

Aims

This study sought to determine the proportion of older adults with hip fractures captured by a multi-centre prospective cohort (WHiTE), whether there was evidence of selection bias during WHiTE recruitment, and the extent to which the WHiTE cohort is representative of the broader population of older adults with hip fractures.

Methods

The characteristics of patients recruited into the WHiTE cohort study were compared with those treated at WHiTE hospitals during the same timeframe and submitted to the National Hip Fracture Database (NHFD).

Results

Patients recruited to WHiTE were more likely to be admitted from their own home (83.5% versus 80.1%, $p < 0.001$) and to have a higher median Abbreviated Mental Test Score (AMTS) (9 (interquartile range (IQR) 6-10) versus 9 (IQR 5-10), $p < 0.001$) than those that were not recruited. In terms of WHiTE cohort generalisability, participating hospitals included a greater proportion of Major Trauma Centres (47.8% versus 7.8%) and large hospitals (997 (IQR 873-1290) versus 707 (459-903) beds) with high-volume Emergency Departments (median annual attendances of 37,242 (IQR 28,784-50,823) versus 35,964 (IQR 26,229-50,551)). However, there were few differences in baseline characteristics between patients in the WHiTE cohort and those recorded in the NHFD.

Conclusion

There is evidence of a weak selection bias towards recruiting fitter patients, which will help contextualise the findings of future studies embedded within the WHiTE cohort. However, the participants within the WHiTE cohort are representative of the national population of older adults with hip fractures across England, Wales, and Northern Ireland.

Introduction

Fragility fractures of the hip are a growing problem worldwide¹. Mortality is high (approximately 10% at 30 days)² and survivors are known to suffer pain, functional disability, and loss of independence³.

In the United Kingdom, the National Hip Fracture Database (NHFD) has emerged as an important tool for observational hip fracture research. All acute hospitals contribute to the NHFD, which captures data on the admission characteristics and procedures of 98% of people admitted with a hip fracture^{2, 4, 5}. However, as a clinical registry, the NHFD collects a narrow range of outcomes, and so studies using this dataset are often limited to reporting mortality.

The World Hip Trauma Evaluation (WHiTE) cohort was established in 2014. WHiTE uses the same inclusion criteria as the NHFD and is based on a convenience sample of hospitals that also reported cases to that registry. However, unlike the NHFD, WHiTE is a research study designed to provide comprehensive follow-up with prospective collection of health-related quality of life outcomes⁶. A number of multi-centre, randomised clinical trials have been embedded within the WHiTE cohort^{3, 7-11}. The validity of future studies will be influenced by the extent to which the WHiTE cohort is representative of the wider population of hip fracture patients.

In this study, the aim was to validate the WHiTE cohort by comparing it to data from the NHFD. The specific objectives were to:

1. Determine the proportion of cases captured by WHiTE and report whether or not there is a selection bias within WHiTE recruitment, i.e. are patients recruited to WHiTE a representative sample of the patients treated at WHiTE hospitals during the study recruitment period?
2. Report the extent to which the WHiTE hospitals and participants are generalisable to the national population of patients with hip fractures.

Methods

Principle data sources

The NHFD was launched in 2007 and receives data from all National Health Service (NHS) hospitals in England, Wales, and Northern Ireland that treat patients with hip fractures⁴. Hospitals are incentivised to report cases to the NHFD by payments under the Hip Fracture Best Practice Tariff (BPT)¹². Specialist nurses within individual trusts typically upload data through a dedicated electronic portal. The NHFD captures approximately 98% of hip fractures

from all participating acute hospitals and has recorded over 500,000 cases since 2007⁴. All adults with hip fractures are eligible for the NHFD except for those aged less than 60 years or undergoing non-operative treatment.

