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Cancer rehabilitation: a barometer for survival?

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Abstract
Purpose This pilot study was conducted to describe the clinical features and functional outcomes of patients attending inpatient rehabilitation for cancer-related deconditioning and neurological deficits and to explore factors associated with improved survival.
Methods Using a retrospective audit, demographic characteristics, discharge outcomes, survival time, and functional status as measured by Functional Independence Measure (FIM) were recorded for 73 patients. Clinical status was estimated by Karnofsky Performance Status Scale (KPS). Cox regression was used to assess factors associated with improved survival following discharge from rehabilitation.
Results Significant functional gains following rehabilitation were observed in total FIM (p=0.02), motor FIM (p=0.001), and KPS (p=0.003). Length of survival ranged from 9.0 to 25.0 months, with 26 cases surviving to the end of study (censored). Patients scoring a total FIM of ≥80 survived significantly longer than patients scoring <80 (p=0.002). At discharge, motor FIM scores (p=0.004), FIM Efficiency (p=0.001), KPS scores (p=0.022), ambulation ability (p=0.026), return to home (p=0.009), and receipt of in-home services (p=0.045) were significantly associated with improved survival.
Conclusions Functional improvement achieved through inpatient rehabilitation was associated with prolonged survival among cancer patients. Rehabilitation leading to improved independence among cancer patients may act as a marker of those with greater likelihood of better prognosis.

Keywords Inpatient rehabilitation · Cancer · Impairment · Survival

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Introduction

Early stage diagnosis and improvements in cancer treatment have enabled patients to live longer. Five-year survival rates across all cancers have increased from 47 to 66 %, between 1987 and 2010 [1]. However, the site of the cancer and the treatment, be it surgical, medical, or radiological, may result in significant disability, such as pain, decreased mobility, weakness, and dependence in activities of daily living [2–4]. As survival rates for many primary cancers continue to improve, it is anticipated that the number of cancer patients with associated disability will also increase [5] and there may be an associated increase in the numbers in need of rehabilitation.

Disabilities due to deconditioning and neurological deficits are considered major triggers for inpatient rehabilitation. Gillis and Graham define deconditioning as "multisystem dysfunction observed with immobilization or prolonged recumbency"

[6]. A study of rehabilitation needs in an acute care medical oncology unit showed that 76 % of patients suffered with deconditioning, 58 % had an inability to mobilize independently and 22 % were dependent in activities of daily living [4]. Previous studies indicate that hematological cancers in particular, can lead to significant deconditioning and prolonged immobility due to medical complications of treatment [7, 8]. Brain and central nervous system tumors account for only 1.4 % of all malignancies, but have a high rate of associated disability and are believed to be a particularly important target for cancer rehabilitation [9]. Patients with brain tumors have responded to inpatient rehabilitation with similar lengths of stay and functional improvements as patients suffering stroke [10–14].

Patients with cancer may have uncertain expectations of success from rehabilitation, so their decision to invest effort in a rehabilitation program will likely include consideration of two key elements, life expectancy and expected quality of life [4]. DeLisa noted that the ultimate goal should be the achievement of the highest functional status possible within the limits of the disease and the patient's choices [15]. It is therefore of interest to patients, rehabilitation physicians, and oncologists to know how inpatient rehabilitation contributes to functional goals and longer term survival. Although the association between functional status and survival has been studied in patients disabled due to one type of brain tumor [16], little is known about patients with neurological impairment resulting from other types of cancer, such as metastatic spinal cord compression [17] or cancer-related neuropathies [18], or those with deconditioning due to other cancers and related treatments.

The aims of this retrospective study were to describe the clinical features and functional outcomes of cancer patients who required inpatient rehabilitation due to deconditioning and neurological impairments, and to explore which of these features or outcomes are associated with improved survival.

