

## Supplementary material

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Supplementary Table S1. OPCS-4 codes used to identify primary hip replacement operations

Category	Code	Description	Notes
Primary Total Hip Replacement	W37.1	Primary total prosthetic replacement of hip joint using cement	
	W37.8	Other specified total prosthetic replacement of hip joint using cement	
	W37.9	Unspecified total prosthetic replacement of hip joint using cement	
	W38.1	Primary total prosthetic replacement of hip joint not using cement	
	W38.8	Other specified total prosthetic replacement of hip joint not using cement	
	W38.9	Unspecified total prosthetic replacement of hip joint not using cement	
	W39.1	Primary total prosthetic replacement of hip joint NEC	
	W39.8	Other specified other total prosthetic replacement of hip joint	
	W39.9	Unspecified other total prosthetic replacement of hip joint	
	W43.1	Primary total prosthetic replacement of other joint using cement NEC	
	W43.8	Other specified total prosthetic replacement of other joint using cement NEC	
	W43.9	Unspecified total prosthetic replacement of other joint using cement NEC	
	W44.1	Primary total prosthetic replacement of other joint not using cement NEC	
	W44.8	Other specified total prosthetic replacement of other joint not using cement NEC	
	W44.9	Unspecified total prosthetic replacement of other joint not using cement NEC	
	W45.1	Other primary total prosthetic replacement of other joint NEC	
	W45.8	Other specified total prosthetic replacement of other joint NEC	
	W45.9	Unspecified total prosthetic replacement of other joint NEC	

W52.1	Primary prosthetic replacement of articulation of bone using cement NEC
W52.8	Other specified prosthetic replacement of articulation of bone using cement NEC
W52.9	Unspecified prosthetic replacement of articulation of bone using cement NEC
W53.1	Primary prosthetic replacement of articulation of bone not using cement NEC
W53.8	Other specified prosthetic replacement of articulation of bone not using cement NEC
W53.9	Unspecified prosthetic replacement of articulation of bone not using cement NEC
W54.1	Primary prosthetic replacement of articulation of bone NEC
W54.8	Other specified prosthetic replacement of articulation of bone NEC
W54.9	Unspecified prosthetic replacement of articulation of bone NEC
W93.1	Primary hybrid prosthetic replacement of hip joint using cemented acetabular component
W93.8	Other specified hybrid prosthetic replacement of hip joint using cemented acetabular component
W93.9	Unspecified hybrid prosthetic replacement of hip joint using cemented acetabular component
W94.1	Primary hybrid prosthetic replacement of hip joint using cemented femoral component
W94.8	Other specified hybrid prosthetic replacement of hip joint using cemented femoral component
W94.9	Unspecified hybrid prosthetic replacement of hip joint using cemented femoral component
W95.1	Primary hybrid prosthetic replacement of hip joint using cement NEC
W95.8	Other specified hybrid prosthetic replacement of hip joint using cement

	W95.9	Unspecified hybrid prosthetic replacement of hip joint using cement	
Resurfacing / Reconstruction	W58.1	Primary resurfacing arthroplasty of joint	Require combination with site + combination codes to ID
	W58.8	Other specified reconstruction of joint	Require combination with site + combination codes to ID
	W58.9	Unspecified other reconstruction of joint	Require combination with site + combination codes to ID

Supplementary Table S2: Sample characteristics for total sample (N=3036), those with complete data (N=2352), those with complete data and with a previous admission (N=1223) and those with any missing data, ie, non-complete cases (N=1813)

