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RESEARCH PAPER

Hip fracture and the influence of dementia on health outcomes and access to hospital-based rehabilitation for older individuals

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ABSTRACT

Background For older individuals who sustain a hip fracture, the presence of dementia can influence their access to hospital-based rehabilitation. **Purpose** This study compares the characteristics and health outcomes of individuals with and without dementia following a hip fracture; and access to, and outcomes following, hospital-based rehabilitation in a population-based cohort. **Method** An examination of hip fractures involving individuals aged 65 years and older with and without dementia using linked hospitalisation, rehabilitation and mortality records during 2009–2013. **Results** There were 8785 individuals with and 23 520 individuals without dementia who sustained a hip fracture. Individuals with dementia had a higher age-adjusted 30-d mortality rate compared to individuals without dementia (11.7% versus 5.7%), a lower proportion of age-adjusted 28-d re-admission (17.3% versus 24.4%) and a longer age-adjusted mean length of stay (22.2 versus 21.9 d). Compared to individuals without dementia, individuals with dementia had 4.3 times (95% CI: 3.90–4.78) lower odds of receiving hospital-based rehabilitation. However, when they did receive rehabilitation they achieved significant motor functional gain at discharge compared to admission using the Functional Independence Measure, but to a lesser extent than individuals without dementia. **Conclusion** Within a population-based cohort, older individuals with dementia can benefit from access to, and participation in, rehabilitation activities following a hip fracture. This will ensure that they have the best chance of returning to their pre-fracture physical function and mobility.

➤ IMPLICATIONS FOR REHABILITATION

- Older individuals with dementia can benefit from rehabilitation activities following a hip fracture.
- Early mobilisation of individuals post-hip fracture surgery, where possible, is advised.
- Further work is needed on how best to work with individuals with dementia after a hip fracture in residential aged care to maximise any potential functional gains.

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Introduction

Hip fracture has been associated with increased morbidity and mortality among older individuals.[1–3] Hip fractures can have a major impact on an older individual's long-term health, their support network and on health services. Hip fractures also represent a considerable cost burden to the health care system.[4,5] Forty per cent of individuals do not return to their pre-fracture ambulatory capacity even by 6 months following their fracture [4] and this can have a negative effect on their independence and quality of life.[1,3]

Falls are the most common cause of hip fracture among older individuals [6] and many older individuals who sustain a hip fracture also have pre-existing comorbid conditions.[2,7–9] Risk factors for falls and hip fracture among older individuals can include older age, comorbidities, osteoporosis, polypharmacy, poor vision and balance.[7,10] Dementia, in particular, is a

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known fall risk factor among older individuals.[1,11] Dementia can increase fall risk due to changes in an individual's ability to recognise and negotiate hazards, such as trip or slip hazards, impaired body awareness and judgement, changes in visual-spatial perception and limited attention span.[12] Delirium, which is often associated with dementia during hospital admission, has been associated with increased mortality following a hip fracture.[13]

Recovery following hip fracture can be aided by access to, and participation in, rehabilitation-related activities.[14] In particular, early and regular weight-bearing activities, where a patient's condition allows, has been shown to benefit recovery to pre-fracture ambulatory ability. The presence of dementia has been negatively associated with functional outcome at 1-year post-hip fracture.[15] However, people with dementia who sustain a hip fracture have been aided in their recovery through participating in rehabilitation activities.[16–20] However, people with moderate to severe dementia may not have as good a postoperative recovery as people with mild to moderate dementia.[21] In some instances, people with dementia are excluded from hospital-based rehabilitation, largely due to the belief they have limited capacity for functional gains.[22] The aim of this study is to compare: (i) the characteristics and health outcomes of individuals with and without dementia who sustained a hip fracture and (ii) access to, and outcomes following, hospital-based rehabilitative services in a population-based cohort.

Materials and methods

A retrospective analysis of individuals aged 65 years and older who sustained a hip fracture identified in linked hospitalisation, sub-acute and non-acute care data collections with an admission date during 1 January 2009 to 31 December 2013 in hospitals in the most populous state of Australia, New South Wales (NSW). Ethics approval was obtained from the NSW Population and Health Services Research Ethics Committee (2014/07/540).

