THE IMPACT OF THE FREQUENCY, DURATION AND TYPE OF PHYSIOTHERAPY ON DISCHARGE AFTER HIP FRACTURE SURGERY

A Secondary Analysis of UK National Linked Audit Data

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Conflicts of interest

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Availability of data and material

The data that support the findings of this study are available from NHS Digital, NHS Wales Informatics Service, the Royal College of Physician's Falls and Fragility Fracture Audit programme and Healthcare Quality Improvement Partnership but restrictions apply to the availability of these data, which were used under license for the current study, and so are not publicly available.

Code availability

The code is available on request from the study authors.

Author's contributions

All authors contributed to the conception and design of the study. In addition, KJS, AG and SA contributed to the acquisition and the analysis of data. KJS, AG, SA, LB, IDC, RMC, CLG, AJ, MTK, JM, FCM, CS, ES, TOS, and BS contributed to the interpretation of the analysis. KJS and AG drafted the manuscript. All authors critically revised the manuscript. All authors approved the final version for submission.

Ethical approval

The study did not require NHS Research Ethics Committee approval as it involves secondary analysis of linked pseudo-anonymised data.

Consent to participate

N/A

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N/A

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ABSTRACT

Purpose

To examine the association between physiotherapy in the first week after hip fracture surgery and discharge from acute hospital.

Methods

We linked data from the UK Physiotherapy Hip Fracture Sprint Audit to hospital records for 5,395 patients with hip fracture in May and June 2017. We estimated the association between the number of days patients received physiotherapy in the first postoperative week, its overall duration (<2 hours, ≥2 hours; 30-minute increment) and type (mobilisation alone, mobilisation and exercise) and the cumulative probability of discharge from acute hospital over 30-days, using proportional odds regression adjusted for confounders and the competing risk of death.

Results

The crude and adjusted odds ratios of discharge were: 1.24 (95% CI 1.19–1.30) and 1.26 (95% CI 1.19–1.33) for an additional day of physiotherapy, 1.34 (95% CI 1.18-1.52) and 1.33 (95% CI 1.12-1.57) for ≥ 2 hours versus < 2 hours physiotherapy, and 1.11 (95% CI 1.08-1.15) and 1.10 (95% CI 1.05-1.15) for an additional 30-minutes of physiotherapy. Physiotherapy type was not associated with discharge.

Conclusion

We report an association between physiotherapy and discharge after hip fracture. An average UK hospital admitting 375 patients annually may save 456 bed-days if current provision increased so all patients with hip fracture received physiotherapy on 6-7 days in the first postoperative week. A seven-day physiotherapy service totalling at least two hours in the first postoperative week may be considered a key performance indicator of acute care quality after hip fracture.

KEYWORDS

rehabilitation, neck of femur, recovery, hip fracture, audit, National Hip Fracture Database

MINI ABSTRACT

Additional physiotherapy in the first postoperative week was associated with fewer days to discharge after hip fracture surgery. A seven-day physiotherapy service in the first postoperative week should be considered as a new key performance indicator in evaluating the quality of care for patients admitted with a hip fracture.

INTRODUCTION

Globally, the incidence of hip fracture is estimated to increase from 2.7 million in 2010 to between seven and 21 million by 2050 [1]. Patients with hip fracture are usually older, living with frailty and poor mobility [2]. These patients often have limited reserve with which to overcome the stress of their injury, the necessary surgery and complete their recovery. Patients with hip fracture describe access to physiotherapy as one of the key factors for their recovery [3]. In the context of postoperative inpatient rehabilitation (average length of stay 15 days), these patients commonly set a goal of returning home as soon as possible [4].

There is inconsistent evidence on what optimal postoperative inpatient physiotherapy consists of for patients after hip fracture. The National Institute for Health and Care Excellence (NICE) guidance is limited to recommending daily mobilisation and regular physiotherapy review [5]. Concern regarding uncertainty on what 'usual care' is in the UK, led the Chartered Society of Physiotherapy (CSP) to commission the 2017 Physiotherapy Hip Fracture Sprint Audit (PHFSA) [6]. The audit demonstrated national variation in the duration, frequency and type of acute physiotherapy practice [6] similar to variation observed internationally [7]. A qualitative interview study of physiotherapists' perceptions of mechanisms for this variation indicated it may be justified by individual patient needs [8]. However, it remains unclear whether the variation in physiotherapy practice influences outcomes after accounting for such patient factors.

Other factors which impact on time to discharge include the promptness of surgery. In 2017, 29% of patients with hip fracture underwent surgery after the recommended 36-hour timeframe in the UK; in part reflecting pressures on theatre capacity [2]. This crude proportion has since increased, suggesting a mismatch between demand for surgical services and capacity in a changing patient population [9, 10]. It is not known whether additional postoperative physiotherapy can mitigate the negative effects of delayed surgery[11].

We aimed to determine whether the frequency, duration and type of physiotherapy in the first postoperative week were associated with discharge from acute hospital after accounting for potential confounders and the competing risk of death. We further sought to determine whether these associations varied with time from first presentation and surgery.

METHODS

This study is reported according to the REporting of studies Conducted using Observational Routinely-collected Data statement [12]. The study did not require NHS Research Ethics Committee approval as it involved secondary analysis of linked pseudo-anonymised data.

Study cohort

The UK National Hip Fracture Database (NHFD) is a clinically-led, web-based audit, collecting data for over 90% of patients aged 60 years and older with hip fracture and the care they received during their acute hospital admission in England or Wales (UK) [2]. The NHFD also oversees 'sprint audits' to capture, for a fixed period of time, additional detailed information on specific aspects of care delivery [13].

In 2017, the CSP commissioned the PHFSA to capture a detailed understanding of the acute physiotherapy management of patients with hip fracture [6]. We linked the individual patient data "routinely" collected by the NHFD to data from the PHFSA, as well as hospital episode statistics (HES) for England, the patient episode database for Wales (PEDW), and the Office of National Statistics (ONS) for additional data on comorbidities, ethnicity, neighbourhood deprivation and mortality. Further details on population selection, codes, and algorithms to classify variables, and person-level linkage across databases are described in Supplementary File 1.

Overall, data were entered into the NHFD for 9,250 patients aged 60 years and older, surgically treated for a non-pathological first hip fracture between May 1 2017 and June 30 2017. Of these, 5,395 patients had additional data collected by physiotherapists for the PHFSA. Following data linkage, we noted patients included in PHFSA were similar to those in the NHFD in terms of

several characteristics including age, sex, deprivation, Charlson Comorbidity Index (CCI)[14], Hospital Frailty Risk Score [15], American Society of Anaesthesiologists (ASA) grade [16], weekday of admission and procedure type [6]. Patients differed according to pre-fracture mobility (20% [no PHFSA data] vs. 25% [PHFSA data] indoor only), fracture type (57% [no PHFSA data] vs. 59% [PHFSA data] intracapsular), time to surgery (68% [no PHFSA data] vs. 71% [PHFSA data] within 36-hours), anaesthetic type (56% [no PHFSA data] vs. 54% [PHFSA data] general anaesthetic), and time of first mobilisation (77% [no PHFSA data] vs. 81% [PHFSA data] within 36-hours). There were differences in degree of missing data for ethnicity and pre-fracture residence among patients with data in both PHFSA and NHFD compared with NHFD alone. Additional detail on patients with and without data in the PHFSA are available in Supplementary File 2, Table S1.

Study exposures

The primary study exposure was frequency defined as having received physiotherapy during the first postoperative week on a total of 0-2, 3, 4, 5, or 6-7 days out of a possible seven days. Secondary exposures included duration and type of physiotherapy. Total duration of physiotherapy during the first post-operative week was classified both as a positive integer and as a binary variable (<2 hours, ≥2 hours). Type of physiotherapy was classified as mobilisation alone [PHFSA code for mobilisation/gait/transfer practice] or mobilisation and exercises [PHFSA code for mobilisation/gait/transfer practice and range of motion/strength/balance]) within the first postoperative week.

Study outcome

The outcome was discharge from acute hospital care after hip fracture surgery [NHFD code: own home/sheltered housing, nursing care/residential care]. Discharges within the first seven

postoperative days were treated as left censored observations i.e., the study exposures were not observed. Patients who were transferred to another hospital/unit and/or those with stays longer than 30-days were treated as right censored observations as average acute length of stay was 16 days in 2017 (mean [standard deviation]: 16.0 [0.6] days) [2, 17]. Deaths in hospital were treated as competing events.

Study confounders

We adjusted for variables with a reported association with our study outcome: age [18], sex [18], ethnicity (White, Black or mixed Black, Asian or mixed Asian) [18], deprivation quintiles [18], ASA grade [16], CCI [14], Hospital Frailty Risk Score (low, intermediate, high risk) [15], pre-fracture residence (own home/sheltered housing, nursing care/residential care) [18], fracture type (intracapsular, intertrochanteric/subtrochanteric) [18], prefracture mobility (mobile outdoors with/without aids, some indoor mobility but never goes outdoors without help, no functional mobility) [18], type of anaesthetic (general, spinal) [19], type of surgery (internal fixation, hemiarthroplasty, total hip arthroplasty) [18], timing of surgery (within 36-hour target, beyond target) [18], timing of first mobilisation (day of/after surgery, beyond two days of surgery) [18], and day of admission (weekday, weekend) [18].

Statistical analysis

For each variable, we estimated median and interquartile range (continuous variables) or frequency and percentage (categorical variables), overall and by exposure. We used χ^2 test and Mann-Whitney U test to compare distributions across groups. We estimated the daily rate of discharge by dividing the number of discharges by the total number of inpatient days, overall and by the frequency, duration and type of physiotherapy.

We estimated the cumulative probability of discharge as a function of postoperative day accounting for the event-specific hazard of inhospital death overall and separately for patients in receipt of each exposure level for the frequency (physiotherapy received on 0-2, 3, 4, 5, or 6-7 days of a possible seven days in the first postoperative week), and the duration (total <2 hours, ≥2 hours of physiotherapy in the first postoperative week), and its type (mobilisation, mobilisation and exercise). We used proportional odds regression models to estimate the association between the cumulative probability of discharge as a function of postoperative day and: 1) a one day increase in the frequency of physiotherapy; 2) receipt of ≥2 hours compared to <2 hours physiotherapy; 3) a 30-minute increase in physiotherapy duration; and 4) receipt of mobilisation and exercise compared to mobilisation alone, overall and by the timing of surgery (within 36-hours target time, beyond 36-hours target time). We adjusted for potential confounders if associations were noted in crude models. To assess our findings' sensitivity to left censoring, we replicated the analysis for exposures: 1) a one day increase in frequency of physiotherapy; 2) a 30-minute increase in physiotherapy duration; and 3) receipt of mobilisation and exercise compared to mobilisation alone for all patients. The detailed plan of analysis is available in Supplementary File 3. We summarised the differences by 30-day risk differences [20] and by odds ratios [21]. We used R [22] packages CIFsmry [23], cmprsk [24], prodlim [25] and geepack [26] for the analyses.

Missing data analysis

We evaluated patients with complete data for exposures, potential confounders and outcomes for our main analysis. Differences between patients with and without complete data for exposures and outcome are available in Supplementary File 2, Tables S4-S7. We imputed missing data by chained equations to determine whether similar findings would be reached following complete

case and imputed analyses [27, 28]. We generated 25 distinct datasets where missing values were replaced with a random sample of imputed values. As in the main analysis, we used proportional odds regression models to estimate the association between the cumulative probability of discharge as a function of postoperative day and the frequency, duration and type of physiotherapy in each of the 25 datasets [27, 29]. We then derived pooled odds ratios, confidence intervals (CI) and p-values across imputed datasets [30].

RESULTS

Patient characteristics

Primary exposure and outcome data were available for a total of 5,177 patients. By 30-days after surgery, 2,180 hospital stays (42.1%) ended with discharge, 114 stays (2.2%) ended with death, 683 (13.2%) had left censoring events (discharged in first seven days to home n=474, to nursing home/residential care n=154, died n=55), 1,726 (33.3%) had right-censoring events (lost to follow-up), and 474 stays (9.2%) were longer than 30 days (Supplementary File 2, Figure S1). In the first postoperative week, 1,026 patients (20%) received physiotherapy on 6-7 out of a possible seven days, 2,647 (53%) received physiotherapy for ≥2 hours and 4,472 (88%) received both mobilisation and exercise (Table 1, Supplementary File 2, Tables S2-S3).

The median age of patients was 84.0 years (Inter-Quartile Range (IQR) 77.0-89.0) with a median CCI score of 1.0 (IQR 1.0-2.0). The majority were women (73%), white (70%), admitted from home (82%), and mobile outdoors prefracture (73%). Over one-third were at high risk of frailty (36%) and one-fifth from the most deprived quintile (23%). Fracture type was most commonly intracapsular (59%) with the remainder being extracapsular (trochanteric or subtrochanteric) fractures. Most patients were admitted on a weekday (69%), underwent surgery with general

anaesthesia (53%) within the recommended target time (72%), and mobilised on the day of or day after their surgery (81%) (Table 1, Supplementary File 2, Tables S2-S3).

Frequency of physiotherapy

The average rate of discharge was 32 (95% CI 31–33) per 1,000 patient days, varying from 22.3 (95% CI 19.7–25.3) among those who received physiotherapy on 0-2 out of a possible seven days in the first postoperative week to 40.4 (95% CI 37.2–43.9) among those who received physiotherapy on 6-7 out of a possible seven days in the first postoperative week (Figure 1). By day 30, there were an additional 228 (95% CI 166-289) discharges per 1,000 patients who received physiotherapy on 6-7 days compared with 0-2 days out of a possible seven days in the first postoperative week. The cumulative incidence of discharge was 704 per 1000 patient days, varying from 533 (95% CI 504–601) among those who received physiotherapy on 0-2 out of a possible seven days in the first postoperative week to 780 (95% CI 745–815) among those who received physiotherapy on 6-7 out of a possible seven days in the first postoperative week (Table 2, Figure 1). For one additional day of physiotherapy in the first postoperative week, the crude and adjusted odds ratios of discharge were 1.24 (95% CI 1.19–1.30) and 1.26 (95% CI 1.19–1.33) respectively (Table 2).

Duration of physiotherapy

In total, 4,950 patients had complete data for physiotherapy duration. The average rate of discharge was 31.8 (95% CI 30.5-33.2) per 1,000 patient days, varying from 29.2 (95% CI 27.5-31.1) among those who received <2 hours of physiotherapy to 34.7 (95% CI 32.6-36.8) among those who received ≥2 hours of physiotherapy, in the first postoperative week (Figure 1). By 30-days, there were an additional 63 (95% CI 25-101) discharges per 1,000 patients who received ≥2 hours of physiotherapy compared with those who received <2 hours of physiotherapy in the

first postoperative week. The crude and adjusted odds ratios of discharge were 1.34 (95% CI 1.18-1.52) and 1.33 (95% CI 1.12-1.57) respectively among those who received ≥2 hours compared with those who received <2 hours of physiotherapy in the first postoperative week (Table 2). A 30-minutes increase in physiotherapy in the first postoperative week was associated with crude and adjusted odds ratios of discharge of 1.11 (95% CI 1.08-1.15) and 1.10 (95% CI 1.05-1.15) respectively (Table 2).

Type of physiotherapy

In total, 5,109 patients had complete data for physiotherapy type. The average rate of discharge was 32.1 (95% CI 30.7–33.5) per 1,000 patient days; being similar among those who received mobilisation alone 31.6 (95% CI 28.2–35.4) and those who received both mobilisation and exercise 32.1 (95% CI 30.7–33.6) (Figure 1, Table 2). For mobilisation and exercise compared with mobilisation alone in the first postoperative week, the crude odds ratio of discharge was 1.11 (95% CI 0.91-1.36) (Table 2).

Analysis stratified by time to surgery

Similar rates of discharge by physiotherapy frequency, duration and type were observed amongst the subgroup of patients who underwent surgery within the target time of 36-hours from presentation as for the overall analysis (Figure 1, Supplementary File 2, Table S8). For one additional day of physiotherapy in the first postoperative week, the adjusted odds ratio of discharge was 1.29 (95% CI 1.21-1.38) for those who underwent surgery within 36 hours and 1.18 (95% CI 1.06–1.31) for those who underwent surgery later (Supplementary File 2 Table S8). Comparing those who received ≥2 and <2 hours of physiotherapy, the adjusted odds ratios of discharge were 1.54 (95% CI 1.27–1.86) for those who underwent surgery within 36 hours and 0.89 (95% CI 0.63–1.25) for those who underwent surgery later (Supplementary File 2,

Table S8). An additional 30 minutes of physiotherapy in the first postoperative week was associated with adjusted odds ratios of discharge of 1.15 (95% CI 1.09-1.21) for those who underwent surgery within 36 hours and 1.02 (95% CI 0.94–1.14) for those who underwent surgery later (Supplementary File 2, Table S8). The crude odds ratio of discharge was similar for those who received mobilisation and exercise and those who received mobilisation alone in the first postoperative week irrespective of time to surgery (Supplementary File 2, Table S8).

Sensitivity and missing data analyses

Supplementary File 2 provides full details of results for analyses without left censoring of patients discharged in the first postoperative week (Table S9) and for analyses with imputation for missing exposure, outcome, and potential confounders (Table S10). Without left censoring, the results were similar to the analysis with left censoring for frequency and type. However, the adjusted odds ratios of discharge were similar among those who received <2 hours and those who received ≥2 hours physiotherapy in the first postoperative week, and for a 30-minute increment in duration of physiotherapy without left censoring (Table S9). The results of imputed analysis were similar to those of the complete case analysis.

DISCUSSION

Key results

These national data show associations between the frequency and the duration of physiotherapy and discharge from acute hospital care after hip fracture surgery. The association for frequency was observed irrespective of surgical timing, whilst the association for duration was only observed for those who underwent surgery within 36 hours of hospital presentation. We found no association between the type of physiotherapy delivered and discharge.

Interpretation

The recent United States Physical Therapy Associations Hip Fracture Clinical Practice Guideline recommends offering patients daily physiotherapy during their inpatient stay [31]. However, in the current study, only 20% of patients received physiotherapy on 6-7 out of a possible seven days in the first postoperative week. This is similar to other international studies which noted 13% of patients received physiotherapy on 6-7 of a maximum seven days a week (Japan) [32], physiotherapy input on a median of five days (Australia) [33], or daily until Day 3 postoperatively and weekdays thereafter (Denmark) [34].

In the UK, a typical hospital will provide hip fracture surgery to an average of 375 patients annually [2]. For the current study, the difference in the cumulative incidence of discharge between those who received physiotherapy on 6-7 of a possible seven days in the first postoperative week compared to overall was 76 per 1000 patient days. This equates to a saving of 456 bed days (for an average length of stay of 16 days). Extrapolating this to the 65,958 patients with hip fracture for 2017, this equates to a potential saving of 80,205 bed days or £27,750,905 (based on £346 cost per excess bed day for a non-elective inpatient) [2, 35, 36]. The reported adjusted associations between physiotherapy frequency and discharge were observed irrespective of time to surgery. This suggests that a seven day physiotherapy service could mitigate the impact of delayed surgery with respect to time to discharge [11]. These findings provide a narrative to support requests for additional staffing to enable implementation of recommended seven day services [11].[37] Further, the results add weight to the argument for the CSP's care standard 'All patients receive daily physiotherapy that should total at least two hours in the first seven days post-surgery' to become a key performance indicator when evaluating the quality of acute postoperative care after hip fracture [6].

Implementing a seven-day service may be a challenge in the absence of additional staffing. Indeed, the PHFSA report indicated 'staffing issue' as a key reason why patients did not receive daily physiotherapy in the first postoperative week [6]. Kimmel and colleagues noted a decrease in length of stay following an intensive physiotherapy intervention where participants received more than twice the time in physiotherapy compared to control participants [33]. The current study builds on this previous work highlighting a potential benefit from an additional 30-minutes of physiotherapy in the first week after surgery. This increase may be achievable within existing resource capacity for some settings. Indeed, group-based rehabilitation may provide an opportunity to increase time in physiotherapy within existing staffing capacity. For example, an Australian inpatient standing balance circuit class of up to eight older adults led by two physiotherapists saw improvements in mobility performance, self-reported functioning and reduction in total length of stay among participants compared to usual care [38].

The reported association between physiotherapy duration and discharge were observed only for those who underwent surgery within the 36-hour target time. This may suggest the presence of unmeasured confounding of patient-related factors in the analysis as these factors are likely more evident among those who were delayed to surgery. Indeed, both patient and non-clinical factors may delay surgery for hip fracture [39] which in turn may limit participation in physiotherapy and lead to longer time to discharge. However, a 2011 cohort of 2,250 patients in Spain reported acute medical problems (33.1%) and lack of operating room availability (60.7%) as the main drivers of delays beyond 48 hours [40]. In the absence of a seven-day physiotherapy service, our findings support reasoning behind efforts to ensure that nonclinical factors do not delay surgery.

Future research

We noted no association between the type of physiotherapy and discharge. This may be due to a lack of detail in our data. Alternatively, it may be a true representation whereby exercise targeting improvements in balance, muscle mass, strength, power and quality do not influence time to discharge. Previous work suggests exercise incorporating balance training of at least three hours per week over an intervention period of several months is required to reduce falls risk [41], and high intensity progressive resistance training on two to three days per week for eight to 12 weeks for improvements in muscle strength, transfers and gait speed among older adults [42]. Finally, it may allude to a benefit of physiotherapy input regardless of type. The findings are in keeping with a recent systematic review which reported exercise in the early postoperative phase after hip fracture surgery led to improvements in physical function but there was uncertainty over the optimal type of exercise [43]. It is therefore unclear whether daily mobilisation (as recommended by NICE guidance[5]) is as effective as a more comprehensive exercise intervention for older adults during their postoperative inpatient stay after hip fracture. This uncertainty should be addressed in future research as there are substantial resource implications with the complexity of an intervention determining the skill set required to support its delivery.

