The 30-day survival and recovery after hip fracture by timing of mobilization and dementia
A UK DATABASE STUDY

Aims
The aim of this study was 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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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).

<table>
<thead>
<tr>
<th>Variable</th>
<th>All (n = 126,897)*</th>
<th>Early mobilization (n = 99,667)</th>
<th>Delayed mobilization (n = 27,230)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Median age, yrs (IQR)</td>
<td>84 (77 to 89)</td>
<td>84 (77 to 89)</td>
<td>85 (79 to 90)</td>
</tr>
<tr>
<td><strong>Sex, n (%)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>91,962 (72.5)</td>
<td>72,650 (79.0)</td>
<td>19,312 (21.0)</td>
</tr>
<tr>
<td>Male</td>
<td>34,933 (27.5)</td>
<td>27,016 (77.3)</td>
<td>7,917 (22.7)</td>
</tr>
<tr>
<td><strong>Ethnicity, n (%)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>White</td>
<td>99,585 (78.5)</td>
<td>78,948 (79.3)</td>
<td>20,637 (20.7)</td>
</tr>
<tr>
<td>Caribbean or African or any mixed black background</td>
<td>244 (0.2)</td>
<td>159 (65.2)</td>
<td>85 (34.8)</td>
</tr>
<tr>
<td>Asian or Asian British or any mixed Asian background</td>
<td>1,262 (1.0)</td>
<td>970 (76.9)</td>
<td>292 (23.1)</td>
</tr>
<tr>
<td><strong>Pre-fracture walking ability, n (%)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Freely ambulatory without aids</td>
<td>47,990 (37.8)</td>
<td>40,516 (84.4)</td>
<td>7,474 (15.6)</td>
</tr>
<tr>
<td>Outdoors with one aid</td>
<td>28,218 (22.2)</td>
<td>22,632 (80.2)</td>
<td>5,586 (19.8)</td>
</tr>
<tr>
<td>Outdoors with two aids or frame</td>
<td>17,929 (14.1)</td>
<td>13,813 (77.0)</td>
<td>4,116 (23.0)</td>
</tr>
<tr>
<td>Some indoor ambulation but never goes outside without help</td>
<td>29,567 (23.3)</td>
<td>20,660 (69.9)</td>
<td>8,907 (30.1)</td>
</tr>
<tr>
<td>No functional ambulation</td>
<td>1,717 (1.4)</td>
<td>1,016 (59.2)</td>
<td>701 (40.8)</td>
</tr>
<tr>
<td><strong>Deprivation, n (%)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Least deprived 10%</td>
<td>10,545 (8.3)</td>
<td>8,194 (77.7)</td>
<td>2,351 (22.3)</td>
</tr>
<tr>
<td>Less deprived 10% to 20%</td>
<td>10,335 (8.1)</td>
<td>7,939 (76.8)</td>
<td>2,396 (23.2)</td>
</tr>
<tr>
<td>Less deprived 20% to 30%</td>
<td>11,254 (8.9)</td>
<td>8,650 (76.9)</td>
<td>2,604 (23.1)</td>
</tr>
<tr>
<td>Less deprived 30% to 40%</td>
<td>12,023 (9.5)</td>
<td>9,342 (77.7)</td>
<td>2,681 (22.3)</td>
</tr>
<tr>
<td>Less deprived 40% to 50%</td>
<td>12,618 (9.9)</td>
<td>9,874 (78.3)</td>
<td>2,744 (21.7)</td>
</tr>
<tr>
<td>More deprived 40% to 50%</td>
<td>13,315 (10.5)</td>
<td>10,430 (78.3)</td>
<td>2,885 (21.7)</td>
</tr>
<tr>
<td>More deprived 30% to 40%</td>
<td>13,149 (10.4)</td>
<td>10,337 (78.6)</td>
<td>2,812 (21.4)</td>
</tr>
<tr>
<td>More deprived 20% to 30%</td>
<td>12,701 (10.0)</td>
<td>10,068 (79.3)</td>
<td>2,633 (20.7)</td>
</tr>
<tr>
<td>More deprived 10% to 20%</td>
<td>12,622 (10.0)</td>
<td>10,095 (80.0)</td>
<td>2,527 (20.0)</td>
</tr>
<tr>
<td>Most deprived 10%</td>
<td>11,910 (9.4)</td>
<td>9,587 (80.5)</td>
<td>2,323 (19.5)</td>
</tr>
<tr>
<td><strong>Hip fracture type, n (%)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intracapsular</td>
<td>74,886 (59.0)</td>
<td>59,322 (79.2)</td>
<td>15,564 (20.8)</td>
</tr>
<tr>
<td>Intertrochanteric</td>
<td>44,463 (35.0)</td>
<td>34,800 (78.3)</td>
<td>9,663 (21.7)</td>
</tr>
<tr>
<td>Subtrochanteric</td>
<td>7,488 (5.9)</td>
<td>5,499 (73.4)</td>
<td>1,989 (26.6)</td>
</tr>
<tr>
<td><strong>Surgery timing, n (%)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Within target time</td>
<td>90,713 (71.5)</td>
<td>72,127 (79.5)</td>
<td>18,586 (20.5)</td>
</tr>
<tr>
<td><strong>Procedure type, n (%)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Internal fixation</td>
<td>61,888 (48.8)</td>
<td>48,735 (78.7)</td>
<td>13,153 (21.3)</td>
</tr>
</tbody>
</table>