Data collections

The Admitted Patient Data Collection (APDC) includes information on all inpatient admissions from all public and private hospitals, private hospital day procedures and public psychiatric hospitals in NSW. The APDC contains information on patient demographics, the source of referral, diagnoses, external cause(s), hospital separation type (e.g. discharge, death), place of occurrence and clinical procedures. Information is extracted from medical records. Diagnoses and external cause codes were classified using the International Classification of Diseases, 10th Revision, Australian Modification (ICD-10-AM).[23] Hip fracture-related hospitalisations for persons aged 65 years and older were identified using a principal diagnosis classification in the APDC (ICD-10-AM: S72.0-S72.2). The first hip fracture-related hospital admission during this time frame was identified as the 'index hip fracture admission'. Any subsequent hospital rehabilitation episodes recorded in the APDC directly following the index hip fracture were identified using a principal diagnosis of 'care involving the use of rehabilitation procedures' (ICD-10-AM: Z50).

Mortality data were obtained from the NSW Registry of Births, Deaths and Marriages (RBDM). All deaths in NSW are registered with the RBDM and information collected from death certificates (certified by a medical practitioner or pathologist) includes demographic data and the cause of death.

The sub-acute non-acute patient (SNAP) data collection collects information regarding sub-acute (e.g. rehabilitation, palliative care, psychogeriatrics and geriatric evaluation and management) and non-acute care (i.e. maintenance care) in public hospitals in NSW. Hospital-based rehabilitation refers to ''care in which the primary clinical purpose or treatment goal is improvement in the functioning of a patient with impairment, activity limitation or participation restriction due to a health condition (p. 26)''. [24] Information collected for the rehabilitation cases includes basic demographic information, details about rehabilitation episode, such as impairment type, accommodation pre- and post-rehabilitation and the Functional Independence Measure (FIM^{TM}). The FIM^{TM} provides an objective assessment of functional status at the start and end of the rehabilitation episode in domains such as self-care, mobility, cognitive function and communication. The FIM^{TM} comprises 18 items (13 motor items and five cognitive items) with each item scored on a 7-point scale: a score of 1 indicates complete dependence and a score of 7 indicates independence. The FIM^{TM} is measured at admission and at discharge for SNAP bed-based rehabilitation episodes of care. Functional gain (discharge FIM^{TM} minus admission FIM^{TM}) was calculated.

Data linkage

The SNAP and the mortality data collections were probabilistically linked to the APDC by the Centre for Health Record Linkage (CHeReL) using *ChoiceMaker*.[25] The CHeReL uses identifying information (e.g. name, address, date of birth and gender) to create a person

project number (PPN), for each unique person identified in the linkage process. A successful link was defined if the PPN matched in both data collections. Upper and lower probability cutoffs started at 0.75 and 0.25 for a linkage and were adjusted for each individual linkage to ensure false links are kept to a minimum. Record groups with probabilities in between the cutoffs were subject to review. The APDC records that included a hip fracture that did not link to a SNAP record were also provided to investigators to calculate the proportion of individuals who did have a SNAP bed-based rehabilitation episode of care post their hip fracture-related admission.

Identification of dementia and other comorbidities

Dementia was identified using the ICD-10-AM diagnosis classifications of F00-F03, F05.1, G30 and G31 recorded in any hospital episode in any of 55 diagnosis fields in the year of, and the year prior to, identification of the hip fracture-related hospital admission (i.e. a 12-month look back period to 1 January 2008 in the hospitalisation records was used to identify dementia). The Charlson comorbidity index (CCI) was used to identify comorbidities using diagnosis classifications from the hospitalisation records.[26] The identification of dementia was excluded from the total CCI score to avoid collinearity between the CCI and dementia status. The CCI was treated as a categorical variable and categorised as a severe comorbidity (CCI ≥ 3), mild comorbidity (CC1 $= 1$ or 2) and no reported comorbidity (CCI $= 0$). A 12-month look-back period was also used for the identification of comorbidities. Delirium (ICD-10-AM: F05) was identified within the hip fracture-related episode of care only.

Data management and analysis

All analyses were performed using SAS version 9.4. [27] Descriptive statistics was conducted. To examine the association between age group, gender, injury mechanism, the number of comorbidities and place of incident, χ^2 tests of independence were used.[28] McNemar χ^2 tests were used to examine changes in the type of accommodation pre- and post-rehabilitation. Thirty-day, 6, 9 and 12-month mortality was calculated from the date of admission of the first hip fracture-related hospital admission (i.e. the index admission). Mortality at 6, 9 and 12 months was calculated for the period 2009–2012 to allow for 12-month follow-up of individuals admitted in 2011. Twenty-eight-day hospital readmission was considered as readmission within 28 d of hospital discharge for any cause, excluding deaths. The calculation of hospital length of stay (LOS) included transfers between hospitals and hospital LOS was truncated to three standard deviations in order to exclude extreme outliers.[29] Linear regression was used to age-adjust for hospital LOS and logistic regression for mortality and 28-d readmission. *T*-tests were used to compare dementia status and unadjusted and age-adjusted hospital LOS.[28] Cell sizes were not large enough to age-adjust for mortality analysis for those who received rehabilitation versus those that did not, except for 12-month mortality for individuals who received rehabilitation.

