■ TRAUMA

The 30-day survival and recovery after hip fracture by timing of mobilization and dementia

A UK DATABASE STUDY

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Aims
The aim of this study to compare 30-day survival and recovery of mobility between patients mobilized early (on the day of, or day after surgery for a hip fracture) and patients mobilized late (two days or more after surgery), and to determine whether the presence of dementia influences the association between the timing of mobilization, 30-day survival, and recovery.

Methods
Analysis of the National Hip Fracture Database and hospital records for 126,897 patients aged ≥ 60 years who underwent surgery for a hip fracture in England and Wales between 2014 and 2016. Using logistic regression, we adjusted for covariates with a propensity score to estimate the association between the timing of mobilization, survival, and recovery of walking ability.

Results
A total of 99,667 patients (79%) mobilized early. Among those mobilized early compared to those mobilized late, the weighted odds ratio of survival was 1.92 (95% confidence interval (CI) 1.80 to 2.05), of recovering outdoor ambulation was 1.25 (95% CI 1.03 to 1.51), and of recovering indoor ambulation was 1.53 (95% CI 1.32 to 1.78) by 30 days. The weighted probabilities of survival at 30 days post-admission were 95.9% (95% CI 95.7% to 96.0%) for those who mobilized early and 92.4% (95% CI 92.0% to 92.8%) for those who mobilized late. The weighted probabilities of regaining the ability to walk outdoors were 9.7% (95% CI 9.2% to 10.2%) and indoors 81.2% (95% CI 80.0% to 82.4%), for those who mobilized early, and 7.9% (95% CI 6.6% to 9.2%) and 73.8% (95% CI 71.3% to 76.2%), respectively, for those who mobilized late. Patients with dementia were less likely to mobilize early despite observed associations with survival and ambulation recovery for those with and without dementia.

Conclusion
Early mobilization is associated with survival and recovery for patients (with and without dementia) after hip fracture. Early mobilization should be incorporated as a measured indicator of quality. Reasons for failure to mobilize early should also be recorded to inform quality improvement initiatives.

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Introduction
In the UK, 30-day survival after a fracture of the hip increased from 88.5% in 2003 to 93.9% in 2018, according to the National Hip Fracture Database (NHFD) which captures 95% of all cases.[1] Improvements in survival have been attributed to improved clinical care associated with the identification and audit of performance indicators, and feedback to participating sites.[2] Recent indicators include early mobilization in the expectation that this impacts rates of survival and recovery.[1]

The evidence for this is based on one trial of 60 patients which was of low to moderate quality.[3] In the UK, further trials may not be ethical or feasible as early mobilization has become standard care on the basis of national guidance.[3] However, analysis

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Table I. Characteristics of patients surgically treated for non-pathological first hip fracture overall and by timing of mobilization in the complete case analysis dataset of 30-day survival outcome (n = 126,897).