Main characteristics		Total sample N=3036	Complete case sample included in multivariable model with categorical days since last discharge variable N=2352	Complete case sample included in multivariable model with continuous days since last discharge variable N=1223	Non-complete cases N=1813
Age, mean (SD)		67.4 (13.5)	67.5 (13.6)	68.2 (13.7)	66.9 (13.3)
Sex, N (%)	Female	1793 (59.1)	1387 (59.0)	735 (60.1)	1058 (58.4)
	Male	1243 (40.9)	965 (41.0)	488 (39.9)	755 (41.6)
IMD score, N (%)	1 (least deprived)	867 (28.6)	679 (28.9)	371 (30.3)	496 (27.4)
	2	717 (23.6)	551 (23.4)	270 (22.1)	447 (24.7)
	3	519 (17.1)	409 (17.4)	203 (16.6)	316 (17.4)
	4	484 (15.9)	381 (16.2)	206 (16.8)	278 (15.3)
	5 (most deprived)	413 (13.6)	332 (14.1)	173 (14.2)	240 (13.2)
	(missing)	36 (1.2)	-	-	36 (2.0)
Ethnicity, N (%)	Non-White	45 (1.5)	37 (1.6)	24 (2.0)	21 (1.2)
	White	1130 (37.2)	898 (38.2)	362 (29.6)	1024 (56.5)
	(missing)	1861 (61.3)	1417 (60.3)	837 (68.4)	768 (42.4)
Comorbidities, N (%)	0	1699 (56.0)	1298 (55.2)	605 (49.5)	1094 (60.3)
	1-2	1086 (35.8)	857 (36.4)	483 (39.5)	603 (33.3)
	3-4	213 (7.0)	170 (7.2)	118 (9.7)	95 (5.2)
	>=5	38 (1.3)	27 (1.2)	17 (1.4)	21 (1.2)

Table S3: Complete table of descriptive statistics for elective admissions for primary hip replacements with complete data (N=2352)

Variable	N (%)	Proportion (%) admitted >7 days	Mean length of stay (SD) N=2331	Proportion (%) exceeding medically fit for discharge date
Age at admission				
0-34	60 (2.6)	15.9	3.8 (2.3)	10.32
35-44	93 (4.0)	6.5	4.1 (3.0)	5.4
45-54	233 (9.9)	6.0	4.0 (2.4) (N=232)	4.3
55-64	440 (18.7)	8.6	4.3 (3.0) (N=437)	5.9
65-74	723 (30.7)	14.7	5.1 (4.2) (N=718)	9.5
75-84	650 (27.6)	27.2	6.6 (4.7) (N=644)	13.7
85+	153 (6.5)	51.6	9.6 (5.9) (N=148)	39.9
Age at admission, mean (SD)	67.5 (13.6)	-	-	-
Sex				
Female	1387 (59.0)	20.1	5.1 (3.9) (N=1367)	14.0
Male	965 (41.0)	15.0	4.7 (3.8) (N=956)	7.2
Deprivation (IMD score)				
1 (least deprived)	679 (28.9)	17.5	5.4 (4.1) (N=674)	9.6
2	551 (23.4)	14.7	5.0 (4.1) (N=547)	7.4
3	409 (17.4)	17.6	5.4 (3.8) (N=406)	11.0
4	381 (16.2)	22.8	6.1 (5.0) (N=377)	16.3
5 (most deprived)	332 (14.1)	19.6	5.6 (4.6) (N=327)	15.1

Ethnicity				
Non-White	37 (2.5)	-	-	-
Asian	8 (0.6)	-	-	-
Black	15 (1.0)	-	-	-
Mixed	7 (0.5)	-	-	-
Other	7 (0.5)	-	-	-
White	1417 (97.5)	-	-	-
Unknown	898	-	-	-
Comorbidities (weighted Charlson index)				
0	1298 (55.2)	11.7	4.7 (3.6) (N=1290)	8.3
1-2	857 (36.4)	22.8	6.1 (4.6) (N=849)	13.3
3-4	170 (7.2)	37.7	7.6 (5.3) (N=166)	20.5
>=5	27 (1.2)	48.2	8.8 (6.0) (N=26)	25.9
Time since last discharge				
0-2 months	341 (14.5)	31.1	6.9 (5.4) (N=335)	20.8
2-12 months	528 (22.5)	21.4	5.7 (4.5) (N=518)	12.3
12 months or more	354 (15.1)	13.0	5.0 (3.7)	10.5
never	1129 (48.0)	14.1	5.0 (3.9) (N=1124)	8.0
Emergency over elective admissions ratio (general/acute, monthly), Mean ± SD	0.8 ± 0.1	-	-	-
Emergency admissions, daily, Mean ± SD	153.3 ± 21.4	-	-	-
Emergency occupied beds, daily, Mean ± SD	913.3 ± 43.0	-	-	-
Admission hour category				