For individuals who received rehabilitation care following their index hip fracture admission (i.e. those individuals who were transferred or their episode type changed, who had a subsequent principal diagnosis of rehabilitation and an episode of care that was not indicated to be acute care), a comparison of key characteristics for individuals with and without dementia was conducted. For individuals who received their rehabilitation care at a public hospital in NSW, additional information regarding their accommodation and pre- and post-cognitive and motor health outcomes using the FIM™ were compared for individuals with and without dementia. Wilcoxon signed-rank sum tests were used to compare the admission and discharge cognitive, motor and total FIM™ and functional gain scores.

For individuals who did not receive hospital-based rehabilitation care following their index hip fracture admission (i.e. those individuals who were transferred or their episode type changed, who had no diagnosis of rehabilitation in any of 55 diagnosis classifications and an episode of care that was not indicated to be acute care), a comparison of key characteristics for individuals with and without dementia was also conducted.

Logistic regression was used to examine the association of a hospital-based rehabilitation-related care episode and individual characteristics. Significant univariate predictors of rehabilitation were included as a set of predictors in a multi-variable logistic regression model using the method of purposeful selection.[30] All variables that were significant at 0.25 in univariate analyses were included in the multi-variable model where significance was assessed at 0.1. Each variable that was not significant in the univariate analysis was reintroduced into the model to assess for possible confounding using the parameter estimate. If the parameter estimate increased by 15% after the reintroduction of the variable then it was kept in the model.[30]

Results

During the 5-year period, there were 32 305 individuals aged 65 years and older who were hospitalised

Table 1. Hip fracture in individuals aged 65 years and older with and without dementia linked hospitalisation and mortality records in NSW, 2009–2013.

	Dementia ($n = 8785$)		No dementia ($n = 23\,520$)		
	n	%	*n*	%	χ^2 (df)
Age group					
65–69	127	1.5	1517	6.5	981.5 (3)*
70–79	1181	13.4	5784	24.6	
80–89	4868	55.4	11 405	48.5	
90+	2609	29.7	4814	20.5	
Gender					
Male	2308	26.3	6709	28.5	16.1 (1)*
Female	6477	73.7	16 811	71.5	
Admission year					
2009	1864	21.2	4290	18.2	39.1 (4)*
2010	1862	21.2	5018	21.3	
2011	1690	19.2	4755	20.2	
2012	1729	19.7	4777	20.3	
2013	1640	18.7	4680	19.9	
Injury mechanism					
Fall	8489	96.6	22 161	94.2	110.9 (2)*
Road transport	34	0.4	422	1.8	
Other injury mechanisms	262	3.0	937	4.0	
Number of comorbidities (excluding dementia)					
None	5688	64.8	14 891	63.3	6.5 (2)**
One or two	2539	28.9	7012	29.8	
Three or more	558	6.4	1617	6.9	
Delirium (during current episode of care)[a]	1566	17.8	1762	7.5	739.2 (1)*
Place of incident					
Home	2323	26.4	13 178	56.0	6124.1 (6)*
Residential care facility	5579	63.5	4374	18.6	
Health service facility	142	1.6	511	2.2	
Street and highway	117	1.3	1021	4.3	
Trade and service area	83	0.9	997	4.3	
Other specified place	44	0.5	588	2.5	
Unspecified and unknown place	497	5.7	2851	12.1	
Total hospital length of stay, including any rehabilitation (days)					
Unadjusted mean (sd)	17.9 (15.4)		23.5 (16.3)		$t = 26.75$*
Age-adjusted mean (sd)	22.2 (0.9)		21.9 (1.3)		$t = -20.05$*
Re-admission within 28 d[b]					
Unadjusted	563	15.4	3717	23.8	382.1 (1)*
Age-adjusted (95% CI)	563	17.3 (16.5–18.2)	3717	24.4 (23.8–24.9)	$t = 23.36$*
Death within 30 d					
Unadjusted	1108	12.6	1422	6.1	120.9 (1)*
Age-adjusted (95% CI)	1108	11.7 (11.0–12.5)	1422	5.7 (5.4–6.0)	$t = -28.21$*

