapists. Correlation of the Functional Comorbidity Index with measured physical function tests and patient

Total patients n=34	Median [IQR]
Age	62.5 [47-77]
Gender (male), n (%)	22 (65)
BMI	27.5 [23-31]
APACHE II	19 [17-25]
Medical/Surgical, n (%)	19/15 (56/44)
Ventilated day 5? (Yes/No)	22/12
Mechanical ventilation hours	122.8 [66-222]
ICU length of stay (days)	9 [6-15]
Acute hospital length of stay (days)	27 [19-43]
Alive at 28 days? (Yes/No)	33/1
FCI (score out of 18)	2.5 [1-4]

Data are median [IQR] unless otherwise specified

Table 2: Demographics of the patient cohort.

	Sensitivity (95% CI)	Specificity (95% CI)
Mortality at 1 year		
Physicians	83% (78, 91%)	96% (36, 100%)
Physiotherapists	50% (12, 88%)	100% (89, 100%)
Return to home at 1 year		
Physicians	88% (53, 98%)	100% (84, 100%)
Physiotherapists	50% (23, 78%)	96% (79, 99%)

Table 3: The success of clinician's predictions for mortality and discharge destination at one year (Item one and two of questionnaire).

	Total patients n = 34	Predictions of physicians			Predictions of Physiotherapists		
		Predicted Alive	Predicted Deceased	Missing	Predicted Alive	Predicted Deceased	Missing
Actual patients alive	28	22	1	5	26	0	2
Actual patients deceased	6	1	5	0	3	3	0

Table 4: Clinician's predictions of mortality compared with actual patient mortality status at one year post ICU discharge.

reported physical function.

Performance based physical function tests

The correlations between the FCI and measured patient physical performance function tests were small, as follows:

Outcome	n	Rho	p value
Baseline Physical Function PFIT at ICU DC	25	0.15	0.49
MRC at day 7 of awakening in ICU	20	-.05	0.83
Long term Physical Function 6MWT (12 months)	27	0.02	0.94
TUG (12 months)	25	0.15	0.47

Correlation of the Functional Comorbidity Index with patient reported physical function, HRQoL mortality and return to home

There was a large correlation [26] between the FCI and the 12 month SF-36 v2 PCS (rho=-0.60 (n=26) p=0.001). There was a moderate [26] correlation between the FCI and the AQoL utility score (rho=-0.43 (n=30) p=0.02) at 12 months. The correlation between the FCI and other 12 month outcomes such as patient mortality and return to home status, were small [26] with a rho of 0. 29 (p=0.09) and 0.19(p 0.28) respectively.

The clinician prediction questionnaire

Item One - Prediction of mortality: The sensitivity and specificity for the physiotherapists' and physicians' predictions for mortality at one-year are reported in Table 3. The sensitivity of the physicians' predictions for mortality was the highest whilst the physiotherapists' predictions had the greatest specificity.

Agreement between physiotherapists and physicians for prediction of mortality at one year

The clinicians' predictions of mortality and the patients' outcomes of mortality at one year are reported in Table 4. At one year, 28 (82%) patients were alive and 6 (18%) patients were deceased. Physicians predicted the highest number of patients would be deceased whilst the physiotherapists predicted the higher number of patients who would be alive at one year.

Patients alive at one year (n=28): Of these 28 patients who were alive, the two disciplines did not concurrently predict for the same patients that they would be deceased at one year. Therefore agreement between disciplines was unable to be calculated using the McNemar-Bowker's test as there were no available predictions on the same patients to compare between the disciplines (Table 4).

Patients deceased at one year (n = 6): Of the six patients who were deceased, the physicians predicted on five occasions that the patient would be deceased compared to the physiotherapists who predicted this correctly on three occasions (*p*=0.5) (Table 4).

Item 2 - Prediction of discharge destination: The sensitivity and specificity for the physiotherapists' and physicians' predictions for discharge destination at one-year are reported in Table 3. The physicians' predictions had the highest sensitivity whilst physiotherapists were comparable in their ability to predict those patients who would return home with a high degree of accuracy (Table 3).

Agreement between physiotherapists and physicians for prediction of discharge destination at one year

The clinicians' predictions of discharge destination and the patients' outcomes of discharge destination at one year are reported in Table 4. At one year following ICU discharge, 25 (74%) patients had returned home, 8 (24%) patients had not and one (2%) patient was lost to follow up.

Patients who returned home at one year (n=25): Of these 25 patients who returned home, the physicians predicted all of these patients would return home, therefore the McNemar-Bowker's test was unable to be calculated for comparisons with the physiotherapist (Table 4).

Patients who did not return home at one year (n=8): Of these eight patients who did not return home, physicians predicted on seven occasions that the patient would not return home compared to the physiotherapists who predicted this on four occasions (p=0.25) (Table 4).

Item 3 – Prediction of HRQoL transition: The Wilcoxon Signed Ranks Test demonstrated that there was no statistical difference between the physicians prediction of change in HRQoL over time (health transition) compared to physiotherapists (p=0.06).

Item 4 – Prediction of future HRQoL: The Wilcoxon Signed Ranks test demonstrated that physicians were more accurate than physiotherapists in predicting future HRQoL (p=0.04).