24.00-06.00	2 (0.1)	100.0	28.0 (0) (N=1)	100.0
06.00-12.00	2217 (94.3)	17.4	5.4 (4.1) (N=2199)	10.6
12.00-18.00	124 (5.3)	23.4	6.3 (6.1) (N=122)	16.1
18.00-24.00	9 (0.4)	88.9	10.9 (3.9) (N=9)	66.7
Year of Admission				
2016	220 (9.4)	17.3	5.3 (4.8) (N=217)	7.3
2017	752 (32.0)	17.6	5.5 (4.4) (N=742)	10.6
2018	730 (31.0)	19.7	5.6 (4.2) (N=725)	13.7
2019	650 (27.6)	16.9	5.3 (4.2) (N=647)	10.3
Month of Admission				
January	143 (6.1)	16.1	5.3 (4.9)	9.1
February	178 (7.6)	17.4	5.4 (4.0) (N=177)	6.2
March	196 (8.3)	21.4	5.7 (4.4) (N=191)	10.2
April	209 (8.9)	18.2	5.4 (4.5) (N=206)	12.0
May	218 (9.3)	20.6	6.1 (4.3)	16.5
June	181 (7.7)	12.2	4.6 (2.7) (N=180)	12.7
July	195 (8.3)	23.1	6.2 (5.3) (N=193)	17.4
August	189 (8.0)	18.5	5.6 (4.6) (N=186)	8.5
September	163 (6.9)	19.6	5.4 (4.1) (N=161)	9.2
October	238 (10.1)	18.5	5.6 (4.5)	10.9



			(N=236)	
November	250 (10.6)	13.6	4.8 (3.8) (N=249)	10.0
December	192 (8.2)	17.2	5.2 (3.7) (N=191)	9.9
Day of the Week of Admission				
Sunday	4 (0.2)	100.0	12.0 (3.6)	25.0
Monday	150 (6.4)	22.7	5.3 (4.3) (N=147)	10.7
Tuesday	621 (26.4)	17.6	5.2 (4.2) (N=618)	11.1
Wednesday	448 (19.1)	19.9	5.3 (4.6) (N=440)	11.8
Thursday	658 (28.0)	15.8	5.7 (4.0)	10.5
Friday	408 (17.4)	20.1	5.9 (4.7) (N=402)	12.5
Saturday	63 (2.7)	3.2	3.4 (1.6) (N=62)	6.4
Season of Admission				
Winter (Dec-Feb)	513 (21.8)	17.0	5.3 (4.2) (N=511)	8.4
Spring (Mar-May)	623 (26.5)	20.1	5.7 (4.4) (N=615)	13.0
Summer (Jun-Aug)	565 (24.0)	18.1	5.5 (4.4) (N=559)	12.9
Autumn (Sep-Nov)	651 (27.7)	16.9	5.3 (4.2) (N=646)	10.1
Spell length of stay, Mean ± SD	5.8 ± 6.3	-	-	-
Spell length of stay up to 30 days, Mean ± SD (N=2331)	5.4 ± 4.3	-	-	-
Patients staying >7 days				
<=7 (no)	1928 (82.0)	-	-	-

>7 (yes)	424 (18.0)	-	-	-
<b>Patients medically fit for discharge (MFFD)</b>				
with MFFD date before discharge	263 (11.2)	-	-	-
no MFFD date	2089 (88.8)	-	-	-
<b>Days between MFFD date and Discharge, Mean ± SD (N=263)</b>	6.2 ± 8.1	-	-	-

Table S4: Multivariable models for binary length of stay outcome (admissions &gt; 7 days)