*$p < 0.0001$;
**$p < 0.05$.
[a]Includes ICD-10-AM: F05.1 delirium superimposed on dementia.
[b]Excludes death.

following a hip fracture. Of these, there were 8785 (27.2%) individuals who were identified as also having dementia. Just less than three-quarters of individuals who were hospitalised were female, with a slightly higher proportion of females having dementia. Individuals who had dementia were more likely to be in the older age groups (i.e. 80–89 and 90 + years). Nearly all hip fractures for individuals with and without dementia were as a result of a fall (96.6% and 94.2%, respectively). Around two-thirds of individuals with and without dementia had no recorded comorbidities using the CCI, excluding dementia. Where comorbidities were identified using the CCI the most common reported comorbidities for individuals with and without dementia were congestive heart failure (10.0% and 10.2%, respectively), renal disease (8.3% and 8.9%, respectively) and diabetes with chronic complications (6.6% and 7.7%, respectively). Individuals with dementia were almost 2.5 times more likely to have an additional diagnosis of delirium. Almost two-thirds of individuals with dementia sustained their hip fracture in a residential aged care (RAC) facility compared to less than 20% for individuals without dementia. Individuals with dementia had a significantly higher age-adjusted 30-d mortality rate following a hip fracture compared to individuals without dementia (11.7% versus 5.7%), a significantly lower proportion of age-adjusted re-admission within 28 d (17.3% versus 24.4%), and a longer age-adjusted mean total hospital LOS (22.2 versus 21.9 d) (Table 1).

Table 2. Hip fracture in individuals aged 65 years and older with and without dementia who had and did not have a rehabilitation-related care admission in a public or private hospital, linked hospitalisation and mortality records in NSW, 2009–2013.

	Rehabilitation-related episode of care					No rehabilitation-related episode of care				
	Dementia (*n*=1695)		No dementia (*n*=10 455)			Dementia (*n*=856)		No dementia (*n*=1224)		
	n	%	*n*	%	χ^2 (df)	*n*	%	*n*	%	χ^2 (df)
Age group										
65–69	34	2.0	532	5.1	130.4 (3)*	14	1.6	38	3.1	26.2 (3)*
70–79	239	14.1	2494	23.9		112	13.1	252	20.6	
80–89	991	58.5	5400	51.7		497	58.1	619	50.6	
90+	431	25.4	2029	19.4		233	27.2	315	25.7	
Gender										
Male	399	23.5	2763	26.4	6.3 (1)**	256	29.9	371	30.3	0.04 (1)
Female	1296	76.5	7692	73.6		600	70.1	853	69.7	
Admission year										
2009	313	18.5	1873	17.9	17.2 (4)**	134	15.7	188	15.4	6.1 (4)
2010	426	25.1	2208	21.1		162	18.9	204	16.7	
2011	341	20.1	2197	21.0		197	23.0	278	22.7	
2012	323	19.1	2125	20.3		225	26.3	308	25.2	
2013	292	17.2	2052	19.6		138	16.1	246	20.1	
Number of comorbidities (excluding dementia)										
None	963	56.8	5999	57.4	0.61 (2)	478	55.8	509	41.6	44.2 (2)*
One or two	591	34.9	3642	34.8		538	44.0	303	35.4	
Three or more	141	8.3	814	7.8		75	8.8	177	14.5	
Delirium (during current episode of care)[a]	544	32.1	1041	10.0	630.1 (1)*	295	34.5	275	22.5	36.4 (1)*
Hospital length of stay (days)										
Unadjusted mean (sd)	19.7 (12.5)		20.0 (12.4)		$t=1.13$	13.1 (12.8)		14.4 (14.6)		$t=1.43$
Age-adjusted mean (sd)	20.2 (0.8)		20.0 (0.9)		$t=-11.31$*	13.8 (1.0)		13.7 (0.9)		$t=-1.89$
Death within 6 months[b]	127	9.3	370	4.4	56.2 (1)*	71	11.3	87	9.5	1.3 (1)
Death within 9 months[b]	204	14.9	616	7.4	85.0 (1)*	90	14.3	125	13.7	0.1 (1)
Death within 12 months[b]										
Unadjusted	294	21.4	969	11.6	99.8 (1)*	118	18.7	156	17.0	0.7 (1)
Age-adjusted (95% CI)	294	19.6 (17.2–22.3)	969	11.3 (10.6–12.0)	$t=-9.23$ (1891.5)*	na	na	na	na	

*$p<0.0001$;
**$p=0.01$.
na = not applicable.
[a]Includes ICD-10-AM: F05.1 delirium superimposed on dementia.
[b]Mortality was calculated for the period 2003–2011.