We did not explore the reasons why daily physiotherapy was not provided. For the current dataset, the PHFSA reported 'contraindications' as the main reason why physiotherapy was not provided in the first two postoperative days and 'staffing issues' thereafter [6]. The most frequently reported contraindication was 'other' followed by pain and hypotension [6]. The report findings were supported by physiotherapists who specified staffing, pain management, patient/carer and multidisciplinary engagement as barriers to provision of protocolised care in a recent qualitative study [8]. Future research and/or audit should seek to collect data specifying

the most frequent contraindications to physiotherapy to enable future intervention to overcome these barriers.

This analysis was focused on the putative association between physiotherapy frequency, duration and type and discharge from acute hospital care after hip fracture surgery. Previous qualitative evidence highlighted discharge home as a defining feature of recovery among patients in the early postoperative phase after hip fracture [4]. However, a recent qualitative synthesis of 14 interview studies (279 participants) indicated older adults considered themselves 'recovered' from hip fracture only when they returned to their prefracture activities or a new 'normal' which enabled independence to participate in meaningful activities [44]. Future research should consider the association between acute physiotherapy input and longer term outcomes reflective of activity and participation domains of the World Health Organisation's International Classification of Functioning [45].

Limitations

There are five principal limitations of this study which should be acknowledged. First, there is the potential for unmeasured confounding by variables associated with physiotherapy frequency, duration and/or type and discharge including those related to the patient (e.g., anticoagulation, motivation), admission (e.g., weekend), overall standard of hip fracture care (e.g., hospitals with understaffed therapy services may also be deficient in other aspects of hip fracture care), or postoperative complications (e.g., tachyarrythmia) which may contribute to the associations observed. It may also be argued that physiotherapy input is related to a patient's ability to engage in physiotherapy with those more able to engage receiving more input and going home earlier. Alternatively, more physiotherapy input may be required for more dependent patients who require more time and support for safe discharge. Further, our analyses focused on physiotherapy

in the first week after surgery and did not account for other interventions such as pain management or additional physiotherapy received between postoperative day eight and discharge (the duration of which varied across patients). We attempted to account for these differences through regression adjustment however, the risk of unmeasured confounding remains. Second, there is potential for misclassification bias in our exposures. For example, duration of physiotherapy may have been interpreted as 'time with patient' as was required by the PHFSA or miscoded using 'overall treatment time inclusive of note writing'. This may have led to an underestimation or overestimation of the association between duration of physiotherapy and discharge. Third, we excluded patients with missing data from the main analysis. To determine the impact of these exclusions we completed missing data analyses with multiple imputation for exposure, potential confounders and outcomes. We reported similar but more conservative findings for complete case than imputed analyses. Fourth, for 33% of patients censored following transfer to another hospital/unit, we are unable to confirm whether their discharge prospects are similar to those not censored. Finally, the study findings may not be generalisable to settings where the organisation of care after hip fracture is distinctly different to that provided in England and Wales in the UK. For example, in England and Wales, physiotherapy is not provided preoperatively for patients admitted with hip fracture.

CONCLUSION

Few patients in the UK receive access to physiotherapy every day in the first seven days after hip fracture surgery. In this study, we have shown an association between additional physiotherapy and a reduction in time to discharge from acute hospital care. A seven-day physiotherapy service totalling at least two hours in the first postoperative week may be considered as a key performance indicator against which to measure the quality of acute postoperative care after hip

fracture. Benefits may be achieved even by offering an additional 30-minutes physiotherapy across the first week after surgery. Our findings will help staff in different hospitals to build the case for this additional service.

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Table 1. Characteristics of patients surgically treated for non-pathological first hip fracture overall and by frequency of physiotherapy in the first postoperative week*

			Days of physiotherapy in first postoperative week				
		All	0-2days	3 days	4 days	5 days	6-7 days
		n = 5,177	n = 880	n = 965	n = 1,288	n = 1,018	n = 1,026
		median [IQR]	median [IQR]	median [IQR]	median [IQR]	median [IQR]	median [IQR]
Age at admission (years)*		84 [78-89]	85 [78-90]	84 [78-89]	84 [77-89]	84 [78-88]	84 [78-88]
		n (%)	n (%)	n (%)	n (%)	n (%)	n (%)
Charlson Comorbidity Index†		1 [1-2]	2 [1-3]	1 [1-2]	1 [0-2]	1 [0-2]	1 [0-2]
Length of stay*		11 [7-18]	9 [4-18]	11 [6-18]	11 [7-17]	12 [8-18]	12 [8-17]
Sex	Male	1,395 (26.95)	273 (31.0)	245 (25.4)	336 (26.1)	254 (25.0)	287 (28.0)
	Female	3,782 (73.05)	607 (69.0)	720 (74.6)	952 (73.9)	764 (75.0)	739 (72.0)
Ethnicity†	White	3,588 (69.31)	615 (69.9)	676 (70.1)	892 (69.3)	721 (70.8)	684 (66.7)
	Caribbean or African (Black or Black British) or any mixed black background	10 (0.19)	2 (0.2)	2 (0.2)	1 (0.1)	3 (0.3)	2 (0.2)
	Asian or Asian British or any mixed Asian background	37 (0.71)	7 (0.8)	7 (0.7)	10 (0.8)	6 (0.6)	7 (0.7)
Deprivation†	most deprived	1,187 (22.93)	198 (20.5)	279 (21.7)	250 (24.6)	236 (23.0)	198 (20.5)
	more deprived	436 (8.42)	81 (8.4)	103 (8.0)	83 (8.2)	93 (9.1)	81 (8.4)
	average deprivation	1,087 (21.00)	213 (22.1)	282 (21.9)	210 (20.6)	192 (18.7)	213 (22.1)
	less deprived	1,030 (19.90)	198 (20.5)	257 (20.0)	211 (20.7)	200 (19.5)	198 (20.5)
	least deprived	1,026 (19.82)	194 (20.1)	263 (20.4)	194 (19.1)	212 (20.7)	194 (20.1)
ASA grade*†	I	114 (2.20)	18 (2.0)	19 (2.0)	38 (3.0)	23 (2.3)	16 (1.6)
	II	1,256 (24.26)	159 (18.1)	228 (23.6)	321 (24.9)	282 (27.7)	266 (25.9)
	III	2,950 (56.98)	511 (58.1)	561 (58.1)	727 (56.4)	559 (54.9)	592 (57.7)
	IV	749 (14.47)	184 (20.9)	144 (14.9)	172 (13.4)	129 (12.7)	120 (11.7)
	V	16 (0.31)	3 (0.3)	1 (0.1)	6 (0.5)	3 (0.3)	3 (0.3)
Prefracture ambulation*†	Freely mobile without aids	1,860 (35.93)	247 (28.1)	344 (35.6)	478 (37.1)	371 (36.4)	420 (40.9)
	Mobile outdoors with one aid	1,154 (22.29)	159 (18.1)	216 (22.4)	273 (21.2)	233 (22.9)	273 (26.6)
	Mobile outdoors with two aids or frame	784 (15.14)	147 (16.7)	136 (14.1)	184 (14.3)	177 (17.4)	140 (13.6)
	Some indoor ambulation but never goes outside without help	1,294 (25.00)	296 (33.6)	251 (26.0)	336 (26.1)	228 (22.4)	183 (17.8)
	No functional ambulation	50 (0.97)	26 (3.0)	10 (1.0)	6 (0.5)	4 (0.4)	4 (0.4)
Hip fracture type†	Intracapsular	3,065 (59.20)	501 (56.9)	538 (55.8)	774 (60.1)	614 (60.3)	638 (62.2)
	Intertrochanteric	1,842 (35.58)	328 (37.3)	375 (38.9)	448 (34.8)	360 (35.4)	331 (32.3)
	Subtrochanteric	269 (5.20)	51 (5.8)	52 (5.4)	66 (5.1)	44 (4.3)	56 (5.5)

			Days of physiotherapy in first postoperative week				
		All	0-2days	3 days	4 days	5 days	6-7 days
		n = 5,177	n = 880	n = 965	n = 1,288	n = 1,018	n = 1,026
Surgery within the target time†	Within target time	3,710 (71.66)	618 (70.2)	704 (73.0)	920 (71.4)	743 (73.0)	725 (70.7)
	Not within target time	1,307 (25.25)	240 (27.3)	236 (24.5)	329 (25.5)	238 (23.4)	264 (25.7)
Procedure type*†	Internal fixation	2,451 (47.34)	443 (50.3)	487 (50.5)	601 (46.7)	477 (46.9)	443 (43.2)
	Hemiarthroplasty	2,312 (44.66)	379 (43.1)	416 (43.1)	568 (44.1)	461 (45.3)	488 (47.6)
	Total Hip replacement	402 (7.77)	54 (6.1)	61 (6.3)	115 (8.9)	79 (7.8)	93 (9.1)
	Missing/Other	12 (0.23)	4 (0.5)	1 (0.1)	4 (0.3)	1 (0.1)	2 (0.2)
Weekday of admission*†	Weekday (Monday-Friday)	3,600 (69.54)	596 (67.7)	645 (66.8)	863 (67.0)	748 (73.5)	748 (72.9)
	Weekend (Saturday-Sunday)	1,571 (30.35)	283 (32.2)	318 (33.0)	423 (32.8)	269 (26.4)	278 (27.1)
First mobilisation day of/day after surgery*†	Within target time	4,180 (80.74)	591 (67.2)	784 (81.2)	1,061 (82.4)	822 (80.7)	922 (89.9)
	After target time	981 (18.95)	288 (32.7)	177 (18.3)	222 (17.2)	191 (18.8)	103 (10.0)
Prefracture residence*†	Own home/sheltered housing	4,212 (81.36)	596 (67.7)	758 (78.5)	1,066 (82.8)	873 (85.8)	919 (89.6)
	Nursing care/residential care	962 (18.58)	284 (32.3)	207 (21.5)	222 (17.2)	142 (13.9)	107 (10.4)
Anaesthesia type†	General (GA)	2,776 (53.62)	483 (54.9)	532 (55.1)	702 (54.5)	546 (53.6)	513 (50.0)
	Spinal (SA)	2,362 (45.62)	393 (44.7)	423 (43.8)	577 (44.8)	466 (45.8)	503 (49.0)
Hospital Frailty Index*†	Low risk	1,127 (21.77)	156 (17.7)	202 (20.9)	307 (23.8)	227 (22.3)	235 (22.9)
	Intermediate risk	1,800 (34.77)	268 (30.5)	319 (33.1)	461 (35.8)	355 (34.9)	397 (38.7)
	High risk	1,886 (36.43)	403 (45.8)	371 (38.4)	428 (33.2)	375 (36.8)	309 (30.1)
Duration of physiotherapy*†	<2hr	2,647 (51.13)	847 (96.2)	765 (79.3)	616 (47.8)	283 (27.8)	136 (13.3)
	>=2hr	2,303 (44.49)	17 (1.9)	158 (16.4)	607 (47.1)	686 (67.4)	835 (81.4)
Type of physiotherapy*†	Mobilisation only	637 (12.30)	221 (25.1)	138 (14.3)	132 (10.2)	77 (7.6)	69 (6.7)
	Mobilisation & exercise	4,472 (86.38)	591 (67.2)	827 (85.7)	1,156 (89.8)	941 (92.4)	957 (93.3)

IQR = interquartile range

*p<0.05

†Does not include the following missing data: Charlson Comorbidity Index n = 364; hospital frailty index n = 364; ethnicity n = 1542; deprivation n = 411; ASA grade n = 92; prefracture ambulation n = 35; hip fracture type n = 1; surgery within target time n = 160; procedure type n = 12; weekday of admission n = 6; mobilisation day of/after surgery n = 16; prefracture residence n =3; anaesthesia type n = 39; duration of physiotherapy n = 227; type of physiotherapy n = 68.

Table 2. Cumulative incidence of discharge by frequency, duration and type of physiotherapy among all patients surgically treated for non-pathological first hip fracture, complete case analysis.

Exposure	Number of patients	Number of deaths*	Number of live discharges*†	Live discharge rate (95% CI)†‡	30-day CIF, % (95% CI) †‡	p value †§	Unadjusted OR of CIF (95% CI) †	Adjusted OR of CIF (95% CI) ‖†
Overall	5177	114	2180	32.8 (30.6-33.3)	704 (686-722)			
Frequency of physiotherapy								
0 - 2 days	880	51	243	22.3 (19.7-25.3)	553 (504-601)			
3 days	965	21	325	25.9 (23.3-28.9)	646 (601-691)			
4 days	1288	21	569	33.3 (30.7-36.2)	733 (698-768)			
5 days	1018	13	481	34.4 (31.5-37.6)	738 (700-776)			
6 - 7 days	1026	8	562	40.4 (37.2-43.9)	780 (745-815)	<0.001		
1 day increase	5177	114	2180				1.24 (1.19-1.30)	1.26 (1.19-1.33)
Duration of physiotherapy								
≥2h	2647	73	1005	29.2 (27.5-31.1)	673 (647-699)		1.00	1.00
<2h	2303	34	1069	34.7 (32.6-36.8)	736 (710-762)	<0.001	1.34 (1.18-1.52)	1.33 (1.12-1.57)
30-minute increase	4950	107	2074				1.11 (1.08-1.15)	1.10 (1.05-1.15)
Type of physiotherapy								
mobilisation only	637	18	291	31.6 (28.2-35.4)	669 (622-716)		1.00	1.00
mobilisation & exercises	4472	86	1871	32.1 (30.7-33.6)	71.5 (695-734)	0.2	1.11 (0.91-1.36)	1.21 (0.92-1.60)

Abbreviations: CIF = cumulative incidence function, CI = confidence interval, OR = odds ratio.

*At 30 days from surgery

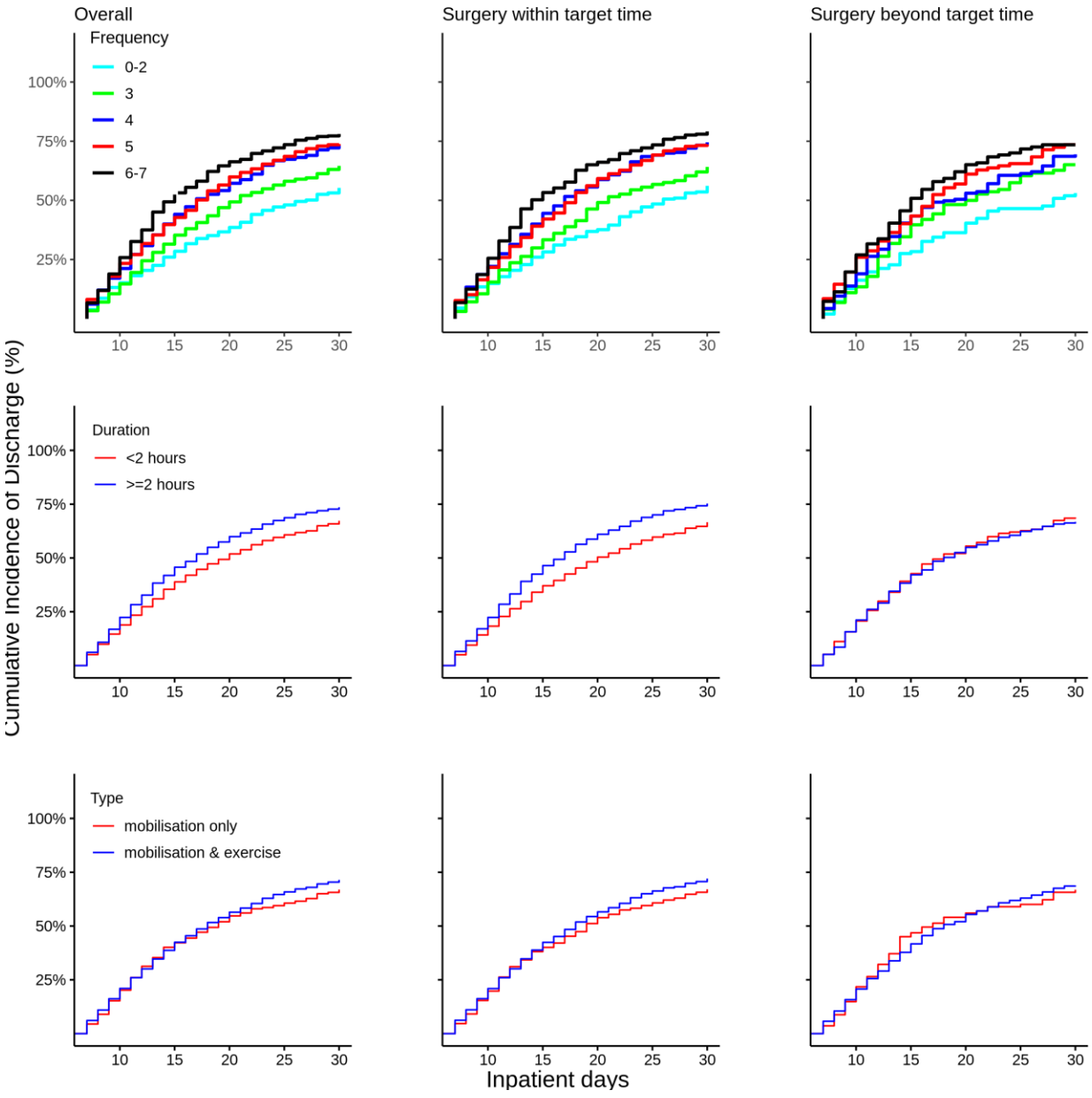
†Does not include patients with missing discharge and exposure for the analysis of duration (n =445) and type (n =286) of physiotherapy.

‡Per 1000 patient–days.

§Gray's test for k samples. Pepe-Mori two–sample test.

‖Adjusted for age, sex, ethnicity, deprivation, ASA grade, Charlson Comorbidity Index, Hospital Frailty risk score, prefracture residence, fracture type, mobility prior to hip fracture, type of surgery, timing of surgery, anaesthetic type, timing of first mobilisation, day of admission. CIF regression at in-patient days 7,9, 10, 12, 16, 18, 20, 24, and 30. Includes patients with complete data for exposure, outcome and adjustment variables for the analysis of frequency (n = 3382), duration (n = 3247) and type (n = 3337) of physiotherapy

Figure 1: Cumulative incidence of postoperative live discharge by days after surgery among patients surgically treated for non-pathological first hip fracture by frequency, duration, and type of physiotherapy, overall and by surgical timing.



Supplementary File 1

Creating an Analytical Dataset for Studying Effects of Rehabilitation Duration, Frequency and Type on Outcomes of Hip Fracture Surgery

Katie Jane Sheehan, Orouba Almilaji, Aicha Goubar

Technical Report 1-20

Foreword

This report has been prepared by Aicha Goubar, Orouba Almilaji, and Katie Sheehan. The study objective is to compare health outcomes among patients exposed to various rehabilitation duration, frequency, and types after hip fracture surgery.

Principal Investigator:

Katie Jane Sheehan, PhD

Investigators:

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Data Management:

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1. INTRODUCTION

The report describes creation of analytical dataset including data linkage, data cleaning, and the identification of new variables from the Physiotherapy 'Hip Sprint' Audit, the National Hip Fracture Database, and English/Welsh hospitalisation records.

