Understanding trends and variation in paediatric fracture management in England

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17 April 2025

Foreword

In this report we have taken paediatric Emergency department (ED) attendances (0-16yrs old) across England (2019-23) and looked at a select number of paediatric fractures where either national guidance or published/emerging evidence suggests limited intervention, imaging or follow up is required. These include clavicle (collarbone), forearm and toe fractures. Given our results we believe future UK wide analysis of other fracture types and/or a wider age range (Adults) may prove beneficial.

For paediatric fractures regarded as minor or 'low need', our analysis demonstrates:

- If the number of follow up appointments was reduced to the lowest quartile of English Trusts circa. 30,000 appointments could be saved annually. (Slide 42 & 52)
- Many clavicle fractures, commonly accepted to heal without intervention, have two or more follow up appointments when evidence suggests none are required. (Slide 25 & 42)
- Marked variance exists across Trusts in the proportion of fractures with follow up and how that occurs (virtual vs face to face). (Slide 42-43)

Our analysis demonstrates between 2019-23 the proportion of forearm fractures manipulated:

- Has reduced in theatre by 50% (Slide 29) and increased in ED (Slide 28).
- Total manipulations (theatre or ED) have reduced by 22% (Slide 30).

Our data shows that forearm fractures are the most common fracture in children and in 2022-23 alone over 25,000 had no follow up (Slide 25). Along with the forearm manipulation data this collectively suggests a fundamental change in forearm fracture management has occurred across England, likely driven by Get It Right First Time (GIRFT) targets and recent/ongoing research (FORCE & CRAFFT).

Lastly, our analysis suggests marked regional variation in fracture incidence exists (Slide 14) and is unaccounted in the current GIRFT/Model hospital 'Wrist manipulations in theatre' dataset. We have formulated an alternative and potentially more nuanced version accounting for regional variation. Interestingly, Trusts currently considered either in the top or bottom quartiles markedly change position within our proposed model (Slide 47).

In conclusion we believe our analysis can help set future GIRFT targets driving change and savings across the NHS.

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Report summary

This report sets out to understanding the opportunities to reduce hospital activity through wider adoption of more conservative management of selected paediatric fractures.

This work may help inform future demand and capacity planning for hospitals and allow trusts to estimate the impact of adopting conservative management of certain paediatric fractures on their future activity levels.

Key findings:

- Over the last 5 years there has been a trend towards more conservative management of paediatric fractures, but further activity savings that could be made.
- While nationally manipulations in theatre have decreased in recent years, at some trusts there is still scope to reduce the proportion of forearm and elbow fractures manipulated in theatre. This could further half the number of elbow and forearm manipulations performed in England.
- There is scope to reduce the number of x-rays for clavicle and toe fractures in emergency care in England by almost a fifth.
- There is scope to reduce the number of follow-up appointments for elbow, forearm, clavicle, tibia/fibula and toes fractures in England by a third.

Background

Epidemiology of paediatric fractures

One hospital in Ireland calculated a paediatric fracture incidence rate of approximately 29 fractures/1,000/year[1]. The most common fracture was distal radial/buckle fractures (27.2%), followed by distal humerus /supracondylar fracture (13.9%), ankle fractures (9.2%), phalanx fractures (8.3%), and radial/ulnar metaphysis fractures (5.7%). It is suggested the incidence rate will depend on the social emphasis on encouraging physical activity[1].

Between 2012–2019, 368,120 children under 18 were admitted to English NHS hospitals with a fracture; 256,008 (69.5%) were upper limb and 85,737 (23.3%) were lower limb fractures[2]. The annual incidence of upper limb fractures was highest in children aged 5–9 (348.3 per 100, 000 children).

The total fracture incidence rate in the UK was found by one study to be 1,370 fractures per 100,000 children[3], while another found the incidence of distal radius fractures to be 337 fractures per 100,000 children at one UK trauma centre[4].

Paediatric fracture management

British Society for Children's Orthopaedic Surgery (BSCOS) guidance suggests that no referral/follow up is required for many fractures of the clavicle, elbow, wrist and toes where there is no or minimal displacement[5].

The FORCE study found in children with a torus fracture of the distal radius there was no difference in outcomes between those who were offered of a bandage and immediate discharge (as per UK National Institute for Health and Clinical Excellence recommendations) and those receiving current treatment of rigid immobilisation and follow-up[6].

One study in Scotland found that uncomplicated paediatric clavicle fractures can be managed without x-rays in the ED as the use of x-rays did not influence fracture management or add valuable information to clinicians' assessment[7].

1. Baig MN. (2017) A Review of Epidemiological Distribution of Different Types of Fractures in Paediatric Age. Cureus. 28;9(8):e1624
2. Marson BA et al. (2021) Trends in hospital admissions for childhood fractures in England. BMJ Paediatr Open. 10;5(1):e001187
3. Moon RJ et al (2016) Ethnic and geographic variations in the epidemiology of childhood fractures in the United Kingdom. Bone. 85:9-14
4. Mamoowala N et al (2019) Trends in paediatric distal radius fractures: an eight-year review from a large UK trauma unit. Ann R Coll Surg Engl. 101(4):297-303
5. Modifiable Templates for Management of Common Fractures. https://www.bscos.org.uk/public/resources
6. Perry DC et al. (2022). Immobilisation of torus fractures of the wrist in children (FORCE): a randomised controlled equivalence trial in the UK. Lancet; 400(10345):39-47
7. Lirette MP et al. (2018) Can paediatric emergency clinicians identify and manage clavicle fractures without radiographs in the emergency department? A prospective study. BMJ Paediatr Open. 10;2(1):e000304

Background (continued)

Manipulation of paediatric fractures

A GIRFT report on Paediatric Trauma and Orthopaedic Surgery found that over 250 weeks of theatre time a year had been used for manipulation of forearm fractures between 2016 and 2019[1]. A significant proportion of these displaced or angulated wrist fractures could have been manipulated and cast in the emergency department rather than being admitted and treated in the operating theatre. The GIRFT report found significant variation between trusts in the number of manipulations being performed in theatre. If the number of fractures manipulated in theatre at all trusts was reduced to the level seen in trusts with well-developed emergency department manipulation protocols there would be an 80% reduction in manipulations in theatre, reducing theatre time for forearm/wrist fractures to under 57 weeks.