Materials and methods

Medical files of patients admitted to the Sacred Heart Rehabilitation Unit, Sydney, Australia between 2005 and 2012 with impairments of deconditioning and neurological deficit due to cancer and cancer treatment were examined. A total of 643 admissions (Fig. 1) were identified in the hospital database using the Australasian Rehabilitation Outcome Centre (AROC) impairment codes of re-conditioning/restorative following surgery (AROC code 16.1), re-conditioning/restorative following medical illness (AROC code 16.2), cancer rehabilitation (AROC code 16.3), neurologic conditions (AROC code 3.9), and spinal cord dysfunction (AROC code 4.111, 4.112, 4.13, 4.1211, 4.1212, 4.23, 4.211, 4.212, 4.2211) [19–21]. In accordance with AROC guidelines,

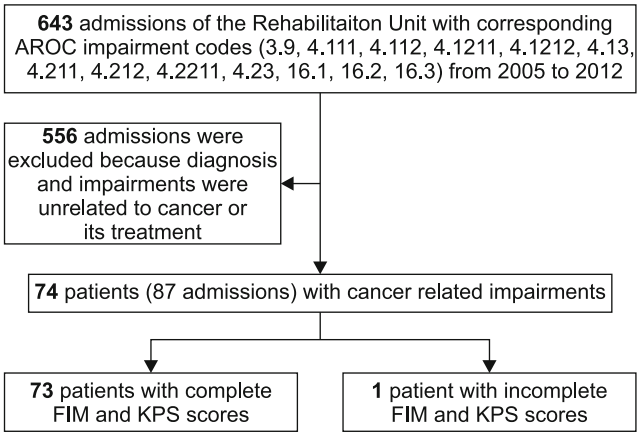

Fig. 1 Flow chart for patient selection

reconditioning describes the restoration of function in those that have generalized deconditioning. Specific AROC impairment codes were chosen to ensure the cohort's admission to rehabilitation was directly related to their diagnosis of cancer. Thus, patients whose disabilities were not directly caused by cancer were excluded from the study. This also may have included patients with cancer that were admitted to hospital and referred to rehabilitation for non-cancer related reasons (e.g. fracture from motor vehicle accident or stroke). Patients with benign brain and spinal tumors were also excluded. A total of 74 patients, 10 of whom had multiple admissions, were identified for the audit. All the Sacred Heart Rehabilitation and Palliative Care ward medical records for each patient were examined. Data collected from medical records included demographic characteristics (age, gender, employment status) and clinical information (type of cancer, length of stay in rehabilitation, ongoing treatment for cancer during rehabilitation, discharge destination, physical functioning, ambulatory status, psychological functioning and receipt of home services). Physical functioning was determined by the Functional Independence Measure (FIM), administered on admission to and discharge from rehabilitation. The 18-item FIM includes 13 motor items (e.g. eating, bladder management, toilet transfer and walking) and 5 cognitive items (e.g. comprehension and memory). Each item is scored on a 7-point scale with 1 representing total assistance and 7 representing complete independence. A FIM efficiency score (a measure of how much a person's functional status improves per day) for each patient was calculated by dividing the difference between admission and discharge FIM scores by the length of stay in days. Ambulatory status was assessed using the motor FIM subscale score for walking. Clinical status of patients, was determined using the Karnofsky Performance Status Scale (KPS) [22] based on both admission and discharge FIM scores according to the method of O'Toole [23]. Psychological functioning was assessed by the presence of depression, anxiety, cognitive impairment, and/or dementia as determined by the scores of the Depression Anxiety Stress Scale or written reference in the

rehabilitation file by the psychologist, medical staff or social worker. The arrangement of home services at discharge was documented in patient files, indicating in-home personal care or domestic care provided by government or private organizations. For patients with two or three admissions for rehabilitation, admission measures (e.g. FIM) were taken from the first admission, while discharge measures were taken from the last discharge. Length of stay was calculated as the total number of days admitted for rehabilitation. Psychological functioning, social services, and discharge destination were assessed at the last discharge.

Length of survival for this study was the number of months between discharge from the rehabilitation unit and date of death or the end of the study period (16 April 2013). The last patient was discharged on 25 December 2012. Date of death was confirmed through application to the NSW Registry of Births Deaths and Marriages.