Continued
of real-world observational data presents an opportunity to study the association between early mobilization and outcomes. 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, while an analysis of unlinked NHFD data from 2013 to 2015 reported a 30-day recovery benefit. 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 and less likely to survive to 30 days. 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. This intervention included early mobilization, but the extent to which this aspect of care contributed to beneficial effects observed is unclear. 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. 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. 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). 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. 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, 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.

**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). 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...
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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 and stcoxtest (Supplementary Material). 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 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). We used Rubin’s rules to obtain the combined point estimate of the odds ratios from 50 datasets. Propensity scores were estimated post imputation for each of the 50 datasets using “Within” and “Across” approaches. 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.

**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).
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 were only able to walk indoors 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 outdoors 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 outdoors 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 outdoors 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 (Table III). 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 were only able to walk indoors 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 outdoors 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 outdoors 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 outdoors 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 (Table III). 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 were only able to walk indoors 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.
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 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, in-hospital mortality, time to discharge from hospital, mortality at six months, return to home, ambulation at 30 days, and ambulation at two months. 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, and admission to an orthogeriatric unit (vs orthopaedic unit) was associated with survival in a cohort of 11,461 patients in Denmark. However, early mobilization is not a standard performance indicator in audits of hip fracture care. Where captured, the proportion of patients mobilized early ranges from 55% in New Zealand to 90% in Denmark. 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”. 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 and/or missing data. We did not impute missing data for our analysis of 30-day recovery as data were not missing at random.\textsuperscript{13} We reported similar findings from imputed and complete case analysis of 30-day survival. There is potential for misclassification bias when clinicians entering data may interpret the ‘ability to sit or stand out of bed’ as without hoist transfer. This may lead to an understimation 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.\textsuperscript{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.\textsuperscript{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.\textsuperscript{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.\textsuperscript{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\textsuperscript{30} and are estimated by a national audit of intermediate care to be insufficient to meet the clinical need.\textsuperscript{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.
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Author information:
A. Goubar, PhD, Research Fellow Medical Statistics
C. Sackley, PhD, Professor of Rehabilitation
S. Ayis, PhD, Senior Lecturer Medical Statistics
K. J. Sheehan, PhD, Senior Lecturer Rehabilitation

Department of Population Health Sciences, School of Population Health & Environmental Sciences, Faculty of Life Science and Medicine, London, UK.

F. C. Martin, MD, Emeritus NHS Consultant Geriatrician and Professor Emeritus Medical Gerontology, Department of Population Health Sciences, School of Population Health & Environmental Sciences, Faculty of Life Science and Medicine, London, UK; Guy’s and St. Thomas’ National Health Service Foundation Trust, London, UK.

C. Potter, MSc, Clinical Specialist Physiotherapist (Rehabilitation and Trauma)
G. D. Jones, PhD, Clinical Lead Physiotherapist (Rehabilitation)
Guy’s and St. Thomas’ National Health Service Foundation Trust, London, UK.

Author contributions:
A. Goubar: Designed the study, Collected and analyzed the data, Interpreted the analysis; Drafted and revised the manuscript, Approved the final version for submission.
F. C. Martin: Conceptualized and designed the study, Interpreted the analysis, Drafted and critically revised the manuscript, Approved the final version for submission.
C. Potter: Conceptualized and designed the study, Interpreted the analysis, Drafted and critically revised the manuscript, Approved the final version for submission.
G. D. Jones: Conceptualized and designed the study, Interpreted the analysis, Critically revised the manuscript, Approved the final version for submission.
S. Ayis: Conceptualized and designed the study, Interpreted the analysis, Criticaly revised the manuscript, Approved the final version for submission.
K. J. Sheehan: Conceptualized and designed the study, Collected and analyzed the data, Interpreted the analysis, Drafted and critically revised the manuscript, Approved the final version for submission.

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Ethical review statement:
This study received NHS Health Research Authority and Health and Care Research Wales approval (IRAS Project ID: 230216). The study did not require ethical approval as an analysis of pseudonymized data.

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