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ORIGINAL REPORT

ASSOCIATIONS BETWEEN HOSPITAL-BASED REHABILITATION FOR HIP FRACTURE AND TWO-YEAR OUTCOMES FOR MORTALITY AND INDEPENDENT LIVING: AN AUSTRALIAN DATABASE STUDY OF 1,724 ELDERLY COMMUNITY-DWELLING PATIENTS

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Objective: **To compare rates of mortality, hospital readmissions and independent living status for 2 years following hip fracture in community-dwelling patients with and without hospital-based rehabilitation.**
Design: **Retrospective cohort study.**
Methods: **Administrative data-sets were linked for hospital treatment, residential aged care admissions, selected community services and date of death for community-dwelling hip fracture patients. Mortality, readmissions, residency within aged care facilities and independent living status at intervals up to 2 years were compared in multivariate logistic regression for patients with and without hospital-based rehabilitation.**
Results: **Age, sex and comorbidity distributions were similar for 1,050 patients who received rehabilitation and 674 patients who did not. Rehabilitation added 11 days to total hospital stay and $AUD 12,000 to hospital costs. Mortality at 90 days after hip fracture was 4.7% for rehabilitation patients vs 10.7% for others (*p*<0.001), and 26.2% vs 37.2% (*p*<0.001) at 2 years. Beyond 90 days there was no significant association between receipt of rehabilitation and the proportion of patients meeting criteria for independent living. Hospital readmissions in the year following the index fracture were not significantly different.**
Conclusion: **In-hospital rehabilitation substantially increases total hospital costs. It is associated with improved early and late survival, but not with the likelihood of living independently for up to 2 years after hip fracture.**

Key words: hip fracture; rehabilitation; hospital costs; mortality; independent living.

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INTRODUCTION

Hip fracture is a common and frequently devastating event for elderly persons. Although age-specific incidence is steadily falling in Australia (1), approximately 13 in every 1,000 women aged 75 years or older and approximately half as many men will be affected each year (1, 2, 3). Despite progress in acute hospital practices in recent decades, 1-year mortality following hip fracture remains in the region of 25–30% (4, 5). Rates of functional recovery after 1 year also remain poor, with more than one-third of survivors failing to regain pre-fracture levels of physical functioning, and at least one-quarter living in permanent institutional care (5–7).

In seeking better patient outcomes, the high rates of co-morbid medical conditions and peri-operative complications in this frail, elderly population are increasingly addressed through advocacy of best-practice guidelines and management by multispecialty, ortho-geriatric teams (8–11). These initiatives have produced short-term benefits; reductions in hospital mortality, complication rates, time in acute hospital care, and improved functional status at hospital discharge. Long-term benefits with regard to survival and independent living status are suggested by only a minority of studies (11, 12).

Attention has therefore turned to post-acute care and rehabilitation (REH) programmes. The majority of hip fracture patients now receive formal rehabilitation. In Ontario Canada, up to 90% of discharges in 2003 were via inpatient REH or skilled nursing facilities (13). In the USA in 2008, 85% were transferred to skilled nursing or "other hospital" facilities, mostly for REH, and fewer than 3% of patients went home with no formal after-care programme (14).

While ambulatory, home-based and even telemedicine models for rehabilitation have been trialled (15–17), the great majority of services are delivered in hospital units (13, 14, 18). Short-term benefits in physical function, especially ambulation, and some additional psycho-social advantages are now almost universally reported by all programmes (19, 20).

Numerous programmes address specific functionalities, such as improved balance or lower limb strength, with a view to improving independence or reducing risk of further injury (21, 22). While specific targets are frequently met in the short term, significantly superior rates of independent living at the end of even the first year after hip fracture are reported for only a few studies (17, 19, 20).

A Cochrane Review published in 2009 described controlled trials of a wide variety of rehabilitation services, mostly delivered to inpatients. Some programmes showed a tendency to infer longer-term benefits to patients, but none achieved

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statistical significance. The concluding comment was that rehabilitation was not harmful (23).

This study compares mortality, hospital readmissions and independent living status across the first 2 years after hip fracture for a cohort of elderly community-dwelling patients who received hospital-based rehabilitation and a series of similar patients with no documented rehabilitation.