Discussion

This is the first study, to compare the FCI with both performances based and patient reported measures of physical function. This study demonstrates that the FCI correlates poorly with short and long term (12 months) performance based measures of physical function in a general cohort of survivors of ICU. Instead, this study found the FCI had

	Predictions of Physicians				**Predictions of Physiotherapists**		
	Total patients n = 34	Predicted to return home	Predicted to not return home	Missing	Predicted to return home	Predicted to not return home	Missing
Actual patients who returned home	25	20	0	5	22	1	2
Actual patients who did not return home	8	1	7	0	4	4	0
Missing	1	1	0	0	1	0	0

Table 5: Clinician's predictions of discharge destination compared with actual patient discharge destination at one year post ICU discharge.

high correlation with patient reported outcomes of physical function as measured by the SF36 PCS. Similar to previous studies, the FCI correlated with patient reported physical function but did not correlate with direction measures of physical function such as the 6MWT. It is useful to consider these outcomes in the context of the World Health Organization's (WHO) International Classification of Functioning, Disability and Health (ICF) [29] as a conceptual framework as suggested by Iwashyna and Netzer [30] and Herridge et al. [31]. This framework describes impairments that can occur in the critically ill at the tissue level, which can cause activity limitations in functional tasks. These limitations can then result in restrictions in participation that lead to disability. Within this conceptual framework, the ICF distinguishes between how a patient performs under test conditions (*limitations*) and what they perform in their usual daily environment (*disability*) [30]. The subsequent perception of this disability and adaptation to it is reflected in the patient's report of HRQoL (30). The results of this study indicate that the FCI correlates poorly with the objective tests of physical function such as the 6MWT and TUG test which are performed under test conditions reflecting the patients' *limitations*. Comparatively, the results from this study support the findings of others (15, 16) where the FCI correlates well with patient reported physical function, indicating that the higher the FCI score on ICU admission, the poorer their future physical function or *disability* will be that is reflected in their report of HRQoL. It could be argued that the performance based physical function tests may be a more accurate representation of the patient's physical capacity than what they report in measures such as the SF36 PCS or alternatively that they reached a ceiling effect on the 6MWT (Alison et al, 2012). However, from a patient's perspective their adaptation to their limitations and perception of disability as reflected in their report of HRQoL may be more meaningful.

This study is also the first to investigate the use of the FCI in a general ICU cohort. These results suggest the FCI may also be applicable in a general critical care population and not solely ARDS or ALI populations as previously studied [15,16] although warrants further validation in a larger general ICU cohort. The correlation observed between the FCI and physical function in our study was higher than a previous study of an American ARDS population [15] where the correlation between one year SF-36 v2 PCS and FCI was moderate (r= -0. 426) despite the FCI scores being similar. This difference may be attributable to demographical differences, as our study had an older generic ICU population than the younger, ARDS population studied by Groll et al. [15]. Use of the FCI to assess pre ICU comorbid disease may help to control for the unknown patient recovery trajectory and could be used in analyses as a covariate.

Evidence is growing for rehabilitation commencing early in the ICU to attenuate the reduction in physical function and HRQoL [32,33] although it is unknown which patients may benefit most from early targeted rehabilitation [34]. The results of this study indicate that ICU clinicians were variable in their ability to predict longer term outcomes for their patients as demonstrated by the wide confidence intervals although the ICU physicians were more accurate than the physiotherapists. Working within the interdisciplinary team, physiotherapists could use this prediction information to assist in the early identification of patients in whom it would be advantageous to direct early rehabilitative strategies toward to potentially hasten their trajectory of recovery [35]. The increased accuracy of the physicians' predictions compared to the physiotherapists may be attributable to their substantially greater experience although this sample of physiotherapists were representative of current clinical practice in Australian tertiary intensive care units [28]. The physicians may have possessed advanced understanding of the ICU disease processes impacting upon patients and this knowledge may be a critical factor in outcome prediction although requires further investigation. The FCI may be useful complementary tool to assist in this decision making process as a measure of baseline comorbidities. Further research is required in a larger cohort of patients to investigate the predictive ability of clinicians and to compare the FCI with the clinicians' predictions.

A key limitation of this study is its single centre design and small sample size and conducting a nested study within an RCT which significantly narrowed the population available to study. An alternative approach would have been to apply the FCI and clinician predictions to all 150 patients of the larger RCT rather than the small subset of patients. This would allow the predictions and the FCI to be more generalizable and is an important consideration in the design of future trials investigating prediction of outcome. Another limitation in the study design was using experienced consultant physicians as participants rather than a mix of senior and junior doctors whose experience would have been more comparable with the physiotherapists. Despite these limitations, this study provides a unique and rare opportunity to compare predictions made in the ICU with longer term patient outcomes and provides a basis for future research.

Further research could use the FCI to define populations and reporting within the ICF framework to facilitate comparisons across patient groups and may be useful to control for pre morbid co-morbidity status. Previous research suggests that the patient's pre-existing comorbidities has a larger impact on future HRQoL than ICU or psychosocial factors [3]. The FCI may be a useful tool for patient assessment for clinical and research purposes as unlike other indices that incorporate chronic health (such as the population-based APACHE score) the FCI is individualised. Furthermore, the FCI uses information easily obtainable with the purpose of predicting morbidity rather than mortality.

We conclude that the FCI predicts patient reported physical function better than objective measure of physical function. Intensive care physiotherapists and physicians have a variable ability to predict longer term outcomes for their patients and larger studies are required to evaluate this further.

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