Due to pressures on hospitals from the COVID-19 pandemic the British Orthopaedic Association developed guidelines for the early management of distal forearm fractures in children. A study conducted at one trust found that the implementation of these guidelines resulted in 86% of distal forearm fractures in children being manipulated in the emergency department, an increase from 32% prior to the COVID pandemic[2]. This saved approximately 63 hours of theatre time in the six-month study period.

The GIRFT report did highlight reluctance to perform procedures in the emergency department because of worries about breaching the 4 hour emergency department treatment target, a lack of space/facilities to perform sedation and a lack of familiarity with techniques[1].

1. Paediatric Trauma and Orthopaedic Surgery. GIRFT Programme National Specialty Report. April 2022. https://gettingitrightfirsttime.co.uk/girft-reports/
2. Fink BE etal (2023) Early Management of Paediatric Wrist and Forearm Fractures in a Busy District General Hospital Emergency Department: A Retrospective Cohort Comparison Study and Audit of BOAST Guidelines. Cureus. 15(7):e41325.

Aims

1. Add to the information in the literature on the incidence rate of various paediatric fractures (forearm, elbow, clavicle, tibia/fibula and toe) recorded in emergency care in England.
2. Understand the trends in management of these fracture types over time, e.g. have changes in guidance during COVID-19 changed the trends in management of fractures in emergency care.
3. Investigate the variation in management of these fracture types between trusts, and the potential activity savings if there was more widespread conservative management, such as reducing unnecessary follow-ups appointments and manipulation in the emergency department rather than in theatre.

Data sources and Study population

The study population included all those aged 16 and under who attended an emergency care centre in England between April 2019 and March 2024 and had a SNOMED code for a closed fracture of toe, clavicle, elbow, forearm or tibia/fibula recorded (see Appendices A-C for full code lists).

Records at a patient level were taken from the Emergency Care dataset (ECDS) and linked with any subsequent fracture related activity recorded in the Outpatient (OPA) and Admitted Patient Care Episode (APCE) datasets in the 3 months post-emergency care attendance. All data were accessed through the National Commissioning Data Repository (NCDR).

This study focuses on closed fractures as this is where there is scope for more conservative management; open, pathological, osteoporotic and birth trauma fractures have been excluded, alongside fractures of the great toe, which should all be followed up.

Incidence rates were calculated using the Office of National Statistics (ONS) mid-year population estimates by age and sex[1].

The coding of fractures is not sufficiently detailed and reliable to determine specific fracture types, and thus what would be the appropriate treatment at an individual patient level. For example, we cannot identify buckle fractures, which we know could be treated more conservatively. However, we could calculate the proportion of children with each fracture type that:

- had a fracture manipulated in theatre (only includes closed manipulations; those requiring internal fixation and re-manipulations are excluded)
- had a fracture manipulated in the emergency department
- received a follow-up outpatient appointment
- had a referral/appointment for physiotherapy
- had an X-ray in the emergency department

Full details of the coding used to identify these procedures/attendances is included in Appendix D.

1. https://www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/populationestimates/datasets/populationestimatesforukenglandandwalesscotlandandnorthernireland

Incidence rates

Incidence rates

Incidence rates were calculated to get a better understanding of the the scale of paediatric fracture attendances in emergency care, including

- trends over time
- the most common fracture types, and how these vary by age and sex
- Variation by region to determine whether there may be a greater burden of fractures in some ICB areas

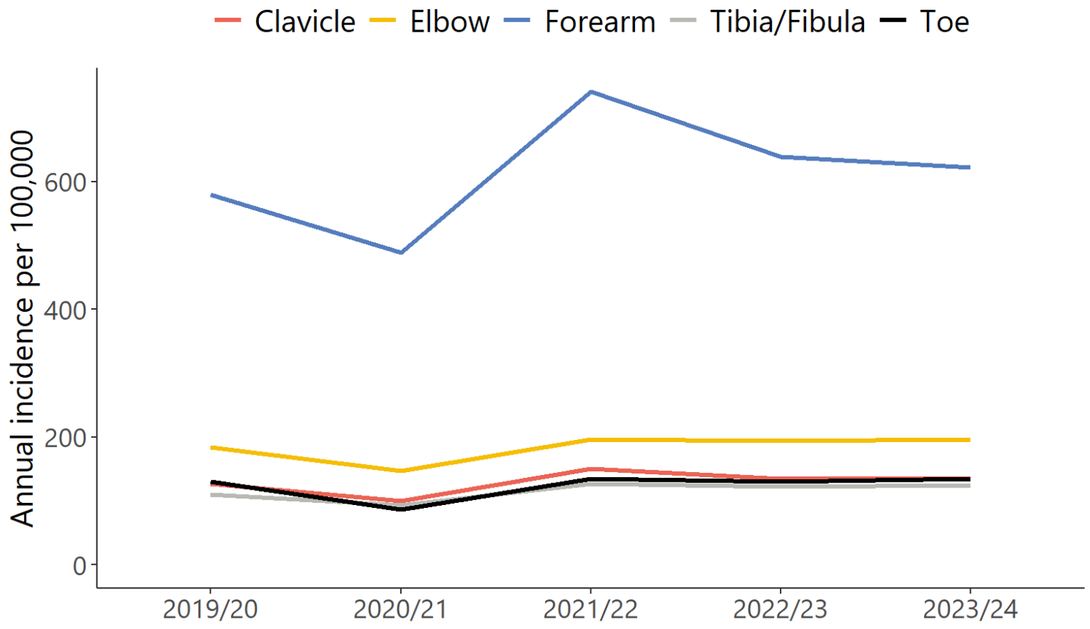
These incidence rates are not the incidence of fractures, but should be considered as the incidence of a recorded emergency care attendance for the specified closed fracture types.