Following a successful single-centre pilot known as the “Warwick” Hip Trauma Evaluation³, the multi-centre World Hip Trauma Evaluation (WHiTE) project was launched in 2014. The inclusion criteria for patients were the same as the NHFD and the protocol for WHiTE is available elsewhere⁶. The locations of the hospitals that recruited participants to the NHFD and WHiTE are shown in Figure 1. WHiTE cohort study sites were selected based on convenience sampling.

WHiTE case capture

In order to determine the proportion of eligible cases captured by WHiTE, the NHFD cohort was limited to all patients treated in each WHiTE hospital after it commenced recruitment. The official launch date of each WHiTE research site is shown in Appendix 1. It was not possible to directly match patients between the two datasets as the terms of our data sharing agreement with the Healthcare Quality Improvement Partnership (HQIP) prohibited linking the NHFD directly to WHiTE data. The number and characteristics of participants recruited into WHiTE were compared with the patients recorded by the NHFD over the same time period to determine the magnitude and direction of any selection biases affecting WHiTE recruitment.

WHiTE generalisability

In order to determine the extent to which WHiTE is generalisable to the wider NHS, we compared the characteristics of both WHiTE hospitals and participants to those in the complete NHFD.

Hospital characteristics: NHS organisations submitting data to the NHFD were identified from a facilities audit conducted in 2017 by the Royal College of Physicians on behalf of HQIP¹³. Other fields extracted from this source were the self-described orthogeriatric model employed by each trust as well as the number of orthogeriatrician hours that are dedicated each week to hip fracture patients. Data on Emergency Department (ED) attendances, inpatient admissions, and hospital bed occupancy were provided by NHS England for the third quarter (i.e. July to September) of 2017. These were matched using parent institution Organisation Data Service (ODS) codes. Hospital postcodes and consumer ratings were obtained on 12 December 2017 from syndicated application programming interface content provided by NHS Choices. These were converted to geographic coordinates (longitude and latitude) using the UK Postcode

Geocoder¹⁴ plugin for Google Chrome. These geographic data were explored using the “rworldmap” package¹⁵ in R v.3.4.1 and Tableau v.10.4.1 Professional Edition (Seattle, WA, USA).

Patient characteristics: The NHFD records used in this analysis were those admitted to hospital between 14 September 2014 (the date that the first WHiTE hospital commenced recruitment) and 14 June 2017. The baseline patient characteristics selected for reporting in this study were those used in the NHFD risk adjustment model and known to predict 30-day mortality¹⁶. These were age, sex, American Society of Anesthesiologists (ASA) physical status grade¹⁷, pre-injury walking mobility, fracture type, and pre-injury living arrangements. In addition, we included the Abbreviated Mental Test Score (AMTS) as a measure of cognitive impairment.

Statistical analyses

Differences in fracture classification between WHiTE and the NHFD were harmonised using the algorithm shown in Appendix 2. Age within the NHFD was recorded as an integer and so equivalent values in WHiTE were rounded to the nearest whole number. Location and spread of continuous variables were estimated using means and standard deviations, where approximate normality could be assumed; otherwise medians and interquartile ranges were reported. All statistical analyses were undertaken using Stata v15.0 (StataCorp, College Station, TX, USA), with significance assessed at the 5% level.

WHiTE case capture: Statistical analyses were undertaken to test the hypothesis that there was no systematic difference between those patients recruited and those patients not recruited into the WHiTE cohort study within each hospital. Baseline categorical variables were compared using chi-squared tests and continuous variables were compared using unpaired t-tests or Kruskal-Wallis tests, depending on distributional assumptions. Data were also visualised using box plots and bar charts.

WHiTE generalisability: When estimating differences in baseline characteristics between the WHiTE and NHFD datasets, we undertook exploratory analyses that focussed on estimation of the magnitude of differences, direction of differences and confidence intervals. However, we did formally test the hypothesis that the distribution of operations would be similar for cases recorded within the WHiTE cohort study and the NHFD.