Survival analysis

Cox regression was used to determine the significance of relationships between survival time and patient characteristics (demographic, clinical, and rehabilitation outcomes), with $p<0.05$. Independent variables first examined individually in univariate survival analyses were age, gender, length of stay, discharge destination (home, acute hospital, other), treatment for cancer in rehabilitation unit (yes, no), functional outcomes at the start and end of rehabilitation (total, motor and cognitive FIM scores, FIM Efficiency, KPS scores), presence of psychological symptoms (depression and/or anxiety, cognitive impairment and/or dementia) and arrangement of home services (yes, no). Deviation contrasts were used for categorical variables. For the functional outcomes, both start and end measures were included in survival analyses, to effectively assess the impact of end scores on survival. Significant variables were then entered together in multivariate Cox regression models to identify those features most strongly associated with survival. FIM, FIM efficiency, and KPS scores are intrinsically highly correlated, so different models were examined using each functional outcome with other significant demographic and clinical variables. The impacts of each functional outcome on other variables included in models were systematically assessed for similarities and differences to determine the most reliable model. FIM efficiency was viewed as the most encompassing outcome measure as it incorporates both start and end FIM measures and number of rehabilitation days. Statistical analyses were performed using SPSS Version 21.

Approval for this study was obtained from the St Vincent's Hospital Human Research Ethics Committee.

Results

Among the 74 patients identified, one did not have complete admission and discharge FIM data and was excluded from analyses (Fig. 1). Table 1 shows demographic and clinical data for the 73 patients. Patients tended to be over 60 years and not employed. A broad range of cancer types were reported. Hematological tumors included multiple myeloma, non-Hodgkin's lymphoma, acute myeloid leukemia, acute lymphoblastic leukemia, and central nervous system lymphoma, while primary neurological cancers included glioblastoma

Table 1 Demographic and clinical characteristics of patients ($n=73$)

Average age (range)	64.7 (21–89)
Gender	*N* (%)
Male	41 (56.2)
Female	32 (43.8)
Employment status	
Employed	16 (21.9)
Unemployed	52 (71.2)
Unknown	5 (6.8)
Primary cancer diagnosis	
Hematologic tumors	28 (38.4)
Non-hematologic tumors	45 (61.6)
Non-hematologic tumors subtype	
Gastrointestinal	12 (16.4)
Skin	8 (11.0)
Head and neck	7 (9.6)
Sarcoma	5 (6.8)
Prostate	2 (2.7)
Primary neurologic	3 (4.1)
Renal	2 (2.7)
Breast	2 (2.7)
Bladder	1 (1.4)
Hepatic	1 (1.4)
Lung	1 (1.4)
Unknown	1 (1.4)
Received cancer treatment during rehabilitation	18 (24.7)
Radiotherapy	8 (11.0)
Chemotherapy	4 (5.48)
Blood transfusion	4 (5.48)
Hormone therapy	2 (2.74)
Discharge destination	
Home	50 (68.5)
Acute hospital	12 (16.4)
Other	11 (15.1)
Psychological symptoms	
Depression and/or anxiety	36 (49.3)
Cognitive impairment and/or dementia	13 (17.8)
Social services provided	34 (46.6)

multiforme and glioma. The mean length of stay at the rehabilitation unit was 22.7±17.3 days.

Regarding functional outcomes as shown in Table 2, significant improvements between admission and final discharge were shown in total FIM (p=0.02), motor FIM (p=0.01), and KPS scores (p=0.003). Cognitive FIM scores did not improve significantly. Mean FIM efficiency was positive (0.437±2.57; range −9.57 to 11.24), further indicating the benefit over time of rehabilitation. At discharge, 27 patients (37 %) had achieved KPS scores over 70, representing the ability to function independently.

Survival

At the end of the study, 47 (64 %) patients had died and 26 (36 %) were alive. Of the 47 patients, 17 (36 %) died within a year following rehabilitation. No patients died during admission to the rehabilitation unit. Median survival time following discharge from the rehabilitation unit was 17.0 months (95 % confidence interval (CI) 9.0–25.2).

Results of univariate survival analyses are shown in Table 3. Patients with non-hematological tumors were more likely to survive longer with median survival of 22.0 months (95 % CI 17.6–26.3) than patients with hematological tumors who survived a median of 5.6 months (95 % CI 0.0–14.5) post discharge from the rehabilitation unit. Cox regression analyses showed significant associations between survival and physical functioning outcomes. Specifically, survival time increased as each total FIM scores (p=0.004), motor FIM scores (p=0.004), ambulatory status (p=0.026), and KPS scores (p=0.022) on discharge improved. On discharge, 75 % of patients had achieved a total FIM score over 80. These patients were significantly more likely to survive to the end of the study than those with total FIM scores less than or equal to 80 at discharge (p=0.011). Figure 2 shows the survival functions for these two groups of patients.