The crude annual incidence rates per 100,000 children were calculated using ONS mid-year population estimates, broken down by age and sex.

Characteristics of the cohort

	Clavicle (N=73,303)	Elbow (N=103,958)	Forearm (N=347,472)	Tibia/Fibula (N=65,368)	Toe (N=69,797)	Overall (N=659,898)
Sex						
Female	22,462 (30.6%)	47,294 (45.5%)	135,026 (38.9%)	26,375 (40.3%)	28,358 (40.6%)	259,515 (39.3%)
Male	50,650 (69.1%)	56,397 (54.2%)	211,579 (60.9%)	38,820 (59.4%)	41,312 (59.2%)	398,758 (60.4%)
Missing/Unknown	191 (0.3%)	267 (0.3%)	867 (0.2%)	173 (0.3%)	127 (0.2%)	1,625 (0.2%)
Age						
0-4 yrs	19,718 (26.9%)	25,978 (25.0%)	43,446 (12.5%)	29,284 (44.8%)	3,385 (4.8%)	121,811 (18.5%)
5-10 yrs	22,129 (30.2%)	50,687 (48.8%)	161,671 (46.5%)	14,097 (21.6%)	25,130 (36.0%)	273,714 (41.5%)
11-16 yrs	31,456 (42.9%)	27,293 (26.3%)	142,355 (41.0%)	21,987 (33.6%)	41,282 (59.1%)	264,373 (40.1%)
Ethnicity						
Asian or Asian British	3,844 (5.2%)	9,155 (8.8%)	21,846 (6.3%)	4,368 (6.7%)	4,342 (6.2%)	43,555 (6.6%)
Black or Black British	1,721 (2.3%)	2,163 (2.1%)	7,200 (2.1%)	2,113 (3.2%)	1,745 (2.5%)	14,942 (2.3%)
Mixed	2,291 (3.1%)	3,663 (3.5%)	10,748 (3.1%)	2,477 (3.8%)	2,226 (3.2%)	21,405 (3.2%)
Other Ethnic Groups	2,050 (2.8%)	2,970 (2.9%)	9,725 (2.8%)	2,142 (3.3%)	1,781 (2.6%)	18,668 (2.8%)
White	56,194 (76.7%)	76,296 (73.4%)	264,921 (76.2%)	48,088 (73.6%)	52,964 (75.9%)	498,463 (75.5%)
Missing/Unknown	7,203 (9.8%)	9,711 (9.3%)	33,032 (9.5%)	6,180 (9.5%)	6,739 (9.7%)	62,865 (9.5%)
IMD Quintiles						
1- Most deprived	16,116 (22.0%)	26,418 (25.4%)	80,955 (23.3%)	16,507 (25.3%)	16,164 (23.2%)	156,160 (23.7%)
2	13,544 (18.5%)	20,349 (19.6%)	66,825 (19.2%)	12,959 (19.8%)	13,262 (19.0%)	126,939 (19.2%)
3	13,904 (19.0%)	19,029 (18.3%)	64,685 (18.6%)	11,835 (18.1%)	13,021 (18.7%)	122,474 (18.6%)
4	14,261 (19.5%)	18,670 (18.0%)	65,157 (18.8%)	11,743 (18.0%)	13,125 (18.8%)	122,956 (18.6%)
5- Least deprived	14,698 (20.1%)	18,396 (17.7%)	66,501 (19.1%)	11,662 (17.8%)	13,630 (19.5%)	124,887 (18.9%)
Missing/Outside England	780 (1.1%)	1,096 (1.1%)	3,349 (1.0%)	662 (1.0%)	595 (0.9%)	6,482 (1.0%)
Emergency Dept type						
Major Emergency Dept	57,459 (78.4%)	81,863 (78.7%)	259,815 (74.8%)	54,357 (83.2%)	44,682 (64.0%)	498,176 (75.5%)
Urgent Treatment Centre/Walk in centre	15,836 (21.6%)	22,088 (21.2%)	87,614 (25.2%)	10,993 (16.8%)	25,113 (36.0%)	161,644 (24.5%)
Mono-specialty Emergency Dept	0 (0%)	0 (0%)	1 (0.0%)	2 (0.0%)	0 (0%)	3 (0.0%)
Same Day Emergency Care	8 (0.0%)	7 (0.0%)	42 (0.0%)	16 (0.0%)	2 (0.0%)	75 (0.0%)
Day of ED attendance						
Weekday	50,917 (69.5%)	74,537 (71.7%)	253,259 (72.9%)	46,088 (70.5%)	51,859 (74.3%)	476,660 (72.2%)
Weekend	22,386 (30.5%)	29,421 (28.3%)	94,213 (27.1%)	19,280 (29.5%)	17,938 (25.7%)	183,238 (27.8%)
Time of ED attendance						
Daytime 7am to 7pm	62,907 (85.8%)	87,237 (83.9%)	301,785 (86.9%)	55,995 (85.7%)	61,135 (87.6%)	569,059 (86.2%)
Nighttime 7pm to 7am	10,396 (14.2%)	16,721 (16.1%)	45,687 (13.1%)	9,373 (14.3%)	8,662 (12.4%)	90,839 (13.8%)
Year of ED attendance						
2019/20	14,565 (19.9%)	21,103 (20.3%)	66,577 (19.2%)	12,711 (19.4%)	14,953 (21.4%)	129,909 (19.7%)
2020/21	11,612 (15.8%)	16,942 (16.3%)	56,492 (16.3%)	10,719 (16.4%)	9,969 (14.3%)	105,734 (16.0%)
2021/22	16,739 (22.8%)	21,943 (21.1%)	82,556 (23.8%)	14,190 (21.7%)	15,034 (21.5%)	150,462 (22.8%)
2022/23	15,119 (20.6%)	21,840 (21.0%)	71,844 (20.7%)	13,740 (21.0%)	14,604 (20.9%)	137,147 (20.8%)
2023/24	15,268 (20.8%)	22,130 (21.3%)	70,003 (20.1%)	14,008 (21.4%)	15,237 (21.8%)	136,646 (20.7%)