Variable	Multivariable logistic regression (no variable selection) N=2348		Multivariable logistic regression (backwards selection at p=0.1) N=2348	
	OR (95%CI)	p	OR	P
<b>Age at admission</b>	1.06 (1.05 to 1.07)	<0.001	1.06 (1.05 to 1.08)	<0.001
<b>Sex (female vs male)</b>	1.42 (1.12 to 1.81)	0.004	1.42 (1.12 to 1.81)	0.004
<b>IMD score</b>				
1 (least deprived)	1.00		1.00	
2	0.80 (0.58 to 1.12)	0.200	0.81 (0.58 to 1.13)	0.210
3	0.88 (0.62 to 1.25)	0.467	0.88 (0.62 to 1.25)	0.478
4	1.46 (1.04 to 2.06)	0.031	1.46 (1.04 to 2.05)	0.031
5 (most deprived)	1.23 (0.85 to 1.78)	0.267	1.24 (0.86 to 1.79)	0.245
<b>Comorbidities - Charlson index (weighted)</b>				
0	1.00		1.00	
1-2	1.86 (1.45 to 2.39)	<0.001	1.84 (1.43 to 2.36)	<0.001
3-4	2.61 (1.77 to 3.86)	<0.001	2.59 (1.76 to 3.82)	<0.001
>=5	3.79 (1.56 to 9.19)	0.003	3.52 (1.45 to 8.55)	0.005
<b>Time since Last Discharge</b>				
0-2 months	1.00		1.00	
2-12 months	0.72 (0.51 to 1.00)	0.051	0.71 (0.51 to 0.99)	0.046
12 months or more	0.34 (0.23 to 0.52)	<0.001	0.35 (0.23 to 0.52)	<0.001
never	0.44 (0.32 to 0.60)	<0.001	0.44 (0.32 to 0.60)	<0.001
<b>Emergency over elective admissions ratio (general/acute, monthly)</b>	0.95 (0.08 to 10.72)	0.966	-	
<b>NEL admissions, daily (from 01/09/2016)</b>	1.01 (1.00 to 1.02)	0.237	-	
<b>NEL occupied beds, daily (from 01/10/2016)</b>	0.996 (0.991 to 1.001)	0.129	-	
<b>Admission hour category</b>				
06.00-12.00	1.00		1.00	
12.00-18.00	1.15 (0.70 to 1.89)	0.593	1.14 (0.69 to 1.86)	0.613

18.00-06:00	32.71 (3.66 to 292.76)	0.002	29.61 (3.29 to 266.66)	0.003
Year of Admission				
2016	1.00			
2017	1.15 (0.67 to 1.97)	0.602		
2018	1.27 (0.69 to 2.32)	0.445		
2019 (until 31st Dec)	1.00 (0.47 to 2.11)	0.999		
Day of the Week of Admission				
Sunday	-		-	-
Monday	1.00		1.00	-
Tuesday	0.80 (0.50 to 1.29)	0.365	0.82 (0.51 to 1.32)	0.417
Wednesday	0.91 (0.55 to 1.49)	0.702	0.93 (0.57 to 1.52)	0.768
Thursday	0.60 (0.37 to 0.97)	0.036	0.62 (0.39 to 1.00)	0.050
Friday	0.87 (0.52 to 1.44)	0.581	0.95 (0.58 to 1.56)	0.836
Saturday	0.19 (0.04 to 0.87)	0.033	0.20 (0.04 to 0.88)	0.033
Season of Admission				
Winter (Dec-Feb)	1.00			
Spring (Mar-May)	1.18 (0.82 to 1.70)	0.363		
Summer (Jun-Aug)	0.89 (0.59 to 1.35)	0.579		
Autumn (Sep-Nov)	0.99 (0.67 to 1.46)	0.971		
C-statistic	0.77 (0.75 to 0.79)		0.77 (0.75 to 0.79)	

Table S5: Multivariable models for binary medically fit for discharge date outcome (MFFD date &lt; discharge date)