Variable	All (n = 126,897)*	Early mobilization (n = 99,667)	Delayed mobilization (n = 27,230)
Median age, yrs (IQR)	84 (77 to 89)	84 (77 to 89)	85 (79 to 90)
Sex, n (%)			
Female	91,962 (72.5)	72,650 (79.0)	19,312 (21.0)
Male	34,933 (27.5)	27,016 (77.3)	7,917 (22.7)
Ethnicity, n (%)			
White	99,585 (78.5)	78,948 (79.3)	20,637 (20.7)
Caribbean or African or any mixed black background	244 (0.2)	159 (65.2)	85 (34.8)
Asian or Asian British or any mixed Asian background	1,262 (1.0)	970 (76.9)	292 (23.1)
Pre-fracture walking ability, n (%)			
Freely ambulatory without aids	47,990 (37.8)	40,516 (84.4)	7,474 (15.6)
Outdoors with one aid	28,218 (22.2)	22,632 (80.2)	5,586 (19.8)
Outdoors with two aids or frame	17,929 (14.1)	13,813 (77.0)	4,116 (23.0)
Some indoor ambulation but never goes outside without help	29,567 (23.3)	20,660 (69.9)	8,907 (30.1)
No functional ambulation	1,717 (1.4)	1,016 (59.2)	701 (40.8)
Deprivation, n (%)			
Least deprived 10%	10,545 (8.3)	8,194 (77.7)	2,351 (22.3)
Less deprived 10% to 20%	10,335 (8.1)	7,939 (76.8)	2,396 (23.2)
Less deprived 20% to 30%	11,254 (8.9)	8,650 (76.9)	2,604 (23.1)
Less deprived 30% to 40%	12,023 (9.5)	9,342 (77.7)	2,681 (22.3)
Less deprived 40% to 50%	12,618 (9.9)	9,874 (78.3)	2,744 (21.7)
More deprived 40% to 50%	13,315 (10.5)	10,430 (78.3)	2,885 (21.7)
More deprived 30% to 40%	13,149 (10.4)	10,337 (78.6)	2,812 (21.4)
More deprived 20% to 30%	12,701 (10.0)	10,068 (79.3)	2,633 (20.7)
More deprived 10% to 20%	12,622 (10.0)	10,095 (80.0)	2,527 (20.0)
Most deprived 10%	11,910 (9.4)	9,587 (80.5)	2,323 (19.5)
Hip fracture type, n (%)			
Intracapsular	74,886 (59.0)	59,322 (79.2)	15,564 (20.8)
Intertrochanteric	44,463 (35.0)	34,800 (78.3)	9,663 (21.7)
Subtrochanteric	7,488 (5.9)	5,499 (73.4)	1,989 (26.6)
Surgery timing, n (%)			
Within target time	90,713 (71.5)	72,127 (79.5)	18,586 (20.5)
Procedure type, n (%)			
Internal fixation	61,888 (48.8)	48,735 (78.7)	13,153 (21.3)
Hemiarthroplasty	54,942 (43.3)	42,128 (76.7)	12,814 (23.3)
THA	9,514 (7.5)	8,416 (88.5)	1,098 (11.5)
Calendar year of surgery, n (%)			
2014	33,361 (26.3)	25,853 (77.5)	7,508 (22.5)
2015	50,875 (40.1)	40,316 (79.2)	10,559 (20.8)
2016	42,661 (33.6)	33,498 (78.5)	9,163 (21.5)
Weekday of admission, n (%)			
Weekday	84,563 (66.6)	66,440 (78.6)	18,123 (21.4)
Weekend	37,966 (29.9)	30,269 (79.7)	7,697 (20.3)
Hospital volume, n (%)†			
High volume	65,307 (51.5)	51,087 (78.2)	14,220 (21.8)
Medium volume	29,171 (23.0)	23,447 (80.4)	5,724 (19.6)
Low volume	32,419 (25.6)	25,133 (77.5)	7,286 (22.5)
ASA grade, n (%)			
I	2,814 (2.2)	2,559 (90.9)	255 (9.1)
II	33,975 (26.6)	29,125 (85.7)	4,850 (14.3)
III	70,338 (55.4)	54,474 (77.4)	15,864 (22.6)
IV	16,440 (13.0)	10,932 (66.5)	5,508 (33.5)
V	284 (0.2)	163 (57.4)	121 (42.6)
Comorbidities, n (%)			
Heart failure / pulmonary oedema	13,543 (10.7)	9,500 (70.1)	4,043 (29.9)
Chronic obstructive pulmonary diseases	18,132 (14.3)	13,649 (75.3)	4,483 (24.7)
Ischemic heart disease (acute)	12,098 (9.5)	9,012 (74.5)	3,086 (25.5)
Cardiac dysrhythmias	27,904 (22.0)	20,743 (74.3)	7,161 (25.7)
Ischemic heart disease (chronic)	21,082 (16.6)	15,741 (74.7)	5,341 (25.3)
Hypertension	68,426 (53.9)	53,880 (78.7)	14,546 (21.3)
Hypotension	10,738 (8.5)	7,681 (71.5)	3057 (28.5)
Diabetes with complication	1,748 (1.4)	1,290 (73.8)	458 (26.2)
Alzheimer's or dementia	36,377 (28.7)	26,111 (71.8)	10,266 (28.2)
Depression	10,077 (7.9)	7,715 (76.6)	2,362 (23.4)
Delirium	10,398 (8.2)	7,441 (71.6)	2,957 (28.4)
Admission from location, n (%)			
Own home/ sheltered housing	100,760 (79.4)	81,611 (81.0)	19,149 (19.0)
Nursing care/ residential care	23,127 (18.2)	16,049 (69.4)	7078 (30.6)
Rehabilitation unit	155 (0.1)	113 (72.9)	42 (27.1)
Hospital site	2,835 (2.2)	1,878 (66.2)	957 (33.8)

*Missing data: age (n = 232), sex (n = 2), ethnicity (n = 25,806), pre-fracture walking ability (n = 1,476), deprivation (n= 6,425), hip fracture type (n = 60), surgery timing (n = 8,083), procedure type (n = 553), weekday of admission (n = 4,368), ASA grade (n = 3,046), comorbidities (n = 5,464), admission from location (n = 20).
†Low (less than first quartile), medium (second and third quartile), or high (fourth quartile) volume at admission based on the average annual number of surgeries at the admitting hospital.
ASA, American Society of Anesthesiologists; IQR, interquartile range; THA, total hip arthroplasty.