Research governance and ethical approval

The flow of data from NHS organisations to the NHFD and onwards to third parties for research purposes is authorised by the Confidentiality Advisory Group (CAG) under s.251 NHS Act 2006. The WHiTE cohort study has NHS Research Ethics Committee (REC) Approval (on 18 August 2011 by London-Camberwell St Giles REC; ref. 11/LO/0927) and approval from the Research & Development Department at each recruiting site. It is registered with the National Institute for Health Research Portfolio (UKCRN ID 12351) and the ISRCTN registry (ISRCTN63982700). The other datasets used in this study (e.g. hospital performance metrics) are from publicly available sources.

Results

There were 365,667 participants extracted from the NHFD and 8,673 from the WHiTE cohort study up until 14 June 2017. The selection of participants for each of the two analyses (“case capture” and “generalisability”) are illustrated by Figure 2.

WHiTE case capture

During the recruitment period, WHITE cohort study participating hospitals reported 16,962 cases to the NHFD and recruited 8,673 participants to the WHiTE cohort study. Figure 3 shows that capture varied among individual sites from 30.6% to 75.6% of eligible cases. The overall case capture was 51.1% of patients admitted to hospitals participating in WHiTE during their recruiting period.

Table 1 shows the patient characteristics between the WHiTE and NHFD groups during the period in which each participating hospital was recruiting to the WHiTE cohort study. There was no evidence of significant differences in terms of patient’s mean age (WHiTE 82.8 (standard deviation (SD) 8.5) years versus NHFD 82.8 (SD 8.5) years, $p=0.537$) and median ASA grade (both 3 (interquartile range (IQR) 2-3), $p=1.000$). There were small differences in sex (WHiTE 72.5% female versus NHFD 71.2%, $p=0.021$), median pre-operative AMTS (WHiTE 9 (IQR 6-10) versus NHFD 9 (IQR 5-10), $p<0.001$), pre-injury living arrangements (WHiTE 83.5% own home versus NHFD 80.1%, $p<0.001$), and pre-injury mobility (WHiTE 41.2% freely mobile versus NHFD 37.9%, $p<0.001$). There were similarly modest differences between the populations in terms of hip fracture classification (WHiTE intertrochanteric 35.3% versus NHFD 34.7%, undisplaced intracapsular 8.9% versus 7.4%, displaced intracapsular 51.1% versus 52.5%, sub-trochanteric 4.7% versus 5.7%, $p<0.001$).

WHiTE generalisability

Hospital characteristics: There were 177 NHS hospitals reporting data to the NHFD in 2017 and 23 (13.0%) of these also contributed data to WHiTE. Figure 2 shows that WHiTE centres

are evenly spread throughout the United Kingdom, with the exception of Scotland which did not have hospitals participating in either WHiTE or the NHFD. Table 2 shows that the WHiTE hospitals included a larger number of Major Trauma Centres (MTCs) compared to the NHFD (47.8% versus 7.8%), had busier EDs (median annual attendances of 37,242 (IQR 28,784-50,893) versus 35,964 (IQR 26,229-50,551)), more acute hospital beds (997 (IQR 873-1290) versus 707 (IQR 459-903)), and more dedicated consultant orthogeriatrician time (27 (IQR 20-44) versus 18 (IQR 10-25) hours per week). There were minimal differences in terms of NHS Choices rating, ED admissions, ED 4-hour breaches, or the self-reported model of orthogeriatric service between the two datasets.