Variable	Multivariable logistic regression (no variable selection) N=2352		Multivariable logistic regression (backwards selection at p<0.1) N=2352	
	OR (95%CI)	p	OR (95%CI)	p
<b>Age at admission</b>	1.06 (1.04 to 1.07)	<0.001	1.06 (1.04 to 1.07)	<0.001
<b>Sex (female vs male)</b>	2.10 (1.55 to 2.85)	<0.001	2.06 (1.52 to 2.79)	<0.001
<b>IMD score</b>				
1 (least deprived)	1.00		1.00	
2	0.75 (0.48 to 1.15)	0.185	0.76 (0.49 to 1.16)	0.201
3	1.08 (0.70 to 1.66)	0.736	1.12 (0.73 to 1.71)	0.613
4	2.06 (1.38 to 3.10)	<0.001	2.11 (1.42 to 3.16)	<0.001
5 (most deprived)	2.00 (1.31 to 3.06)	0.001	2.08 (1.37 to 3.16)	0.001
<b>Comorbidities - Charlson index (weighted)</b>				
0	1.00			
1-2	1.40 (1.04 to 1.89)	0.028		
3-4	1.35 (0.84 to 2.18)	0.220		
>=5	1.78 (0.64 to 4.97)	0.268		
<b>Time since Last Discharge</b>				
0-2 months	1.00		1.00	
2-12 months	0.60 (0.40 to 0.89)	0.011	0.56 (0.38 to 0.84)	0.004
12 months or more	0.43 (0.27 to 0.69)	<0.001	0.41 (0.26 to 0.65)	<0.001
never	0.36 (0.25 to 0.52)	<0.001	0.33 (0.23 to 0.47)	<0.001
<b>Emergency over elective admissions ratio (general/acute, monthly)</b>	1.86 (0.10 to 33.30)	0.675		
<b>NEL admissions, daily (from 01/09/2016)</b>	1.01 (1.00 to 1.02)	0.143	1.01 (1.00 to 1.02)	0.049
<b>NEL occupied beds, daily (from 01/10/2016)</b>	0.99 (0.98 to 0.99)	<0.001	0.99 (0.98 to 0.99)	<0.001
<b>Admission hour category</b>				
06.00-12.00	1.00		1.00	
12.00-18.00	1.50 (0.86 to 2.63)	0.152	1.55 (0.90 to 2.66)	0.114

18.00-06:00	43.42 (7.94 to 237.33)	<0.001	33.00 (7.71 to 141.30)	<0.001
Year of Admission				
2016	1.00		1.00	
2017	2.66 (1.30 to 5.43)	0.007	2.46 (1.30 to 4.67)	0.006
2018	3.27 (1.49 to 7.14)	0.003	3.13 (1.62 to 6.04)	0.001
2019 (until 31st Dec)	2.55 (1.00 to 6.52)	0.051	2.42 (1.13 to 5.20)	0.023
Day of the Week of Admission				
Sunday				
Monday	1.00			
Tuesday	1.25 (0.66 to 2.35)	0.488		
Wednesday	1.24 (0.65 to 2.39)	0.510		
Thursday	1.00 (0.53 to 1.87)	0.993		
Friday	1.16 (0.60 to 2.26)	0.663		
Saturday	0.72 (0.20 to 2.64)	0.619		
Season of Admission				
Winter (Dec-Feb)	1.00			
Spring (Mar-May)	1.24 (0.79 to 1.94)	0.358		
Summer (Jun-Aug)	0.95 (0.58 to 1.58)	0.851		
Autumn (Sep-Nov)	1.01 (0.63 to 1.64)	0.952		
C-statistic	0.78 (0.75 to 0.81)		0.77 (0.74 to 0.80)	

Table S6: Multivariable models for continuous length of stay outcome (< 30 days) in hip surgeries