Table II. Odds ratios of 30-day survival by timing of mobilization among patients surgically treated for non-pathological first hip fracture overall and across subgroups defined by dementia.

Mobilization timing	Patients, n (%)	Survivors, n (%)	Unweighted OR (95% CI)	Adjusted OR (95% CI)*
Overall (n = 126,897)				
Mobilized 2 days or more after surgery	27,230 (21.5)	24,283 (89)	1.00	1.00
Mobilized on the day of or day after surgery	99,667 (78.5)	95,656 (96)	2.89 (2.75 to 3.04)	1.92 (1.80 to 2.05)
Without dementia (n = 85,056)				
Mobilized 2 days or more after surgery	15,906 (18.7)	14,548 (91)	1.00	1.00
Mobilized on the day of or day after surgery	69,150 (81.3)	67,207 (97)	3.23 (3.01 to 3.47)	2.06 (1.88 to 2.26)
With dementia (n = 36,377)				
Mobilized 2 days or more after surgery	10,266 (28.2)	8,915 (87)	1.00	1.00
Mobilized on the day of or day after surgery	26,111 (71.8)	24,393 (93)	2.15 (2.00 to 2.32)	1.77 (1.61 to 1.95)

*Using propensity weighting scores that were calculated using a model to predict the mobilization timing from the confounding variables: age, sex, ethnicity, comorbidities, fracture type, fracture surgery type, surgery timing, fracture year calendar, deprivation, week day of admission, pre-fracture residence, ASA grade, pre-fracture mobility, and hospital volume. In all, 35,285, 24,582, and 10,703 cases with missing data of at least one of these confounding variables were excluded from the overall, without dementia group, and with dementia group, respectively.
†Unweighted odds ratios from the analysis of complete case analysis for day 30 survival outcome includes 126,897 patients for the overall analysis, and 121,433 in the analysis by dementia.
CI, confidence interval; OR, odds ratio.

of real-world observational data presents an opportunity to study the association between early mobilization and outcomes.[4] Indeed, a cohort of 532 patients in New York, USA, points to a possible six-month survival and two-month recovery benefit of early mobilization,[5] while an analysis of unlinked NHFD data from 2013 to 2015 reported a 30-day recovery benefit.[6] These analyses could be built upon with estimation of survival among a larger patient cohort, adjustment for confounders with the use of linked data, and by considering ambulation in light of pre-fracture ability.

These benefits reflect mean (or median) values encompassing a wide range of patients. Whether all patients benefit remains unclear. Previous analyses reported that patients with dementia are less likely to mobilize early[7] and less likely to survive to 30 days.[8] However, a subgroup analysis of a trial of rehabilitation in patients with hip fracture found that those with mild to moderate dementia benefited more from the intervention in terms of independence at three months than those without or with severe dementia.[9] This intervention included early mobilization, but the extent to which this aspect of care contributed to beneficial effects observed is unclear.[9] Directly comparing the association between early mobilization and outcomes across subgroups defined by dementia would resolve this uncertainty.

The objectives of this study were to compare 30-day survival and recovery of the ability to walk pre-fracture between patients mobilized early and those mobilized late, and to determine whether the presence of dementia influences the association between the timing of mobilization and 30-day survival and recovery.

Methods

This study is reported according to the REporting of studies Conducted using Observational Routinely collected health Data (RECORD) statement.[4] This study received NHS Health Research Authority and Health and Care Research Wales approval (IRAS Project ID: 230215). The study did not require ethical approval as an analysis of pseudonymized data.

Cohort. The NHFD assembles data on the characteristics of patients and their care following acute admission with a hip fracture.[1] Between 1 January 2014 and 31 December 2016, data were submitted for 170,970 patients aged ≥ 60 years who had been surgically treated for a non-pathological first hip fracture and with a postoperative hospital stay of ≥ one day in England or Wales. Case ascertainment was estimated at 95% (for 2015).[10] Data were linked to the English Hospital Episode Statistics database and Patient Episode Database for Wales for data on comorbidities, ethnicity, deprivation, and survival. Details of data cleaning, linkage, selection, and validation are available elsewhere.[7] We selected patients with complete data for exposure and either of our primary outcomes (n = 126,897). Differences between patients with and without complete data are presented in the Supplementary Material.