Patients who were discharged home were more likely to survive than those transferred to acute hospital or other settings (p=0.009). In addition, those who received home services following discharge were more likely to survive than those not receiving home services (p=0.045). There was no significant interaction between the type of cancer treatment and survival, although patients receiving hormone therapy and radiotherapy appeared to be more effective at prolonging survival (Table 4). Age, length of stay, cancer treatment during rehabilitation, symptoms of depression and/or anxiety, and symptoms of cognitive impairment and/or dementia were not significantly associated with survival.

When previously significant variables were combined and assessed in multivariate models, results revealed that FIM measures, particularly total and motor FIM scores at discharge and FIM efficiency scores maintained significant relationship to survival, while most other variables (e.g. discharge destination and receipt of home services) did not. Note that FIM and KPS measures were assessed independently in models due to high inter-correlations, but FIM efficiency was viewed as the most encompassing outcome measure as it incorporates both start and end FIM measures and number of rehabilitation days. Table 5 shows the results of the analysis using FIM efficiency with four other variables that were significant in univariate analyses. Only FIM efficiency and cancer diagnosis (i.e. hematological versus other types) remained significant.

Table 2 Functional outcomes

	Admission (mean±SD)	Discharge (mean±SD)	p value
Total FIM	84.1±23.9	93.0±35.8	0.02*
Motor FIM	54.3±19.1	64.2±27.2	0.001*
Cognitive FIM	29.8±8.5	28.9±10.7	0.38
KPS	49.7±13.2	57.1±23.0	0.003*

FIM functional independence measure, *KPS* Karnofsky Performance Status Scale

*p<0.05 indicates statistical significance

Discussion

This study has identified a number of outcomes that may be associated with longer survival in cancer patients who received rehabilitation for cancer-related deconditioning and neurological deficits. Although exploration of survival-related factors has been reported for glioblastoma multiforme [15] and NSCC patients [24–33], limited findings are mentioned in recent rehabilitation literature concerning patients with other forms of cancer [7, 34]. FIM measures the extent of the patient's disability and their physical and mental capacities, and can be considered a measure of rehabilitation outcomes of individual patients, at the time of measurement. Motor and total FIM scores on discharge have been shown to improve following rehabilitation [24], and the FIM scores of our patients were similar to a previous study [24]. In our study, those patients who responded well to an inpatient rehabilitation program by achieving improved functional independence at discharge were more likely to survive longer compared to those who did not. Although in our cohort, the association between FIM at discharge and survival appears positive, we sought to identify other co-factors that influenced survival, such as gender, differences in impairment, and in cancer type. The fact that cancer type (i.e. hematological cancers versus others) was the only other factor that remained significantly related to survival in our patient group in combination with FIM measures at discharge was not entirely surprising, as

Table 3 Factors influencing survival among 73 cases receiving rehabilitation for cancer-related deconditioning and neurological deficits: single factor comparisons

Independent variable	Change in model coefficient[a]	Hazard ratio[b]	95 % confidence interval	p[c]
Gender	1.273			0.259
(female)		1.187	0.882–1.596	0.258
Primary cancer diagnosis	4.144			0.042*
(hematologic tumours)		1.374	1.019–1.853	0.037*
Cancer treatment during rehab	2.241			0.134
(yes)		1.569	0.924–2.665	0.095
Length of stay in rehabilitation unit	1.024			0.312
(continuous, 3 to 97 days)		0.991	0.971–1.010	0.339
Discharge destination	6.519			0.011*
(home)		0.677	0.506–0.905	0.009*
Received "in-home" services	4.055			0.044*
(yes)		0.739	0.549–0.993	0.045*
Total FIM[d]	8.450			0.015*
At admission		1.002	0.989–1.015	0.738
At discharge		0.988	0.980–0.996	0.004*
Motor FIM[d]	9.184			0.010*
At admission		1.003	0.986–1.021	0.723
At discharge		.983	0.972–0.994	0.004*
Cognitive FIM[d]	5.324			0.070
At admission		1.013	0.978–1.050	0.464
At discharge		0.967	0.941–0.993	0.014*
FIM subscore—ambulatory status[d]	7.566			0.023*
At admission		1.030	0.953–1.244	0.761
At discharge		0.840	0.721–0.979	0.026*
FIM efficiency	11.945			0.001*
(continuous, −9.6 to 11.2)		0.788	0.694–0.894	0.000*
KPS[d]	5.763			0.056
At admission		1.000	0.977–1.023	0.987
At discharge		0.985	0.972–0.998	0.022*