Variable	Multivariable linear regression (no variable selection) N=2331		Multivariable linear regression (backwards selection at p<0.1) N=2331	
	Coef (95%CI)	p	Coef (95%CI)	p
Age at admission	0.08 (0.06 to 0.09)	<0.001	0.08 (0.06 to 0.09)	<0.001
Sex (female vs male)	0.63 (0.31 to 0.95)	<0.001	0.63 (0.31 to 0.95)	<0.001
IMD score				
1 (least deprived)	0.00		0.00	
2	-0.33 (-0.75 to 0.10)	0.134	-0.32 (-0.75 to 0.10)	0.137
3	-0.12 (-0.57 to 0.34)	0.614	-0.12 (-0.57 to 0.34)	0.616
4	0.82 (0.26 to 1.38)	0.004	0.80 (0.24 to 1.35)	0.005
5 (most deprived)	0.32 (-0.24 to 0.87)	0.265	0.32 (-0.24 to 0.87)	0.264
Comorbidities - Charlson index (weighted)				
0	0.00		0.00	
1-2	0.98 (0.62 to 1.35)	<0.001	0.98 (0.61 to 1.34)	<0.001
3-4	1.74 (0.93 to 2.56)	<0.001	1.74 (0.93 to 2.56)	<0.001
>=5	2.73 (0.71 to 4.75)	0.008	2.68 (0.67 to 4.69)	0.009
Time since Last Discharge				
0-2 months	0.00		0.00	
2-12 months	-0.85 (-1.51 to -0.20)	0.010	-0.87 (-1.53 to -0.22)	0.009
12 months or more	-1.56 (-2.22 to -0.91)	<0.001	-1.59 (-2.25 to -0.93)	<0.001
never	-1.35 (-1.94 to -0.77)	<0.001	-1.36 (-1.94 to -0.78)	<0.001
Emergency over elective admissions ratio (general/acute, monthly)	-0.67 (-4.01 to 2.67)	0.693	-	
NEL admissions, daily (from 01/09/2016)	0.01 (-0.01 to 0.02)	0.228	-	
NEL occupied beds, daily (from 01/10/2016)	-0.01 (-0.01 to 0.00)	0.074	-0.004 (-0.008 to 0.001)	0.100

Admission hour category				
06.00-12.00	0.00		0.00	
12.00-18.00	0.87 (-0.15 to 1.89)	0.095	0.84 (-0.18 to 1.85)	0.106
18.00-06:00	6.02 (2.17 to 9.86)	0.002	5.94 (2.08 to 9.80)	0.003
Year of Admission				
2016	0.00			
2017	0.37 (-0.36 to 1.11)	0.321		
2018	0.33 (-0.49 to 1.16)	0.429		
2019 (until 31st Dec)	0.05 (-0.97 to 1.06)	0.930		
Day of the Week of Admission				
Sunday				
Monday	0.00		0.00	
Tuesday	0.17 (-0.52 to 0.87)	0.623	0.21 (-0.48 to 0.90)	0.556
Wednesday	0.18 (-0.57 to 0.94)	0.630	0.19 (-0.56 to 0.93)	0.621
Thursday	0.39 (-0.29 to 1.07)	0.258	0.43 (-0.25 to 1.10)	0.215
Friday	0.71 (-0.05 to 1.48)	0.068	0.79 (0.05 to 1.53)	0.037
Saturday	-0.99 (-1.91 to -0.07)	0.036	-1.04 (-1.85 to -0.22)	0.013
Season of Admission				
Winter (Dec-Feb)	0.00			
Spring (Mar-May)	0.22 (-0.29 to 0.72)	0.392		
Summer (Jun-Aug)	-0.17 (-0.77 to 0.42)	0.569		
Autumn (Sep-Nov)	-0.19 (-0.69 to 0.31)	0.459		
R <sup>2</sup>	0.157		0.154	



Figure S1: Forest plot of predictors of binary measure of length of stay (>7 days)