Incidence rates for England (2023/2024)



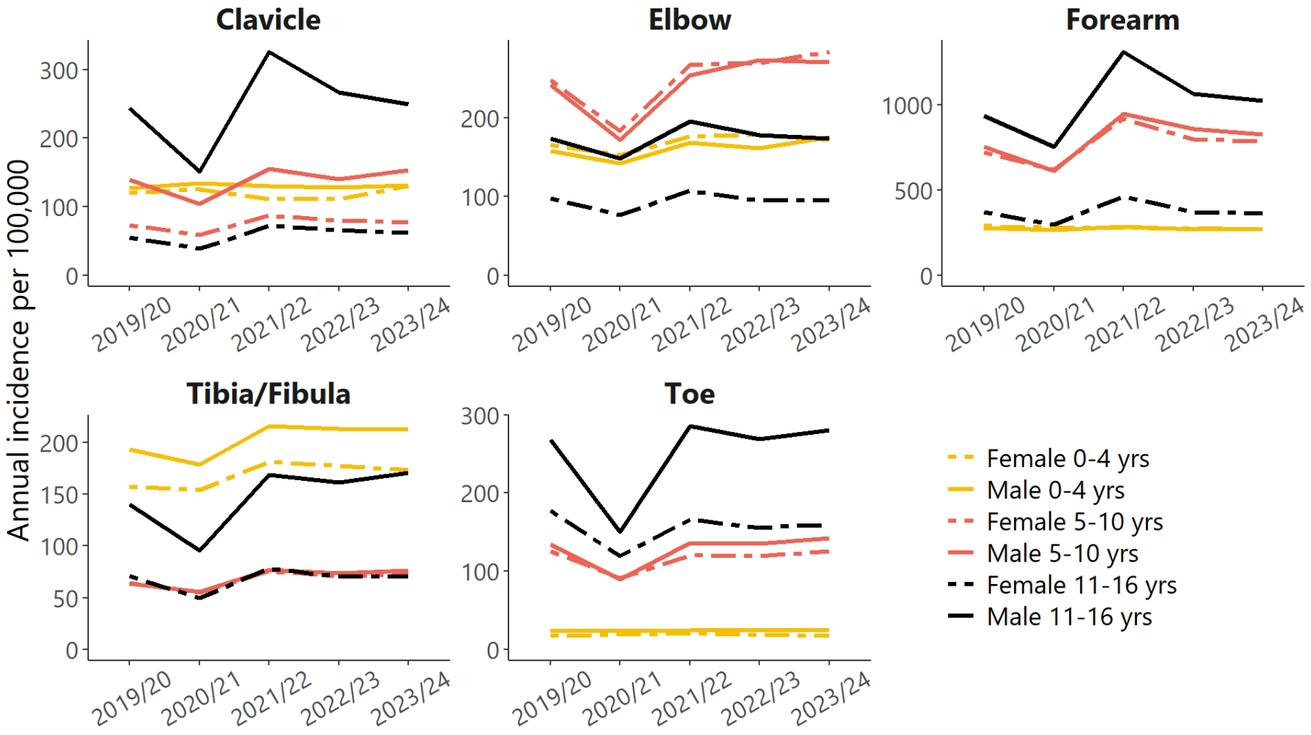
Annual crude incidence of attendance in emergency care with a fracture, per 100,000 children

Type	Female 0-4 yrs	Female 5-10 yrs	Female 11-16 yrs	Male 0-4 yrs	Male 5-10 yrs	Male 11-16 yrs	**Total**
Clavicle	131	77	62	131	154	250	**136**
Elbow	172	284	95	175	271	174	**197**
Forearm	270	786	362	273	828	1,024	**622**
Tibia/Fibula	174	72	71	213	76	171	**124**
Toe	17	125	160	26	142	281	**135**
Total	**764**	**1,344**	**750**	**818**	**1,471**	**1,900**	**1,214**

Forearm fractures are the most common followed by elbow fractures.

The overall fracture rate was lowest during the peak of the COVID-19 pandemic (2020/2021) and highest the following year (2021/2022).

Incidence rate by age/sex group



Tibia/Fibula fractures are most common in those aged 0-4 years.

Elbow fractures are most common in those aged 5-10 years.

In the 11-16 year old age group all fracture types are more common in males compared to females, with males aged 11-16 years old having the highest incidence of clavicle, forearm and toe fractures.