Patient characteristics: There were 8,673 WHiTE and 160,660 NHFD records included between 14 September 2014 and 14 June 2017. Table 3 shows the patient characteristics between the WHiTE and NHFD cohorts across England, Wales, and Northern Ireland. The populations were similar in terms of mean age (WHiTE 82.8 (95% CI 82.6 to 82.9) years versus NHFD 82.8 (95% CI 82.7 to 82.8) years), AMTS (both 9 (95% CI 9 to 9)), and ASA (both 3 (95% CI 3 to 3)). They had similar distributions of sex (WHiTE 72.5% female versus NHFD 71.5%), pre-injury living arrangements (WHiTE own home 83.5% versus NHFD 79.4%), pre-injury mobility (WHiTE independently mobile 41.2% versus NHFD 36.8%), and fracture classifications (WHiTE 60.0% intracapsular and 40.0% extracapsular versus NHFD 59.2% and 40.9%). Table 4 shows that there were only small differences in the distribution of the type of operations performed within WHiTE and the NHFD. For example, general anaesthesia occurred more commonly in the WHiTE cohort (55.6 versus 49.7%, $p<0.001$), as did total hip replacement (9.4% versus 7.3%, $p<0.001$) and sliding hip screw fixation (33.9 versus 32.8%, $p<0.001$). By contrast, spinal anaesthesia was reported more frequently within the NHFD (46.8% versus 35.1%), as was intramedullary nail fixation (11.4 versus 9.8%, $p<0.001$).

Discussion

This study aimed to report the proportion of cases captured by WHiTE, whether or not there is a selection bias within WHiTE hospitals, and the extent to which the WHiTE cohort is generalisable to the broader hip fracture population. It found that the WHiTE cohort captures data on over half of the eligible patients presenting to participating hospitals. There was evidence of a weak selection bias towards recruiting fitter patients but the overall WHiTE cohort was very similar in terms of baseline characteristics to the national cohort of patients recorded in the NHFD.

WHiTE case capture

The WHiTE participants were similar in terms of age and ASA grade to those recorded in the NHFD across England, Wales, and Northern Ireland. There were statistically significant differences among the other patient characteristics (sex, AMTS, pre-injury living arrangements, pre-injury mobility, and fracture classification), although the absolute differences were small. Given the number of records within the two datasets, it is possible that differences would be statistically significant but clinically unimportant. A greater proportion of participants within the WHiTE cohort were admitted to hospital from their own home and independently mobile before admission. This suggests the possibility of a weak selection bias in favour of recruiting fitter patients to WHiTE, which is consistent with previous reports of under-recruitment of older patients with frailty from clinical studies^{18, 19}. As patients with cognitive impairment are an important sub-group of patients with hip fracture, WHiTE facilitates their inclusion in the study using a system of Consultee Agreement agreed with the Research Ethics Committee⁶. One possibility is that research associates were reluctant to fully engage with this recruitment process. However, AMTS was slightly higher within the WHiTE cohort study and so this seems unlikely to account for the differences in pre-injury living arrangements and mobility between the WHiTE and NHFD datasets. An alternative explanation is that fitter patients are less likely to be unwell or to die in the early post-operative period before they could be recruited to WHiTE. These patients would however typically be included within the NHFD, particularly as there is a financial incentive (through the Hip Fracture BPT) for their records to be submitted. The similarities between the two datasets do however suggest that any such selection bias affecting WHiTE recruitment is small and does not affect all patient characteristics.

WHiTE generalisability

This study found that large hospitals with high-volume Emergency Departments and Major Trauma Centres (MTCs) are over-represented amongst the organisations recruiting participants to WHiTE. The WHiTE hospitals also offered more specialist orthogeriatrician time and were more likely to admit hip fracture patients under shared care between orthogeriatricians and orthopaedic surgeons (47.8% versus 38.6%). However, the differences in patient characteristics between WHiTE and the complete NHFD cohort highlighted the same weak selection bias in favour of fitter patients that was found in the “WHiTE case capture” analysis. Although the populations were the same in terms of age, AMTS, and ASA grade, patients recorded within WHiTE were more likely to have been admitted from their own home (84.2% versus 79.4%) and have been independently mobile before admission (41.3% versus 36.7%). This suggests that the WHiTE cohort study is broadly generalisable to the national population except for the weak selection bias in favour of recruiting fitter patients.