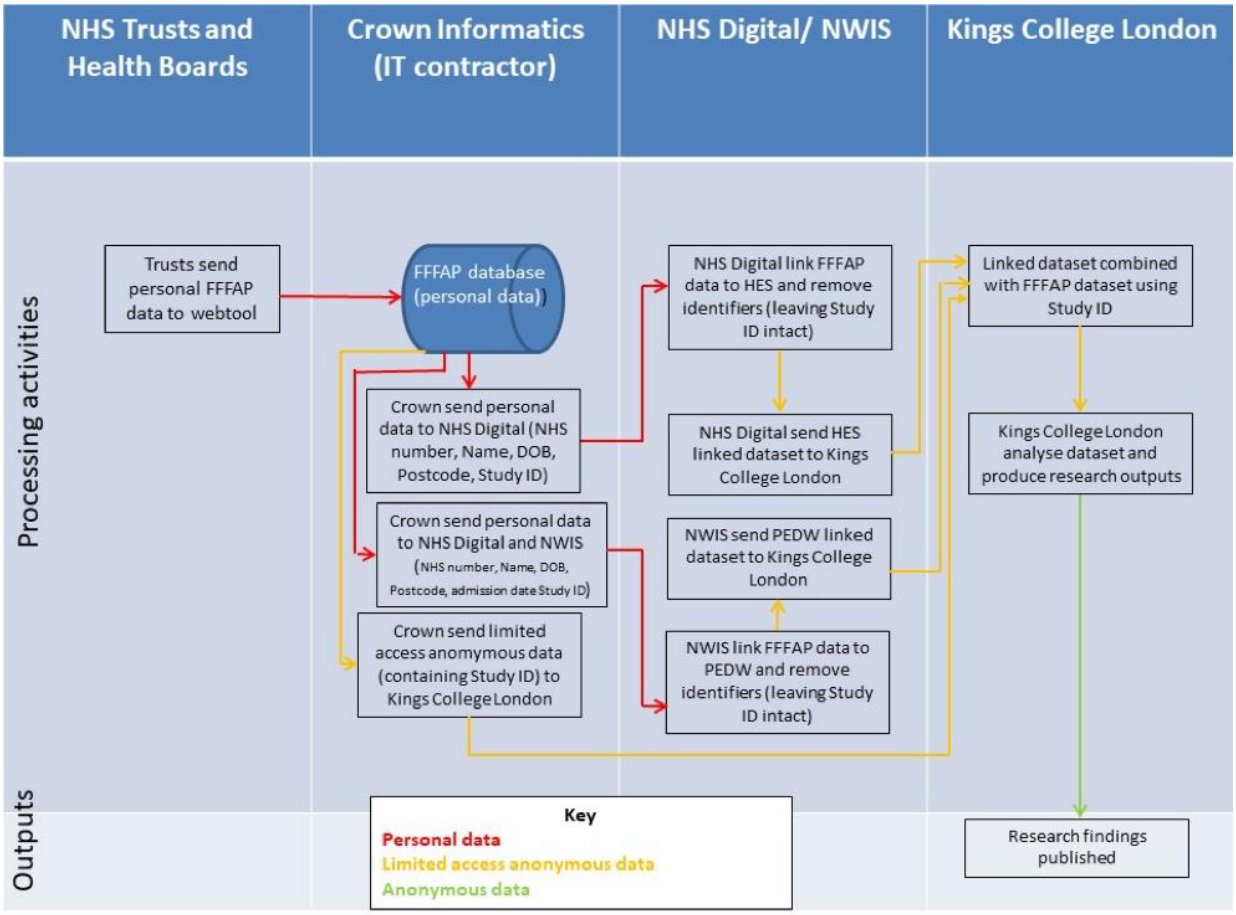
1.1 Data flow

We requested data from:

1. Physiotherapy Hip Fracture Sprint Audit (PHFSA), Falls and Fragility Fracture Audit Programme (FFFAP) (Data processor: Crown Informatics on behalf of data controller Healthcare Quality Improvement Partnership (HQIP));
2. Acute Facilities Audit (AcuteFA), FFFAP (Data processor: Crown Informatics on behalf of data controller HQIP);
3. National Hip Fracture Database (NHFD), FFFAP (Data processor: Crown Informatics on behalf of data controller HQIP);
4. Hospital Episode Statistics (HES) (Data controller: National Health Service Digital (NHSD));
5. Patient Episode Database for Wales (PEDW) (Data controller: NHS Wales Informatics Service (NWIS)).

The Study cohort was identified by Crown Informatics. Personal identifiers were sent to NHSD and NWIS to enable the identification of the study cohort in HES and PEDW. Personal identifiers were then removed by Crown Informatics, NHSD, and NWIS (leaving a Study identifier (ID) intact) prior to release of 5 datasets to Kings College London (KCL). Data flow is outlined in Figure 1.

Figure 1: Data flow



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1.2 Data summary

A Study ID reflects a hip fracture care spell. In total, we received 6,428 unique Study ID's from PHFSA. For NHFD, we received 10,296 unique Study ID's. For NWIS, we received 554 unique Study ID's. For NHSD we received 9,553 unique Study ID's (Table 1).

Table 1: Summary of data from NHFD, PHFSA, NHSD, NWIS, and AcuteFA

DATASET					
	NHFD	PHFSA	NHSD	NWIS	AcuteFA
Number of rows	10,440	6,584	125,642	676	73
Number of rows with non-unique Study ID	72	54	62,814	0	NA
Number of columns	28	144	31	81	20
Unique Number of Study ID's*	10,296	6,428	9,553	554	NA

*Following removal of rows with non-unique Study ID

1.3 Data structure

1.3.1 Physiotherapy Hip Fracture Sprint Audit (PHFSA)

We requested Study ID, Hospital, Trust, and for each of the first seven days physiotherapy postoperatively: Intensity and quality of therapy: what therapy? Intensity and quality of therapy: by whom? Intensity and quality of therapy: for how long? Intensity and quality of therapy: if not, why not? How do you get around?

We received 6,584 care spells (54 duplicates) for 6,428 unique Study ID's.

1.3.2 Acute 'Facilities Audit' (AcuteFA)

We requested Study ID, what are your services normal working hours on week days? Who typically provides physiotherapist-led rehabilitation on weekdays in the first week post-op? Who typically provides physiotherapist-led rehabilitation at weekends in the first week post op.? On which days of the week could your service provide physiotherapy led mobilisation to hip fracture patients on the day after their operation? Are you able to continue physiotherapist-led rehabilitation for all hip fracture patients every day until they have achieved their rehabilitation goals? Do physiotherapists involved attend a trauma and orthopaedic clinical governance meeting? What do you feel limits your ability to provide physiotherapist-led rehabilitation (select up to 2)? Do you have adequate space for rehabilitation? What functional outcome measure do you routinely use? What quality of life outcome measure do you routinely use?

We received 73 hospital audits for 66 Trust.

1.3.3 National Hip Fracture Database (NHFD)

We requested Study ID, Days from A&E admission to orthopaedic/orthogeriatric ward admission, Weekend A&E admission, Weekend orthopaedic/orthogeriatric ward admission, After hours A&E admission, After hours orthopaedic/orthogeriatric ward admission, Days from orthopaedic/ orthogeriatric ward admission to surgery, Weekend surgery, After hours surgery, Age at admission, Sex, Admitted from, Pre-fracture mobility, AMTS preop, AMTS postop, Type of fracture, Pathological, Days from surgery to discharge from acute orthopaedic ward, ASA grade, Type of anaesthesia, Reason if delayed >36 hours, Operation performed, Mobilised on day of or day following surgery, Discharge destination from acute orthopaedic ward, Residential status: 30 days, and Mobility at 120 days.

We received 10,440 care spells of which 72 were records with a non-unique Study ID (Crown Informatics indicated: 20 Bilateral fractures, 42 hospital errors, 6 duplicate records and 4 Misidentified patients (a pair of records with the same NHS number but differing patient names/DoB). Care spells of the patients with these records were excluded leaving 10,296 unique Study ID's.

1.3.4 Hospital episode statistics (NHSD)

We requested Study ID, ethnicity, IMD index of multiple deprivation, IMD health and disability domain, IMD overall rank, diagnosis codes (up to 20) and fact of death at 30-days for hip fracture care spells during the study period. We also requested diagnosis codes (up to 20 per care spell) for all care spells in the year prior to the hip fracture care spell (irrespective of admitting diagnosis) and any care spells that occurred in the 30-days post discharge from the hip fracture care spell.

We received 125,642 care spells from NHSD for 9,553 unique Study ID's. 62,814 care spells were kept, and the rests were duplicates. Readmission is identified by considering the repetition of the study id within 30-days from the discharge date, given that the admission date for the same study ID was in the period of [2017-05-01, 2017-06-30].

1.3.5 Patient episode database for Wales (NWIS)

We requested Study ID, ethnicity, IMD index of multiple deprivation, IMD health and disability domain, IMD overall rank, diagnosis codes (up to 14) and fact of death at 30-days for hip fracture care spells during the study period. We also requested any care spells that occurred in the 30-days post discharge from the hip fracture care spell.

We received 676 care spells (0 duplicates) for 554 unique Study ID's.

2. PREPEARING DATA

2.1 Data validation

1. In the final dataset, we included data for Study ID's from PHFSA if the same Study ID's were present in NHFD. We identified 483 unique Study ID's (496 rows) in PHFSA that do not exist in NHFD. We removed these 483 unique Study ID's.
2. In the final dataset, we included one row per Study ID from PHFSA. We identified 85 unique Study ID's occurring on 2 rows and 2 unique Study ID's occurring on 3 rows. We retained the most complete Study ID only.
3. In the final dataset, we included data for Study IDs from either NWIS or NHSD. We identified 63 Study ID's (with 68 rows) common to NWIS and NHSD. We retained data from NHSD only.
4. In the final dataset, we included data for Study ID's from NHSD and NWIS if the same Study ID's were present in NHFD. We identified 73 unique Study ID's (516 rows) in NHSD and NWIS that do not exist in NHFD. We removed these 73 unique Study ID's.

2.2 Variables for the analytical dataset

1. We retained variables from the original datasets (section 3.1) with the application of predefined rules for the following:
    a. Blank fields in the variables for durations of physiotherapy in minutes received on each day (Day 0 to Day 6) during the first week postoperative were interpreted following four rules:
        i. If physiotherapy was not received on day X for a recorded reason and the type of physiotherapy is missing then blank cell for duration was imputed to 0 minutes.
        ii. If physiotherapy was not received on day X for a recorded reason and the type of physiotherapy is recorded then blank cell for duration was considered missing.
        iii. If no reason is given for physiotherapy not been received on day X and the type of physiotherapy is missing then blank cell for duration was imputed to 0.
        iv. If no reason is given for physiotherapy not been received on day X and the type of physiotherapy is recorded then blank cell for duration was considered missing.

2. We created new variables for the analytical dataset (section 3.2). In particular,
    a. Hospital frailty risk score (HFS) and Charlson Comorbidity Index scores (CCI) was were calculated using all available diagnostic codes that were documented in the year prior to hip fracture surgery for each patient from the NHSD and NWIS following published guidance from:
        - Gilbert T, Neuburger J, Kraindler J, Keeble E, Smith P, Ariti C, Arora S, Street A, Parker S, Roberts HC, Bardsley M. Development and validation of a Hospital Frailty Risk Score focusing on older people in acute care settings using electronic hospital records: an observational study. The Lancet. 2018 May 5;391(10132):1775-82.
        - Deyo RA, Cherkin DC, Ciol MA. Adapting a clinical comorbidity index for use with ICD-9-CM administrative databases. J Clin Epidemiol. 1992; 45: 613-9
    b. Defined readmission as the repetition of the study id within 30-days from the discharge date:
        i. If an admission date is in the study time period [2017-05-01, 2017-06-30] and another admission date is found within 30-days post discharge then readmission was imputed to 1.
        ii. If an admission date is in the study time period [2017-05-01, 2017-06-30] but no other admission is found in that time period, readmission was imputed to 0.
        iii. If no admission date is recorded in the time period of [2017-05-01, 2017-07-31], readmission was imputed to 0.

2.3 Linking data

We created three mutually exclusive datasets, all subsets of NHFD, using Study ID as the common data element (Figure 2, Table 2):

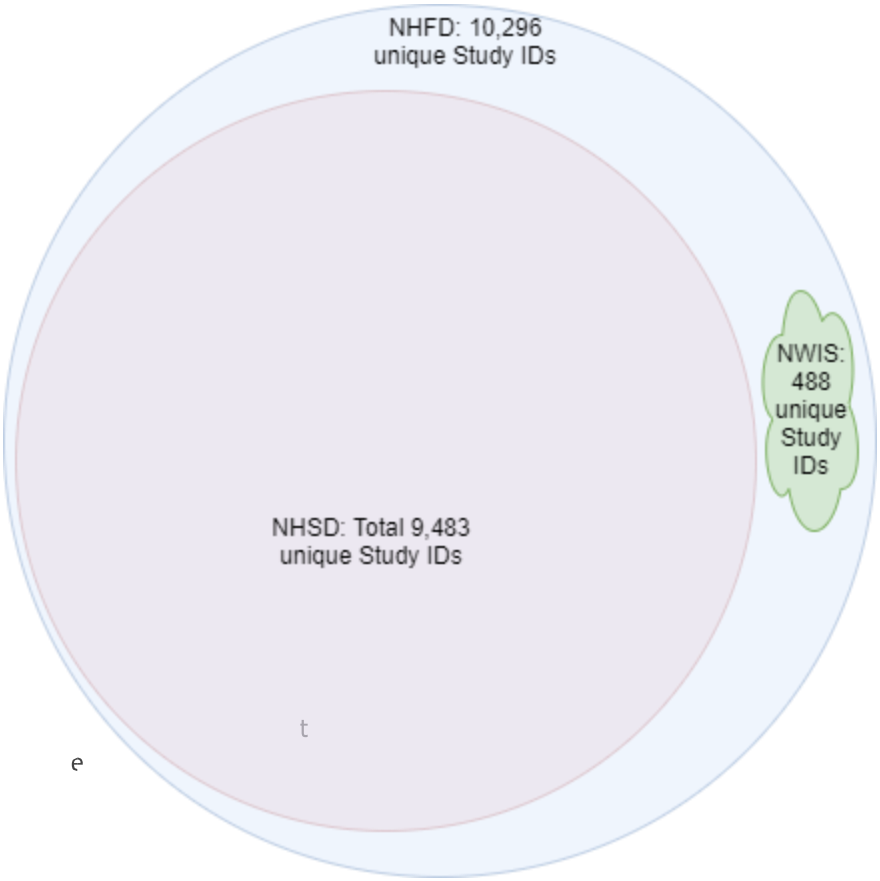
- NHFD set (excluding study IDs not existing in NHSD or NWIS),
- NHSD set (including the common study IDs with NWIS)
- and NWIS set (excluding study IDs common with NHSD).

These three datasets were reunited in one final dataset that we linked to PHFSA using Study ID. The final dataset was linked to AcuteFA using Hospital as the common data element between AcuteFA and NHFD.

Table 2: datasets after cleaning

	DATASET				
	NHFD	PHFSA	NHSD	NWIS	AcuteFA
Number of columns	28	144	31	81	20
No of rows	10,296	5,858	62,300	598	73
No. of unique Study IDs	10,296	5,858	9,483	488	NA

Figure 2: The intersections among datasets per study IDs



3. VARIABLES IN THE ANALYTICAL DATASET

3.1 Original variables

We retained Study ID (patients' identifiers), age, sex, hospital at surgery, accident and emergency length of stay, preoperative length of stay, and postoperative length of stay in the analytical dataset (Table 3).

Table 3 Original variables retained in the analytical dataset

Variable	Description	Data field / Database	Code or values
STUDY_ID	Unique ID to identify individual care spells.	1 - NHFD	Nominal

AGE	Age at admission.	13 - NHFD	positive integer NA - missing
SEX	Sex.	14 - NHFD	0 - Female 1 – Male NA- missing
HOSPITAL	Hospital at surgery.	3 - NHFD	Nominal
AE_LOS	Days from AE admission to orthopaedic/ orthogeriatric ward admission.	4 - NHFD	positive integer NA- missing
PREOP_LOS	Days from orthopaedic orthogeriatric ward admission to surgery.	10 - NHFD	positive integer NA – missing
POSTOP_LOS	Days from surgery to discharge from acute orthopaedic ward.	26 - NHFD	positive integer NA – missing

3.2 New variables

Other variables calculated for the analytical dataset include patient and system factors, which may affect rehabilitation and outcomes after hip fracture surgery, as well as study outcome variables (Table 4).

Table 4: New variables included in the analytical dataset

Variable	Description	Data field / Database	Code or values
DATASET	Name of mutually exclusively dataset- NHFD, NHSD, NWIS	Calculated based on StudyID from NHFD, NWIS and NHSD	Character NHFDOnly- NHFD only NHSDOnly- NHSD only NWISOnly- NWIS only
PATHHF	Pathological fracture at index admission.	Calculated from diagnosis codes [NWIS/NHSD databases] [NHFD]	0 – No 1 – Yes (C34, C50, C61, C64, C65, C78,C79, C80, C90) NA– Missing
PAGET	Presentation of Paget's disease of the bone in year prior to, and including admission	Calculated from diagnosis codes [NWIS/NHSD databases]	0 -No 1 – Yes (M88) NA– Missing
HRTFAIL	Presentation of heart failure or pulmonary edema in year prior to, and including admission	Calculated from diagnosis codes [NWIS/NHSD databases]	0 – No 1 – Yes (ICD-10 I50, J81) NA– Missing

COPD	Presentation of chronic obstructive pulmonary diseases in year prior to, and including admission	Calculated from diagnosis codes [NWIS/NHSD databases]	0 – No 1 – Yes (ICD-10 J41, J42, J43, J44, J47) NA– Missing
IHDA	Presentation of ischemic heart disease (acute) in year prior to, and including admission	Calculated from diagnosis codes [NWIS/NHSD databases]	0 – No 1 – Yes (ICD-10 I20, I21, I22, I24) NA– Missing
CDYS	Presentation of cardiac dysrhythmias in year prior to, and including admission	Calculated from diagnosis codes [NWIS/NHSD databases]	0 – No 1 – Yes (ICD-10 I47, I48, I49) NA– Missing
IHDC	Presentation of ischemic heart disease (chronic) in year prior to, and including admission	Calculated from diagnosis codes [NWIS/NHSD databases]	0 – No 1 – Yes (ICD-10 I25) NA– Missing
HYP	Presentation of hypertension in year prior to, and including admission	Calculated from diagnosis codes [NWIS/NHSD databases]	0 – No 1 – Yes (ICD-10 I10, I11) NA– Missing
HYPO	Presentation of hypotension in year prior to, and including admission	Calculated from diagnosis codes [NWIS/NHSD databases]	0 – No 1 – Yes (ICD-10 I95) NA– Missing
DIA	Presentation of diabetes with complication in year prior to, and including admission	Calculated from diagnosis codes [NWIS/NHSD databases]	0 – No 1 – Yes (ICD-10 E100-E108, E110-E118, E130-E138, E140-E148) NA– Missing

DEMENTIA	Presentation of Alzheimer's or dementia in year prior to, and including admission	Calculated from diagnosis codes [NWIS/NHSD databases]	0 -No 1 – Yes (ICD-10 F00, F01, F02, F03, G30) NA– Missing
DEPR	Presentation of depression in year prior to, and including admission	Calculated from diagnosis codes [NWIS/NHSD databases]	0 -No 1 – Yes (ICD-10 F204, F32, F33, F34, F43) NA– Missing
DELIRIUM	Presentation of delirium in year prior to, and including admission	Calculated from diagnosis codes [NWIS/NHSD databases]	0 -No 1 – Yes (ICD-10 F05) NA– Missing
HFR_score	Hospital frailty risk score	Calculated from diagnosis codes [NWIS/NHSD databases]	Integer NA-missing
HFR	Hospital frailty risk group	Calculated from HFR_score [Analytical dataset]	• Lowe risk • Intermeridate risk • Higher Risk NA-missing
CCI_score	Charlson Comorbidity index Score	Calculated from diagnosis codes [NWIS/NHSD databases]	Integer ranged 0-9 NA-missing
CCI	Charlson Comorbidity index group	Calculated from CCI_score [Analytical dataset]	0- CCI=0 1- CCI=1 or 2 2- CCI=3 or 4 3- CCI >=5
CCI_wscore	Charlson Comorbidity index Score	Calculated from diagnosis codes [NWIS/NHSD databases]	Integer ranged 0-14 NA-missing
CCI_w	Charlson Comorbidity Score group	Calculated from CCI_wscore [Analytical dataset]	0- CCI=0 1- CCI=1 or 2 2- CCI=3 or 4 3- CCI >=5

PREOP_DEL_AMTS	Presentation of delirium during admission before surgery	Calculated from AMTS preop score [NHFD]	0 -No 1- Yes (AMTS score of 6 or less) NA- missing
POSTOP_DEL_AMTS	Presentation of delirium during admission after surgery	Calculated from AMTS postop score [NHFD]	0 -No 1- Yes (AMTS score of 6 or less) NA- missing
DEL_AMTS	Presentation of delirium during admission	Calculated from AMTS preop and postop score [NHFD]	0 -No 1- Yes (AMTS score of 6 or less in either or both preop and postop AMTS) NA - missing
COMORBIDCOUNT	Count of comorbid diagnoses	Calculated from count of diagnosis codes for HRTFAIL, COPD, IHDA, CDYS, IHDC, HYP, HYPO, DIA, DEMENTIA, DEPR, DELIRIUM [analytical dataset]	positive integer

ETHNICITY		[NHSD]	0 - White 1- White and Black Caribbean (Mixed) 2- White and Black African (Mixed) 3 - White and Asian (Mixed) 4 - Any other Mixed background 5 - Asian/Asian British 6 – Black or Black British 7 - Chinese NA- missing
DEPRIVATION1	IMD Index of multiple deprivation	IMD04 [NHSD]	positive integer NA - missing
DEPRIVATION2	IMD Heath and disability domain value	IMD04HD [NHSD]	positive integer NA- missing
DEPRIVATION3	IMD Overall rank	IMD04RK [NHSD]	positive integer NA- missing
DEPRIVATION4	IMD Decile Group	Calculated from IMD04RK [NHSD and NWIS]	0 - least deprived 10% 1 -less deprived 10-20% 2 - less deprived 20-30% 3 - less deprived 30-40% 4- less deprived 40-50% 5- more deprived 40-50% 6 - more deprived 30-40% 7- more deprived 20-30% 8- more deprived 10-20% 9- most deprived 10% NA - missing

DAYADM	Indicator of admission on weekend or weekday.	Calculated from: weekend a&e admission and weekend orthopaedic/orthogeriatric ward admission [NHFD]	0 - weekday (Monday-Friday) 1 - weekend (Saturday-Sunday) NA- missing
TIMEADM	Indicator of admission after hours or during working hours.	Calculated from: after hours a&e admission and after hours orthopaedic/orthogeriatric ward admission [NHFD]	0 – working hours 1- after hours (19:00 – 06:59) NA - missing
RESIDENCE	Prefracture residence	Calculated from Admitted from [NHFD]	0 – Own home/sheltered housing 1- nursing care/residential care NA- missing
FR_TYPE	Subtype of hip fracture at admission	Calculated from: Fracture type [NHFD]	0 – Intracapsular 1 – Intertrochanteric 2 – Subtrochanteric NA- missing
SXFLAG	Flag for any record of hip fracture surgery	Calculated from Operation type [NHFD]	0 - No 1 – Yes NA - missing
Sx_TIMING	Indicator of surgery within target time of 36 hours.	Calculated from reason if delayed >36 hours [NHFD]	0 - yes 1- no NA - missing
AdmSxDelay	Indicator of administrative surgical delay	Calculated from reason if delayed >36 hours [NHFD]	0 - no (/not delayed) 1- yes NA– missing/medical reason for delay