METHODS

The study population was drawn from a cohort of 2,552 Australian veterans and war widows hospitalized for a first hip fracture (ICD-10-AM, S72.0-S72.2 inclusive) between July 2008 and June 2009. The existence of a unique identifying number for each patient in Department of Veterans' Affairs (DVA) databases permitted linkage of continuous hospital episodes, residential aged care (RAC) admission history, hospital readmissions, delivery of community nursing and/or veterans' home care services, and date of death for each individual subject. Details of this cohort have been reported previously (24).

Subjects who were RAC residents immediately prior to hospital admission for hip fracture or who died within the acute surgical phase of hospital care were excluded. Patients admitted from RAC have shorter hospital stays, higher hospital mortality, and survivors almost exclusively return permanently to RAC (25). Since referral to REH presupposes survival to the end of the acute phase episode, the exclusion of non-REH patients who died in the acute phase reduces bias in mortality comparisons.

Study data were obtained from DVA administrative databases for care in public and private hospitals for all patients. Data items included patient age, gender, fracture type, operation type, comorbidities and complications, treatment in intensive care, and separation code for each component episode. Fracture type was classified from ICD-10-AM codes for principal diagnosis as cervical (S72.01–72.04), trochanteric (S72.05, S72.10–72.11), subtrochanteric (S72.2) and "other" (S72.00, S72.08). Comorbidity codes were extracted from all hospital episodes in the study year, up to and including the episode(s) comprising the index hip fracture admission. Comorbidity weight was assessed by the Quan modification of the Charlson Comorbidity Index (26).This algorithm, derived from hospital data in Alberta Canada and internationally validated, assigns a score of 1–6 for each of 12 conditions.

Complications of skin ulceration (L89, L97), delirium (F05), anaemia (D62, D64.9), and urinary (N39), lower respiratory (J13–J15, J18, J20–22) and surgical site (T81.4, T84.5–7) infections were also identified, due to known associations with either length of stay (LOS) or unwanted outcomes following hip fracture (2, 13, 19). Complications were identified only from those episodes comprising the index fracture admission. Admitted care for REH was identified if 1 or more episodes with principal diagnosis, coded as ICD-10-AM Z50.9 or Z50.8, was included in an episode sequence continuous with the index admission date. No additional details of the processes of delivering the various REH services were available in the database.

Acute phase care was defined as those episodes with principal diagnosis of hip fracture (S72.0-S72.2 inclusive) that were continuous with the admission date. Rehabilitation LOS was the total of all REH episodes between the end of the acute phase and final discharge. "Other" care included all episodes included within an episode sequence continuous with the index admission date, but not defined as acute or REH care. Total length of stay described the duration of hospitalization from the index admission date until final discharge. The total cost of hospitalization included all charges for accommodation, theatre, prostheses, and fees for medical, allied health and diagnostic services accepted for payment by DVA in respect of the index hospital admission. Hospital readmissions, and the LOS and cost of each episode were identified for 1 year dated from the index admission. Costs were expressed in Australian dollars ($AUD) at 2009 values.

The 3 main outcome measures were mortality, RAC status and "living independently" measured since index admission date. Mortality was obtained by linkage with the DVA Death Index. RAC status was defined as living in RAC, as identified in DVA records, but the denominators include only those patients who are alive at the specified time-point. "Living independently" was defined as neither deceased nor resident within RAC nor receiving community nursing or Veterans' Home Care services at the specified time-point. Female subjects, aged <85 years with 1 or 0 coded comorbidities were defined as a "low risk" group for mortality at 1 year, on the evidence of a previously published study of the complete study population (24).

Statistical analyses

Univariate analyses were conducted comparing patients who did and did not receive rehabilitation, using Student's t-test and Pearson's χ^2 test for continuous and categorical variables, respectively. A multivariate logistic model was also fitted for receiving vs not receiving rehabilitation. Variables were included in the regression model if $p<0.25$ in the univariate analyses and remained in the final model if $p<0.05$ after backwards elimination. For the outcomes of mortality, RAC and "independent living" logistic regression models were each fitted separately for the specified time-points of 90 days, 1 and 2 years, with rehabilitation as the exposure variable and adjusted for the following other factors: sex, age group and comorbidity. Logistic regression was used rather than survival analysis as, unlike mortality, commencement dates for RAC status were not consistently available. These outcomes were also analysed against LOS in acute care and REH episodes within the index hospitalization.