*$p<0.05$

[a] Initial −2 log likelihood coefficient=328.041. Changes from this value with the addition of each variable are provided

[b] Hazard ratio is interpreted as the predicted change in the hazard (death) for a unit increase in the independent variable

[c] Significance of change in model and Wald statistic for individual hazard ratios

[d] For all FIM measures and KPS, scores at admission and discharge were entered together in the Cox regression to assess impact on survival

those with hematological malignancy were more likely to have a generalized deconditioning rather than focal neurological loss. Outcomes such as discharge destination and receipt of home services are likely linked to FIM at discharge. That is, those with lower FIM scores are less likely to be discharged home. A prospective study is needed to delineate these relationships further and to capture other patient and treatment factors such as stage and chronicity of cancer that might clarify the role of rehabilitation for these patients.

The FIM was chosen as it is the most widely used standardized outcome tool in Australia providing a uniform measurement of disability and burden of care. It has excellent test re-test reliability [35] and excellent overall interrater reliability (0.95, median intraclass correlation coefficient, ICC) across a heterogeneous group of patients with varying levels of impairment [36]. However, when separated, the cognitive items have lower median reliability values (0.61–0.78 ICC for communication and social cognition, respectively) [36] and ceiling effects [35]. The role of cognitive FIM scores remains unclear in our study. Although cognitive FIM scores did not improve significantly after rehabilitation, improvements in cognitive FIM were positively related to survival. Variability in cognitive FIM scores was high with some patients improving substantially and other declining. Cognitive function may be

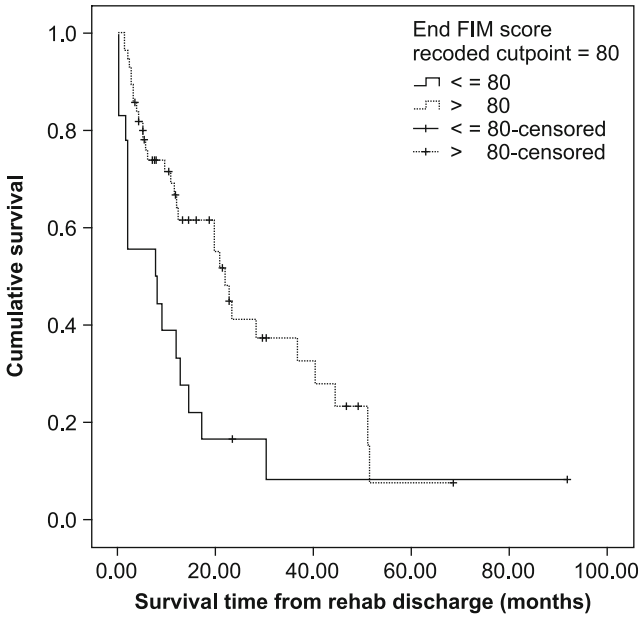

Fig. 2 Survival functions for patients with total FIM scores <80, compared to those with total FIM scores >80

affected by the distribution of primary cancer site, severity of depression, and overall physical condition. A larger sample size and the inclusion of a variety of cognitive measures and psychological assessments in future research may provide greater clarity.

In the studies of NSCC patients, Parsch and colleagues [25] found total FIM scores of 65 or greater on admission indicated longer survival for spinal cord malignancy due to solid organ tumors. Tang et al. [37], found admission FIM scores for metastatic spinal cord compression did not correlate with survival. Our cohort's admission FIM scores also did not correlate with survival and supports Tang et al.'s findings. It is also important to note that higher dependency levels (lower FIM scores) on admission to rehabilitation do not offer any information on how a patient may respond to rehabilitation—it simply offers a snapshot of the level of disability on admission which may relate to the timing of the rehabilitation episode, severity of treatment complications, local referral patterns, or the severity of the disease itself.