MedSxDelay	Indicator of medical surgical delay	Calculated from reason if delayed >36 hours [NHFD]	0 - no (/not delayed) 1- yes NA – missing/administrative reason for delay
ANAESTH	Type of anaesthesia	Calculated from X4.03v10.Anaesthesia [NHFD]	0 - General (GA) 1 - Spinal (SA) NA - missing
PROCTYPE	Procedure type	Calculated from: Operation type [NHFD]	0 – no operation performed 1 - Internal fixation 2 - Hemi 3 - THR NA- missing
MOB_TIMING	Indicator of mobilisation after surgery within target time of day of/day after.	Calculated from: mobilisation on day of surgery [NHFD]	0 - Within target time 1 - After target time NA - missing
TOTAL_LOS	Total length of stay	Sum of "Days.from.A.E.admission.to.orthopaedic.orthogeriatric.ward.admission...Integer.", "Days.from.orthopaedic.orthogeriatric.ward.admission.to.surgery...Integer.", "Days.from.surgery.to.discharge.from.acute.orthopaedic.ward....Integer." [NHFD]	Positive integer NA- missing
HOSPITALDEATH	Indicator of inhospital death	Calculated from: discharge destination from acute orthopaedic ward [NHFD]	0 – no 1 – yes NA - missing

DISCHARGEDEST	Discharge destination	Calculated from: X6.02v9.Ward.discharge. destination [NHFD]	0 – Own home/sheltered housing 1- nursing care/residential care 2 – rehabilitation unit 3 – acute hospital/unit 4 - dead NA– missing/Other
READMIT30	Indicator of readmission within 30-days of discharge from hip fracture care spell	Calculated from: discharge date [NHSD] Check first admission to be in the study period Then check discharge date. New admission should be with 30 days of the last discharge date	0 – no 1 – yes NA – missing
DEATH30	Indicator of death at 30 days	Calculated from: fact of death at 30 days post admission [NHSD , NWIS]	0 – no 1 – yes NA - missing
PREFRACTURE_MOB	Level of mobility prior to hip fracture.	Calculated from: Pre.fracture.mobility [NHFD]	0- Freely mobile without aids 1 - Mobile outdoors with one aid 2 - Mobile outdoors with two aids or frame 3 – Some indoor mobility but never goes outside without help 4 - No functional mobility NA- missing

ASA	The American Society of Anesthesiologists (ASA) physical status classification system was developed to offer clinicians a simple categorization of a patient's physiological status that can be helpful in predicting operative risk.	Calculated from: X4.02v10.ASA.Grade [NHFD]	0 - Normal healthy individual 1 - Mild systemic disease that does not limit activity 2 - Severe systemic disease that limits activity but is not incapacitating 3 - Incapacitating systemic disease which is constantly life-threatening 4 - Moribund - not expected to survive 24 hours with or without surgery NA- missing
RESIDENCE120	Residence at 120 days post fracture	Calculated from X8.01v9.Residential.120.days [NHFD]	0 – Own home/sheltered housing 1- nursing care/residential care 2 – rehabilitation unit 3 – acute hospital 4 - dead NA – missing/NA/Other/Unknown

RECOVERY120	Indicator of mobility recovery at 120 days	Calculated as no change (or an improvement) in the measure of function (X8.02v8.Mobility.at.120 .days) from prefracture to 120-days post-fracture. The NHFD defines function as mobile without aids, mobile outdoors with one aid, mobile outdoors with two aids or frame, some indoor mobility but never goes outside without help, or no functional mobility. [NHFD]	0 – no 1 – yes NA - missing
EXT_HR	Indicator of extended hours in physiotherapy service	Calculated from 3b. services working hours [Acute Facilities Audit]	0 – No (Monday to Friday (0800-1600/1700)) 1 – Yes (Monday to Friday (extended hours)) NA-Missing
Staff_WEEKD	Indicator of rehabilitation staff case mix on weekdays	Calculated from 2a. physio rehab Weekdays [Acute Facilities Audit]	0 –Physiotherapists/ physiotherapy assistants/ nurses/OT/OT assistants 1 – Physiotherapists/ physiotherapy assistants 2– Physiotherapists
Staff_WEEKE	Indicator of rehabilitation staff case mix on weekend	Calculated from 2b. physio rehab Weekends [Acute Facilities Audit]	0 –Physiotherapists/ physiotherapy assistants/ nurses/OT/OT assistants 1 – Physiotherapists/ physiotherapy assistants 2– Physiotherapists NA-Missing

PT_Staff_Week	Indicator of physiotherapy staff during week	Calculated from 3a. physio available to mobilise [Acute Facilities Audit]	0– Monday to Friday 1– Monday to Saturday 2– Monday to Sunday (Saturday and Sunday half day) 3– Monday to Sunday (Saturday full day and Sunday half day) 4– Monday to Sunday (Saturday and Sunday full days)
REHAB_GOALS	Indicator of whether rehabilitation is goal orientated	Calculated from 3c. Continue rehab to achieve goals [Acute Facilities Audit]	0 – No 1 – Monday to Friday 2 – Monday to Sunday
GOVERNANCE	Indicator of whether physiotherapists attend governance meetings	Calculated from 5. physio attend gov meetings [Acute Facilities Audit]	0 – No 1 – Yes 2 – no meetings occur NA: Missing
REHAB_SPACE	Indicator of adequate space for rehabilitation	Calculated from 12. adequate space for rehab [Acute Facilities Audit]	0 -No 1 – Yes in hospital 2 – Yes on ward &within the word NA-Missing
Fx_Mx	Functional outcome measures used by physiotherapy team	Calculated from 9. functional outcome measure [Acute Facilities Audit]	0 – No 1 – Yes NA-Missing
QOL_Mx	Quality of life outcome measures used by physiotherapy team	Calculated from 10. life outcome measures [Acute Facilities Audit]	0 – No 1 – Yes NA-Missing

PT_FTE	Indicator of perceived insufficient staffing to meet demand	Calculated from 4. Limit = lack of physiotherapy full time equivalent [Acute Facilities Audit]	0 – No 1 – Yes NA-Missing
PT_FTE2	Indicator of perceived insufficient staffing due to sick/maternity to meet demand	Calculated from 4. Limit = absence (sick/maternity) [Acute Facilities Audit]	0 – No 1 – Yes NA-Missing
PT_WE	Indicator of perceived insufficient weekend staffing to meet demand	Calculated from 4. Limit = no weekend staff cover [Acute Facilities Audit]	0 – No 1 – Yes NA-Missing
PT_EQ	Indicator of perceived insufficient equipment to support goal attainment	Calculated from 4. Limit = lack of equipment [Acute Facilities Audit]	0 – No 1 – Yes NA-Missing
PT_BEDS	Indicator of perceived insufficient bed capacity to support goal attainment	Calculated from 4. Limit = hospital capacity (beds) [Acute Facilities Audit]	0 – No 1 – Yes NA-Missing
ISPHFSA	Indicator of being included in PHFSA	Calculated in [PHFSA]	0 – No 1 – Yes
PTDAY0	Indicator of physiotherapy day 0	Calculated from 'Day0Moblised' 'Day0GAIT' 'Day0ROM Exercise' 'Day0 Strength' 'Day0 Balance' Day0 Transfer Practice' [PHFSA]	0 – No 1 – Yes NA -Missing
PTDAY1	Indicator of physiotherapy day 1	Calculated from 'Day1Moblised' 'Day1GAIT' 'Day1ROM Exercise' 'Day1Strength' 'Day1Balance' Day1 Transfer Practice' [PHFSA]	0 – No 1 – Yes NA – Missing

PTDAY2	Indicator of physiotherapy day 2	Calculated from 'Day2Moblised' 'Day2GAIT' 'Day2ROM Exercise' 'Day2Strength' 'Day2Balance' Day2 Transfer Practice' [PHFSA]	0 – No 1 – Yes NA – Missing
PTDAY3	Indicator of physiotherapy day 3	Calculated from 'Day3Moblised' 'Day3GAIT' 'Day3ROM Exercise' 'Day3Strength' 'Day3Balance' Day3 Transfer Practice' [PHFSA]	0 – No 1 – Yes NA – Missing
PTDAY4	Indicator of physiotherapy day 4	Calculated from 'Day4Moblised' 'Day4GAIT' 'Day4ROM Exercise' 'Day4Strength' 'Day4Balance' Day4 Transfer Practice' [PHFSA]	0 – No 1 – Yes NA – Missing
PTDAY5	Indicator of physiotherapy day 5	Calculated from 'Day5Moblised' 'Day5GAIT' 'Day5ROM Exercise' 'Day5Strength' 'Day5Balance' Day5 Transfer Practice' [PHFSA]	0 – No 1 – Yes NA – Missing
PTDAY6	Indicator of physiotherapy day 6	Calculated from 'Day6Moblised' 'Day6GAIT' 'Day6ROM Exercise' 'Day6Strength' 'Day6Balance' Day6 Transfer Practice' [PHFSA]	0 – No 1 – Yes NA– Missing
FREQUENCY	Days of physiotherapy received in the first postoperative week	Calculated from PTDAY0 – PTDAY6 [Analytical dataset]	positive integer NA – Missing

FREQUENCY_IND	Indicator of 0-5 vs. 6-7 days physiotherapy	Calculated from FREQUENCY [Analytical dataset]	0 – 0-5 days 1 – 6-7 days NA – Missing
DURATION_0	Duration of physiotherapy (in minutes) received on the first postoperative day	Calculated from 'Day0.Physio.time', 'Rehab.Day.0' and 'No.Rehab.Day.0' '[PHFSA]	Positive integer NA-Missing
DURATION_1	Duration of physiotherapy (in minutes) received on the second postoperative day	Calculated from 'Day1.Physio.time' ' [PHFSA]	Positive integer NA-Missing
DURATION_2	Duration of physiotherapy (in minutes) received on the third postoperative day	Calculated from 'Day2.Physio.time' ' [PHFSA]	Positive integer NA-Missing
DURATION_3	Duration of physiotherapy (in minutes) received on the fourth postoperative day	Calculated from 'Day3.Physio.time' ' [PHFSA]	Positive integer NA-Missing
DURATION_4	Duration of physiotherapy (in minutes) received on the fifth postoperative day	Calculated from 'Day4.Physio.time' ' [PHFSA]	Positive integer NA-Missing
DURATION_5	Duration of physiotherapy (in minutes) received on the sixth postoperative day	Calculated from 'Day5.Physio.time' ' [PHFSA]	Positive integer NA-Missing

DURATION_6	Duration of physiotherapy (in minutes) received on the seventh postoperative day	Calculated from 'Day6.Physio.time' ' [PHFSA]	Positive integer NA-Missing
DURATION_TOTAL	Total minutes of physiotherapy in the first postoperative week	Calculated from DURATION_0 DURATION_1 DURATION_2 DURATION_3 DURATION_4 DURATION_5 DURATION_6 [Analytical dataset]	positive integer NA- missing
DURATION_ AVG	Total minutes of physiotherapy in the first postoperative week	Calculated from DURATION_0 DURATION_1 DURATION_2 DURATION_3 DURATION_4 DURATION_5 DURATION_6 [Analytical dataset]	positive integer NA- missing
DURATION_2HR	Indicator of rehabilitation duration of ≥2hours in the first week	Calculated from DURATION_TOTAL [Analytical dataset]	0 – <120min 1 – >=120min NA – Missing
PTTYPE0	Indicator of physiotherapy type day 0 – mobilisation vs. mobilisation and exercises	Calculated from Mobilised: 'Day0Moblised' 'Day0GAIT' Day0 Transfer Practice'[PHFSA] and Exercise: 'Day0ROM Exercise' 'Day0 Strength' 'Day0 Balance' [PHFSA]	0 – mobilised not exercise 1 - mobilised and exercise 2 – not mobilised not exercise 3 – not mobilised exercise

PTTYPE1	Indicator of physiotherapy type day 1 – mobilisation vs. mobilisation and exercises	Calculated from 'Day1Moblised' 'Day1GAIT' 'Day1ROM Exercise' 'Day1Strength' 'Day1Balance' Day1 Transfer Practice' [PHFSA]	0 – mobilised not exercise 1 - mobilised and exercise 2 – not mobilised not exercise 3 – not mobilised exercise
PTTYPE2	Indicator of physiotherapy type day 2 – mobilisation vs. mobilisation and exercises	Calculated from 'Day2Moblised' 'Day2GAIT' 'Day2ROM Exercise' 'Day2Strength' 'Day2Balance' Day2 Transfer Practice' [PHFSA]	0 – mobilised not exercise 1 - mobilised and exercise 2 – not mobilised not exercise 3 – not mobilised exercise
PTTYPE3	Indicator of physiotherapy type day 3 – mobilisation vs. mobilisation and exercises	Calculated from 'Day3Moblised' 'Day3GAIT' 'Day3ROM Exercise' 'Day3Strength' 'Day3Balance' Day3 Transfer Practice' [PHFSA]	0 – mobilised not exercise 1 - mobilised and exercise 2 – not mobilised not exercise 3 – not mobilised exercise
PTTYPE4	Indicator of physiotherapy type day 4 – mobilisation vs. mobilisation and exercises	Calculated from 'Day4Moblised' 'Day4GAIT' 'Day4ROM Exercise' 'Day4Strength' 'Day4Balance' Day4 Transfer Practice' [PHFSA]	0 – mobilised not exercise 1 - mobilised and exercise 2 – not mobilised not exercise 3 – not mobilised exercise
PTTYPE5	Indicator of physiotherapy type day 5 – mobilisation vs. mobilisation and exercises	Calculated from 'Day5Moblised' 'Day5GAIT' 'Day5ROM Exercise' 'Day5Strength' 'Day5Balance' Day5 Transfer Practice' [PHFSA]	0 – mobilised not exercise 1 - mobilised and exercise 2 – not mobilised not exercise 3 – not mobilised exercise
PTTYPE6	Indicator of physiotherapy type day 6 – mobilisation vs. mobilisation and exercises	Calculated from 'Day6Moblised' 'Day6GAIT' 'Day6ROM Exercise' 'Day6Strength' 'Day6Balance' Day6 Transfer Practice' [PHFSA]	0 – mobilised not exercise 1 - mobilised and exercise 2 – not mobilised not exercise 3 – not mobilised exercise

PTTYPE_IND	Indicator of physiotherapy type – mobilisation vs. mobilisation and exercises	Calculated from PTTYPE0 – PTTYPE6 [Analytical dataset]	0 – mobilised only in the 7 days [PTTYPE0-PTTYPE6: 0 – mobilised not exercise only OR 0 – mobilised not exercise and 2 – not mobilised not exercise observed across the 7 days] 1 – mobilisation and exercises across the 7 days [PTTYPE0-PTTYPE6: 1 - mobilised and exercise OR 1 - mobilised and exercise AND 2 – not mobilised not exercise OR 1 - mobilised and exercise AND 3 – not mobilised exercise OR 0 – mobilised not exercise AND 1 - mobilised and exercise OR 0 – mobilised not exercise AND 3 – not mobilised exercise OR 2 – not mobilised not exercise AND 3 – not mobilised exercise across the 7 days]
PTTYPE_COUNT	Count of days that physiotherapy type includes both mobilisation and exercises across the 7 days	Calculated from PTTYPE0 – PTTYPE6 [Analytical dataset]	positive integer

Supplementary File 2

SUPPLEMENTARY FILE 2

Figure S1. Cumulative incidence of postoperative live discharge and death by days after surgery among patients surgically treated for non-pathological hip fracture.

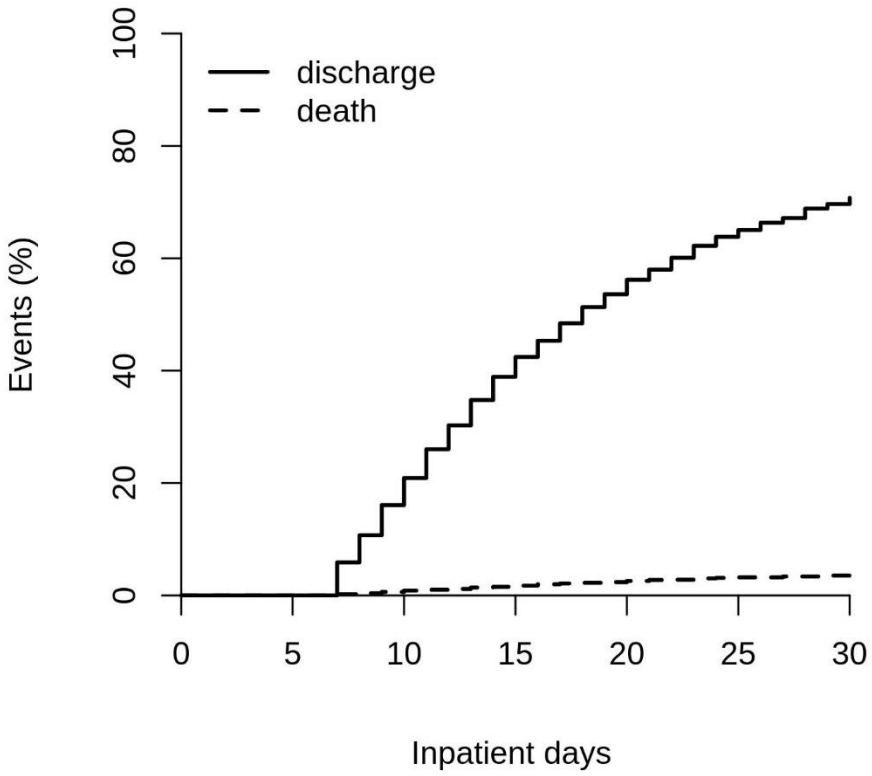


Table S1: Characteristics of patients surgically treated for non-pathological hip fracture following linkage of the Physiotherapy Hip Fracture Sprint Audit (PHFSA) to the National Hip Fracture Database, hospital episode statistics (HES) for England, and the patient episode database for Wales (PEDW), by presence of data in the PHFSA

		All	No Data available in PHFSA	Data available in PHFSA
		N=9,250	**N=3,855**	**N=5,395**
		median [IQR]	**median [IQR]**	**median [IQR]**
Age at admission (years)		84 [77-89]	84 [77-89]	84 [77-89]
Charlson Comorbidity Index		1 [1-1.53]	1 [0-2]	1 [1-2]
Length of stay		11[7-18]	11 [13-18]	11[7-18]
Sex	Female	2555 (27.62)	1103 (28.6)	1452 (26.9)
	Male	6695 (72.38)	2752 (71.4)	3943 (73.1)
Ethnicity*	White	6564 (70.96)	2825 (73.3)	3739 (69.3)
	Caribbean or African (Black or Black British) or any mixed black background	17 (0.18)	7 (0.2)	10 (0.2)
	Asian or Asian British or any mixed Asian background	76 (0.82)	38 (1.0)	38 (0.7)
	Any other Mixed background	3 (0.03)	3 (0.1)	0 (0.0)
	Missing	2590 (28.00)	982 (25.5)	1608 (29.8)
Prefracture ambulation*	Freely mobile without aids	3344 (36.15)	1412 (36.6)	1932 (35.8)
	Mobile outdoors with one aid	2085 (22.54)	876 (22.7)	1209 (22.4)
	Mobile outdoors with two aids or frame	1489 (16.10)	671 (17.4)	818 (15.2)
	Some indoor ambulation but never goes outside without help	2129 (23.02)	785 (20.4)	1344 (24.9)
	No functional ambulation	101 (1.09)	48 (1.2)	53 (1.0)
	Missing	102 (1.10)	63 (1.6)	39 (0.7)
Deprivation	most deprived	2198 (23.76)	964 (25.0)	1234 (22.9)
	more deprived	803 (8.68)	350 (9.1)	453 (8.4)
	average deprivation	1908 (20.63)	771 (20.0)	1137 (21.1)
	less deprived	1820 (19.68)	744 (19.3)	1076 (19.9)
	least deprived	1823 (19.71)	756 (19.6)	1067 (19.8)
	Missing	698 (7.55)	270 (7.0)	428 (7.9)
Hip fracture type*	Intracapsular	5401 (58.39)	2204 (57.2)	3197 (59.3)