Hospital-based rehabilitation-related care

For older individuals who both did and did not have a rehabilitation-related episode of care, there were significant differences in age group and experience of delirium for individuals with and without dementia. For those who did not have a rehabilitation-related episode of care, there were also significant differences in the proportion of comorbidities recorded for individuals with and without dementia. Individuals who had a rehabilitation-related episode of care stayed approximately 7 d longer in the hospital (19.7 versus 13.1 d) than individuals who were not reported to receive rehabilitation (Table 2).

Provision of hospital-based rehabilitation

Univariate associations identified that individuals who did not receive hospital-based rehabilitation were less likely to be female than male (OR 0.82; 95% CI: 0.74–0.90), were more likely to be in older age groups compared to individuals aged 65–69 years, have dementia (OR 4.31; 95% CI: 3.90–4.78), have multiple comorbidities compared to individuals with no identified comorbidities identified using the CCI, and where the incident occurred in residential care facilities (OR 2.58; 95% CI: 2.27–2.93) or health service facilities (OR 3.30; 95% CI: 2.80–3.89) compared to at home. Multivariate associations revealed several significant interactions with dementia. Females without dementia had lower odds of receiving hospital-based rehabilitation compared to males (OR = 0.94; 95% CI: 0.82–1.08) and females with dementia had even lower odds of receiving hospital-based rehabilitation compared to males (OR = 0.72; 95% CI: 0.60–0.88). Individuals without dementia who had one or two comorbidities (OR = 1.63; 95% CI: 1.43–1.86) or three or more comorbidities (OR = 2.29; 95% CI: 1.88–2.79) had significantly higher odds of receiving hospital-based rehabilitation compared to individuals with no comorbidities. Individuals with dementia who had one or two comorbidities (OR = 0.95; 95% CI: 0.79–1.14) or three or more comorbidities (OR = 0.98; 95% CI: 0.72–1.34) had lower odds of receiving hospital-based

Table 3. Univariate and multivariable logistic regression of characteristics of individuals aged 65 years and older who had and did not have a rehabilitation-related care admission in a public or private hospital, linked hospitalisation and mortality records in NSW, 2009–2013.

	Univariate logistic regression		Multivariable logistic regression		
	Odds ratio[a]	95% CI	Odds ratio[a]	95% CI	Wald χ^2 (df)
Age group					31.9 (3)*
65–69	1		1		
70–79	1.45**	1.07–1.97	1.87	1.12–3.12	
80–89	1.90*	1.42–2.54	2.45**	1.49–4.02	
90+	2.43*	1.80–3.27	3.04*	1.83–5.05	
Gender					0.7 (1)
Male	1		1		
Female	0.82*	0.74–0.90	0.94	0.82–1.08	
Number of comorbidities (excluding dementia)					90.0 (2)*
None	1		1		
One or two	1.40*	1.27–1.55	1.63*	1.43–1.86	
Three or more	1.86*	1.60–2.17	2.29*	1.88–2.79	
Dementia[b]	4.31*	3.90–4.78	6.82*	5.19–8.96	249.8 (1)*
Delirium (during current episode of care)[b,c]	2.52*	2.25–2.81	2.15*	1.78–2.61	61.2 (1)*
Place of incident					28.7 (6)*
Home	1		1		
Residential care facility	2.58*	2.27–2.93	7.39**	2.35–23.28	
Health service facility	3.30*	2.80–3.89	5.82*	2.56–13.24	
Street and highway	0.78*	0.58–1.04	1.91	0.58–6.34	
Trade and service area	0.46	0.31–0.67	1.08	0.14–8.64	
Other specified place	0.60**	0.38–0.93	1.59	0.37–6.86	
Unspecified and unknown place	0.49*	0.43–0.56	0.86	0.35–2.12	
Interactions					
Gender × dementia					4.9 (1)***
Dementia and male	–	–	1		
Dementia and female	–	–	0.76	0.60–0.97	
Comorbidities (excluding dementia)×dementia					33.1 (2)*
Dementia and none	–	–	1		
Dementia and one or two comorbidities	–	–	0.58*	0.46–0.73	
Dementia and three or more comorbidities	–	–	0.43*	0.30–0.62	
Dementia × delirium					34.1 (1)*
Dementia and not delirium	–	–	1		
Dementia and delirium	–	–	0.49*	0.38–0.62	
Dementia × location					15.4 (6)**
Dementia and home	–	–	1		
Dementia and residential care facility	–	–	0.71	0.53–0.93	
Dementia and health service facility	–	–	0.97	0.66–1.43	
Dementia and street and highway	–	–	1.15	0.57–2.31	
Dementia and trade and service area	–	–	2.75	1.14–6.63	
Dementia and other specified place	–	–	1.29	0.31–5.37	
Dementia and unspecified and unknown place	–	–	1.18	0.86–1.62	
Delirium × location	–	–	NR[d]	NR[d]	11.8 (6)
Age group × location	–	–	NR[d]	NR[d]	32.6 (18)**