All analyses were performed using SAS 9.3 (SAS Institute Inc., Cary, NC, USA) or Excel 2010 (Microsoft Corporation, Redmond, WA, USA). Ethics approval was obtained from the DVA Human Research Ethics Committee in December 2010 and renewed in December 2013.

RESULTS

There were 1,050 community patients who were referred to hospital units for REH following acute care for hip fracture. An additional 674 community patients who survived the acute phase of care did not receive formal rehabilitation. The characteristics of these 2 groups are listed in Table I. This DVA population was somewhat older (mean age 86 years) and with a higher proportion of males (36.5%) than is customary for series of hip fracture patients (26). The proportions of patients meeting the defined criteria for low mortality risk were not significantly different (Table I). Patients aged under 80 years and those with associated dementia or delirium were under-represented in the REH population, while the reverse applied for patients treated surgically (Table I). Multivariate models confirmed a two-thirds increase in referral rate for surgical patients. Patients with dementia (ICD10-AM, F01-F05.1 inclusive) were referred at one-third of the rate of other patients (data not shown).

REH involved a distinct increase in total LOS for the index hospitalization and in the cost of hospital care, as shown in Table II. The mean total time spent in REH units (there were 1,172 coded episodes for the 1,050 patients) had a duration of 25 days and a mean cost of almost $AUD 15,000. Acute phase LOS and cost were higher for the non-REH patients, who also had more frequent and longer hospital episodes for care of complications and comorbid conditions ("other" episodes). In univariate models mean total LOS was 14 days longer and total costs $AUD 14,000 greater for REH patients, or 11 days and $AUD 12,000 in models adjusted for sex, age-group and comorbidity.

Table I. *Patient characteristics of 1,724 community-dwelling patients by rehabilitation selection*

	Rehabilitation (n=1,050)		No rehabilitation (n=674)		
Characteristics	n	%	n	%	p-value
Males	383	36.5	245	36.4	0.96
Mean age, years		86.0		85.8	0.45
Age group					0.004
≥90 years	226	21.5	151	22.4	
85–89 years	471	44.9	302	44.8	
80–84 years	289	27.5	152	22.6	
<80 years	64	6.1	69	10.2	
Fracture type					0.10
Cervical	413	39.3	255	37.8	
Trochanteric	459	43.7	277	41.1	
Subtrochanteric	37	3.5	38	5.6	
Other	141	13.4	104	15.4	
Surgery		88.9		84.9	0.02
Quan score					0.12
≥3	132	12.6	106	15.7	
1–2	312	29.7	205	30.4	
0	606	57.7	414	53.9	
Low mortality risk[a]	174	16.6	104	15.4	0.53
Comorbidities					
Cancer	83	7.9	42	6.2	0.19
Cardiac failure	132	12.6	67	9.9	0.09
Dementia	101	9.6	152	22.6	<0.001
Diabetes	44	4.2	33	4.9	0.17
Cardiac ischaemia	106	10.0	57	8.5	0.25
Renal failure	136	13.0	82	12.2	0.63
Respiratory disease	92	8.8	41	6.1	0.13
Stroke	62	5.9	37	5.5	0.72
Complications					
Anaemia	83	7.9	53	7.9	0.46
Delirium	92	8.8	41	6.1	0.04
Pressure ulcer	87	8.3	46	6.8	0.27
Respiratory infection	122	11.6	76	11.3	0.83
Urinary infection	112	10.7	82	12.2	0.34

[a]Relative low mortality risk: females aged <85 years, comorbidity=0.

Patient outcomes

Outcomes were assessed at intervals of 90 days, 1 year and 2 years from the index admission date. In unadjusted data, the 90-day mortality for REH patients was less than half that of un-referred patients (4.7% vs 10.7%, $p<0.001$). In the remainder of the first year after fracture the difference was not significant (11.1% vs 13.8% $p=0.11$), but in the second year, REH patients again had lower mortality (12.9% vs 18.5%, $p=0.005$). At the end of all 3 time periods, mortality rates were substantially and significantly lower for REH patients (Table III).