		All	No Data available in PHFSA	Data available in PHFSA
		N=9,250	N=3,855	N=5,395
	Intertrochanteric	3272 (35.37)	1356 (35.2)	1916 (35.5)
	Subtrochanteric	547 (5.91)	266 (6.9)	281 (5.2)
	Missing	30 (0.32)	29 (0.8)	1 (0.0)
Surgery within the target time*	Within target time	6460 (69.84)	2621 (68.0)	3839 (71.2)
	Not within target time	2448 (26.46)	1066 (27.7)	1382 (25.6)
	Missing	342 (3.70)	168 (4.4)	174 (3.2)
Procedure type	Internal fixation	4454 (48.15)	1899 (49.3)	2555 (47.4)
	Hemiarthroplasty	4066 (43.96)	1655 (42.9)	2411 (44.7)
	Total Hip replacement	704 (7.61)	287 (7.4)	417 (7.7)
	Missing/Other	26 (0.28)	14 (0.4)	12 (0.2)
Weekday of admission	Weekday (Monday-Friday)	6304 (68.15)	2655 (68.9)	3649 (67.6)
	Weekend (Saturday-Sunday)	2684 (29.02)	1094 (28.4)	1590 (29.5)
	Missing	262 (2.83)	106 (2.7)	156 (2.9)
First mobilisation day of/day after surgery*	Within target time	7332 (79.26)	2982 (77.4)	4350 (80.6)
	After target time	1878 (20.30)	855 (22.2)	1023 (19.0)
	Missing	40 (0.43)	18 (0.5)	22 (0.4)
ASA grade	I	194 (2.10)	71 (1.8)	123 (2.3)
	II	2259 (24.42)	936 (24.3)	1323 (24.5)
	III	5260 (56.86)	2198 (57.0)	3062 (56.8)
	IV	1361 (14.71)	590 (15.3)	771 (14.3)
	V	26 (0.28)	9 (0.2)	17 (0.3)
	Missing	150 (1.62)	51 (1.3)	99 (1.8)
Prefracture residence*	Own home/sheltered housing	7542 (81.54)	3137 (81.4)	4405 (81.6)
	Nursing care/residential care	1694 (18.31)	707 (18.3)	987 (18.3)
	Missing	14 (0.15)	11 (0.3)	3 (0.1)
Anaesthesia type*	General (GA)	5044 (54.53)	2146 (55.7)	2898 (53.7)
	Spinal (SA)	4145 (44.81)	1692 (43.9)	2453 (45.5)
	Missing	61 (0.66)	17 (0.4)	44 (0.8)
Physiotherapy staffing levels*	Monday to Friday	156 (1.69)	46 (1.2)	110 (2.0)
	Monday to Saturday	49 (0.53)	3 (0.1)	46 (0.9)
	Monday to Sunday (Saturday and Sunday half day)	1138 (12.30)	190 (4.9)	948 (17.6)
	Monday to Sunday	55 (0.59)	7 (0.2)	48 (0.9)

		All	No Data available in PHFSA	Data available in PHFSA
.		**N=9,250**	**N=3,855**	**N=5,395**
	(Saturday full day and Sunday half day)			
	Monday to Sunday (Saturday and Sunday full days)	2589 (27.99)	497 (12.9)	2092 (38.8)
	Missing	5263 (56.90)	3112 (80.7)	2151 (39.9)
Hospital Frailty Index	Low risk	2028 (21.92)	846 (21.9)	1182 (21.9)
	Intermediate risk	3245 (35.08)	1365 (35.4)	1880 (34.8)
	High risk	3371 (36.44)	1416 (36.7)	1955 (36.2)
	Missing	606 (6.55)	228 (5.9)	378 (7.0)
Extended physiotherapy hours*	Monday to Friday (0800-1600/1700)	3819 (41.29)	734 (19.0)	3085 (57.2)
	Monday to Friday (extended hours)	168 (1.82)	9 (0.2)	159 (2.9)
	Missing	5263 (56.90)	3112 (80.7)	2151 (39.9)

IQR = interquartile range

*p<0.05

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Table S2. Characteristics of patients surgically treated for non-pathological hip fracture overall and by duration of physiotherapy in the first postoperative week*

		All	≥2 hours physiotherapy in first postoperative	<2 hours physiotherapy in first postoperative
		N=4,950)	N=2,647	N=2,303)
		median [IQR]	median [IQR]	median [IQR]
Age at admission (years)*		84 [77- 89]	84 [77-90]	84 [78-88.5]
Charlson Comorbidity Index*		1 [1-2]	1 [0-2]	1 [1-2]
Length of stay*		11 [7-18]	11 [6-18]	11 [8-17]
Sex	Female	1335 (26.97)	708 (26.7)	627 (27.2)
	Male	3615 (73.03)	1939 (73.3)	1676 (72.8)
Ethnicity	White	3439 (69.47)	1851 (69.9)	1588 (69.0)
	Caribbean or African (Black or Black British) or any mixed black background	10 (0.20)	7 (0.3)	3 (0.1)
	Asian or Asian British or any mixed Asian background	35 (0.71)	14 (0.5)	21 (0.9)
	Missing	1466 (29.62)	775 (29.3)	691 (30.0)
Deprivation*	most deprived	1151 (23.25)	653 (24.7)	498 (21.6)
	more deprived	416 (8.40)	238 (9.0)	178 (7.7)
	average deprivation	1037 (20.95)	553 (20.9)	484 (21.0)
	less deprived	981 (19.82)	508 (19.2)	473 (20.5)
	least deprived	982 (19.84)	495 (18.7)	487 (21.1)
	Missing	383 (7.74)	200 (7.6)	183 (7.9)
ASA grade*	I	110 (2.22)	58 (2.2)	52 (2.3)
	II	1208 (24.40)	575 (21.7)	633 (27.5)
	III	2824 (57.05)	1534 (58.0)	1290 (56.0)
	IV	711 (14.36)	426 (16.1)	285 (12.4)
	V	14 (0.28)	8 (0.3)	6 (0.3)
	Missing	83 (1.68)	46 (1.7)	37 (1.6)
Hospital Frailty Index*	Low risk	1073 (21.68)	580 (21.9)	493 (21.4)
	Intermediate risk	1724 (34.83)	858 (32.4)	866 (37.6)
	High risk	1813 (36.63)	1034 (39.1)	779 (33.8)
	Missing	340 (6.87)	175 (6.6)	165 (7.2)
Prefracture ambulation*	Freely mobile without aids	1780 (35.96)	888 (33.5)	892 (38.7)
	Mobile outdoors with one aid	1104 (22.30)	523 (19.8)	581 (25.2)
	Mobile outdoors with two aids	750 (15.15)	417 (15.8)	333 (14.5)

		All	≥2 hours physiotherapy in first postoperative	<2 hours physiotherapy in first postoperative
		N=4,950)	N=2,647	N=2,303)
	or frame			
	Some indoor ambulation but never goes outside without help	1234 (24.93)	758 (28.6)	476 (20.7)
	No functional ambulation	48 (0.97)	38 (1.4)	10 (0.4)
	Missing	34 (0.69)	23 (0.9)	11 (0.5)
Prefracture residence*	Own home/sheltered housing	4026 (81.33)	2023 (76.4)	2003 (87.0)
	Nursing care/residential care	921 (18.61)	621 (23.5)	300 (13.0)
	Missing	3 (0.06)	3 (0.1)	0 (0.0)
Hip fracture type	Intracapsular	2931 (59.21)	1525 (57.6)	1406 (61.1)
	Intertrochanteric	1765 (35.66)	981 (37.1)	784 (34.0)
	Subtrochanteric	253 (5.11)	141 (5.3)	112 (4.9)
	Missing	1 (0.02)	0 (0.0)	1 (0.0)
Anaesthesia type	General (GA)	2646 (53.45)	1419 (53.6)	1227 (53.3)
	Spinal (SA)	2268 (45.82)	1209 (45.7)	1059 (46.0)
	Missing	36 (0.73)	19 (0.7)	17 (0.7)
Surgery within the target time*	Within target time t	3548 (71.68)	1870 (70.6)	1678 (72.9)
	Not within target time	1254 (25.33)	716 (27.0)	538 (23.4)
	Missing	148 (2.99)	61 (2.3)	87 (3.8)
Procedure type*	Internal fixation	2352 (47.52)	1310 (49.5)	1042 (45.2)
	Hemiarthroplasty	2205 (44.55)	1159 (43.8)	1046 (45.4)
	Total Hip replacement	384 (7.76)	172 (6.5)	212 (9.2)
	Missing/Other	9 (0.18)	6 (0.2)	3 (0.1)
Weekday of admission	Weekday (Monday-Friday)	3437 (69.43)	1827 (69.0)	1610 (69.9)
	Weekend (Saturday-Sunday)	1507 (30.44)	818 (30.9)	689 (29.9)
	Missing	6 (0.12)	2 (0.1)	4 (0.2)
First mobilisation day of/day after surgery*	Within target time	3994 (80.69)	2035 (76.9)	1959 (85.1)
	After target time	940 (18.99)	600 (22.7)	340 (14.8)
	Missing	16 (0.32)	12 (0.5)	4 (0.2)
Physiotherapy staffing levels*	Monday to Friday	97 (1.96)	59 (2.2)	38 (1.7)
	Monday to Saturday	46 (0.93)	12 (0.5)	34 (1.5)
	Monday to Sunday (Saturday and Sunday half day)	821 (16.59)	460 (17.4)	361 (15.7)
	Monday to Sunday (Saturday full day and Sunday half day)	46 (0.93)	43 (1.6)	3 (0.1)

		All	≥2 hours physiotherapy in first postoperative	<2 hours physiotherapy in first postoperative
		N=4,950)	N=2,647	N=2,303)
	Monday to Sunday (Saturday and Sunday full days)	1925 (38.89)	1028 (38.8)	897 (38.9)
	Missing	2015 (40.71)	1045 (39.5)	970 (42.1)
Extended physiotherapy hours *	Monday to Friday (0800-1600/1700)	2800 (56.57)	1549 (58.5)	1251 (54.3)
	Monday to Friday (extended hours)	135 (2.73)	53 (2.0)	82 (3.6)
	Missing	2015 (40.71)	1045 (39.5)	970 (42.1)
Outcome event type*	Stay longer than 30 days	455 (9.19)	270 (10.2)	185 (8.0)
	right-censored	2314 (46.75)	1299 (49.1)	1015 (44.1)
	Live discharge	2074 (41.90)	1005 (38.0)	1069 (46.4)
	in-hospital death	107 (2.16)	73 (2.8)	34 (1.5)

IQR = interquartile range

*p<0.05

Table S3. Characteristics of patients surgically treated for non-pathological hip fracture overall and by type of physiotherapy in the first postoperative week

		All	mobilisation only	mobilisation & exercises
		N=5,109	**N=637**	**N=4,472**
		median [IQR]	**median [IQR]**	**median [IQR]**
Age at admission (years)*		84 [78-89]	85 [79-89]	84 [77-89]
Charlson Comorbidity Index*		1 [1-2]	1 [1-2]	1 [0-2]
Length of stay*		11 [7-18]	12 [8-20]	11 [7-17]
Sex	Female	1371 (26.83)	178 (27.9)	1193 (26.7)
	Male	3738 (73.17)	459 (72.1)	3279 (73.3)
Ethnicity	White	3542 (69.33)	419 (65.8)	3123 (69.8)
	Caribbean or African (Black or Black British) or any mixed black background	10 (0.20)	3 (0.5)	7 (0.2)
	Asian or Asian British or any mixed Asian background	37 (0.72)	4 (0.6)	33 (0.7)
	Missing	1520 (29.75)	211 (33.1)	1309 (29.3)
Deprivation	most deprived	1167 (22.84)	156 (24.5)	1011 (22.6)
	more deprived	429 (8.40)	52 (8.2)	377 (8.4)
	average deprivation	1077 (21.08)	141 (22.1)	936 (20.9)
	less deprived	1018 (19.93)	119 (18.7)	899 (20.1)
	least deprived	1018 (19.93)	108 (17.0)	910 (20.3)
	Missing	400 (7.83)	61 (9.6)	339 (7.6)
ASA grade*	I	114 (2.23)	10 (1.6)	104 (2.3)
	II	1250 (24.47)	115 (18.1)	1135 (25.4)
	III	2911 (56.98)	389 (61.1)	2522 (56.4)
	IV	726 (14.21)	110 (17.3)	616 (13.8)
	V	16 (0.31)	2 (0.3)	14 (0.3)
	Missing	92 (1.80)	11 (1.7)	81 (1.8)
Hospital Frailty Index*	Low risk	1118 (21.88)	105 (16.5)	1013 (22.7)
	Intermediate risk	1786 (34.96)	198 (31.1)	1588 (35.5)
	High risk	1850 (36.21)	276 (43.3)	1574 (35.2)
	Missing	355 (6.95)	58 (9.1)	297 (6.6)
Prefracture ambulation*	Freely mobile without aids	1843 (36.07)	161 (25.3)	1682 (37.6)
	Mobile outdoors with one aid	1150 (22.51)	108 (17.0)	1042 (23.3)
	Mobile outdoors with two aids or frame	768 (15.03)	109 (17.1)	659 (14.7)
	Some indoor ambulation but never goes outside without help	1269 (24.84)	233 (36.6)	1036 (23.2)
	No functional ambulation	44 (0.86)	16 (2.5)	28 (0.6)

		All	mobilisation only	mobilisation & exercises
		N=5,109	N=637	N=4,472
		median [IQR]	median [IQR]	median [IQR]
	Missing	35 (0.69)	10 (1.6)	25 (0.6)
Prefracture residence*	Own home/sheltered housing	4175 (81.72)	393 (61.7)	3782 (84.6)
	Nursing care/residential care	931 (18.22)	244 (38.3)	687 (15.4)
	Missing	3 (0.06)	0 (0.0)	3 (0.1)
Hip fracture type	Intracapsular	3034 (59.39)	386 (60.6)	2648 (59.2)
	Intertrochanteric	1813 (35.49)	225 (35.3)	1588 (35.5)
	Subtrochanteric	261 (5.11)	26 (4.1)	235 (5.3)
	Missing	1 (0.02)	0 (0.0)	1 (0.0)
Anaesthesia type*	General (GA)	2736 (53.55)	372 (58.4)	2364 (52.9)
	Spinal (SA)	2334 (45.68)	263 (41.3)	2071 (46.3)
	Missing	39 (0.76)	2 (0.3)	37 (0.8)
Surgery within the target time	Within target time	3668 (71.79)	451 (70.8)	3217 (71.9)
	Not within target time	1282 (25.09)	170 (26.7)	1112 (24.9)
	Missing	159 (3.11)	16 (2.5)	143 (3.2)
Procedure type*	Internal fixation	2411 (47.19)	297 (46.6)	2114 (47.3)
	Hemiarthroplasty	2288 (44.78)	323 (50.7)	1965 (43.9)
	Total Hip replacement	398 (7.79)	13 (2.0)	385 (8.6)
	Missing/Other	12 (0.23)	4 (0.6)	8 (0.2)
Weekday of admission	Weekday (Monday-Friday)	3548 (69.45)	422 (66.2)	3126 (69.9)
	Weekend (Saturday-Sunday)	1555 (30.44)	215 (33.8)	1340 (30.0)
	Missing	6 (0.12)	0 (0.0)	6 (0.1)
First mobilisation day of/day after surgery*	Within target time	4156 (81.35)	481 (75.5)	3675 (82.2)
	After target time	937 (18.34)	150 (23.5)	787 (17.6)
	Missing	16 (0.31)	6 (0.9)	10 (0.2)
Physiotherapy staffing levels*	Monday to Friday	105 (2.06)	6 (0.9)	99 (2.2)
	Monday to Saturday	44 (0.86)	4 (0.6)	40 (0.9)
	Monday to Sunday (Saturday and Sunday half day)	863 (16.89)	156 (24.5)	707 (15.8)
	Monday to Sunday (Saturday full day and Sunday half day)	47 (0.92)	10 (1.6)	37 (0.8)
	Monday to Sunday (Saturday and Sunday full days)	1988 (38.91)	197 (30.9)	1791 (40.0)
	Missing	2062 (40.36)	264 (41.4)	1798 (40.2)
Extended physiotherapy hours	Monday to Friday (0800-1600/1700)	2911 (56.98)	361 (56.7)	2550 (57.0)
	Monday to Friday (extended hours)	136 (2.66)	12 (1.9)	124 (2.8)
	Missing	2062 (40.36)	264 (41.4)	1798 (40.2)

Table S4: Differences between patients with and patients without complete data for physiotherapy frequency and discharge

		All	Complete	Incomplete
		N=5395	N=5177	N=218
		median [IQR]	median [IQR]	median [IQR]
Age at admission (years)		84 [77-89]	84 [78-89]	83 [76-89]
Charlson Comorbidity Index		1 [1-2]	1 [1-2]	1 [1-2]
Length of stay		11 [7-18]	12 [7-19]	11 [7-18]
Sex	Female	1452 (26.91)	1395 (26.9)	57 (26.1)
	Male	3943 (73.09)	3782 (73.1)	161 (73.9)
Ethnicity	White	3739 (69.30)	3588 (69.3)	151 (69.3)
	Caribbean or African (Black or Black British) or any mixed black background	10 (0.19)	10 (0.2)	0 (0.0)
	Asian or Asian British or any mixed Asian background	38 (0.70)	37 (0.7)	1 (0.5)
	Missing	1608 (29.81)	1542 (29.8)	66 (30.3)
Prefracture ambulation	Freely mobile without aids	1932 (35.81)	1860 (35.9)	72 (33.0)
	Mobile outdoors with one aid	1209 (22.41)	1154 (22.3)	55 (25.2)
	Mobile outdoors with two aids or frame	818 (15.16)	784 (15.1)	34 (15.6)
	Some indoor ambulation but never goes outside without help	1344 (24.91)	1294 (25.0)	50 (22.9)
	No functional ambulation	53 (0.98)	50 (1.0)	3 (1.4)
	Missing	39 (0.72)	35 (0.7)	4 (1.8)
Deprivation	most deprived	1234 (22.87)	1187 (22.9)	47 (21.6)
	more deprived	453 (8.40)	436 (8.4)	17 (7.8)
	average deprivation	1137 (21.08)	1087 (21.0)	50 (22.9)
	less deprived	1076 (19.94)	1030 (19.9)	46 (21.1)
	least deprived	1067 (19.78)	1026 (19.8)	41 (18.8)
	Missing	428 (7.93)	411 (7.9)	17 (7.8)
Hip fracture type	Intracapsular	3197 (59.26)	3065 (59.2)	132 (60.6)
	Intertrochanteric	1916 (35.51)	1842 (35.6)	74 (33.9)
	Subtrochanteric	281 (5.21)	269 (5.2)	12 (5.5)
	Missing	1 (0.02)	1 (0.0)	0 (0.0)
Surgery within the target time*	Within target time	3839 (71.16)	3710 (71.7)	129 (59.2)
	Not within target time	1382 (25.62)	1307 (25.2)	75 (34.4)
	Missing	174 (3.23)	160 (3.1)	14 (6.4)
Procedure type	Internal fixation	2555 (47.36)	2451 (47.3)	104 (47.7)
	Hemiarthroplasty	2411 (44.69)	2312 (44.7)	99 (45.4)
	Total Hip replacement	417 (7.73)	402 (7.8)	15 (6.9)

		All	Complete	Incomplete
		N=5395	N=5177	N=218
	Missing/Other	12 (0.22)	12 (0.2)	0 (0.0)
Weekday of admission*	Weekday (Monday-Friday)	3649 (67.64)	3600 (69.5)	49 (22.5)
	Weekend (Saturday-Sunday)	1590 (29.47)	1571 (30.3)	19 (8.7)
	Missing	156 (2.89)	6 (0.1)	150 (68.8)
First mobilisation day of/day after surgery*	Within target time	4350 (80.63)	4180 (80.7)	170 (78.0)
	After target time	1023 (18.96)	981 (18.9)	42 (19.3)
	Missing	22 (0.41)	16 (0.3)	6 (2.8)
ASA grade*	I	123 (2.28)	114 (2.2)	9 (4.1)
	II	1323 (24.52)	1256 (24.3)	67 (30.7)
	III	3062 (56.76)	2950 (57.0)	112 (51.4)
	IV	771 (14.29)	749 (14.5)	22 (10.1)
	V	17 (0.32)	16 (0.3)	1 (0.5)
	Missing	99 (1.84)	92 (1.8)	7 (3.2)
Prefracture residence*	Own home/sheltered housing	4405 (81.65)	4212 (81.4)	193 (88.5)
	Nursing care/residential care	987 (18.29)	962 (18.6)	25 (11.5)
	Missing	3 (0.06)	3 (0.1)	0 (0.0)
Duration	>=2hr	2766 (51.27)	2647 (51.1)	119 (54.6)
	<2hr	2391 (44.32)	2303 (44.5)	88 (40.4)
	Missing	238 (4.41)	227 (4.4)	11 (5.0)
Days of physiotherapy in first postoperative week*	0-2 days	920 (17.05)	880 (17.0)	40 (18.3)
	3 days	1022 (18.94)	965 (18.6)	57 (26.1)
	4 days	1343 (24.89)	1288 (24.9)	55 (25.2)
	5 days	1058 (19.61)	1018 (19.7)	40 (18.3)
	6-7 days	1052 (19.50)	1026 (19.8)	26 (11.9)
Anaesthesia type*	General (GA)	2898 (53.72)	2776 (53.6)	122 (56.0)
	Spinal (SA)	2453 (45.47)	2362 (45.6)	91 (41.7)
	Missing	44 (0.82)	39 (0.8)	5 (2.3)
Type of physiotherapy	Mobilisation only	667 (12.36)	637 (12.3)	30 (13.8)
	Mobilisation & exercise	4656 (86.30)	4472 (86.4)	184 (84.4)
	Missing	72 (1.33)	68 (1.3)	4 (1.8)
Physiotherapy staffing levels*	Monday to Friday	110 (2.04)	105 (2.0)	5 (2.3)
	Monday to Saturday	46 (0.85)	46 (0.9)	0 (0.0)
	Monday to Sunday (Saturday and Sunday half day)	948 (17.57)	888 (17.2)	60 (27.5)
	Monday to Sunday (Saturday full day and Sunday half day)	48 (0.89)	47 (0.9)	1 (0.5)
	Monday to Sunday	2092 (38.78)	2006 (38.7)	86 (39.4)