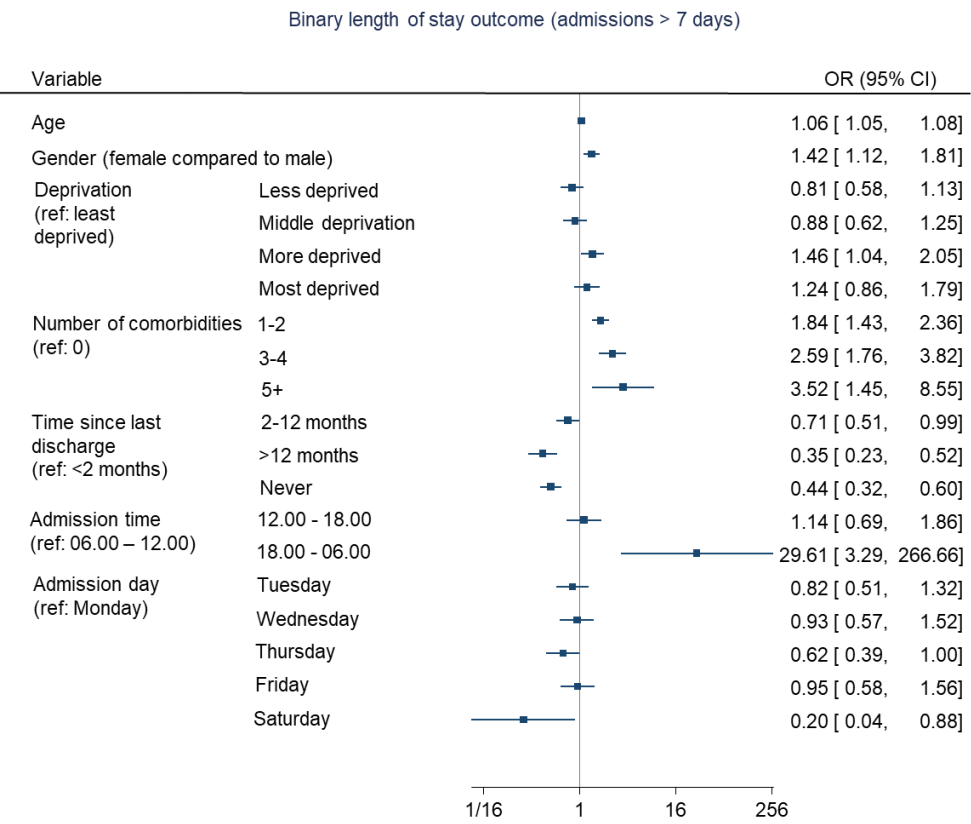


Figure S1: Predictors of binary measure of length of stay (>7 days)