Although the populations were similar, there were differences between the anaesthetic and surgical techniques recorded in the two datasets. For example, total hip arthroplasty (THA) and general anaesthesia were more commonly used in the WHiTE cohort study whereas cannulated screws and spinal anaesthesia were more prevalent within the NHFD. There are a number of possible explanations for these findings. First, such differences might reflect varying case mix between the two cohorts; for example, THA is principally indicated for patients with displaced intracapsular fractures that are cognitively intact and independently mobile pre-injury²⁰. There were greater proportions of patients with displaced intracapsular fractures (51.1% versus 49.5%) in the WHiTE cohort as well as those that were independently mobile pre-injury (41.2% versus 36.8%), although these differences were small. Second, unexplained variation across the U.K. has already been documented in terms of THA provision for older adults with hip fractures⁵. It is therefore possible that resources and cultural differences within individual hospitals might have influenced the operations offered to patients. Large hospitals with high-volume EDs and MTCs designation were disproportionately represented amongst hospitals recruiting patients for the WHITE cohort study. There is evidence that large specialist hospitals may differ in terms of hip fracture care from smaller hospitals^{4, 21, 22}.

Limitations

The principle limitation of this validation study is that it treated the NHFD as a gold standard. Although the NHFD is the most comprehensive hip fracture registry in the world²³, there have been few attempts to validate the dataset. One centre reported that their own submissions to the NHFD contained inaccuracies over a number of years²⁴, and this is consistent with the experience of other orthopaedic registries^{25, 26}. However, the authors of this study reported that demographic characteristics were recorded correctly in the NHFD in 99.6% of the cases they audited²⁴. Moreover, there were much higher rates of miscoding of fracture type and operation performed. This audit data is reassuring for the integrity of the WHiTE cohort study data as the greatest similarities with the NHFD were found in the demographic fields. It is possible that some differences in terms of fracture classification and hospital treatment were a result of NHFD miscoding. Further work is necessary to determine the extent to which miscoding affects NHFD data.

Conclusion

This validation study found that patients recruited to our large multi-centre prospective cohort study were representative of the wider population of hip fracture patients treated at participating hospitals and to the national hip fracture population across England, Wales and

Northern Ireland. There was evidence of a weak selection bias towards recruiting fitter patients. An understanding of the magnitude and direction of this bias will help contextualise future observational and interventional studies based on the WHiTE cohort study.