		All	Complete	Incomplete
		N=5395	**N=5177**	**N=218**
	(Saturday and Sunday full days)			
	Missing	2151 (39.87)	2085 (40.3)	66 (30.3)
Hospital Frailty Index	Low risk	1182 (21.91)	1127 (21.8)	55 (25.2)
	Intermediate risk	1880 (34.85)	1800 (34.8)	80 (36.7)
	High risk	1955 (36.24)	1886 (36.4)	69 (31.7)
	Missing	378 (7.01)	364 (7.0)	14 (6.4)
Extended physiotherapy hours*	Monday to Friday (0800-1600/1700)	3085 (57.18)	2954 (57.1)	131 (60.1)
	Monday to Friday (extended hours)	159 (2.95)	138 (2.7)	21 (9.6)
	Missing	2151 (39.87)	2085 (40.3)	66 (30.3)

IQR = interquartile range

*p<0.05

Table S5: Differences between patients with and patients without complete data for physiotherapy duration and discharge

		All	Complete	Incomplete
		N=5,395	N=4,950	N=445
		median [IQR]	median [IQR]	median [IQR]
Age at admission (years)		84 [77-89]	84 [77-89]	84 [78-89]
Charlson Comorbidity Index		1 [1-2]	1 [0.5-2]	1 [1-2]
Length of stay		11 [7-18]	12 [8-18]	11 [7-18]
Sex	Female	1452 (26.91)	1335 (27.0)	117 (26.3)
	Male	3943 (73.09)	3615 (73.0)	328 (73.7)
Ethnicity	White	3739 (69.30)	3439 (69.5)	300 (67.4)
	Caribbean or African (Black or Black British) or any mixed black background	10 (0.19)	10 (0.2)	0 (0.0)
	Asian or Asian British or any mixed Asian background	38 (0.70)	35 (0.7)	3 (0.7)
	Missing	1608 (29.81)	1466 (29.6)	142 (31.9)
Prefracture ambulation	Freely mobile without aids	1932 (35.81)	1780 (36.0)	152 (34.2)
	Mobile outdoors with one aid	1209 (22.41)	1104 (22.3)	105 (23.6)
	Mobile outdoors with two aids or frame	818 (15.16)	750 (15.2)	68 (15.3)
	Some indoor ambulation but never goes outside without help	1344 (24.91)	1234 (24.9)	110 (24.7)
	No functional ambulation	53 (0.98)	48 (1.0)	5 (1.1)
	Missing	39 (0.72)	34 (0.7)	5 (1.1)
Deprivation	most deprived	1234 (22.87)	1151 (23.3)	83 (18.7)
	more deprived	453 (8.40)	416 (8.4)	37 (8.3)
	average deprivation	1137 (21.08)	1037 (20.9)	100 (22.5)
	less deprived	1076 (19.94)	981 (19.8)	95 (21.3)
	least deprived	1067 (19.78)	982 (19.8)	85 (19.1)
	Missing	428 (7.93)	383 (7.7)	45 (10.1)
Prefracture ambulation	Outdoor ambulation	3959 (73.38)	3634 (73.4)	325 (73.0)
	indoor ambulation	1344 (24.91)	1234 (24.9)	110 (24.7)
	No functional ambulation	53 (0.98)	48 (1.0)	5 (1.1)
	Missing	39 (0.72)	34 (0.7)	5 (1.1)
Hip fracture type	Intracapsular	3197 (59.26)	2931 (59.2)	266 (59.8)
	Intertrochanteric	1916 (35.51)	1765 (35.7)	151 (33.9)
	Subtrochanteric	281 (5.21)	253 (5.1)	28 (6.3)
	Missing	1 (0.02)	1 (0.0)	0 (0.0)

		All	Complete	Incomplete
		N=5,395	N=4,950	N=445
Surgery within the target time*	Within target time	3839 (71.16)	3548 (71.7)	291 (65.4)
	Not within target time	1382 (25.62)	1254 (25.3)	128 (28.8)
	Missing	174 (3.23)	148 (3.0)	26 (5.8)
Procedure type	Internal fixation	2555 (47.36)	2352 (47.5)	203 (45.6)
	Hemiarthroplasty	2411 (44.69)	2205 (44.5)	206 (46.3)
	Total Hip replacement	417 (7.73)	384 (7.8)	33 (7.4)
	Missing/Other	12 (0.22)	9 (0.2)	3 (0.7)
Weekday of admission*	Weekday (Monday-Friday)	3649 (67.64)	3437 (69.4)	212 (47.6)
	Weekend (Saturday-Sunday)	1590 (29.47)	1507 (30.4)	83 (18.7)
	Missing	156 (2.89)	6 (0.1)	150 (33.7)
First mobilisation day of/day after surgery*	Within target time	4350 (80.63)	3994 (80.7)	356 (80.0)
	After target time	1023 (18.96)	940 (19.0)	83 (18.7)
	Missing	22 (0.41)	16 (0.3)	6 (1.3)
ASA grade*	I	123 (2.28)	110 (2.2)	13 (2.9)
	II	1323 (24.52)	1208 (24.4)	115 (25.8)
	III	3062 (56.76)	2824 (57.1)	238 (53.5)
	IV	771 (14.29)	711 (14.4)	60 (13.5)
	V	17 (0.32)	14 (0.3)	3 (0.7)
	Missing	99 (1.84)	83 (1.7)	16 (3.6)
Prefracture residence	Own home/sheltered housing	4405 (81.65)	4026 (81.3)	379 (85.2)
	Nursing care/residential care	987 (18.29)	921 (18.6)	66 (14.8)
	Missing	3 (0.06)	3 (0.1)	0 (0.0)
Duration*	>=2hr	2766 (51.27)	2647 (53.5)	119 (26.7)
	<2hr	2391 (44.32)	2303 (46.5)	88 (19.8)
	Missing	238 (4.41)	0 (0.0)	238 (53.5)
Days of physiotherapy in first postoperative week*	0-2 days	920 (17.05)	864 (17.5)	56 (12.6)
	3 days	1022 (18.94)	923 (18.6)	99 (22.2)
	4 days	1343 (24.89)	1223 (24.7)	120 (27.0)
	5 days	1058 (19.61)	969 (19.6)	89 (20.0)
	6-7 days	1052 (19.50)	971 (19.6)	81 (18.2)
Anaesthesia type*	General (GA)	2898 (53.72)	2646 (53.5)	252 (56.6)
	Spinal (SA)	2453 (45.47)	2268 (45.8)	185 (41.6)
	Missing	44 (0.82)	36 (0.7)	8 (1.8)
Type of physiotherapy	Mobilisation only	667 (12.36)	602 (12.2)	65 (14.6)
	Mobilisation & exercise	4656 (86.30)	4280 (86.5)	376 (84.5)

		All	Complete	Incomplete
		N=5,395	**N=4,950**	**N=445**
	Missing	72 (1.33)	68 (1.4)	4 (0.9)
Physiotherapy staffing levels*	Monday to Friday	110 (2.04)	97 (2.0)	13 (2.9)
	Monday to Saturday	46 (0.85)	46 (0.9)	0 (0.0)
	Monday to Sunday (Saturday and Sunday half day)	948 (17.57)	821 (16.6)	127 (28.5)
	Monday to Sunday (Saturday full day and Sunday half day)	48 (0.89)	46 (0.9)	2 (0.4)
	Monday to Sunday (Saturday and Sunday full days)	2092 (38.78)	1925 (38.9)	167 (37.5)
	Missing	2151 (39.87)	2015 (40.7)	136 (30.6)
Hospital Frailty Index	Low risk	1182 (21.91)	1073 (21.7)	109 (24.5)
	Intermediate risk	1880 (34.85)	1724 (34.8)	156 (35.1)
	High risk	1955 (36.24)	1813 (36.6)	142 (31.9)
	Missing	378 (7.01)	340 (6.9)	38 (8.5)
Extended physiotherapy hours*	Monday to Friday (0800-1600/1700)	3085 (57.18)	2800 (56.6)	285 (64.0)
	Monday to Friday (extended hours)	159 (2.95)	135 (2.7)	24 (5.4)
	Missing	2151 (39.87)	2015 (40.7)	136 (30.6)

IQR = interquartile range

*p<0.05

Table S6: Differences between patients with and patients without complete data for physiotherapy type and discharge

		All	Complete	Incomplete
		N=5395	N=5109	N=286
		median [IQR]	median [IQR]	median [IQR]
Age at admission (years)		84 [77-89]	84 [77-89]	84 [78-89]
Charlson Comorbidity Index		1 [1-2]	1 [1-2]	1 [1-2]
Length of stay		11 [7-18]	12 [6-20]	11 [7-18]
Sex	Female	1452 (26.91)	1371 (26.8)	81 (28.3)
	Male	3943 (73.09)	3738 (73.2)	205 (71.7)
Ethnicity	White	3739 (69.30)	3542 (69.3)	197 (68.9)
	Caribbean or African (Black or Black British) or any mixed black background	10 (0.19)	10 (0.2)	0 (0.0)
	Asian or Asian British or any mixed Asian background	38 (0.70)	37 (0.7)	1 (0.3)
	Missing	1608 (29.81)	1520 (29.8)	88 (30.8)
Prefracture ambulation*	Freely mobile without aids	1932 (35.81)	1843 (36.1)	89 (31.1)
	Mobile outdoors with one aid	1209 (22.41)	1150 (22.5)	59 (20.6)
	Mobile outdoors with two aids or frame	818 (15.16)	768 (15.0)	50 (17.5)
	Some indoor ambulation but never goes outside without help	1344 (24.91)	1269 (24.8)	75 (26.2)
	No functional ambulation	53 (0.98)	44 (0.9)	9 (3.1)
	Missing	39 (0.72)	35 (0.7)	4 (1.4)
Deprivation	most deprived	1234 (22.87)	1167 (22.8)	67 (23.4)
	more deprived	453 (8.40)	429 (8.4)	24 (8.4)
	average deprivation	1137 (21.08)	1077 (21.1)	60 (21.0)
	less deprived	1076 (19.94)	1018 (19.9)	58 (20.3)
	least deprived	1067 (19.78)	1018 (19.9)	49 (17.1)
	Missing	428 (7.93)	400 (7.8)	28 (9.8)
Prefracture ambulation*	Outdoor ambulation	3959 (73.38)	3761 (73.6)	198 (69.2)
	indoor ambulation	1344 (24.91)	1269 (24.8)	75 (26.2)
	No functional ambulation	53 (0.98)	44 (0.9)	9 (3.1)
	Missing	39 (0.72)	35 (0.7)	4 (1.4)
Hip fracture type	Intracapsular	3197 (59.26)	3034 (59.4)	163 (57.0)

		All	Complete	Incomplete
		N=5395	N=5109	N=286
	Intertrochanteric	1916 (35.51)	1813 (35.5)	103 (36.0)
	Subtrochanteric	281 (5.21)	261 (5.1)	20 (7.0)
	Missing	1 (0.02)	1 (0.0)	0 (0.0)
Surgery within the target time*	Within target time	3839 (71.16)	3668 (71.8)	171 (59.8)
	Not within target time	1382 (25.62)	1282 (25.1)	100 (35.0)
	Missing	174 (3.23)	159 (3.1)	15 (5.2)
Procedure type	Internal fixation	2555 (47.36)	2411 (47.2)	144 (50.3)
	Hemiarthroplasty	2411 (44.69)	2288 (44.8)	123 (43.0)
	Total Hip replacement	417 (7.73)	398 (7.8)	19 (6.6)
	Missing/Other	12 (0.22)	12 (0.2)	0 (0.0)
Weekday of admission*	Weekday (Monday-Friday)	3649 (67.64)	3548 (69.4)	101 (35.3)
	Weekend (Saturday-Sunday)	1590 (29.47)	1555 (30.4)	35 (12.2)
	Missing	156 (2.89)	6 (0.1)	150 (52.4)
First mobilisation day of/day after surgery*	Within target time	4350 (80.63)	4156 (81.3)	194 (67.8)
	After target time	1023 (18.96)	937 (18.3)	86 (30.1)
	Missing	22 (0.41)	16 (0.3)	6 (2.1)
ASA grade	I	123 (2.28)	114 (2.2)	9 (3.1)
	II	1323 (24.52)	1250 (24.5)	73 (25.5)
	III	3062 (56.76)	2911 (57.0)	151 (52.8)
	IV	771 (14.29)	726 (14.2)	45 (15.7)
	V	17 (0.32)	16 (0.3)	1 (0.3)
	Missing	99 (1.84)	92 (1.8)	7 (2.4)
Prefracture residence	Own home/sheltered housing	4405 (81.65)	4175 (81.7)	230 (80.4)
	Nursing care/residential care	987 (18.29)	931 (18.2)	56 (19.6)
	Missing	3 (0.06)	3 (0.1)	0 (0.0)
Duration*	≥2hr	2766 (51.27)	2579 (50.5)	187 (65.4)
	<2hr	2391 (44.32)	2303 (45.1)	88 (30.8)
	Missing	238 (4.41)	227 (4.4)	11 (3.8)
Days of physiotherapy in first postoperative week*	0-2 days	920 (17.05)	812 (15.9)	108 (37.8)
	3 days	1022 (18.94)	965 (18.9)	57 (19.9)
	4 days	1343 (24.89)	1288 (25.2)	55 (19.2)
	5 days	1058 (19.61)	1018 (19.9)	40 (14.0)

		All	Complete	Incomplete
		N=5395	N=5109	N=286
	6-7 days	1052 (19.50)	1026 (20.1)	26 (9.1)
Anaesthesia type	General (GA)	2898 (53.72)	2736 (53.6)	162 (56.6)
	Spinal (SA)	2453 (45.47)	2334 (45.7)	119 (41.6)
	Missing	44 (0.82)	39 (0.8)	5 (1.7)
Physiotherapy staffing levels*	Monday to Friday	110 (2.04)	105 (2.1)	5 (1.7)
	Monday to Saturday	46 (0.85)	44 (0.9)	2 (0.7)
	Monday to Sunday (Saturday and Sunday half day)	948 (17.57)	863 (16.9)	85 (29.7)
	Monday to Sunday (Saturday full day and Sunday half day)	48 (0.89)	47 (0.9)	1 (0.3)
	Monday to Sunday (Saturday and Sunday full days)	2092 (38.78)	1988 (38.9)	104 (36.4)
	Missing	2151 (39.87)	2062 (40.4)	89 (31.1)
Hospital Frailty Index	Low risk	1182 (21.91)	1118 (21.9)	64 (22.4)
	Intermediate risk	1880 (34.85)	1786 (35.0)	94 (32.9)
	High risk	1955 (36.24)	1850 (36.2)	105 (36.7)
	Missing	378 (7.01)	355 (6.9)	23 (8.0)
Weighted Charlson comorbidity index	score: 0	1217 (22.56)	1158 (22.7)	59 (20.6)
	score: 1-2	2389 (44.28)	2265 (44.3)	124 (43.4)
	score: 3-4	1002 (18.57)	942 (18.4)	60 (21.0)
	>=5	409 (7.58)	389 (7.6)	20 (7.0)
	Missing	378 (7.01)	355 (6.9)	23 (8.0)
Extended physiotherapy hours*	Monday to Friday (0800-1600/1700)	3085 (57.18)	2911 (57.0)	174 (60.8)
	Monday to Friday (extended hours)	159 (2.95)	136 (2.7)	23 (8.0)
	Missing	2151 (39.87)	2062 (40.4)	89 (31.1)

IQR = interquartile range

*p<0.05

Table S7: Differences between patients with known and with missing values of physiotherapy duration among patients with known outcome.

		All	Missing physiotherapy duration	Not missing physiotherapy duration
		N=5,177	N=227	N=4,950
		median [IQR]	median [IQR]	median [IQR]
Age at admission (years)		84 [78-89]	85 [79-89]	84 [77-89]
Charlson Comorbidity Index		1 [1-2]	1 [1-2]	1 [1-2]
Length of stay		11 [7-18]	12 [8-18]	11 [7-18]
Sex	Female	1395 (26.95)	60 (26.4)	1335 (27.0)
	Male	3782 (73.05)	167 (73.6)	3615 (73.0)
Ethnicity	White	3588 (69.31)	149 (65.6)	3439 (69.5)
	Caribbean or African (Black or Black British) or any mixed black background	10 (0.19)	0 (0.0)	10 (0.2)
	Asian or Asian British or any mixed Asian background	37 (0.71)	2 (0.9)	35 (0.7)
	Missing	1542 (29.79)	76 (33.5)	1466 (29.6)
Prefracture ambulation	Freely mobile without aids	1860 (35.93)	80 (35.2)	1780 (36.0)
	Mobile outdoors with one aid	1154 (22.29)	50 (22.0)	1104 (22.3)
	Mobile outdoors with two aids or frame	784 (15.14)	34 (15.0)	750 (15.2)
	Some indoor ambulation but never goes outside without help	1294 (25.00)	60 (26.4)	1234 (24.9)
	No functional ambulation	50 (0.97)	2 (0.9)	48 (1.0)
	Missing	35 (0.68)	1 (0.4)	34 (0.7)
Deprivation*	most deprived	1187 (22.93)	36 (15.9)	1151 (23.3)
	more deprived	436 (8.42)	20 (8.8)	416 (8.4)
	average deprivation	1087 (21.00)	50 (22.0)	1037 (20.9)
	less deprived	1030 (19.90)	49 (21.6)	981 (19.8)
	least deprived	1026 (19.82)	44 (19.4)	982 (19.8)
	Missing	411 (7.94)	28 (12.3)	383 (7.7)
Hip fracture type	Intracapsular	3065 (59.20)	134 (59.0)	2931 (59.2)
	Intertrochanteric	1842 (35.58)	77 (33.9)	1765 (35.7)
	Subtrochanteric	269 (5.20)	16 (7.0)	253 (5.1)
	Missing	1 (0.02)	0 (0.0)	1 (0.0)
Surgery within the target time	Within target time	3710 (71.66)	162 (71.4)	3548 (71.7)
	Not within target time	1307 (25.25)	53 (23.3)	1254 (25.3)
	Missing	160 (3.09)	12 (5.3)	148 (3.0)
Procedure type*	Internal fixation	2451 (47.34)	99 (43.6)	2352 (47.5)
	Hemiarthroplasty	2312 (44.66)	107 (47.1)	2205 (44.5)
	Total Hip replacement	402 (7.77)	18 (7.9)	384 (7.8)

		All	Missing physiotherapy duration	Not missing physiotherapy duration
		N=5,177	N=227	N=4,950
	Missing/Other	12 (0.23)	3 (1.3)	9 (0.2)
Weekday of admission	Weekday (Monday-Friday)	3600 (69.54)	163 (71.8)	3437 (69.4)
	Weekend (Saturday-Sunday)	1571 (30.35)	64 (28.2)	1507 (30.4)
	Missing	6 (0.12)	0 (0.0)	6 (0.1)
First mobilisation day of/day after surgery	Within target time	4180 (80.74)	186 (81.9)	3994 (80.7)
	After target time	981 (18.95)	41 (18.1)	940 (19.0)
	Missing	16 (0.31)	0 (0.0)	16 (0.3)
ASA grade*	I	114 (2.20)	4 (1.8)	110 (2.2)
	II	1256 (24.26)	48 (21.1)	1208 (24.4)
	III	2950 (56.98)	126 (55.5)	2824 (57.1)
	IV	749 (14.47)	38 (16.7)	711 (14.4)
	V	16 (0.31)	2 (0.9)	14 (0.3)
	Missing	92 (1.78)	9 (4.0)	83 (1.7)
Prefracture residence	Own home/sheltered housing	4212 (81.36)	186 (81.9)	4026 (81.3)
	Nursing care/residential care	962 (18.58)	41 (18.1)	921 (18.6)
	Missing	3 (0.06)	0 (0.0)	3 (0.1)
Anaesthesia type	General (GA)	2776 (53.62)	130 (57.3)	2646 (53.5)
	Spinal (SA)	2362 (45.62)	94 (41.4)	2268 (45.8)
	Missing	39 (0.75)	3 (1.3)	36 (0.7)
Physiotherapy staffing levels	Monday to Friday	105 (2.03)	8 (3.5)	97 (2.0)
	Monday to Saturday	46 (0.89)	0 (0.0)	46 (0.9)
	Monday to Sunday (Saturday and Sunday half day)	888 (17.15)	67 (29.5)	821 (16.6)
	Monday to Sunday (Saturday full day and Sunday half day)	47 (0.91)	1 (0.4)	46 (0.9)
	Monday to Sunday (Saturday and Sunday full days)	2006 (38.75)	81 (35.7)	1925 (38.9)
	Missing	2085 (40.27)	70 (30.8)	2015 (40.7)
Hospital Frailty Index	Low risk	1127 (21.77)	54 (23.8)	1073 (21.7)
	Intermediate risk	1800 (34.77)	76 (33.5)	1724 (34.8)
	High risk	1886 (36.43)	73 (32.2)	1813 (36.6)
	Missing	364 (7.03)	24 (10.6)	340 (6.9)
Extended physiotherapy hours*	Monday to Friday (0800-1600/1700)	2954 (57.06)	154 (67.8)	2800 (56.6)
	Monday to Friday (extended hours)	138 (2.67)	3 (1.3)	135 (2.7)
	Missing	2085 (40.27)	70 (30.8)	2015 (40.7)

IQR = interquartile range

*p<0.05

Table S8: Cumulative incidence of live discharge by frequency, duration and type of physiotherapy among patients surgically treated for non-pathological hip fracture and who underwent surgery within and outside of the target time (36 hours) respectively, complete case analysis.