A study of patients with glioblastoma multiforme showed that low FIM gains during inpatient rehabilitation was associated with shorter survival times [37], consistent with our findings. Further in our cohort, FIM efficiency scores (i.e. the rate of improvement made during rehabilitation) were positively associated with longer survival. This suggests that those who respond well, making progressive gains in a timely manner, may be more likely to survive for longer than those who do not. A cancer patient's successful course in rehabilitation may reflect either their response to the rehabilitation intervention, natural recovery or both. Physical rehabilitation in a supportive setting may allow patients the confidence to exercise and challenge their concepts of personal frailty. On the other hand, those with adequate cardiorespiratory reserve, minimal myopathy and/or neuropathy, and adequate balance and cognition can make the most of the benefits of regular exercise and task specific activity. Rehabilitation and associated exercise puts a patient through physiological challenges that will often test the patient's ability to benefit from muscle strengthening, motor relearning, balance training, and higher activity levels. Some patients may not have the requisite physical reserves or be too significantly affected by their burden of disease, and as such be unable to tolerate the increased activity levels associated with rehabilitation which may result in intolerable breathlessness, fatigue or pain. This may prevent functional improvement despite optimal rehabilitation. One may consider that cancer patient's response to inpatient rehabilitation may be a marker of their capacity to respond physiologically to the stresses of physical activity. Although speculative, one may also consider that those who are able to tolerate and benefit from the physical and psychological stresses of exercise may be more likely to tolerate, the added physical demands of their disease burden.

In our study, a discharge FIM score of greater than or equal to 80 was associated with a longer survival rate. This supports the relationship between FIM scores and discharge destination previously mentioned, and implies that cancer patients who are able to be independent enough to live in the community may have a better prognosis. A previous study of 75 patients with NSCC showed that survival time was longer for ambulatory patients before and/or after radiation therapy [38]. In our study, ambulatory ability on discharge was also significantly related to longer survival. The ability to ambulate at discharge from rehabilitation may allow patients the opportunity to exercise once discharged and reap the physiological benefits of regular exercise on muscle and bone strength, blood pressure control, mood, and cardiorespiratory reserve.

Table 4 Interaction of treatment and survival. The primary cancer site for patients who received treatment is as follows: radiotherapy: skin cancer (n=3), renal (n=1), head and neck (n=1), breast (n=1), gastrointestinal (n=1), and primary neurologic tumor (n=1); chemotherapy: hematologic tumor (n=3) and sarcoma (n=1); blood transfusion: hematologic tumor (n=4); hormone therapy: primary neurologic tumor (n=1) and breast cancer (n=1)

N=73	Number of patients (/73)	Total (sum) of length of survival (days)	Average length of survival (day)
Non-treatment	55	26861	488.38
Treatment	18	7969	442.72
Radiotherapy	8	4679	584.86
Chemotherapy	4	1093	273.25
Blood transfusion	4	375	93.75
Hormone therapy	2	1822	911
Radiotherapy and chemotherapy	12	5772	481

Table 5 Multivariate Cox regression model: backward stepwise method

Independent variables	Change in model coefficient[a]	Hazard ratio	95 % confidence interval	*p*
Step 1	20.296			0.001*
FIM efficiency		0.837	0.715–0.979	0.026*
Cancer diagnosis (hematologic tumors)		1.386	1.003–1.916	0.048*
Discharge destination (home)		0.855	0.574–1.274	0.442
Cancer Rx during rehab (yes)		1.254	0.921–1.707	0.151
Received in-home services (yes)		0.873	0.614–1.241	0.448
Step 4[b]	16.023			0.000*
FIM efficiency		0.797	0.704–.979	0.000*
Cancer diagnosis (hematologic tumors)		1.379	1.017–1.870	0.039*

*$p<0.05$

[a] Initial −2 log likelihood coefficient=328.041. Changes from this value for the model steps are provided

[b] Steps 2, 3, and 4 removed "Received in-home services," "Discharge destination," and "Cancer Rx during rehab" in this order with no significant change to the model coefficient at each step

In our study, we found those with hematological tumors referred for inpatient cancer rehabilitation were more likely to have shorter survival times than those rehabilitation patients with other cancer types. As most patients with hematological tumors were admitted for reconditioning rather than neurological loss, one might suggest that they had a more global disability rather than a more focal one. This may have made their ability to exercise more difficult and more affected by fatigue, and as such, their ability to benefit from the rehabilitation may have been curtailed. Rehabilitation techniques addressing fatigue in these patients, including medication review, pacing of physical reconditioning or addressing sleep hygiene, may confer improved outcomes for these patients in the future.