References

1. Oden A, McCloskey EV, Kanis JA, Harvey NC, Johansson H. Burden of high fracture probability worldwide: secular increases 2010-2040. *Osteoporos Int*. 2015 Sep;26(9):2243-8.
2. Neuburger J, Currie C, Wakeman R, Tsang C, Plant F, De Stavola B, et al. The impact of a national clinician-led audit initiative on care and mortality after hip fracture in England: an external evaluation using time trends in non-audit data. *Med Care*. 2015 Aug;53(8):686-91.
3. Griffin XL, Parsons N, Achten J, Fernandez M, Costa ML. Recovery of health-related quality of life in a United Kingdom hip fracture population. The Warwick Hip Trauma Evaluation--a prospective cohort study. *Bone Joint J*. 2015 Mar;97-B(3):372-82.
4. Metcalfe D, Gabbe BJ, Perry DC, Harris MB, Ekegren CL, Zogg CK, et al. Quality of care for patients with a fracture of the hip in major trauma centres: a national observational study. *Bone Joint J*. 2016 Mar;98-B(3):414-9.
5. Perry DC, Metcalfe D, Griffin XL, Costa ML. Inequalities in use of total hip arthroplasty for hip fracture: population based study. *BMJ*. 2016 Apr 27;353:i2021.
6. Costa ML, Griffin XL, Achten J, Metcalfe D, Judge A, Pinedo-Villanueva R, et al. World Hip Trauma Evaluation (WHiTE): framework for embedded comprehensive cohort studies. *BMJ Open*. 2016 Oct 21;6(10):e011679.
7. Griffin XL, Parsons N, Achten J, Costa ML. the Targon femoral neck hip screw versus cannulated screws for internal fixation of intracapsular fractures of the hip: a randomised controlled trial. *Bone Joint J*. 2014 May;96-B(5):652-7.
8. Griffin XL, Parsons N, Achten J, Costa ML. A randomised feasibility study comparing total hip arthroplasty with and without dual mobility acetabular component in the treatment of displaced intracapsular fractures of the proximal femur : The Warwick Hip Trauma Evaluation Two : WHiTE Two. *Bone Joint J*. 2016 Nov;98-B(11):1431-5.
9. Griffin XL, Parsons N, McArthur J, Achten J, Costa ML. The Warwick Hip Trauma Evaluation One: a randomised pilot trial comparing the X-Bolt Dynamic Hip Plating System with sliding hip screw fixation in complex extracapsular hip fractures: WHiTE (One). *Bone Joint J*. 2016 May;98-B(5):686-9.
10. Sims AL, Parsons N, Achten J, Griffin XL, Costa ML, Reed MR. The World Hip Trauma Evaluation Study 3: Hemiarthroplasty Evaluation by Multicentre Investigation - WHITE 3: HEMI - An Abridged Protocol. *Bone Joint Res*. 2016 Jan;5(1):18-25.
11. Sims AL, Parsons N, Achten J, Griffin XL, Costa ML, Reed MR, et al. A randomized controlled trial comparing the Thompson hemiarthroplasty with the Exeter polished tapered stem and Unitrax modular head in the treatment of displaced intracapsular fractures of the hip. *Bone Joint J*. 2018 Mar 1;100-B(3):352-60.
12. Oakley B, Nightingale J, Moran CG, Moppett IK. Does achieving the best practice tariff improve outcomes in hip fracture patients? An observational cohort study. *BMJ Open*. 2017 Feb 6;7(2):e014190.
13. Royal College of Physicians. Facilities Audit Data. London, UK: 2017.
14. Patrick E. UK Postcode Geocoder. 8.0 ed2016.
15. South R. rworldmap: A New R Package for Mapping Global Data. *The R Journal*. 2011;3(1):35-43.
16. Tsang C, Boulton C, Burgon V, Johansen A, Wakeman R, Cromwell DA. Predicting 30-day mortality after hip fracture surgery: Evaluation of the National Hip Fracture Database case-mix adjustment model. *Bone Joint Res*. 2017 Sep;6(9):550-6.
17. Dripps RD. New classification of physical status. *Anesthesiology*. 1963;24:111.

18. Clegg A, Relton C, Young J, Witham M. Improving recruitment of older people to clinical trials: use of the cohort multiple randomised controlled trial design. *Age Ageing*. 2015 Jul;44(4):547-50.
19. McMurdo ME, Roberts H, Parker S, Wyatt N, May H, Goodman C, et al. Improving recruitment of older people to research through good practice. *Age Ageing*. 2011 Nov;40(6):659-65.
20. National Institute for Health and Care Excellence (NICE). Hip fracture: management. London, U.K.: 2017.
21. Metcalfe D, Olufajo OA, Zogg CK, Gates JD, Weaver MJ, Harris MB, et al. Are Older Adults With Hip Fractures Disadvantaged in Level 1 Trauma Centers? *Med Care*. 2016 Jun;54(6):616-22.
22. Metcalfe D, Salim A, Olufajo O, Gabbe B, Zogg C, Harris MB, et al. Hospital case volume and outcomes for proximal femoral fractures in the USA: an observational study. *BMJ Open*. 2016 Apr 7;6(4):e010743.
23. Royal College of Physicians. National Hip Fracture Database National Report 2013. London, U.K.: 2013.
24. Cundall-Curry DJ, Lawrence JE, Fountain DM, Gooding CR. Data errors in the National Hip Fracture Database: a local validation study. *Bone Joint J*. 2016 Oct;98-B(10):1406-9.
25. Hoiberg MP, Gram J, Hermann P, Brixen K, Haugeberg G. The incidence of hip fractures in Norway -accuracy of the national Norwegian patient registry. *BMC Musculoskelet Disord*. 2014 Nov 13;15:372.
26. Kosy JD, Kassam AA, Hockings M. National Joint Registry data inaccuracy: a threat to proper reporting. *Br J Hosp Med (Lond)*. 2013 Dec;74(12):691-3.