Exposure	Number of patients	Number of events	Number of deaths	Live discharge rate (95% CI)†	3 - day CIFs, % (95% CI)	p value ‡	Unadjusted OR of CIF (95% CI)*	Adjusted OR of CIF (95% CI)*
	Surgery within target							
0-2 Days	618	171	37	22.6 (19.4-26.2)	561 (503-620)			
3 Days	704	226	13	25.1 (22-28.6)	641 (587-696)			
4 Days	920	407	14	34 (30.9-37.5)	745 (704-787)			
5 Days	743	346	9	33.8 (30.4-37.6)	736 (691-782)			
6-7 Days	725	407	6	41.2 (37.4-45.4)	791 (750-832)	81.7 (<0.0001)		
one day increase	3710	1557	79				1.24 (1.18-1.30)	1.29 (1.21-1.38)
	Surgery not within target							
0-2 Days	240	65	13	21.6 (16.9-27.5)	531 (437-624)			
3 Days	236	90	7	28 (22.8-34.5)	651 (564-738)			
4 Days	329	144	6	31.4 (26.6-36.9)	694 (623-766)			
5 Days	238	117	3	35.3 (29.4-42.3)	735 (658-813)			
6-7 Days	264	133	2	37.2 (31.4-44.1)	735 (663-807)	22.1 (0.0002)		
one day increase	1307	549	31				1.24 (1.14-1.35)	1.18 (1.06-1.31)
	Surgery within target							
<2hr	1870	680	51	28.2 (26.1-30.4)	666 (635-698)		1.00	1.00
≥2hr	1678	795	24	35.7 (33.3-38.3)	753 (723-783)	27.2 (<0.001)	1.48 (1.28-1.71)	1.54 (1.27-1.86)
30 minutes increase	3548	1475	75				1.12 (1.08-1.17)	1.15 (1.09-1.21)
	Surgery not within target							
<2hr	716	298	21	31.7 (28.3-35.5)	688 (641-736)		1.00	
>=2hr	538	232	8	30.7 (27-34.9)	668 (612-724)	0.2 (0.69)	0.93 (0.72--1.21)	

Exposure	Number of patients	Number of events	Number of deaths	Live discharge rate (95% CI)†	3 - day CIFs, % (95% CI)	p value ‡	Unadjusted OR of CIF (95% CI)*	Adjusted OR of CIF (95% CI)*
30 minutes increase	1254	530	29				1.05 (0.99--1.12)	
	Surgery within timing							
mobilisation only	170	79	5	32.3 (25.9-40.3)	669 (579-759)		1.00	1.00
mobilisation & exercise	1112	465	24	31.2 (28.5-34.2)	688 (649-727)	0 (0.16)	1.16 (0.91-1.47)	
	Surgery not within timing							
mobilisation only	451	205	13	31.3 (27.3-35.9)	671 (615-727)		1.00	1.00
mobilisation & exercise	3217	1339	59	32.2 (30.5-34)	721 (698-743)	2 (1.00)	0.95 (0.64-1.42)	

Table S9. Cumulative incidence of discharge by frequency, duration, and type of physiotherapy-sensitivity analysis accounting for discharges that occurred within the first postoperative week among patients surgically treated for non-pathological hip fracture. Complete case analysis.

Exposure	Number of patients	Number of deaths*	Number of live discharges*†	Live discharge rate (95% CI)†‡	30-day CIF, % (95% CI) †	p value †§	Unadjusted OR of CIF (95% CI) †	Adjusted OR of CIF (95% CI) ‖†
Frequency of physiotherapy								
0 - 2 days	880	94	383	35.2 (31.8-38.9)	601 (560-642)			
3 days	965	29	487	38.9 (35.6-42.5)	703 (665-741)			
4 days	1288	24	744	43.6 (40.6-46.8)	768 (738-799)			
5 days	1018	13	576	41.2 (38.0-44.7)	763 (728-798)			
6 - 7 days	1026	9	618	44.4 (41.1-48.1)	792 (759-825)	1.5e-07		
1 day increase	5177	169	2808				1.15 (1.11-1.19)	1.08 (1.02-1.13)
Duration of physiotherapy								
≥2h	2647	126	1397	40.6 (38.5-42.8)	710 (688-732)		1.00	1.00
<2h	2303	35	1289	41.8 (39.6-44.1)	762 (738-785)	0.09	1.15 (1.03-1.28)	1.03 (0.88-1.19)
30-minute	4950	161	2686				1.06	1.03

Exposure	Number of patients	Number of deaths*	Number of live discharges*†	Live discharge rate (95% CI)†‡	30-day CIF, % (95% CI) †	p value †§	Unadjusted OR of CIF (95% CI) †	Adjusted OR of CIF (95% CI) ‖†
increase							(1.03-1.09)	(0.99-1.07)
Type of physiotherapy								
mobilisation only	637	27	351	38.1 (34.3-42.3)	692 (650-735)		1.00	1.00
mobilisation & exercises	4472	119	2433	41.8 (40.2-43.5)	747 (730-764)	0.02	1.18 (0.99-1.41)	

Abbreviations: CIF = cumulative incidence function, CI = confidence interval, OR = odds ratio.

*At 30 days from surgery

†Does not include patients with missing discharge and exposure for the analysis of duration (n =445), and type (n = 286) of physiotherapy.

‡Per 1000 patient–days.

§Gray's test for k samples. Pepe-Mori two–sample test.

‖Adjusted for age, sex, ethnicity, deprivation, ASA grade, Charlson Comorbidity Index, Hospital Frailty risk score, prefracture residence, fracture type, mobility prior to hip fracture, type of surgery, timing of surgery, anaesthetic type, timing of first mobilisation, day of admission. CIF regression at in-patient days 3, 5, 7, 9, 10, 12, 16, 18, 20, 24, and 30. Includes patients with complete data for exposure, outcome and adjustment variables for the analysis of frequency (n = 3382), duration (n = 3247) and type (n = 3337) of physiotherapy.

Table S10: Cumulative incidence of discharge by frequency, duration and type of physiotherapy among all patients surgically treated for non-pathological hip fracture, and among those who underwent surgery within and outside of the target time (36 hours) respectively, imputed analysis.

	Exposure	3 - day CIFs, % (95% CI)	Unadjusted OR of CIF (95% CI)*	Adjusted OR of CIF (95% CI)*
Overall	**0-2 Days**	549 (500-597)		
	3 Days	650 (605-696)		
	4 Days	734 (698-768)		
	5 Days	741 (702-780)		
	6-7 Days	781 (746-816)		
	one day increase	549 (500-597)	1.25 (1.2-1.3)	1.25 (1.2-1.31)
	<2hr	673 (648-698)	1.00	1.00
	≥2hr	737 (712-762)	1.35 (1.19-1.52)	1.31 (1.15-1.5)
	30-minute increase		1.11 (1.08-1.15)	1.11 (1.07-1.15)
	mobilisation only	661 (614-708)	1.00	1.00
	mobilisation & exercise	713 (694-732)	1.15 (0.94-1.41)	
Surgery within target				
	0-2 Days	557 (500-615)		
	3 Days	646 (592-700)		
	4 Days	747 (706-788)		
	5 Days	742 (697-786)		
	6-7 Days	796 (756-837)		
	one day increase		1.25(1.19-1.31)	1.25 (1.15-1.32)
Surgery not within target				
	0-2 Days	528 (434-621)		
	3 Days	658 (572-745)		
	4 Days	698 (627-770)		
	5 Days	737 (660-814)		
	6-7 Days	741 (669-812)		
	one day increase		1.25 (1.15-1.36)	1.25 (1.15-1.37)
Surgery within target				
	<2hr	667 (637-698)	1.00	1.00
	≥2hr	758 (729-786)	1.50 (1.30-1.72)	1.45 (1.24-1.7)
	30-minute increase		1.13 (1.09-1.17)	1.13 (1.08-1.18)
Surgery not within target				
	<2hr	687 (640-734)	1.00	1.00
	≥2hr	674 (619-728)	0.97 (0.76-1.26)	
	30-minute increase		1.06 (0.99-1.17)	
Surgery within target				
	mobilisation only	664 (608-719)	1.00	1.00
	mobilisation &	722 (700-744)	1.19 (0.94-1.51)	

	exercise			
Surgery not within target				
.	**mobilisation only**	688 (649-727)	1.00	1.00
	mobilisation & exercise	688 (649-727)	1.04 (0.7-1.54)	

SUPPLEMENTARY FILE 3: PLAN OF ANALYSIS

NAME OF THE STUDY

Discharge after Hip Fracture Surgery by Frequency, Duration, and Type Of Physiotherapy: Secondary Analysis of the English and Welsh Physiotherapy Hip Fracture Sprint Audit

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DATE LAST MODIFIED

12/02/2021 (KS); 16/02/2021 (KS); 24/02/2021 (AG); 01/03/2021 (KS); 02/03/21 (KS, SA, AG); 04/03/21 (AG); 05/03/21 (KS); 17/03/2021 (KS); 23/03/2021 (AG); 23/03/21 (KS); 07/04/21 (KS); 12/04/21 (AG)

BRIEF RATIONALE

Patients with hip fracture describe physiotherapy as key to their recovery. Yet, the optimal physiotherapy remains unclear. Concern about this uncertainty led the Chartered Society of Physiotherapy to commission the Physiotherapy Hip Fracture Sprint Audit (Hip Sprint) in 2017. The audit highlighted marked national variation in the duration, frequency, and type of rehabilitation after hip fracture. However, it remains unclear whether this variation is associated with outcomes.

STUDY OBJECTIVE

1. To estimate the probability of discharge by time after surgery by frequency of physiotherapy after adjustment for potential confounders and the competing risk of death

2. To estimate the probability of discharge by time after surgery by duration and type of physiotherapy after adjustment for potential confounders and the competing risk of death
3. To determine whether probabilities of discharge by time after surgery by frequency, duration and type of physiotherapy vary patients who underwent surgery within and beyond the target time

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STUDY COHORT

All patients 60 years of age or older who underwent hip fracture surgery in England or Wales during the Hip Sprint audit May-June 2017 (see Supplementary File 1 for dataset creation and data dictionary)

METHODOLOGY

1. Distribution of patient characteristics

1. For each variable level, frequency and percentage of patients overall and by presence in the Physiotherapy Hip Fracture Sprint Audit.
2. Chi-square test and Mann-Whitney U test to compare distributions across groups.

Patient characteristics will be presented by exposures: frequency of physiotherapy (0-2, 3, 4, 5, 6-7), duration (< 2hrs, ≥2hours), and type (mobilisation, mobilisation and exercise) in the first postoperative week

1. For each variable level, frequency and percentage of patients overall and by exposure.
2. Chi-square test, Mann-Whitney U test, and Kruskal-Wallis test to compare distributions across exposure groups.

2. Cumulative incidence of postoperative live discharge among all patients

1. Time to live discharge is measured as the number of inpatient days between the date of surgery for hip fracture and the date of live discharge, in hospital death, loss to follow up, or end of follow up, whichever is earliest. The surgery day is day 1:
    - live discharge
    - in hospital death:
    - loss to follow up:
    - end of follow up: after inpatient day 30
    - Incomplete physiotherapy in first postoperative week
2. Estimate the cumulative incidence (CIF) of postoperative live discharge as a function of inpatient days after surgery (the cumulative probability of postoperative live discharge within t inpatient days after surgery accounting for the event-specific hazard of death) (Figure S1). CIF is interpreted as percentage of patients with surgical treatment who were discharged alive by days after surgery for an observed death rate

- In-hospital death is a competing event for live discharge.
- Observations lost to follow up, stopped at the end of follow up, or with incomplete physiotherapy in the first postoperative week are treated as right censored

3. Cumulative incidence of postoperative live discharge among patients in receipt of 0-2 days, 3 days, 4 days, 5 days, 6-7 days physiotherapy in the first postoperative week.

1. For patients in receipt of physiotherapy for 0-2 days, 3 days, 4 days, 5 days, 6-7 days in the first postoperative week, estimate separately the CIF of postoperative live discharge as a function of inpatient days after surgery (Figure 1). Compare CIFs of postsurgical live discharge between patients in receipt of physiotherapy for 0-2 days, 3 days, 4 days, 5 days, 6-7 days comparing between incremental pairs using Gray's test.
2. Use proportional odds model to estimate the effect of a one day increase in physiotherapy on CIF of live discharge at day 7, 9, 10, 12, 14, 16, 18, 20, 24, 30 while accounting for potential confounders.

    - Estimate association between one day increase in physiotherapy and cumulative incidence of discharge (Table 2).
    - The following potential confounders factors will be considered: age, sex, ethnicity, deprivation, ASA grade, Charlson Comorbidity Index, Hospital Frailty risk score, prefracture residence, fracture type, mobility prior to hip fracture, type of surgery, timing of surgery, anaesthetic type, timing of first mobilisation, day of admission.

4. Cumulative incidence of postoperative live discharge among patients in receipt of <2hours physiotherapy vs. those in receipt of ≥2hours physiotherapy in the first postoperative week.

1. For patients in receipt of <2hours physiotherapy vs. those in receipt of ≥2hours physiotherapy, estimate separately the CIF of postoperative live discharge as a function of inpatient days after surgery (Figure 1). Compare CIFs of postsurgical live discharge between patients in receipt of <2hours physiotherapy vs. those in receipt of ≥2hours physiotherapy using Pepe-Mori 2-sample test.
2. Use proportional odds model to estimate the effect of ≥2hours physiotherapy on CIF of live discharge at day 7, 9, 10, 12, 14, 16, 18, 20, 24, 30 while accounting for potential confounders.

    - Estimate differences between patients in receipt of <2hours physiotherapy vs. those in receipt of ≥2hours physiotherapy (Table 2).
    - The following potential confounders factors will be considered: age, sex, ethnicity, deprivation, ASA grade, Charlson Comorbidity Index, Hospital Frailty

risk score, prefracture residence, fracture type, mobility prior to hip fracture, type of surgery, timing of surgery, anaesthetic type, timing of first mobilisation, day of admission.

5. **Cumulative incidence of postoperative live discharge for an increase in the duration of physiotherapy in the first postoperative week.**

1. Use proportional odds model to estimate the effect for every 30-minute increase in the duration of physiotherapy in the first postoperative week on CIF of live discharge at day 7, 9, 10, 12, 14, 16, 18, 20, 24, 30 while accounting for potential confounders.

    - The following potential confounders factors will be considered: age, sex, ethnicity, deprivation, ASA grade, Charlson Comorbidity Index, Hospital Frailty risk score, prefracture residence, fracture type, mobility prior to hip fracture, type of surgery, timing of surgery, anaesthetic type, timing of first mobilisation, day of admission.

6. **Cumulative incidence of postoperative live discharge among patients in receipt of <2hours physiotherapy vs. those in receipt of ≥2hours physiotherapy for each day increase in physiotherapy in the first postoperative week.**

1. Use proportional odds model to estimate the effect of ≥2hours physiotherapy for one day increase in the first week of physiotherapy on CIF of live discharge at day 7, 9, 10, 12, 14, 16, 18, 20, 24, 30 while accounting for potential confounders.

    - Estimate differences between patients in receipt of <2hours physiotherapy vs. those in receipt of ≥2hours physiotherapy for each day increase in physiotherapy.
    - The following potential confounders factors will be considered: age, sex, ethnicity, deprivation, ASA grade, Charlson Comorbidity Index, Hospital Frailty risk score, prefracture residence, fracture type, mobility prior to hip fracture, type of surgery, timing of surgery, anaesthetic type, timing of first mobilisation, day of admission.

7. **Cumulative incidence of postoperative live discharge among patients in receipt of mobilisation only vs. those in receipt of mobilisation and exercise in the first postoperative week.**

For this analysis we will exclude patients who were not mobilised nor received exercises in the first postoperative week.

1. For patients in receipt of in receipt of mobilisation only vs. those in receipt of mobilisation and exercise, estimate separately the CIF of postoperative live discharge as a function of inpatient days after surgery (Figure 1). Compare CIFs of postsurgical live discharge between patients in receipt of mobilisation only vs. those in receipt of mobilisation and exercise using Pepe-Mori 2-sample test.
2. Use proportional odds model to estimate the effect of mobilisation and exercise on CIF of live discharge at day 7, 9, 10, 12, 14, 16, 18, 20, 24, 30 while accounting for potential confounders.

    - Estimate differences between patients in receipt of in receipt of mobilisation only vs. those in receipt of mobilisation and exercise (Table 2).
    - The following potential confounders factors will be considered: age, sex, ethnicity, deprivation, ASA grade, Charlson Comorbidity Index, Hospital Frailty risk score, prefracture residence, fracture type, mobility prior to hip fracture, type of surgery, timing of surgery, anaesthetic type, timing of first mobilisation, day of admission.

8. Subgroup analyses

1. For 3-7 above by indicator of whether surgery was received within the target time (Sx_TIMING) (Figure 1).

9. Sensitivity analysis

1. We will explore the association between frequency (a 1-day increment), duration (30minute increment) and type (mobilisation only/mobilisation and exercise) of physiotherapy on discharge without left censoring of patients discharged in the first postoperative week.
2. We will adopt complete case analysis for the above analyses (1-7, 8.1). We will consider the influence of missing data in exposure, confounding, and outcome variables in a series of sensitivity analyses using multiple imputation by chained equations. We will check the missingness against length of stay (to see if violates missing at random assumption). We will replace the missing values with random samples of imputed values and estimate the 30-day risk differences and odds ratios in 25 distinct imputed datasets to reduce sampling variability while limiting the loss of power for assessing the exposure-discharge association to no more than 1%. We will combine results across imputed datasets and compare these to the estimates from complete case analysis (Supplementary File).

TABLES

Manuscript File

- Table 1. Characteristics of XX patients surgically treated for non-pathological first hip fracture overall and by frequency of physiotherapy in the first postoperative week

- Table 2. Cumulative incidence of live discharge by frequency, duration, and type of physiotherapy in the first postoperative week among all patients surgically treated for non-pathological first hip fracture, complete case analysis

Supplementary File

- Table S1: Characteristics of patients surgically treated for non-pathological first hip fracture by presence in the Physiotherapy Hip Fracture Sprint Audit (PHFSA)
- Table S2. Characteristics of patients surgically treated for non-pathological first hip fracture overall and by duration of physiotherapy in the first postoperative week*
- Table S3. Characteristics of patients surgically treated for non-pathological first hip fracture overall and by type of physiotherapy in the first postoperative week
- Table S4: Differences between patients with and patients without complete data for physiotherapy frequency and discharge
- Table S5: Differences between patients with and patients without complete data for physiotherapy duration and discharge
- Table S6: Differences between patients with and patients without complete data for physiotherapy type and discharge
- Table S7: Differences between patients with known and with missing values of physiotherapy duration among patients with known outcome.
- Table S8: Cumulative incidence of live discharge by frequency, duration and type of physiotherapy among patients surgically treated for non-pathological first hip fracture and who underwent surgery within target and outside of target respectively, complete case analysis.

FIGURES

Manuscript File

- Figure 1. Cumulative incidence of postoperative live discharge by days after surgery among patients surgically treated for non-pathological first hip fracture by frequency, duration, and type of physiotherapy, overall and by surgical timing.

  9-panel-figure:

	Overall	Surgery within target time	Surgery beyond target time
Frequency	panel (1)	panel (2)	panel (3)
Duration	panel (4)	panel (5)	panel (6)
Type	panel (7)	panel (8)	panel (9)

x-label for each panel: Inpatient days (1 to 30 range) y-label for each panel: Discharge (%)
legend for frequency: 0-2, 3, 4, 5, 6-7
legend for duration: < 2 hours, ≥ 2 hours
legend for type: mobilisation only, mobilisation & exercise

Supplementary File

- Figure S1. Cumulative incidence of postoperative live discharge and death by days after surgery among patients surgically treated for non-pathological first hip fracture.
    - x-label: Inpatient days (1 to 30 range)
    - y-label: Events (%)
    - legend: Death, Discharge

TEXT

Database

Overall, data were entered into the UK NHFD for XX patients aged 60 years and older, surgically treated for a non-pathological first hip fracture between May 1, 2017 and June 30, 2017. Of these, XX patients had corresponding data collected by physiotherapists within the PHFSA.

Patient characteristics

Exposure and outcome data were available for a total of XX patients. By day 30 after surgery, XX hospital stays (XX %) ended with discharge, XX stays (XX %) ended with death, XX (XX %) had left censoring events (discharged in first 7-days to home n = XX, to nursing home/residential care n = XX, died n = XX), XX (XX %) had right-censoring events (transfer to an acute hospital/unit), and XX stays (XX %) were longer than 30 days (Supplementary File 2, Figure S1). In the first postoperative week, XX patients (XX %) received physiotherapy on 6-7 days, XX (XX %) received physiotherapy for ≥2 hours and XX (XX %) received both mobilisation and exercise (Table 1, Supplementary File 2, Tables S2-S3).