RAC residency among all surviving patients at the end of 90 days was higher for non-REH subjects: this difference was maintained when the 50 REH and 28 non-REH subjects still in hospital at 90 days were excluded. At 1 year and 2 years after hip fracture there were no significant differences in RAC residency rates between the groups.

The proportion of patients who were living independently, as defined, showed no significant differences between the groups at the end of any of the 3 follow-up periods (Table III). The higher proportion of REH patients accessing community services at 90 days (38.5% vs 24.1%, $p<0.001$) was a factor in reducing the rate of independence for REH patients at this time-point.

There were 3912 hospital readmission episodes (for all causes) recorded for 1,007 (58.4%) patients within 1 year of the index fracture (Table II). Readmission rates were marginally higher for REH patients (60.3% vs 55.6%, $p=0.049$). However, readmission status was not a significant variable in regression models for the 3 defined outcomes for REH against non-REH patients. Within each subgroup, higher 2-year mortality for readmitted REH patients (31% vs 18%, $p<0.001$) was the only instance in which readmission was significantly associated with outcomes. For all causes of readmission, occupied bed days and costs per capita were not different for REH and non-REH patients Table II). There were 635 readmission episodes coded

Table II. *Hospital utilization data: 1,724 community patients with hip fractures*

	Rehabilitation (n=1,050)			No rehabilitation (n=674)			
	Patients	Days	95% CI	Patients	Days	95% CI	p-value
Mean length of stay: index hospital admission[a]							
Acute phase	1,050	11.8	11.3–12.3	674	17.5	16.3–18.7	<0.001
Rehabilitation	1,050	25.1	24.2–26.0	–	–	–	–
Other episodes	273	20.7	18.4–23.0	238	30.5	27.1–34.1	<0.001
Total[b]	1,050	42.3	40.9–43.9	674	28.3	26.1–30.5	<0.001
Re-admissions within 365 days of index admission							
Patients[c] (%)	633	60.3	57.3–63.3	374	55.6	51.8–59.4	0.05
Mean, days[d]	1,050	14.5	12.6–16.4	674	17.1	13.5–20.6	0.11
Days >30[e] (%)	182	28.8	25.3–32.3	112	29.9	25.3–34.5	0.69
		$AUD	95% CI		$AUD	95% CI	
Mean total hospital costs							
Index admission		40,439	39,338–41,640		26,242	24,913–27,571	<0.001
Readmissions		14,170	12,566–15,774		14,729	12,373–17,085	0.06
Total		54,595	52,685–56,505		40,970	22,492–30,022	<0.001

[a]LOS data for rehabilitation patients from Table II in Ireland et al. (41).
[b]Total LOS=11.8+25.1+(20.7* 273/1050)=42.3 for rehabilitation patients.
[c]Patients who had at least one hospital readmission.
[d]Days=sum of LOS for all readmission episodes/all patients.
[e]Mean days as for 4 above.
95% CI: 95% confidence interval; LOS: length of stay.

Table III. *Outcome rates by rehabilitation status in 1,724 acute phase survivors after hip fracture*

Interval[a]	With rehabilitation $n=1,050$ n	%	95% CI	Without rehabilitation $n=674$ n	%	95% CI	p-value
Univariate analyses							
Death							
90 days	49	4.7	3.4–6.0	72	10.7	8.4–13.0	<0.001
1 year	160	15.2	13.0–17.4	155	23.0	19.8–26.2	<0.001
2 years	275	26.2	23.5–28.9	251	37.2	33.5–40.9	<0.001
RAC resident							
At 90 days	150	15.0[b]	12.8–17.2	114	18.9	15.8–22.0	0.04
At 1 year	192	21.6	18.9–24.3	120	23.1	19.5–26.7	0.50
At 2 years	148	19.1	16.3–21.9	79	18.7	15.0–22.4	0.95
Independent living[c]							
At 90 days	592	56.3[b]	53.3–59.3	404	59.9[b]	56.2–63.6	0.14
At 1 year	438	41.7	38.7–44.7	313	46.4	42.6–50.2	0.054
At 2 years	396	37.7	34.8–40.6	271	40.2	36.5–43.9	0.30