Figure legends

Figure 1: Distribution of hospitals submitting data to WHiTE (red) and the NHFD (blue)

Figure 2: Flow diagram showing the records used in each analysis

Figure 3: Histogram showing WHiTE capture of eligible cases by individual hospital

Table 1: Characteristics of patients treated within WHiTE centres during the period that they were recruiting to the study – WHiTE dataset versus National Hip Fracture Database (NHFD).

Characteristic	WHiTE (n=8,673)	NHFD (n=16,962)	P
Age*	82.8 (8.5)	82.8 (8.5)	0.537***
Sex			
Male	2,383 (27.5%)	4,893 (28.9%)	0.021¥
Female	6,290 (72.5%)	12,069 (71.2%)	
Pre-operative AMTS**	9 (6-10)	9 (5-10)	<0.001¥
ASA physical status grade**	3 (2-3)	3 (2-3)	1.000 ***
Pre-injury living arrangements			
Own home / sheltered housing	7,159 (83.5%)	13,594 (80.2%)	<0.001¥¥
Rehabilitation unit	10 (0.1%)	20 (0.1%)	
Residential or nursing home	1,303 (15.2%)	3,147 (18.6%)	
Acute hospital	101 (1.2%)	198 (1.2%)	
Pre-injury mobility			
Freely mobile without aids	3,498 (41.2%)	6,338 (37.9%)	<0.001¥¥
Mobile indoors with one aid	2,063 (24.3%)	3,778 (22.6%)	
Mobile outdoors with two aids or frame	1,419 (16.7%)	3,103 (18.6%)	
	1,325 (15.6%)	3,197 (19.1%)	
Some indoor mobility	191 (2.3%)	292 (1.8%)	
No functional mobility			
Fracture classification			
Intertrochanteric	3,030 (35.3%)	5,877 (34.7%)	<0.001¥¥
Intracapsular (undisplaced)	764 (8.9%)	1,254 (7.4%)	
Intracapsular (displaced)	4,384 (51.1%)	8,830 (52.2%)	
Subtrochanteric	402 (4.7%)	959 (5.7%)	

*Mean (standard deviation); **Median (interquartile range); ***T-test; ¥Kruskal-Wallis test; ¥¥Chi-squared test.

Table 2: Characteristics of hospitals submitting data to WHiTE and the NHFD		
Characteristic	WHiTE (n=24)	NHFD (n=153)
MTC designation	11 (47.8%)	12 (7.8%)
NHS Choices score*	4.1 (3.8-4.3)	3.9 (3.6-4.2)
ED attendances*		
Total	43,981 (37,147-54,385)	35,964 (26,229-50,551)
Type 1	32,652 (28,336-43,175)	26,514 (21,075-35,864)
Admissions	9,443 (7,833-12,854)	7,646 (6,108-10,372)
ED breaches (4 hours) *		
Total	5,417 (2,462-8,668)	3,781 (2,247-6,673)
Type 1	5,417 (2,436-8,556)	3,703 (2,246-6,586)
Percentage seen <4 hours	86.4% (82.3-92.5%)	88.7% (86.1-92.6%)
Bed status*		
Available	997 (873-1290)	707 (459-903)
Occupied	903 (741.0-1183)	634 (417-828)
Proportion occupied	90.3% (85.7-92.5%)	89.9% (85.1-92.5%)
Orthogeriatric model		
Traditional orthopaedic care	0 (0.0%)	6 (3.9%)
Routine orthogeriatric review	6 (26.1%)	62 (40.5%)
Postoperative geriatric care	2 (8.7%)	7 (4.6%)
Shared care	11 (47.8%)	59 (38.6%)
Admitted under geriatricians	1 (4.4%)	4 (2.6%)
No response or “other”	3 (13.1%)	15 (9.8%)
Orthogeriatric time*		
Consultant hours	27 (20-44)	18 (10-25)
Registrar hours	18 (0-40)	6 (0-26)