Our results did not suggest any significant association between survival and either age, gender, cancer treatment during inpatient rehabilitation, or length of stay in the rehabilitation unit. Palacio et al. [39] state that fragility and complications from concurrent medical treatment of patients can prevent full access to rehabilitation services. This could then impact on survival. However, in this study, receiving cancer treatment in rehabilitation was not significantly associated with survival or inpatient length of stay. This suggests that even if patients require continuing cancer treatment, they could be considered for inpatient rehabilitation. This may be due to the fact that radiotherapy and chemotherapy in the last decade has been more easily tolerated by patients [40]. Gamble et al. suggest that rehabilitation teams align closely with oncology teams during surveillance years so that cancer patients are able to access more comprehensive and coordinated follow-up cancer care [41]. In our cohort, a model of care was instituted in which the acute oncology teams would review and assess patients on a weekly basis and were in regular contact with the rehabilitation team and patient. This model of care is both practical and appropriate if the rehabilitation unit is on the same site as the acute hospital. All patients were followed up by both the rehabilitation team and the oncology or palliative care teams. Rehabilitation can serve to integrate patient and family efforts to improve function with a multidisciplinary team approach and prevent future complications from neurological compromise when combined with improvements in medical, radiation and surgical oncology care [42]. Coordination of care and integration of a variety of acute teams is a hallmark of the rehabilitation model of care used in our cohort, with weekly case conferences, discharge family conferences and daily care coordination meetings. As such, the inpatient rehabilitation model may offer cancer patients admission under a subacute medical team whose focus is functional outcomes rather than simply the execution of components of acute care.

Methodological considerations

Our study has several limitations. Firstly, it is a retrospective analysis with data collected from a small sample of patients with very heterogeneous diseases. In NSW, specialized spinal units care for those with spinal cord injury and as such there were few such cases in our cohort. As a purely descriptive study with no comparator control group, this retrospective study may only suggest possible associations between rehabilitation and survival outcome in patients with cancer. While the heterogeneity of the cohort may reduce the specificity of the results, it provides a realistic "real world" sample of cancer patients in NSW inpatient rehabilitation units. Also, while the sample size is small, it is focused on patients who were admitted to rehabilitation for reasons directly associated with their cancer and not for secondary reasons that may have biased the data. Secondly, not all cancer patients treated in acute

hospitals may have been considered by their oncologists as in need or suitable for inpatient rehabilitation. Decisions regarding suitability for referral may have biased our study. Thirdly, mean survival time in our study may be influenced by the presence of metastasis. It is important to note that medical records did not always note the existence of all metastases, stages of cancer, nor date of diagnosis. Thus, these factors could not be analyzed. Future studies with *a priori* designs could collect this information. A study of NSCC reported that absence of other organ metastasis was associated with good prognostic indicators [43]. Finally, we estimated survival time based on date of discharge from rehabilitation rather than diagnosis date, as this study was examining the association of an episode of inpatient rehabilitation on survival. Patients may have had cancer for prolonged periods prior to rehabilitation, and this time period could influence response to rehabilitation as well as survival time.

In conclusion, the importance of rehabilitation is expected to grow as survival of many cancer patients becomes more prolonged. In this study, a number of indices of advantageous rehabilitation outcomes were associated with the likelihood of longer survival. These included among others a discharge FIM of over 80, higher FIM efficiency scores, and independent mobility at discharge. For rehabilitation clinicians and oncologists, it may be helpful to be able to consider good functional outcomes in rehabilitation as an indicator of longer survival. Further, it may assist in identifying which patients may have better prognoses. The present study is, to our knowledge, the first Australian study to describe rehabilitation outcomes in a mixed population of cancer patients and the first to suggest that better rehabilitation outcomes may be associated with the likelihood of longer survival in cancer patients disabled due to deconditioning and/or neurological deficits.

Disclosures None

Conflict of interest The authors declare that they have no conflict of interest. This research was investigator initiated, and research funds were not sought. The authors have full control of all primary data and permit the journal to review the data if requested.

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