The median age of patients was XX years (Inter-Quartile Range (IQR) XX- XX) with a median CCI score of XX (IQR XX - XX). The majority were women (XX %), white (XX %), admitted from home (XX %), and mobile outdoors prefracture (XX %). Over one-third were at high risk of frailty (XX %) and one-fifth from the most deprived quintile (XX %). Fracture type was most commonly intracapsular (XX %) with the remainder being extracapsular (trochanteric or subtrochanteric) fractures. Most patients were admitted on a weekday (XX %), underwent surgery with general anaesthesia (XX %) within the recommended target time (XX %), and mobilised on the day of or day after their surgery (XX %) (Table 1, Supplementary File 2, Tables S2-S3).

Frequency of physiotherapy

The average rate of discharge was XX (95% confidence intervals [CI] XX- XX) per 1,000 patient days, varying from XX (95% CI XX- XX) among those who received physiotherapy on 0-2 days in the first postoperative week to XX (95% CI XX- XX) among those who received physiotherapy on 6-7 days in the first postoperative week (Figure 1). By day 30, there were an additional XX (95% CI XX- XX) discharges per 1,000 patients who received physiotherapy on 6-7 days compared with 0-2 days in the first postoperative week. By day 30, there were an additional XX (95% CI XX - XX) discharges per 1,000 patients who received physiotherapy on 6-7 days compared with 5 days in the first postoperative week. For an additional day of physiotherapy in the first postoperative week, the crude and adjusted odds of discharge were XX (95% CI XX- XX) and XX (95% CI XX- XX) respectively (Table 2).

Duration of physiotherapy

In total, XX patients had complete data for physiotherapy duration. The average rate of discharge was XX (95% CI XX- XX) per 1,000 patient days, varying from XX (95% CI XX- XX) among

those who received < 2 hours of physiotherapy in the first postoperative week to XX (95% CI XX- XX) among those who received ≥2 hours of physiotherapy in the first postoperative week (Figure 1). By day 30, there were an additional XX (95% CI XX- XX) discharges per 1,000 patients who received ≥2 hours of physiotherapy compared with those who received < 2 hours of physiotherapy in the first postoperative week. The crude and adjusted odds ratios of discharge were XX (95% CI XX- XX) and XX (95% CI XX- XX) respectively among those who received ≥ 2 hours compared with those who received < 2 hours of physiotherapy in the first postoperative week (Table 2). For a 30-minutes increase in physiotherapy in the first postoperative week, the crude and adjusted odds of discharge were XX (95% CI XX- XX) and XX (95% CI XX- XX) respectively (Table 2).

Type of physiotherapy

In total, XX patients had complete data for physiotherapy type. The average rate of discharge was XX (95% CI XX- XX) per 1,000 patient days; being similar among those who received mobilisation alone XX (95% CI XX- XX) and those who received both mobilisation and exercise XX (95% CI XX- XX) (Figure 1, Table 2). For mobilisation and exercise compared with mobilisation alone in the first postoperative week, the crude and adjusted odds of discharge were XX (95% CI XX- XX) and XX (95% CI XX- XX) respectively (Table 2).

Analysis stratified by time to surgery

Similar rates of discharge by physiotherapy frequency, duration and type were observed amongst the subgroup of patients who underwent surgery within the target time of 36-hours from presentation as for the overall analysis (Figure 1, Supplementary File 2, Table S8). For an additional day of physiotherapy in the first postoperative week, the adjusted odds of discharge were XX (95% CI XX- XX) for those who underwent surgery within 36 hours and XX (95% CI

XX- XX) for those who underwent surgery later (Supplementary File 2 Table S8). Among those who received ≥2 hours versus <2 hours physiotherapy, the adjusted odds of discharge were XX (95% CI XX- XX) for those who underwent surgery within 36 hours and XX (95% CI XX- XX) for those who underwent surgery later (Supplementary File 2, Table S8). For a 30-minute increase in physiotherapy in the first postoperative week, the adjusted odds of discharge were XX (95% CI XX- XX) for those who underwent surgery within 36 hours and XX (95% CI XX- XX) for those who underwent surgery later (Supplementary File 2, Table S8). The adjusted odds of discharge were similar amongst those who received mobilisation and exercise compared with those who received mobilisation alone in the first postoperative week irrespective of time to surgery (Supplementary File 2, Table S8).

Limitations

The proportion of missing data for exposure variables was XX%, XX%, and XX% for frequency, duration, and type respectively

Table 1. Characteristics of patients surgically treated for non-pathological first hip fracture overall and by frequency of physiotherapy in the first postoperative week

			Days of physiotherapy in first postoperative week				
		All	0-2days	3 days	4 days	5 days	6-7 days
		n =	n =	n =	n =	n =	n =
		median [IQR]	median [IQR]	median [IQR]	median [IQR]	median [IQR]	median [IQR]
Age at admission (years) †							
Charlson Comorbidity Index†							
Length of stay							
Sex†	Male						
	Female						
Ethnicity	White						
	Caribbean or						

			Days of physiotherapy in first postoperative week				
		All	0-2days	3 days	4 days	5 days	6-7 days
		n =	n =	n =	n =	n =	n =
	African (Black or Black British) or any mixed black background						
	Asian or Asian British or any mixed Asian background						
Deprivation	most deprived						
	more deprived						
	average deprivation						
	less deprived						
	least deprived						
ASA grade†	I						
	II						
	III						
	IV						
	V						
Hospital Frailty Index†	Low risk						
	Intermediate risk						
	High risk						
Prefracture ambulation†	Freely mobile without aids						
	Mobile outdoors with one aid						
	Mobile outdoors with two aids or frame						
	Some indoor ambulation but never goes outside without help						
	No functional ambulation						
Hip fracture type	Intracapsular						
	Intertrochanteric						
	Subtrochanteric						
Surgery within the target time	Within target time						
	Not within target time						
Procedure type†	Internal fixation						
	Hemiarthroplasty						

			Days of physiotherapy in first postoperative week				
		All	**0-2days**	**3 days**	**4 days**	**5 days**	**6-7 days**
		n =	**n =**	**n =**	**n =**	**n =**	**n =**
	Total Hip replacement						
Weekday of admission†	Weekday (Monday-Friday)						
	Weekend (Saturday-Sunday)						
Mobilisation day of/day after surgery†	Within target time						
	After target time						
Prefracture residence†	Own home/sheltered housing						
	Nursing care/residential care						
Anaesthesia type	General (GA)						
	Spinal (SA)						
Duration of physiotherapy	>=2hr						
	<2hr						
Type of physiotherapy†	Mobilisation only						
	Mobilisation & exercise						

IQR = interquartile range
*p<0.05
†Does not include the following missing data: xx

Table 2. Cumulative incidence of live discharge by frequency, duration and type of physiotherapy among all patients surgically treated for non-pathological first hip fracture, complete case analysis.

Exposure	Number of patients	Number of deaths*	Number of live discharges*†	Live discharge rate (95% CI)†‡	30-day CIF, % (95% CI) †	p value †§	Unadjusted OR of CIF (95% CI) †	Adjusted OR of CIF (95% CI) ‖†
Frequency of physiotherapy								
0 - 2 days								
3 days								
4 days								
5 days								
6 - 7 days								
1 day increase								
Duration of physiotherapy								
≥2h								
<2h								
30-minute increase								
Type of physiotherapy								
mobilisation only								
mobilisation & exercises								

Abbreviations: CIF = cumulative incidence function, CI = confidence interval, OR = odds ratio.

*At 30 days from surgery

†Does not include patients with missing discharge and exposure for the analysis of frequency (n = XX), duration (n = XX), and type (n = XX) of physiotherapy.

‡Per 1000 patient–days.

§Gray's test for k samples. Pepe-Mori two–sample test.

‖Adjusted for age, sex, ethnicity, deprivation, ASA grade, Charlson Comorbidity Index, Hospital Frailty risk score, prefracture residence, fracture type, mobility prior to hip fracture, type of surgery, timing of surgery, anaesthetic type, timing of first mobilisation, day of admission. CIF regression at in-patient days 7,9, 10, 12, 16, 18, 20, 24, and 30. Includes patients with complete data for exposure, outcome and adjustment variables for the analysis of frequency (n = XX), duration (n = XX) and type (n = XX) of physiotherapy.

Table S1: Characteristics of patients surgically treated for non-pathological first hip fracture by presence in the Physiotherapy Hip Fracture Sprint Audit (PHFSA)

		All	No Data available in PHFSA	Data available in PHFSA	P
		n = XX	n = XX	n = XX	
		median [IQR]	median [IQR]	median [IQR]	
Age at admission (years) †					
Charlson Comorbidity Index†					
Length of stay					
Sex†	Male				
	Female				
Ethnicity	White				
	Caribbean or African (Black or Black British) or any mixed black background				
	Asian or Asian British or any mixed Asian background				
Deprivation	most deprived				
	more deprived				
	average deprivation				
	less deprived				
	least deprived				
ASA grade†	I				
	II				
	III				
	IV				
	V				
Hospital Frailty Index†	Low risk				
	Intermediate risk				
	High risk				
Prefracture ambulation†	Freely mobile without aids				
	Mobile outdoors with one aid				
	Mobile outdoors with two aids or frame				
	Some indoor ambulation but never goes outside without help				
	No functional ambulation				
Hip fracture type	Intracapsular				
	Intertrochanteric				

		All	No Data available in PHFSA	Data available in PHFSA	P
		n = XX	n = XX	n = XX	
	Subtrochanteric				
Surgery within the target time	Within target time				
	Not within target time				
Procedure type†	Internal fixation				
	Hemiarthroplasty				
	Total Hip replacement				
Weekday of admission†	Weekday (Monday-Friday)				
	Weekend (Saturday-Sunday)				
Mobilisation day of/day after surgery†	Within target time				
	After target time				
Prefracture residence†	Own home/sheltered housing				
	Nursing care/residential care				
Anaesthesia type	General (GA)				
	Spinal (SA)				
Frequency of physiotherapy	0-2				
	3				
	4				
	5				
	6-7				
Duration of physiotherapy	>=2hr				
	<2hr				
Type of physiotherapy†	Mobilisation only				
	Mobilisation & exercise				

Table S2. Characteristics of patients surgically treated for non-pathological first hip fracture overall and by duration of physiotherapy in the first postoperative week*

		All	≥2 hours physiotherapy in first postoperative	<2 hours physiotherapy in first postoperative	P
		n = XX	n = XX	n = XX	
		median [IQR]	median [IQR]	median [IQR]	
Age at admission (years) †					
Charlson Comorbidity Index†					
Length of stay					
Sex†	Male				
	Female				
Ethnicity	White				
	Caribbean or African (Black or Black British) or any mixed black background				
	Asian or Asian British or any mixed Asian background				
Deprivation	most deprived				
	more deprived				
	average deprivation				
	less deprived				
	least deprived				
ASA grade†	I				
	II				
	III				
	IV				
	V				
Hospital Frailty Index†	Low risk				
	Intermediate risk				
	High risk				
Prefracture ambulation†	Freely mobile without aids				
	Mobile outdoors with one aid				
	Mobile outdoors with two aids or frame				
	Some indoor ambulation but never goes outside without help				
	No functional ambulation				
Hip fracture type	Intracapsular				
	Intertrochanteric				

		All	≥2 hours physiotherapy in first postoperative	<2 hours physiotherapy in first postoperative	P
		n = XX	n = XX	n = XX	
	Subtrochanteric				
Surgery within the target time	Within target time				
	Not within target time				
Procedure type†	Internal fixation				
	Hemiarthroplasty				
	Total Hip replacement				
Weekday of admission†	Weekday (Monday-Friday)				
	Weekend (Saturday-Sunday)				
Mobilisation day of/day after surgery†	Within target time				
	After target time				
Prefracture residence†	Own home/sheltered housing				
	Nursing care/residential care				
Anaesthesia type	General (GA)				
	Spinal (SA)				
Frequency of physiotherapy	0-2				
	3				
	4				
	5				
	6-7				
Type of physiotherapy†	Mobilisation only				
	Mobilisation & exercise				

Table S3. Characteristics of patients surgically treated for non-pathological first hip fracture overall and by type of physiotherapy in the first postoperative week

		All	mobilisation only	mobilisation & exercises	P
		n = XX	n = XX	n = XX	
		median [IQR]	median [IQR]	median [IQR]	
Age at admission (years) †					
Charlson Comorbidity Index†					
Length of stay					
Sex†	Male				
	Female				
Ethnicity	White				
	Caribbean or African (Black or Black British) or any mixed black background				
	Asian or Asian British or any mixed Asian background				
Deprivation	most deprived				
	more deprived				
	average deprivation				
	less deprived				
	least deprived				
ASA grade†	I				
	II				
	III				
	IV				
	V				
Hospital Frailty Index†	Low risk				
	Intermediate risk				
	High risk				
Prefracture ambulation†	Freely mobile without aids				
	Mobile outdoors with one aid				
	Mobile outdoors with two aids or frame				
	Some indoor ambulation but never goes outside without help				
	No functional ambulation				
Hip fracture type	Intracapsular				
	Intertrochanteric				

		All	mobilisation only	mobilisation & exercises	P
		n = XX	n = XX	n = XX	
		median [IQR]	median [IQR]	median [IQR]	
	Subtrochanteric				
Surgery within the target time	Within target time				
	Not within target time				
Procedure type†	Internal fixation				
	Hemiarthroplasty				
	Total Hip replacement				
Weekday of admission†	Weekday (Monday-Friday)				
	Weekend (Saturday-Sunday)				
Mobilisation day of/day after surgery†	Within target time				
	After target time				
Prefracture residence†	Own home/sheltered housing				
	Nursing care/residential care				
Anaesthesia type	General (GA)				
	Spinal (SA)				
Frequency of physiotherapy	0-2				
	3				
	4				
	5				
	6-7				
Duration of physiotherapy	>=2hr				
	<2hr				

Table S4: Differences between patients with and patients without complete data for physiotherapy frequency and discharge

		All	Complete	Incomplete	P
		n = XX	n = XX	n = XX	
		median [IQR]	median [IQR]	median [IQR]	
Age at admission (years) †					
Charlson Comorbidity Index†					
Length of stay					
Sex†	Male				
	Female				
Ethnicity	White				
	Caribbean or African (Black or Black British) or any mixed black background				
	Asian or Asian British or any mixed Asian background				
Deprivation	most deprived				
	more deprived				
	average deprivation				
	less deprived				
	least deprived				
ASA grade†	I				
	II				
	III				
	IV				
	V				
Hospital Frailty Index†	Low risk				
	Intermediate risk				
	High risk				
Prefracture ambulation†	Freely mobile without aids				
	Mobile outdoors with one aid				
	Mobile outdoors with two aids or frame				
	Some indoor ambulation but never goes outside without help				
	No functional ambulation				
Hip fracture type	Intracapsular				
	Intertrochanteric				

		All	Complete	Incomplete	P
		n = XX	n = XX	n = XX	
	Subtrochanteric				
Surgery within the target time	Within target time				
	Not within target time				
Procedure type†	Internal fixation				
	Hemiarthroplasty				
	Total Hip replacement				
Weekday of admission†	Weekday (Monday-Friday)				
	Weekend (Saturday-Sunday)				
Mobilisation day of/day after surgery†	Within target time				
	After target time				
Prefracture residence†	Own home/sheltered housing				
	Nursing care/residential care				
Anaesthesia type	General (GA)				
	Spinal (SA)				
Duration of physiotherapy	>=2hr				
	<2hr				
Type of physiotherapy†	Mobilisation only				
	Mobilisation & exercise				

Table S5: Differences between patients with and patients without complete data for physiotherapy duration and discharge

		All	Complete	Incomplete	P
		n = XX	n = XX	n = XX	
		median [IQR]	median [IQR]	median [IQR]	
Age at admission (years) †					
Charlson Comorbidity Index†					
Length of stay					
Sex†	Male				
	Female				
Ethnicity	White				
	Caribbean or African (Black or Black British) or any mixed black background				
	Asian or Asian British or any mixed Asian background				
Deprivation	most deprived				
	more deprived				
	average deprivation				
	less deprived				
	least deprived				
ASA grade†	I				
	II				
	III				
	IV				
	V				
Hospital Frailty Index†	Low risk				
	Intermediate risk				
	High risk				
Prefracture ambulation†	Freely mobile without aids				
	Mobile outdoors with one aid				
	Mobile outdoors with two aids or frame				
	Some indoor ambulation but never goes outside without help				
	No functional ambulation				
Hip fracture type	Intracapsular				
	Intertrochanteric				
	Subtrochanteric				
Surgery within the	Within target time				

		All	Complete	Incomplete	P
		n = XX	n = XX	n = XX	
target time					
	Not within target time				
Procedure type†	Internal fixation				
	Hemiarthroplasty				
	Total Hip replacement				
Weekday of admission†	Weekday (Monday-Friday)				
	Weekend (Saturday-Sunday)				
Mobilisation day of/day after surgery†	Within target time				
	After target time				
Prefracture residence†	Own home/sheltered housing				
	Nursing care/residential care				
Anaesthesia type	General (GA)				
	Spinal (SA)				
Frequency of physiotherapy	0-2				
	3				
	4				
	5				
	6-7				
Type of physiotherapy†	Mobilisation only				
	Mobilisation & exercise				

Table S6: Differences between patients with and patients without complete data for physiotherapy type and discharge

		All	Complete	Incomplete	P
		n = XX	**n = XX**	**n = XX**	
		median [IQR]	**median [IQR]**	**median [IQR]**	
Age at admission (years) †					
Charlson Comorbidity Index†					
Length of stay					
Sex†	Male				
	Female				
Ethnicity	White				
	Caribbean or African (Black or Black British) or any mixed black background				
	Asian or Asian British or any mixed Asian background				
Deprivation	most deprived				
	more deprived				
	average deprivation				
	less deprived				
	least deprived				
ASA grade†	I				
	II				
	III				
	IV				
	V				
Hospital Frailty Index†	Low risk				
	Intermediate risk				
	High risk				
Prefracture ambulation†	Freely mobile without aids				
	Mobile outdoors with one aid				
	Mobile outdoors with two aids or frame				
	Some indoor ambulation but never goes outside without help				
	No functional				

		All	Complete	Incomplete	P
		n = XX	n = XX	n = XX	
	ambulation				
Hip fracture type	Intracapsular				
	Intertrochanteric				
	Subtrochanteric				
Surgery within the target time	Within target time				
	Not within target time				
Procedure type†	Internal fixation				
	Hemiarthroplasty				
	Total Hip replacement				
Weekday of admission†	Weekday (Monday-Friday)				
	Weekend (Saturday-Sunday)				
Mobilisation day of/day after surgery†	Within target time				
	After target time				
Prefracture residence†	Own home/sheltered housing				
	Nursing care/residential care				
Anaesthesia type	General (GA)				
	Spinal (SA)				
Frequency of physiotherapy	0-2				
	3				
	4				
	5				
	6-7				
Duration of physiotherapy	>=2hr				
	<2hr				

Table S7: Differences between patients with known and with missing values of physiotherapy duration among patients with known outcome.

		All	Missing physiotherapy duration	Not missing physiotherapy duration	P
		n = XX	n = XX	n = XX	
		median [IQR]	median [IQR]	median [IQR]	
Age at admission (years) †					
Charlson Comorbidity Index†					
Length of stay					
Sex†	Male				
	Female				
Ethnicity	White				
	Caribbean or African (Black or Black British) or any mixed black background				
	Asian or Asian British or any mixed Asian background				
Deprivation	most deprived				
	more deprived				
	average deprivation				
	less deprived				
	least deprived				
ASA grade†	I				
	II				
	III				
	IV				
	V				
Hospital Frailty Index†	Low risk				
	Intermediate risk				
	High risk				
Prefracture ambulation†	Freely mobile without aids				
	Mobile outdoors with one aid				
	Mobile outdoors with two aids or frame				
	Some indoor ambulation but never goes outside without help				
	No functional ambulation				
Hip fracture type	Intracapsular				
	Intertrochanteric				
	Subtrochanteric				
Surgery within the target	Within target time				

		All	Missing physiotherapy duration	Not missing physiotherapy duration	P
		n = XX	n = XX	n = XX	
time					
	Not within target time				
Procedure type†	Internal fixation				
	Hemiarthroplasty				
	Total Hip replacement				
Weekday of admission†	Weekday (Monday-Friday)				
	Weekend (Saturday-Sunday)				
Mobilisation day of/day after surgery†	Within target time				
	After target time				
Prefracture residence†	Own home/sheltered housing				
	Nursing care/residential care				
Anaesthesia type	General (GA)				
	Spinal (SA)				
Frequency of physiotherapy	0-2				
	3				
	4				
	5				
	6-7				
Type of physiotherapy†	Mobilisation only				
	Mobilisation & exercise				

Table S8: Cumulative incidence of live discharge by frequency, duration and type of physiotherapy among patients surgically treated for non-pathological first hip fracture and who underwent surgery within target and outside of target respectively, complete case analysis.

Exposure	Number of patients	Number of events	Number of deaths	Live discharge rate (95% CI)†	3 - day CIFs, % (95% CI)	p value ‡	Unadjusted OR of CIF (95% CI)*	Adjusted OR of CIF (95% CI)*
	Surgery within target							
0-2 Days								
3 Days								
4 Days								
5 Days								
6-7 Days								
one day increase								
	Surgery not within target							
0-2 Days								
3 Days								
4 Days								
5 Days								
6-7 Days								
one day increase								
	Surgery within target							
<2hr								
≥2hr								
30 minutes increase								
	Surgery not within target							
<2hr								
>=2hr								
30 minutes increase								
	Surgery not within timing							
mobilisation only								
mobilisation & exercise								
	Surgery not within timing							
mobilisation only								
mobilisation & exercise								