Of the 126,897 patients, 72% were female, 78% white, 55% with an American Society of Anesthesiologists (ASA) grade III,[11] 79% admitted from home, and 38% able to walk indoors and outdoors without aids pre-fracture (Table I). More than half were admitted to high-volume hospitals (52%), on weekdays (67%), and underwent surgery within the target time (72%) (Table I).

Exposure. The exposure was an indicator for timing of mobilization: ‘early’ (on the day of or day after surgery); or ‘late’ (two days or more after surgery). The NHFD defines mobilization as the ability to sit or stand out of bed with or without help.[1]

Outcomes. The primary outcome was survival at 30 days post-admission. The secondary outcome was recovery of the ability to walk, defined as no change (or improvement) in that ability from pre-fracture to 30 days post-admission. We defined levels of walking based on a patient’s (or surrogate’s) report of being able to walk outdoors (NHFD: ambulatory in and outdoors without aids, ambulatory outdoors with one aid, ambulatory outdoors with two aids or frame) or ambulatory indoors (NHFD: some indoor ambulation but never outside without help).[6] We chose this definition to reflect the ability to walk which increases opportunity for wider social participation. We excluded patients who were unable to walk pre-fracture from the analysis of recovery to prevent overestimation of recovery.

Subgroup. We used ICD-10 codes to identify patients with dementia (ICD-10: E100-E108; E110-E118; E130-E138; E140-E148) during their hip fracture admission or an admission in the previous year. For recovery analysis, we stratified

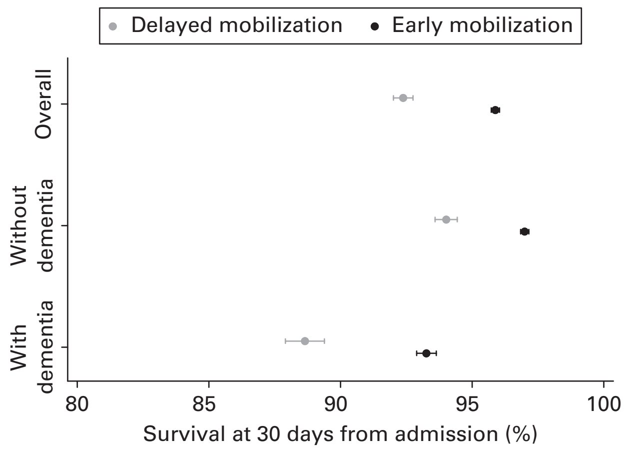

Fig. 1

Weighted probability of survival at 30 days from admission in relation to timing of mobilization, overall, and by dementia.

patients according to their ability to walk pre-fracture: outdoors or indoors only.

Statistical analysis. We used Stata v. 16 for analysis (StataCorp, USA). We described patient and care characteristics by median and interquartile ranges (IQRs) for continuous variables and proportions for categorical variables, overall, and by mobilization timing. We used the chi-squared test and the Wilcoxon rank test to compare distributions by mobilization timing. We estimated the proportion of patients mobilized early and who had survived and recovered by 30 days post-admission.

We defined a propensity score (PS) for mobilization timing with respect to confounders using logistic regression and defined weights to estimate the average treatment effect, equal to 1/PS if a patient was mobilized early and 1/(1-PS) otherwise, with Stata psmatch2[12] and scenttest[13] (Supplementary Material).[14] We used logistic regression with propensity score weighting to regress survival and ambulation recovery at 30 days with respect to mobilization timing, overall, and by dementia. We summarized results with odds ratios and probabilities.

Sensitivity analysis. We assessed the influence of missing data on the association between mobilization timing and survival through multiple imputation by chained equations[15] using mi impute chained command in Stata v. 16 (StataCorp). We replaced missing values with a random sample of imputed values to generate 50 distinct datasets via imputation models for each variable based on a rule to reduce sampling variability while limiting loss of power for assessing the association to no more than 1% (Supplementary Material).[15,16] We used Rubin's rules to obtain the combined point estimate of the odds ratios from 50 datasets.[17] Propensity scores were estimated post imputation for each of the 50 datasets using "Within" and "Across" approaches.[18,19] We did not explore the potential influence of missing data in our analysis of 30-day recovery as the data were not missing at random.[15]

Results

30-day survival: overall. Of 126,897 patients, 99,667 (79%) mobilized early and 119,939 (94%) survived to 30 days post-admission. The weighted odds ratio of survival at 30 days was 1.92 (95% CI 1.80 to 2.05) among those who mobilized early when compared with those who mobilized late (Table II). The weighted probabilities of survival at 30 days post-admission were 95.9% (95% CI 95.7% to 96.0%) and 92.4% (95% CI 92.0% to 92.8%), respectively, among those who mobilized early and those who mobilized late (Figure 1).