Denominator for calculating incidence rate is the number of children of that age and sex in England taken from the ONS mid-year population estimates, e.g. incidence per 100,000 0-4 year old males.

Most common fracture types (2023/2024)

SNOMED description		Number	Percentage
Closed fracture of radius (disorder)	Forearm	48,043	35.2
Elbow fracture - closed (disorder)	Elbow	18,613	13.6
Closed fracture of radius AND ulna (disorder)	Forearm	17,498	12.8
Closed fracture of clavicle	Clavicle	15,259	11.2
Closed fracture of phalanx of foot (disorder)	Toe	15,232	11.1
Closed fracture of tibia (disorder)	Tibia/Fibula	8,549	6.3
Closed fracture of ulna (disorder)	Forearm	4,347	3.2
Closed supracondylar fracture of humerus (disorder)	Elbow	3,394	2.5
Closed fracture of fibula (disorder)	Tibia/Fibula	3,278	2.4
Closed fracture of tibia AND fibula (disorder)	Tibia/Fibula	2,145	1.6
Closed Monteggia's fracture (disorder)	Elbow	108	0.1
Closed Galeazzi fracture (disorder)	Forearm	65	0.0
Closed fracture of distal end of radius (disorder)	Forearm	23	0.0

Only showing those fracture types recorded 10 or more times

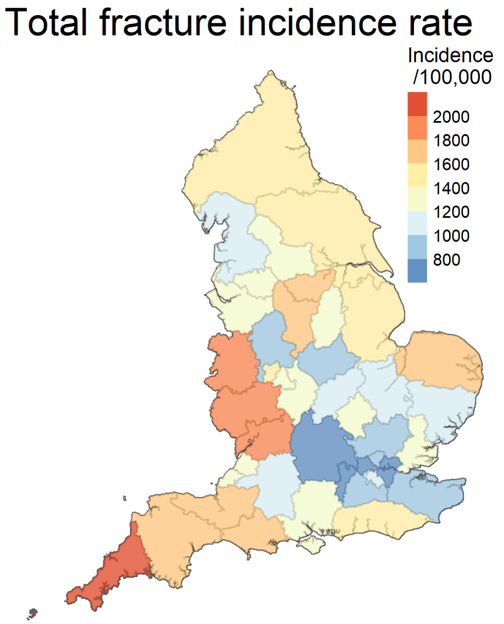
The majority of fractures are recorded within the emergency care dataset under just a few snomed codes.

There are codes available that specify whether a radius fracture is proximal or distal, but these are not used, instead the general code ‘Closed fracture of radius (disorder)’ is used. We have classified this as a forearm fracture but some of these might be proximal radius fractures and therefore more accurately classified at elbow fractures.

Fractures of great toe were excluded as these should be followed up, however <10 codes related to the fracture of the great toe were recorded over the whole 5 year period in England, suggesting that many of great toe fractures may be coded as ‘Closed fracture of phalanx of foot (disorder)’ and thus included within our dataset.

Incidence rates per 100,000 by ICB (2023/2024)

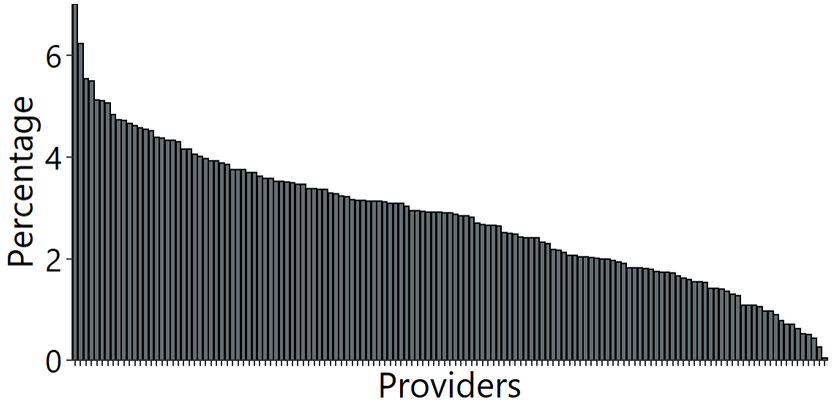
ICB	Clavicle	Elbow	Forearm	Tibia/Fibula	Toe	Total	% of ED attendances w/o diagnosis
NHS Cornwall and the Isles of Scilly ICB	220	365	1,136	177	262	2,159	1
NHS Herefordshire and Worcestershire ICB	201	308	1,016	142	269	1,934	22
NHS Shropshire, Telford and Wrekin ICB	215	292	971	139	230	1,847	24
NHS Gloucestershire ICB	222	186	1,004	183	205	1,800	37
NHS Derby and Derbyshire ICB	185	256	905	169	232	1,747	13
NHS Somerset ICB	195	280	925	150	190	1,740	18
NHS Dorset ICB	188	280	857	145	194	1,664	26
NHS South Yorkshire ICB	192	305	803	169	193	1,662	18
NHS Norfolk and Waveney ICB	198	281	842	167	165	1,653	8
NHS Devon ICB	188	262	871	163	150	1,634	23
NHS Black Country ICB	164	304	818	148	144	1,578	42
NHS Sussex ICB	162	241	825	128	171	1,528	16
NHS North East and North Cumbria ICB	146	232	748	148	186	1,460	26
NHS Humber and North Yorkshire ICB	187	213	727	136	162	1,425	18
NHS Lincolnshire ICB	146	214	736	134	187	1,417	6
NHS Coventry and Warwickshire ICB	174	189	717	146	149	1,375	16
NHS Bedfordshire, Luton and Milton Keynes ICB	132	246	688	110	146	1,322	22
NHS Greater Manchester ICB	140	196	708	114	164	1,322	32
NHS Mid and South Essex ICB	138	215	660	163	137	1,312	6
NHS Cheshire and Merseyside ICB	150	221	661	139	141	1,311	31
NHS Hampshire and Isle of Wight ICB	134	231	638	139	125	1,267	19
NHS West Yorkshire ICB	156	200	621	132	133	1,243	23
NHS Birmingham and Solihull ICB	127	236	603	123	142	1,232	18
NHS Bristol, North Somerset and South Gloucestershire ICB	125	226	589	177	91	1,208	7
NHS Nottingham and Nottinghamshire ICB	131	216	597	150	114	1,208	13
NHS Northamptonshire ICB	144	202	578	97	118	1,139	13
NHS Bath and North East Somerset, Swindon and Wiltshire ICB	145	191	571	116	94	1,117	24
NHS South West London ICB	130	111	569	149	141	1,101	39
NHS Cambridgeshire and Peterborough ICB	146	179	550	99	120	1,094	45
NHS Suffolk and North East Essex ICB	145	157	523	106	129	1,060	27
NHS Lancashire and South Cumbria ICB	122	170	530	124	107	1,052	31
NHS Hertfordshire and West Essex ICB	110	150	506	100	113	980	22
NHS Surrey Heartlands ICB	130	162	460	102	115	970	31
NHS Leicester, Leicestershire and Rutland ICB	99	168	446	128	94	934	2
NHS Staffordshire and Stoke-on-Trent ICB	87	121	503	88	125	923	12
NHS North Central London ICB	92	135	438	107	92	864	34
NHS Kent and Medway ICB	85	104	440	63	109	801	48
NHS North West London ICB	82	132	393	88	74	770	38
NHS Buckinghamshire, Oxfordshire and Berkshire West ICB	84	116	356	78	55	689	39
NHS Frimley ICB	70	118	327	77	46	639	35
NHS South East London ICB	62	103	293	72	69	598	23
NHS North East London ICB	59	121	276	80	47	584	33