Interval[a]	Death OR[d] (95% CI)	p-value	RAC resident OR (95% CI)	p-value	Independent living[c] OR (95% CI)	p-value
Multivariate[e] analyses: Outcome risk for rehabilitation patients						
90 days	0.40 (0.3–0.6)	<0.001	0.89 (0.7–1.2)	0.42	0.87 (0.7–1.1)	0.19
1 year	0.61 (0.5–0.8)	<0.001	1.09 (0.8–1.4)	0.52	0.46 (0.4–0.6)	0.002
2 years	0.59 (0.5–0.7)	0.003	1.22 (0.9–1.6)	0.18	0.87 (0.7–1.1)	0.20

[a]Interval = time since index hospital admission.
[b]Percentage of survivors at specified time-point: 150/(1050–49) = 15.0% at 90 days.
[c]Not deceased, not in residential aged care (RAC), not receiving community nursing or veterans' home care.
[d]OR = odds ratio for given outcome for REH vs non-REH.
[e]Adjusted for sex, age-group, comorbidity.
95% CI: 95% confidence interval; LOS: length of stay.

as rehabilitation within the first year, for 239 patients. Of these, 580 episodes and 199 patients came from the REH group.

In models adjusted for sex, age group, and comorbidity (Table III) REH patients again had significantly lower mortality risk at the end of all follow-up periods. There were no differences in probability of RAC residency across the 2-year period. There was a clear increase in probability of independent status at 1 year for non-REH patients, but the results at 90 days and 2 years were not different in the adjusted models. These profiles persisted when patients with defined "low-risk" were considered separately: 12-month mortality was 5% for REH and 13% for non-REH patients ($p=0.009$), but there were no differences in RAC occupation. The inclusion of individual comorbid conditions rather than Quan scores in multivariate models did not materially change the direction or dimension of these results.

Among 1050 REH patients, the length of the acute care phase prior to REH transfer, a close approximate of time delay between fracture and commencement of REH, was directly related to the 1-year mortality rate in the univariate analysis (Table IV). Longer acute care was associated with higher rates of RAC residency and lower rates of independence at 1 year. The total time in REH was not associated with 1-year mortality in either univariate analysis or in models adjusted for sex, age-group and comorbidity weight. There was a direct association between duration of REH and rate of residence in RAC, and an inverse relationship with the likelihood of independent living, at 1-year post-fracture, in both univariate and multivariate analyses (Table IV). Similar associations were found in respect of acute phase LOS.

A total of 306 patients (29.1%) who received REH and 212 (31.5%) of those without REH became RAC residents at some time within 1 year of fracture. Total time in RAC was 68.3 days per capita for REH patients and 71.5 days for non-REH patients. Neither of these differences was significant.

Among community-dwelling survivors at 1 year, 275 subjects (25.0%) were receiving community nursing and/or veterans' home care services. These subjects did not differ from those not receiving services with regard to male/female distribution, mean age, or comorbidity scores. It was found that more REH patients were referred to community nursing in the first 90 days after hospital discharge, but the difference was not significant for later end-points. Rates of death or RAC placement between 1 and 2 years were not different for these patients (data not shown).

DISCUSSION

Admitted care for rehabilitation following hip fracture added almost 2 weeks to the index hospital stay and at least $AUD 12,000 to hospital costs. Among patients referred for REH, mortality at 1 and 2 years post-fracture was lower by 40% than for patients not referred. The rates of admission into, duration of residence in aged care facilities, or proportion of patients meeting criteria for independent living, were not significantly different in multivariate models. Hospital readmission rates during the first post-fracture year were not reduced for REH patients.

The acute hospital management of hip fracture continues to be refined, and continues to yield better results with respect to hospi-

Table IV. *One-year outcomes by length of stay in acute care and rehabilitation for 1,050 patients receiving rehabilitation*