30-day survival: by dementia. Overall, 36,377 patients (29%) had dementia at the time of presentation, 85,056 (67%) did not have dementia, and 5,464 (4%) had missing data for dementia. In total, 26,111 patients (72%) with dementia and 69,150 (81%) without dementia mobilized early (Supplementary Material). A total of 33,308 patients (92%) with dementia and 81,755 (96%) without dementia survived to 30 days post-admission.

The weighted odds ratios of survival at 30 days post-admission were 1.77 (95% CI 1.61 to 1.95) for those with dementia, and 2.06 (95% CI 1.88 to 2.26) for those without dementia among those who mobilized early when compared with those who mobilized late (Table II). The weighted probabilities of survival at 30 days post-admission for those with dementia and without dementia were 93.3% (95% CI 92.9% to 93.6%) and 97.0% (95% CI 96.8% to 97.2%), respectively, among those who mobilized early, and were 88.7% (95% CI 87.9% to 89.4%) and 94.0% (95% CI 93.6% to 94.4%), respectively, among those who mobilized late (Figure 1).

30-day ambulation recovery: overall. In total, 33,273 patients (26%) had complete data for timing of mobilization and recovery of the ability to walk at 30 days (Supplementary Material). Of these, 24,492 patients (74%) were able to walk outdoors pre-fracture and 8,781 (26%) could only walk indoors. Of those who could walk outdoors pre-fracture, 20,820 patients (85%) mobilized early and 2,275 (9%) recovered their pre-fracture ability to walk by 30 days post-admission. Of those who could only walk indoors pre-fracture, 6,517 (74%) mobilized early and 6,960 (79%) recovered their pre-fracture ability to walk by 30 days post-admission.

Of those who could walk outdoors pre-fracture, the weighted odds ratio of recovering their ability to walk at 30 days post-admission was 1.25 (95% CI 1.03 to 1.51) among those who mobilized early when compared with those who mobilized late (Table III). Of those with who could only walk indoors pre-fracture, the weighted odds ratio of recovering the ability to walk at 30 days was 1.53 (95% CI 1.32 to 1.78) among those who mobilized early when compared with those who mobilized late (Table III). The weighted probabilities of recovering the ability to walk among those who could walk outdoors and indoors pre-fracture were 9.7% (95% CI 9.2% to 10.2%) and 81.2% (95% CI 80.0% to 82.4%), respectively, among those who first mobilized early, and 7.9% (95% CI 6.6% to 9.2%) and 73.8% (95% CI 71.3% to 76.2%), respectively, among those who first mobilized late (Figure 2).

30-day ambulation recovery: by dementia. Of the 33,273 patients with complete data for timing of mobilization and recovery of walking ability at 30 days, 8,320 patients (25%) presented with dementia, 20,558 (62%) presented without dementia, and 4,395 (13%) had missing data for dementia. In total, 6,381 patients (77%) with dementia and 17,259 (84%) without dementia mobilized early (Supplementary Material).

Table III. Odds ratios of 30-day recovery by timing of mobilization among patients surgically treated for non-pathological first hip fracture across subgroups defined by mobility pre-fracture and dementia.