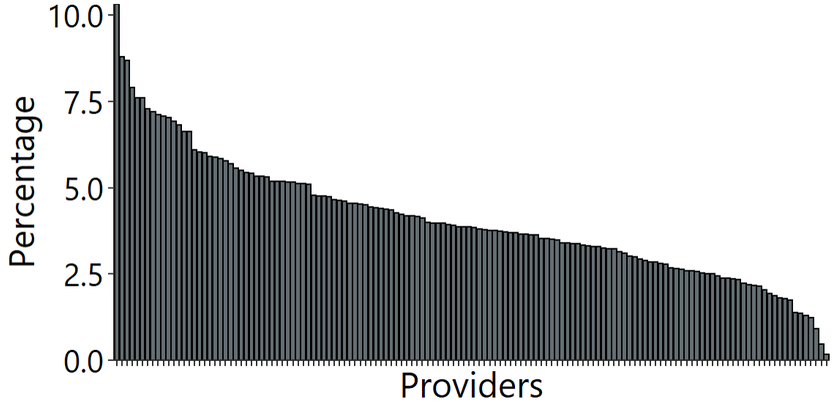
While lower rates in some areas will be the result of some trusts in those areas not reliably recording diagnoses codes for emergency care attendances there is evidence of variation in incidence rates by ICB. For example, diagnoses rates are high in both the Cornwall and Leicestershire ICB areas, but incidence rates are considerably lower in the Leicestershire ICB area compared to Cornwall.

Proportion of ED attendances with a fracture code (2022/2023)

Percentage of all emergency care attendances for those aged 16 or under where a fracture code is recorded.



Percentage of emergency care attendances **with a diagnosis code** for those aged 16 or under, where the recorded code is for a fracture.