Figure S2: Forest plot of predictors of continuous length of stay outcome

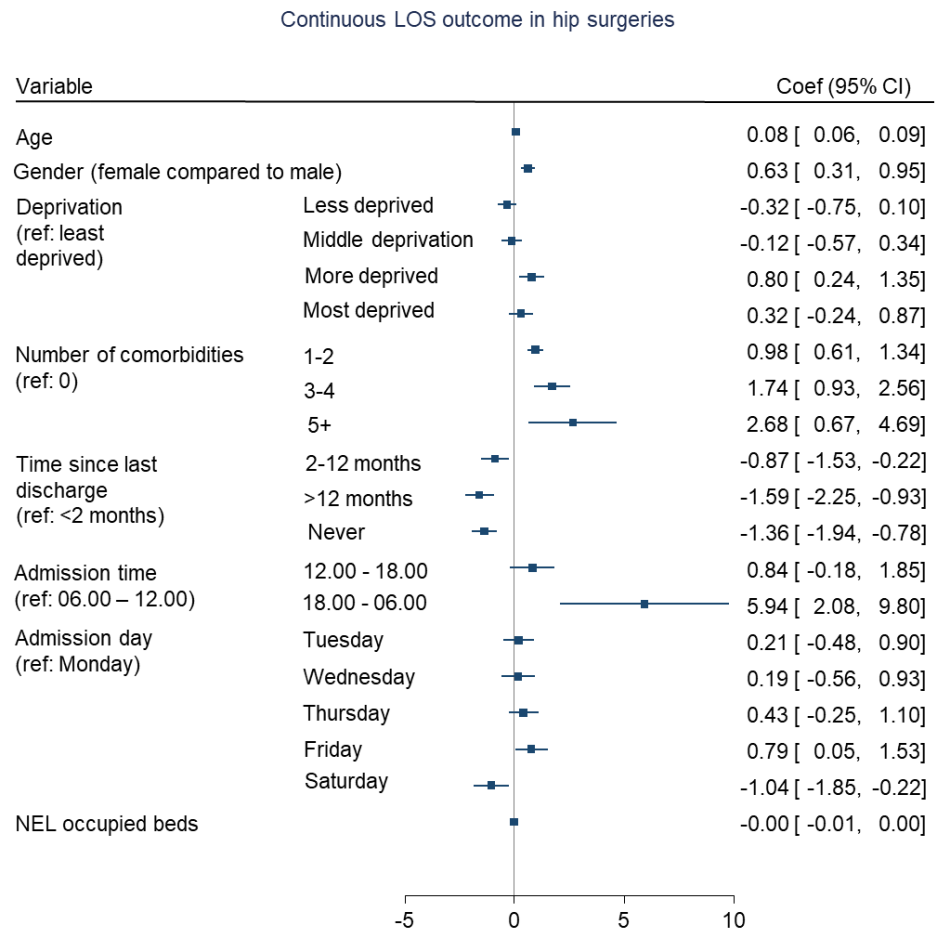


Figure S2: Predictors of length of stay in days

Figure S3: Forest plot of predictors of staying in hospital when medically fit for discharge

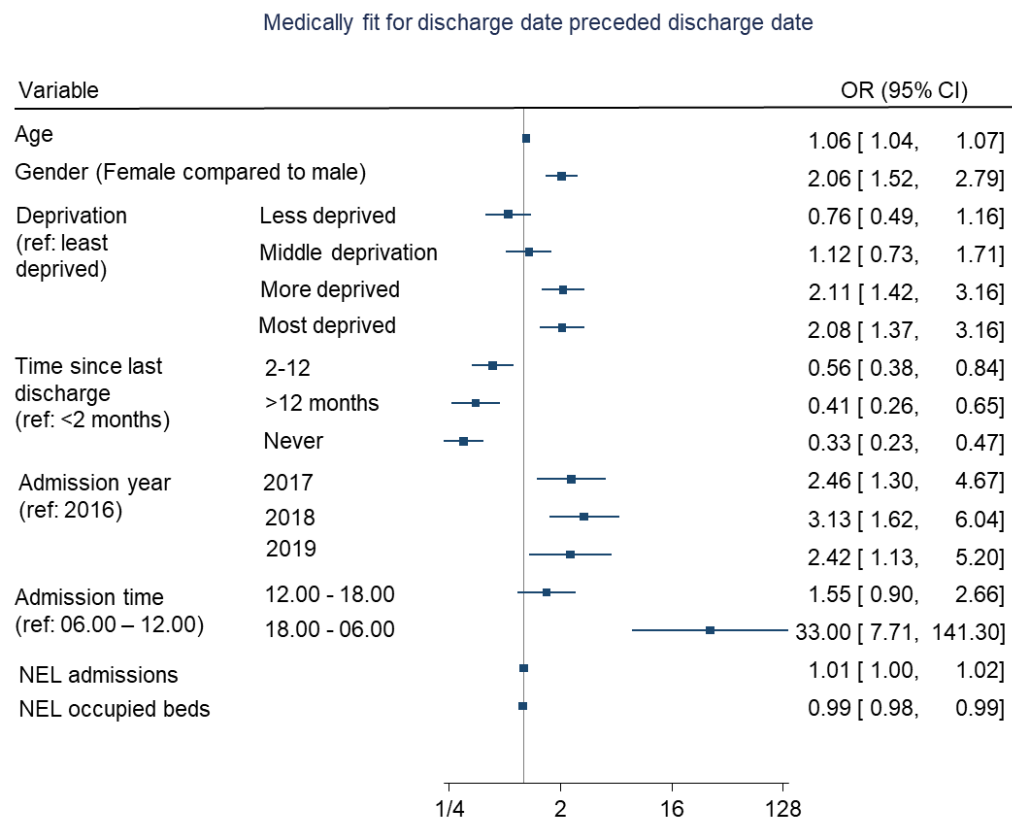


Figure S3: Predictors of staying in hospital when medically fit for discharge