Mobilization timing	Patients, n (%)	Patients who recovered, n (%)	Unweighted OR, (95% CI)	Weighted OR, (95% CI)
Outdoor ambulation (n = 24,492)				
Mobilized 2 days or more after surgery	3,672 (15.0)	263 (7)	1.00	1.00
Mobilized on the day of or day after surgery	20,820 (85.0)	2,012 (10)	1.39 (1.21 to 1.58)	1.25 (1.03 to 1.51)*
Indoor ambulation only (n = 8,781)				
Mobilized 2 days or more after surgery	2,264 (25.8)	1,629 (72)	1.00	1.00
Mobilized on the day of or day after surgery	6,517 (74.2)	5,331 (82)	1.75 (1.57 to 1.96)	1.53 (1.32 to 1.78)*
Without dementia and outdoor ambulation (n = 16,761)				
Mobilized 2 days or more after surgery	2,375 (14.2)	188 (8)	1.00	1.00
Mobilized on the day of or day after surgery	14,386 (85.8)	1,371 (10)	1.23 (1.05 to 1.44)	1.19 (0.96 to 1.47)†
Without dementia and indoor ambulation (n = 3,797)				
Mobilized 2 days or more after surgery	924 (24.3)	717 (78)	1.00	1.00
Mobilized on the day of or day after surgery	2,873 (75.7)	2,509 (87)	1.99 (1.65 to 2.41)	1.73 (1.35 to 2.20)†
With dementia and outdoor ambulation (n = 4,338)				
Mobilized 2 days or more after surgery	862 (19.9)	45 (5)	1.00	1.00
Mobilized on the day of or day after surgery	3,476 (80.1)	316 (9)	1.82 (1.32 to 2.50)	1.52 (1.03 to 2.23)†
With dementia and indoor ambulation (n = 3,982)				
Mobilized 2 days or more after surgery	1,077 (27.0)	711 (66)	1.00	1.00
Mobilized on the day of or day after surgery	2,905 (73.0)	2,207 (76)	1.63 (1.40 to 1.90)	1.52 (1.26 to 1.84)†

*Using propensity weighting scores that were calculated using a model to predict the mobilization timing from the confounding variables: age, sex, ethnicity, comorbidities, fracture type, fracture surgery type, surgery timing, fracture year calendar, deprivation, week day of admission, pre-fracture residence, ASA grade, pre-fracture ambulation and hospital volume. A total of 12,947 cases with missing data of at least one of these confounding variables were excluded from the main analysis. In the analysis by pre-fracture ambulation, 9,650 and 3,297 with missing data were excluded from outdoor ambulation group and indoor ambulation group, respectively. In the analysis by dementia condition, 6,054 and 2,498 with missing data were excluded from the group without dementia and with dementia, respectively.
†Using propensity weighting scores that were calculated using a model to predict the mobilization timing from the confounding variables: age, sex, ethnicity, comorbidities, fracture type, fracture surgery type, surgery timing, fracture year calendar, deprivation, week day of admission, pre-fracture residence, ASA grade, pre-fracture ambulation, and hospital volume. In total, 4,934, 1,120, 1,323, and 1,175 cases with missing data of at least one of these variables were excluded from "without dementia and outdoor ambulation", "without dementia and indoor ambulation", "with dementia and outdoor ambulation", and "with dementia and outdoor ambulation" subgroups, respectively.
ASA, American Society of Anesthesiologists; CI, confidence interval; OR, odds ratio.

A total of 3,982 patients (48%) with dementia and 3,797 (19%) without dementia were only able to walk indoors pre-fracture. In total, 3,279 patients (39%) with dementia and 4,785 (23%) without dementia recovered their pre-fracture ability to walk by 30 days post-admission.

Of those with dementia who were able to walk outdoors pre-fracture, the weighted odds ratio of recovering the ability to walk at 30 days was 1.52 (95% CI 1.03 to 2.23) among those who mobilized early compared with those who mobilized late (Table III). Of those without dementia and the ability to walk outdoors pre-fracture, the weighted odds ratio of recovering the ability to walk outdoors at 30 days was 1.19 (95% CI 0.96 to 1.47) among those who mobilized early compared with those who mobilized late (Table III). The weighted probabilities of recovering the ability to walk at 30 days among patients with dementia and who could walk outdoors pre-fracture were 10.1% (95% CI8.9% to 11.3%) and 6.9% (95% CI 4.6% to 9.2%), respectively, for those who mobilized early and for those who mobilized late (Figure 2b). Among patients without dementia and who could walk outdoors pre-fracture, these probabilities were 9.6% (95% CI 9.0% to 10.2%) and 8.2% (95% CI 6.7% to 9.7%), respectively, for those who mobilized early and for those who mobilized late.