*$p < 0.0001$;
**$p = 0.02$;
***$p = 0.05$.
[a]No rehabilitation is the referent group.
[b]No is the referent group.
[c]Includes ICD-10-AM: F05.1 delirium superimposed on dementia.
[d]Not reported.

rehabilitation compare to presenting without comorbidities (Table 3).

Hospital-based rehabilitation outcomes

There were significant differences for both individuals with and without dementia in the type of accommodation the individual resided in pre- and post-hip fracture ($\chi^2 = 213.5$, df (6), $p < 0.0001$ and $\chi^2 = 736$, df (6), $p < 0.0001$, respectively) (Table 4). Just over half (55.2%) the individuals with dementia who were residing in a private residence prior to their hip fracture returned to their residence compared to 79.0% of individuals without dementia. Of the remaining individuals with and without dementia who were previously residing in a private residence, 5.6% versus 3.6% went to low-level RAC, 19.6% versus 5.0% went to high-level RAC and 19.6% versus 12.4% went to either community group homes, boarding houses or transitional living units.

Where the FIM™ scores were reported, there was a significant improvement for individuals on both the

Table 4. Accommodation type at admission and discharge for individuals aged 65 years and older with and without dementia who sustained a hip fracture and had a rehabilitation-related care admission in a public hospital, linked hospitalisation, sub-acute and non-acute care and mortality records in NSW, 2009–2013.

	Dementia ($n = 680$)					No dementia ($n = 4291$)				
	Prior to admission		At discharge			Prior to admission		At discharge		
Accommodation type	*n*	%	*n*	%	McNemar χ^2 (df)[a]	*n*	%	*n*	%	McNemar χ^2 (df)[a]
Private residence, including unit in retirement village	504	74.1	254	37.4	231.5 (6)*	3810	88.8	2821	65.7	736.9 (6)*
Residential aged care, low level care	113	16.6	94	13.8		264	6.2	284	6.6	
Residential aged care, high level care	28	4.1	133	19.6		44	1.0	256	6.0	
Other, including community group home, boarding house, and transitional living unit	26	3.8	117	17.2		81	1.9	512	11.9	
Not specified	9	1.3	82	12.1		93	2.2	419	9.8	

*$p < 0.0001$.
[a]Not specified excluded from the McNemar test.

Table 5. FIM™ scores at admission and discharge for individuals aged 65 years and older with and without dementia who sustained a hip fracture and had a rehabilitation-related care admission in a public hospital, linked hospitalisation, sub-acute and non-acute care and mortality records in NSW, 2009–2013.

	Dementia (n=680)					No dementia (n=4291)				
FIM™ scores	*n*	Mean	Standard deviation	Median	Sign test[a]	*n*	Mean	Standard deviation	Median	Sign test[a]
Admission										
Cognitive subscale		18.7	7.5	18.0			27.9	6.8	30.0	
Motor subscale		37.7	14.6	38.0			47.7	14.3	49.0	
Total[b]	676	56.4	19.5	57.0		4226	75.6	18.6	77.0	
Discharge										
Cognitive subscale		19.8	7.7	20.0	12 930*		29.1	6.4	31.0	541451.5*
Motor subscale		50.5	19.9	53.0	84958.5*		66.6	17.0	72.0	3 876 072*
Total[b]	674	70.3	25.2	74.0	84410.5*	4210	95.7	21.3	102.0	3 871 730*
Total functional gain	674	13.9	15.5	13.0	84410.5*	4208	20.0	15.6	20.0	3 871 730*
Cognitive gain	674	1.1	4.0	0	541451.5*	4207	1.2	3.7	0	12 930*
Motor gain	674	12.8	13.3	12.0	3 876 072*	4206	18.7	13.8	19.0	84958.5*