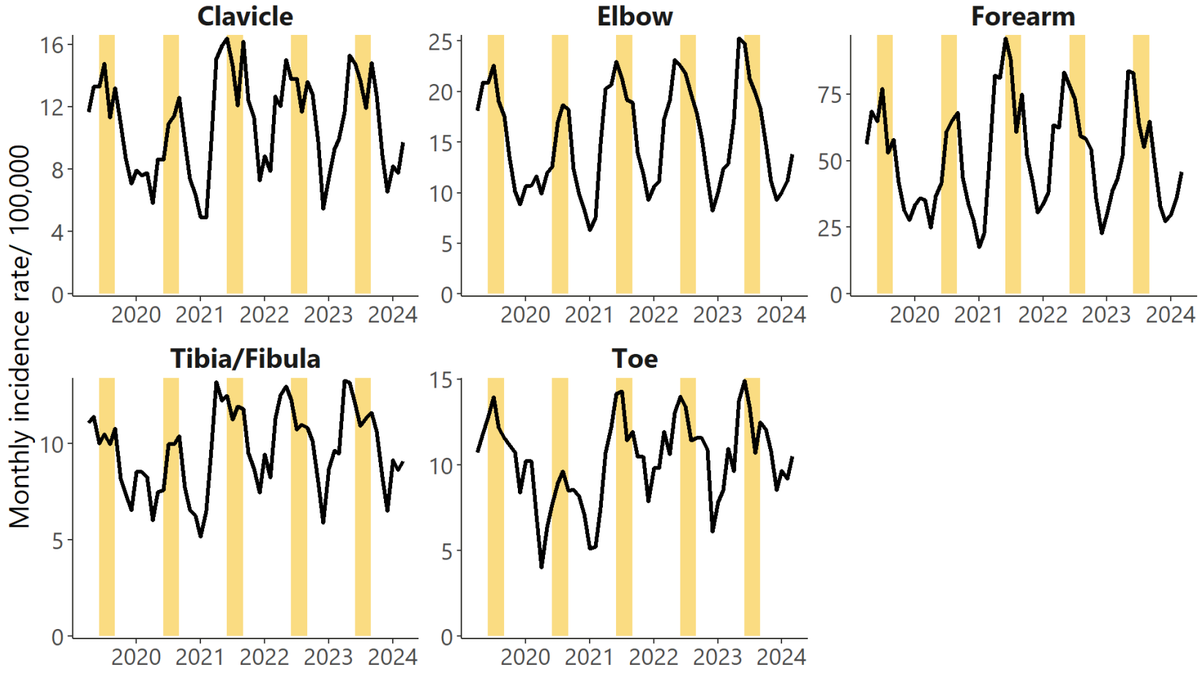


There is considerable variability between providers in the percentage emergency care attendances where a fracture is recorded. Even when accounting for the different rates of recording diagnoses seen between trusts, the percentage of diagnoses that are fractures varies considerably.

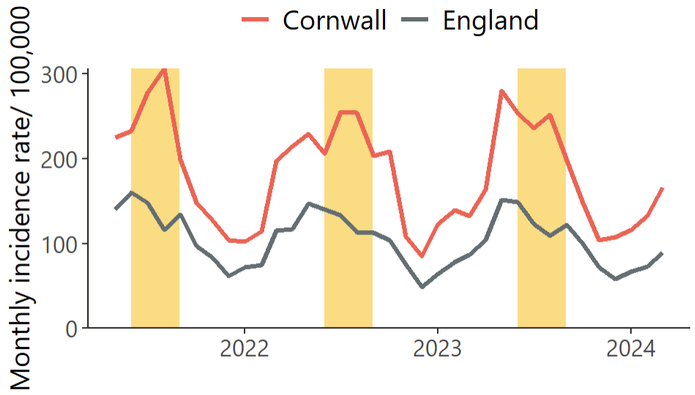
These differences could be due to:

- Alternative provision locally, e.g. in some areas there is independent urgent care provision available.
- Regional differences in fracture rate, which may be related to levels of physical activity, visitors from out of area and the demographic of the area.
- Issues with coding/reporting, including variation in what diagnoses are recorded.

Seasonal trends incidence rate



For all fracture types incidence rates increase in the summer months (June-Aug, highlighted in yellow), likely due to increases in children participating in physical activities.



The incidence rate in Cornwall is higher year round compared to England as a whole. However, in the summer months (June-Aug, highlighted in yellow) the incidence rate in Cornwall increases more than in England as a whole; in Cornwall the summer incidence rate is on average 78% higher than in the winter, whereas for England as it is 66% higher. Therefore some of the higher incidence rate in Cornwall may be as a result of tourism in the summer months.

Only one trust in the Cornwall ICB area provides emergency care and in 2022/23 they recorded diagnoses codes for over 99% of emergency care attendances, so this will be contributing to the higher rate seen in Cornwall, as nationally only 70% of attendances had diagnoses codes recorded in 2022/23.

Summary of analysis of incidence rates

- In children, forearm fractures are the most common followed by elbow fractures.
- Fractures of tibia/fibula are most common in under 5. Elbow fractures are most common in 5-10 year olds. For older children the fracture rate is higher in boys compared to girls, with boys aged 11-16 years having the highest rates of clavicle, forearm and toe fractures.
- There is significant seasonality with much higher fractures rates seen in the summer months, likely related to increased outdoor physical activity.
- Incidence rates vary considerably by ICB region and by trust. Some of these differences will be due to issues with coding and reporting of fractures, as the proportion of emergency care attendances without a diagnosis code recorded varies significantly between trusts. However, some of the differences seen between trusts are likely related to availability of alternative provision locally (independent urgent treatment centres or alternative specialist paediatric provision nearby) or due to differences between areas in the patient demographic and in levels of physical activity.
- Lack of detailed coding of fractures means some fractures may be misclassified, e.g. it is not possible to determine which radius fractures may be more accurately classified as elbow rather than forearm fractures, and great toe fractures are not specifically recorded.