	Death	Residential aged care	Independent living[a]
	% (95% CI)	% (95% CI)	% (95% CI)
Acute care LOS			
<10 days	12.0 (9.1–14.9)	17.9[b] (14.2–21.6)	72.3 (68.3–76.3)
10–14 days	15.7 (11.7–19.7)	22.6 (17.6–27.6)	65.2 (60.0–70.4)
≥15 days	20.2 (15.3–25.1)	31.1 (24.8–37.9)	55.0 (48.1–61.1)
p-value	0.004	0.017	<0.001
Rehabilitation LOS			
<21 days	13.5 (10.4–16.6)	16.3 (12.7–19.9)	72.4 (68.3–75.5)
21–34 days	15.3 (11.7–18.9)	22.4 (17.9–27.0)	65.7 (60.9–60.5)
≥35 days	19.2 (13.8–24.6)	32.3 (25.2–39.4)	54.7 (47.9–61.5)
p-value	0.16	<0.001	<0.001
	OR 95% CI	OR 95% CI	OR 95% CI
Multivariate[c] analysis for acute LOS			
<10 days	Referent	Referent	Referent
10–14 days	1.47 (0.96–2.24)	1.09 (0.73–1.64)	0.79 (0.58–1.05)
≥15 days	1.60 (1.04– 2.45)	1.93 (1.30–2.88)	0.66 (0.48–0.91)
p-value	0.066	0.003	0.030
Multivariate[c] analysis for rehabilitation LOS			
<21 days	Referent	Referent	Referent
21–34 days	1.07 (0.72–1.59	1.34. (0.92–1.97)	0.79 (0.59–1.04)
≥35 days	1.28 (0.81–2.03)	2.21 (1.44–3.43)	0.60 (0.42–0.86)
p-value	0.57	0.002	0.015

[a]Neither deceased, resident in RAC nor receiving community services.
[b]Percentage of survivors at 365 days.
[c]Adjusted for sex, age group, comorbidity.
OR: odds ratio; RAC: residential aged care; LOS; length of stay; 95% CI: 95% confidence interval.

tal mortality, complication rates and hospital costs (27, 28). The benefits of subsequent REH for sustained survival and independent living, whether in hospital units or a variety of community-based programmes, have not been so convincing (19, 20, 22).

The claim that multidisciplinary REH may have both short-term and longer term benefits is advanced in both systematic reviews (19) and meta-analyses (20). However, only a minority of the quoted studies (4 of 9 in the latter report) relating to hip fracture continued follow-up to the end of the first post-fracture year. Our paper suggests that outcomes in the first 90 days after fracture are not consistently predictive of ongoing outcomes. When data from meta-analyses (20) were restricted to studies with at least 12-months follow-up, associations between REH and positive 12-month outcomes were significant for Katz scores (2 studies only), but not significant for RAC admission risk ratio (RR) 0.79, 95% confidence interval (95% CI) 0.51–1.22, $p = 0.30$) and borderline for mortality (RR 0.76, 95% CI 0.58–1.00, $p = 0.047$).

Analyses of a large sample of Medicare (USA) data for the period 2000–08 (14) showed that the proportion of hip fracture patients admitted from RAC (the most frail) declined, while providing indirect evidence for an increase in rates of transfer to and duration of post-acute REH. Despite these trends, the proportion of subjects resident in RAC at 1 year post-fracture remained essentially unchanged at 35%. Providing more institution-based REH for a seemingly more robust population did not translate into better outcomes (14).

In the present study, increased length of in-hospital REH was inversely related to independence at 1 year, with residence in RAC being more than twice as likely for patients in REH for ≥35 days than for patients in REH for less than 3 weeks. Data from almost 68,000 REH episodes for "orthopaedic conditions" (22% hip fracture) in the USA showed a 42% reduction in LOS over the period 1994–2001, associated with a slight increase in proportion of patients living at home at 180-day follow-up (29). An earlier American study found that longer stay in REH was associated with reduced capacity for activities of daily living (ADL) after 1 year (30).

The present study has confirmed the overall findings from a systematic review (23) that REH does not impact on hospital readmission rates. The relationship between readmissions and longer term outcomes is complex for hip fracture patients. One Italian study reported ongoing higher mortality beyond 180 days for readmitted patients, but this finding was not tested in multivariate analysis (31). A study in Genoa found that the predictors for readmission within 1 year of fracture were co-morbidity and low functional status at original discharge (32), factors that are themselves associated with higher mortality.