*$p < 0.0001$.
[a]Wilcoxon signed-rank sum test comparing admission and discharge FIM scores.
[b]Seventy individuals did not have an FIM assessment at admission and 88 individuals did not have a FIM assessment at discharge.

cognitive and motor subscales of the FIM™ at discharge compared to admission for individuals with and without dementia. Both individuals with and without dementia had the significant functional gain at discharge following rehabilitation compared to their initial admission scores (Table 5).

Discussion

The treatment and return to pre-fracture functional ability following an orthopaedic injury, such as hip fracture, for older individuals with dementia can be a challenge. Early mobilisation of individuals post-surgery is advised, along with some form of rehabilitation to aid in the regaining of pre-fracture mobility.[2,31] In the current study, the majority of individuals who sustained a hip fracture were aged 80 years and older, were female, were injured as a result of a fall and around one-third had comorbid conditions identified using the CCI. It is known that both the incidence of falls and of hip fracture increases with age, so the high proportion of individuals aged 80 + years with a hip fracture following a fall is not surprising.[6,32] Individuals with cognitive impairment are known to have a further increased risk of a fall,[20] with these individuals having a reported five-fold risk of a fall and just over a two-fold increased risk of injury following the fall.[33]

There was a significantly higher proportion of delirium experienced among individuals with dementia compared to those without dementia (17.8% versus 7.5%, respectively). Delirium has been associated with an increased falls risk and individuals with dementia are also known to be at-risk of developing delirium while hospitalised with a hip fracture.[34] The risk of experiencing delirium is also increased for individuals who have multiple comorbid conditions and associated polypharmacy and for those with low levels of physical activity pre-fracture.[35]

Falls in residential institutions accounted for almost two-thirds of hip fractures in individuals with dementia while 56.0% of hip fractures for cognitively intact individuals occurred in the home. Individuals with dementia, especially those that also have physical impairments, are more often institutionalised compared to individuals without dementia who may choose to remain longer in their own home. The location of the fall is likely to reflect where older individuals spend the majority of their time.

In terms of overall health outcomes, 28-d hospital readmission was less likely and 30-d mortality was double the proportion for individuals with dementia compared to those without dementia (11.7% versus 5.7%, respectively). Higher mortality rates for individuals with dementia following a hip fracture have been found in other studies,[1,16] while studies that excluded individuals from RAC facilities have found that individuals with dementia did not have higher mortality rates.[13] However, this could be due to the less advanced state of disease. Both the total hospital and rehabilitation-related LOS were slightly longer for people with dementia as has been found elsewhere.[36] It is possible that a hip fracture has a greater impact on the cognitive and physical functioning and rehabilitation of individuals with dementia and results in a longer LOS.

As shown in Table 3, hospital-based rehabilitation was less likely for females (OR: 0.82; 95% CI: 0.74–0.90), had between 1.5 and 2.4 times lower odds for individuals in age groups from 70 years and older than individuals aged 65–69 years, and had 1.4 and 1.9 times lower odds for individuals with 1–2 or 3 + comorbidities, respectively. It is possible that older individuals with multiple comorbidities are not perceived as being able to participate in rehabilitation activities.

Individuals with dementia had 4.3 times lower odds of receiving hospital-based rehabilitation following their hip fracture. However, for individuals that received rehabilitation there was significant improvement found for both individuals with and without dementia on both the cognitive and motor subscales of the FIM^{TM} and on the overall functional gain. Beloosesky et al. [18] who examined the return to physical function 6 months post-surgery in 153 patients, found no differences in functional gain between individuals with and without dementia, if the individuals were physically mobile prior to their fracture. It is likely that individuals with dementia were excluded from rehabilitation activities due to beliefs that due to their impaired insight, poor attention span and inability to perform purposeful movement they would be unable to follow instructions [12] and thus were perceived as being unable to cope with and participate in rehabilitation activities.[37] However, other studies have found that cognitively impaired individuals can show improvements in physical functioning and can benefit from receiving rehabilitation post-hip fracture.[17,19,36] In some cases, cognitively impaired individuals have been shown to achieve comparable motor functional gain to cognitively intact individuals if they were mobile pre-fracture.[18,38] Although, the importance of conducting an individualised assessment of the potential of an individual to regain function and over what time frame should be examined.