Of those with dementia who could only walk indoors pre-fracture, the weighted odds ratio of recovering the ability to walk at 30 days was 1.52 (95% CI 1.26 to 1.84) among those who mobilized early compared with those who mobilized late (Table III). Of those without dementia and could only walk indoors pre-fracture, the weighted odds ratio of recovering the ability to walk at 30 days was 1.73 (95% CI 1.35 to 2.20) among those who mobilized early compared with those who mobilized late (Table III). The weighted probabilities of recovering the ability to walk at 30 days among patients with dementia and who could only walk indoors pre-fracture were 75.5% (95% CI 73.7% to 77.4%) and 67.0% (95% CI 63.4% to 70.6%), respectively, for those who mobilized early and for those who mobilized late (Figure 2b). Of patients without dementia and who could only walk indoors pre-fracture, these probabilities were

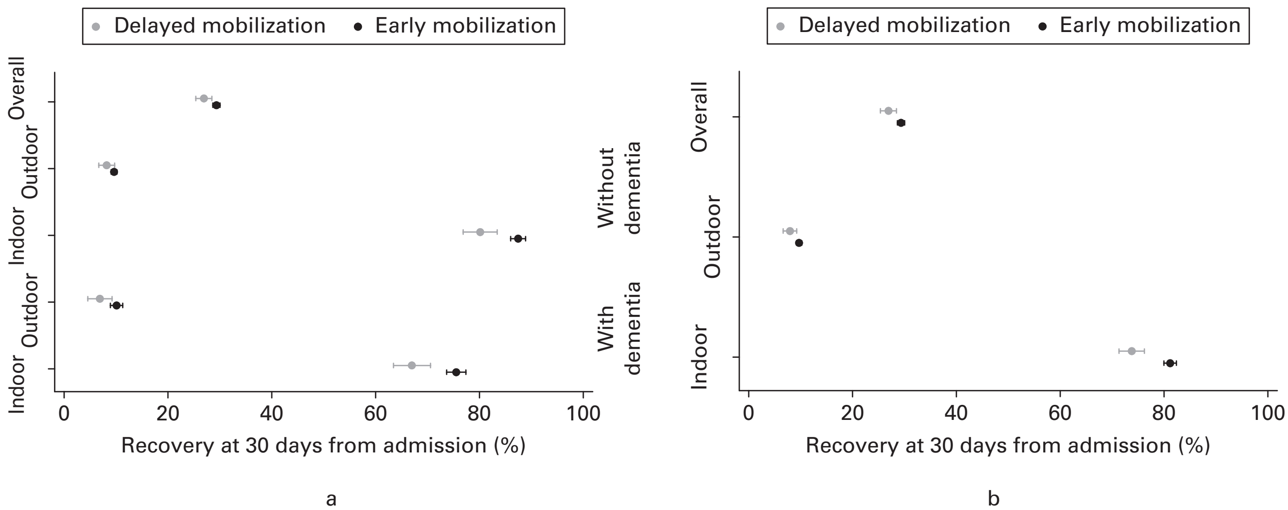

Fig. 2

a) Weighted probability of recovery at 30 days from admission in relation to timing of mobilization by ambulation pre-fracture. b) Weighted probability of recovery at 30 days from admission in relation to timing of mobilization by ambulation pre-fracture and dementia.

87.5% (95% CI 86.0% to 88.9%) and 80.1% (95% CI 76.9% to 83.4%), respectively, for those who mobilized early and for those who mobilized late.

Sensitivity analyses. Full details of the potential influence of missing data in the exposure and potential confounders on the association between the timing of mobilization and survival at 30 days are presented in in the Supplementary Material. Results using the "Within" and "Across" approaches in these analyses were consistent and yielded similar estimates to those of the complete case analysis.

Discussion

Early mobilization was associated with 30-day survival and recovery of pre-fracture ability to walk after hip fracture surgery. The association between early mobilization and recovering the ability to walk within 30 days was stronger for those who could only mobilize indoors pre-fracture compared to those with the ability to walk outdoors pre-fracture. Patients with dementia were less likely to mobilize early despite similar associations for survival and recovery of pre-fracture ability to walk noted for those with and without dementia.

The findings of this study support previous evidence of a beneficial association between the timing of mobilization and outcomes after hip fracture surgery. This evidence reports reductions in complications,[20] in-hospital mortality,[21] time to discharge from hospital,[7] mortality at six months,[5] return to home,[22] ambulation at 30 days,[6] and ambulation at two months.[5] Here we provide additional evidence to support the survival benefits of early mobilization from a large dataset with weighting for confounders. We build upon analyses of recovery by considering the outcome in relation to the ability to walk pre-fracture. A notable new finding is by 30 days post-admission, only 9% of those who could walk outdoors pre-fracture recovered this ability, while 80% of those who could only walk indoors pre-fracture recovered the ability to do so, (among those mobilized early).