The evidence for any superior clinical benefit from delivery of REH in hospital units compared with use of alternative models, including home-based programmes, is also weak. More than 30 years ago Swedish researchers (33) noted that prolonged hospitalization, whether in orthopaedic or rehabilitation units, was associated with reduced capacity for subsequent independence. They advocated early hospital discharge and consideration of rehabilitation as a domiciliary programme. At the same time a Danish team (34) identified substantially lower costs, but equivalent outcomes, for patients rehabilitated in convalescent hospitals with physical therapy services, compared with similar patients treated in specialist REH hospitals.

A small Australian trial of domiciliary vs hospital-based REH for previously independent patients showed no differences in measures of physical function at 12 months. Importantly, carer burden was reduced for patients treated at home (35). Another Australian programme (HIPFIT) provided 12 months of high-intensity resistance training coupled with evidence-based treatment of other issues relevant to frailty, in a multidisciplinary outpatient programme supervised by a geriatrician. Although study numbers were small (62 participants and 62 controls) significant reduction in mortality and nursing home occupation after 12 months was achieved (18). In 2007, a study in Tuscany (17) showed that REH models for hip fracture ranging from admitted care to domiciliary programmes, with an 18-fold cost variation, produced very similar 6-month mortality rates.

Despite the weak evidence for sustained benefits from hospital-based REH, the age-standardized rates of hospital-based REH (for all conditions) increased in Australia from 18 to 32/1000 persons aged ≥ 65 years in 1998–99 and 2011–12 (2, 3). Evidence for a similar increase in ambulatory programmes is lacking. Of almost 50,000 episodes of REH for orthopaedic fractures (all types) reported to the Australasian Rehabilitation Outcomes Collaboration (AROC) from 2012 to 2014, inclusive, only 2.4% were in ambulatory settings (36).

The assessment of "potential to benefit", which is integral to the process of selection for transfer into REH appears to identify factors associated with better survival. In this analysis of community patients, referral to REH was associated with prolonged survival benefit. Perhaps surprisingly, given that REH programmes are directed toward improvement in functional capacities, no impact was found upon longer-term dependence upon RAC, or use of community support services, even though there were lower rates of identified dementia in the REH group.

The principal strengths of this study lie in the substantial patient numbers, the comprehensive data-set and, most importantly, the facility for linkage of hospital, aged care and mortality data. The potential for coding errors in administrative data is acknowledged, but acceptable coding accuracy for hip fracture in database records has been confirmed (37), further enhanced by the additional inputs through episode linkage (38). Under-reporting of some comorbidities is highly probable, particularly as the look-back period, confined to the "study-year" was, of necessity, brief for some patients.

The analytical models used in this study would have been strengthened by access to variables describing physical function status, such as scores for Functional Independence Measure (FIM) or similar assessments, and also by information on carer and social context at both the commencement of rehabilitation and at specified follow-up intervals. Associations between these items and short-term mortality and improvement in specific functional elements following REH are well established (21, 22, 39, 40). The study data contained no details of differences in the processes or intensity of the REH programmes delivered by a variety of public and private hospitals.

It is acknowledged that the DVA population is atypical, being several years older than the general hip fracture population in Australia (29), and having a higher proportion of males. Where comparable data-sets are available, mostly relating to acute hospital care, utilization data are very similar (25, 29), and patient age has only minor impact upon hospital stay and costs in the population presented here (25). However, the findings and conclusions should be generalized with caution, unless compared in age-gender specific analyses.

Database studies, despite their restricted capacity for describing clinical details, have an important role in presenting broad descriptions of process and outcomes for large patient populations. As with this study, important questions of efficacy and cost-efficiency may be posed, which call for analyses based upon studies with access to deeper levels of both clinical and administrative detail.

In summary, this paper has found, in a large series of elderly, community-dwelling Australians, that post-fracture rehabilitation in hospital was associated with lower mortality for up to 2 years. There were no consistently significant effects attributable to REH upon hospital readmission rates, proportions of survivors who required support in aged care facilities, in the total days in RAC for the first post-fracture year, or in the proportions of patients living without defined community services. Hospital-based REH added substantially to the duration and cost of the index hospital admission and prolonged stay in rehabilitation units was associated with poorer long-term outcomes. Given that hospital-based REH is resource intensive, and the cited evidence that non-hospital REH programmes provide equivalent long-term outcomes, it is suggested that community-based programmes be further considered for hip fracture patients.

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