It is possible that some individuals did not receive hospital-based rehabilitation in the current study because they had severe cognitive impairment. However, Morghen et al. [39] in an examination of walking ability in 306 cognitively impaired individuals 1-year post-hip fracture, found that post-discharge 29.4% of individuals with severe cognitive impairment could walk unaided and that 57.1% of individuals with severe cognitive impairment could walk independently at 1-year post-fracture. In fact, even individuals with severe cognitive impairment may still retain procedural memory, making them capable of participating in activities to regain motor skills post-fracture.[12,39] In a survey of health care professionals, McGilton et al. [12] identified common strategies used by staff to successfully involve cognitively impaired individuals in rehabilitation activities, which included positive reassurance, visual and verbal cueing, use of simple instructions, modifications to the physical environment and using repetitive routines.[12]

Where the hip fracture occurred in a residential institution or in a health service facility, the current study found that individuals were 2.5 times and 3.3 times, respectively less likely to undergo hospital-based rehabilitation independent of dementia status. Similarly, Al-Ani et al.[20] in an examination of rehabilitation following a hip fracture for the cognitively impaired, identified that individuals already residing in RAC were seldom considered for rehabilitation, with only around 10% of these individuals going to rehabilitation. Further research is required to examine how best to work with people with dementia after a hip fracture, particularly those in RAC so as to maximise any potential functional gains.

Just over half of the individuals with dementia and 79.0% of those without dementia returned home after rehabilitation following their hip fracture. Similarly, Rösler et al. [40] found that individuals with dementia were more likely to be discharged to a nursing home than individuals without dementia (44% versus 20%). Likewise, Diamond et al. [38] identified that cognitively impaired individuals were more likely to require nursing home placement after

rehabilitation, but that being cognitively impaired did not preclude individuals returning home. Huusko et al.,[16] in a randomised control trial of 243 individuals with mild/moderate dementia who participated in intensive rehabilitation in Finland, also found that individuals with mild/moderate dementia could be discharged to their private residence after receiving active geriatric rehabilitation (incorporating twice-daily physiotherapy sessions) following a hip fracture.

There are several limitations of the current study that need to be taken into account. The study only examined hospital-based rehabilitation and only identified a principal diagnosis of rehabilitation immediately following hospital admission for a hip fracture, so is likely to underestimate rehabilitation. No information was available on dementia severity in the hospitalisation data, the mobility/ambulatory status of individuals pre-fracture or prior hip fracture experience, on the living or carer arrangements of individuals, nor was information available on the level of injury severity or the type or frequency of the rehabilitation provided. The results of the FIM™ and accommodation pre- and post-discharge were only available for public hospitals who provide this data for the SNAP data collection. It is estimated that around one-third of rehabilitation is conducted in private hospitals. Data validity was not able to be assessed and it is possible that there could be some misclassification in records. Delirium could only be identified using ICD-10-AM classifications in hospitalisation records, which is likely to underestimate the number of patients experiencing delirium.[41,42]

Only health conditions that were relevant to the current hospital episode of care are reported in each hospitalisation record. However, by using a 1-year look-back period, better estimates of the prevalence of medical conditions, including dementia, were able to be obtained in the current study.[43] It is possible that there is some survival bias, with older individuals who experience poor health conditions, more likely than healthy individuals to have premature deaths.[44] Lastly, when using record linkage there is likely to be some degree of error in the data linkage process. However, for the current study, the CHeReL estimates the false positive rate for this linkage to be 0.5% (i.e. the proportion of false matches) and estimated the rate of false negatives at 0.5% (i.e. failure to identify matches).[45]

In terms of clinical practise, it appears that individuals with dementia who have sustained a hip fracture are able to demonstrate physical functional gain following participation in rehabilitation-related activities. It is possible that participation in rehabilitation may not be viable for all individuals with dementia, particularly individuals with severe dementia.

Conclusion

This study provides evidence that, in a population-based cohort, individuals with dementia can benefit from access to, and participation in, rehabilitation activities following a hip fracture. As the proportion of older individuals increases worldwide and with it the proportion of individuals experiencing cognitive impairment, access to rehabilitation for individuals with dementia who sustain a hip fracture is important to ensure that this group has the best chance of returning to their pre-fracture physical function and mobility.

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Declaration of interest

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