*Median (interquartile range)

Table 3: Characteristics of patients treated across England, Wales, and Northern Ireland after the WHiTE study began.

Characteristic	WHiTE (n=8,673)	NHFD (n=160,660)
Age*	82.8 (82.6-82.9)	82.8 (82.7-82.8)
Sex		
Male	2,383 (27.5%)	45,846 (28.5%)
Female	6,290 (72.5%)	114,814 (71.5%)
Pre-operative AMTS**	9 (9-9)	9 (9-9)
ASA physical status grade**	3 (3-3)	3 (3-3)
Pre-injury living arrangements		
Own home / sheltered housing	7,159 (83.5%)	127,452 (79.4%)
Rehabilitation unit	10 (0.1%)	168 (0.1%)
Residential or nursing home	1,303 (15.2%)	30,365 (18.9%)
Acute hospital	101 (1.2%)	2,604 (1.6%)
Pre-injury mobility		
Freely mobile without aids	3,498 (41.2%)	58,366 (36.8%)
Mobile indoors with one aid	2,063 (24.3%)	35,315 (22.6%)
Mobile outdoors with two aids or frame	1,419 (16.7%)	23,629 (14.9%)
Some indoor mobility	1,325 (15.6%)	39,070 (24.6%)
No functional mobility	191 (2.3%)	2,342 (1.5%)
Fracture classification		
Intertrochanteric	3,030 (35.3%)	55,576 (34.8%)
Intracapsular (undisplaced)	764 (8.9%)	15,550 (9.7%)
Intracapsular (displaced)	4,384 (51.1%)	78,996 (49.5%)
Subtrochanteric	402 (4.7%)	9,725 (6.1%)

*Mean (95% confidence interval); **Median (interquartile range).

Table 4: Treatment of patients within NHFD and WHiTE hospitals

Characteristic	WHiTE (n=8,673)	NHFD (n=160,660)	P
Anaesthetic type			
General anaesthesia (GA)	4,824 (55.6%)	79,848 (49.7%)	<0.001*
GA + epidural	37 (0.4%)	356 (0.2%)	
GA + nerve block	3,041 (35.1%)	44,140 (27.7%)	
GA + spinal	330 (3.8%)	6,903 (4.3%)	
GA only	1,746 (20.1%)	35,352 (22.0%)	
Spinal anaesthesia (SA)	3,048 (35.1%)	75,170 (46.8%)	
SA + epidural	16 (0.2%)	841 (0.5%)	
SA + nerve block	1,164 (13.4%)	21,822 (13.6%)	
SA + sedation	227 (2.6%)	1,887 (1.2%)	
SA + sedation + epidural	2 (0.0%)	124 (0.1%)	
SA only	1,309 (15.1%)	43,593 (27.1%)	
Unknown	801 (9.2%)	5,642 (3.5%)	
Operation type			
Hemiarthroplasty	3,710 (42.8%)	69,078 (43.0%)	<0.001*
Total hip replacement	814 (9.4%)	11,669 (7.3%)	
Screw fixation	263 (3.0%)	5,080 (3.2%)	
Intramedullary nail fixation	849 (9.8%)	18,335 (11.4%)	
Sliding hip screw fixation	2,941 (33.9%)	52,710 (32.8%)	
Unknown	94 (1.1%)	845 (0.5%)	

*Chi-squared test.