We report early mobilization was associated with survival and recovery of pre-fracture ability to walk at 30 days. This benefit is in keeping with other established indicators of care quality after hip fracture. For example, early surgery (on the day of, or day after admission) was associated with survival at 30 days in a cohort of 139,119 patients in Canada,[23] and admission to an orthogeriatric unit (vs orthopaedic unit) was associated with survival in a cohort of 11,461 patients in Denmark.[24] However, early mobilization is not a standard performance indicator in audits of hip fracture care.[25] Where captured, the proportion of patients mobilized early ranges from 55% in New Zealand to 90% in Denmark.[25] We propose early mobilization as a measured indicator of performance internationally. This would enable clinicians to determine the extent to which they are achieving early mobilization with their patients and to evaluate the benefit of quality improvement initiatives to improve performance.

Patients with dementia benefited from early mobilization in terms of survival and recovery of the ability to walk. Yet, fewer patients with dementia (72%) mobilized early compared with those without dementia (81%). This suggests variations in practice may deny patients, both with and without dementia, the best chance of recovery. Physiotherapists recently reported pressure to adhere to guidelines “which may not be achievable or appropriate for those with dementia”.[26] A better understanding of the appropriate management of patients with dementia after a hip fracture and consequent therapist training may be warranted.

There is potential for bias due to residual confounding by variables associated with early mobilization, survival, and recovery. These include those related to the patient (e.g. motivation, frailty, acute illness), operation (e.g. intraoperative fracture, wound haematoma, anaesthetic type), admission (e.g. weekend), and overall standard of hip fracture care (i.e. hospitals with understaffed therapy services may also be deficient in other aspects of hip fracture care). This may have led to an overestimation of the association between early mobilization and the outcomes reported here. There is potential for bias due to data quality[27] and/or missing data. We did not impute missing data for our analysis of 30-day recovery as data were not missing at random.[15] We reported similar findings from imputed and complete case analysis of 30-day survival. There is potential for misclassification bias where clinicians entering data may interpret the 'ability to sit or stand out of bed' as without hoist transfer. This may lead to an underestimation of the association between the timing of mobilization and 30-day outcomes. We classified patients as 'with dementia' or 'without dementia' as we did not have information related to the disease stage. Patients with new-onset dementia may have a different chance of early mobilization, survival, and/or recovery when compared with those with advanced/end-stage dementia. In addition, pre-existing cognitive impairment is associated with delirium and further cognitive decline following surgery.[28] We did not capture this potential change in cognitive status in our classification by dementia. Last, our data are not generalizable to populations with different patient demographics receiving care along different pathways.

The average figures reported here do not reveal the considerable variation in rates of early mobilization reported by different hospitals in the UK. In 2015, the median percentage of patients mobilized early was 77% (Q1 to Q3: 61.9% to 90.6%), far more than can be explained by differences in case-mix.[10] In 2017, a UK national audit of physiotherapy after hip fracture highlighted short-staffing, lack of equipment, pain control, hypotension, agitation/refusal, and poor pre-fracture function as barriers to early mobilization.[29] There is a need to quantify the extent to which these parameters moderate the association between the timing of mobilization and outcomes. This would determine which aspects of care to target for improvement and, ultimately, patient benefit.

The differences in recovery of the ability to walk by 30 days in relation to pre-fracture ability have significance for service delivery and clinical practice. In 2015, the mean length of stay (acute and post-acute inpatient NHS facility) was 21 days, with only two hospitals reporting average stays over 30 days.[10] Rehabilitation beyond 30 days is required to support recovery, particularly for those who had a greater ability to walk pre-fracture. Arrangements for ongoing community-based rehabilitation are highly variable across the UK[30] and are estimated by a national audit of intermediate care to be insufficient to meet the clinical need.[31] Moreover, whether the ability to walk outdoors is consistently incorporated into community-based rehabilitation after hip fracture is uncertain.

Early mobilization (the ability to sit or stand out of bed on the day of or day after surgery) was associated with survival and recovery for patients with and without dementia after a fracture of the hip. Early mobilization should be incorporated as a measured indicator of quality internationally. Reasons for failure to mobilize early should be captured to inform quality improvement initiatives.

Take home message

- Early mobilization is defined as the ability to sit or stand out of bed on the day of or the day after hip fracture surgery.
- When achieved, this was associated with survival and recovery of pre-fracture walking abilities, irrespective of the presence of a dementia diagnosis.

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Supplementary material

Characteristics of patients for complete case analysis by subgroups, and for patients included and excluded from complete case analysis; balance checks for propensity weighting; and results from the analyses of the imputed data.

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