Trends in paediatric fracture management

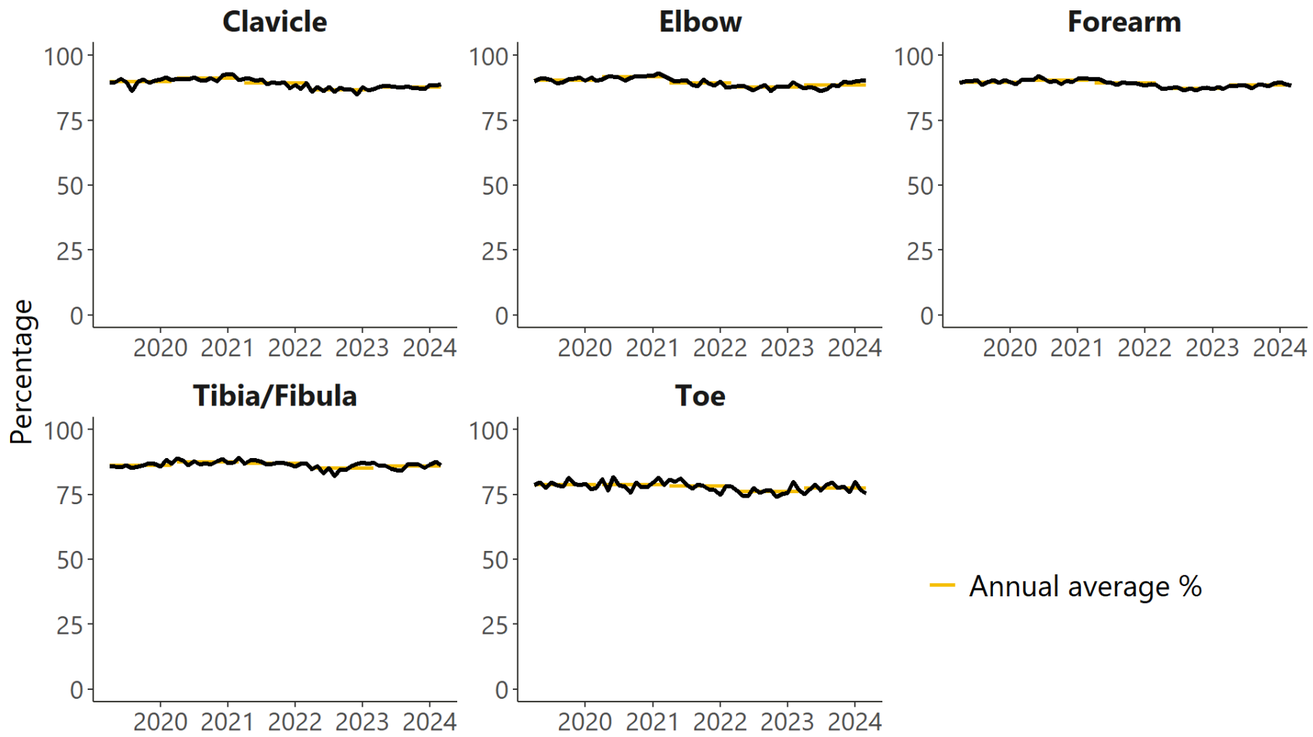
Exploring fracture management

There have been recent studies and guidance suggesting a more conservative approach to managing paediatric fractures should be adopted. Therefore we set out to consider whether paediatric fracture management has changed over the last 5 years.

We have investigated:

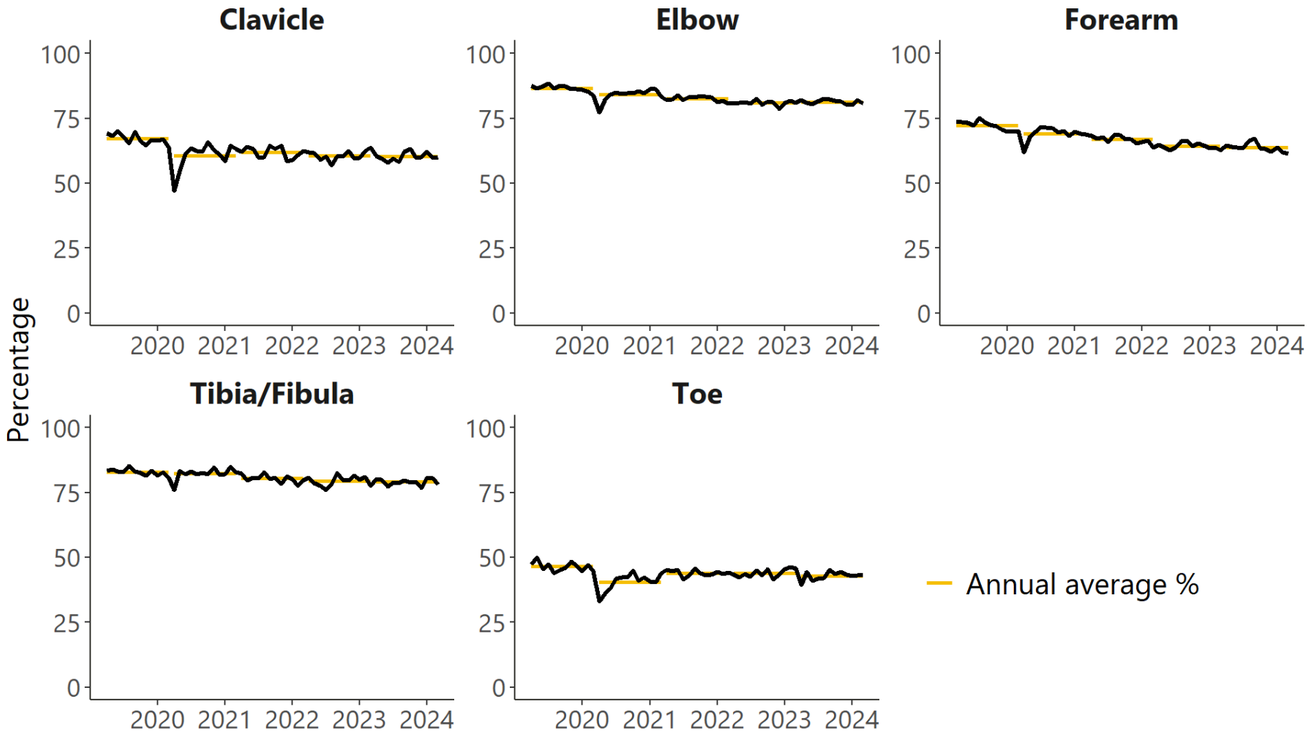
- The proportion of fracture that are x-rayed within the emergency department
- The proportion of fractures that receive an outpatient follow-up appointment, which could be an outpatient or physiotherapy appointment.
- The types of follow-up appointments, including looking specifically at physiotherapy appointments.
- The proportion of fractures being manipulated and the trends in manipulations in both the emergency department and in theatre.

Percentage of fractures with a X-ray recorded in the ED



The majority of fractures of all types are x-rayed in the emergency department, although the percentage of toe fractures x-rayed is slightly lower.

Percentage of fractures with a follow-up appointment

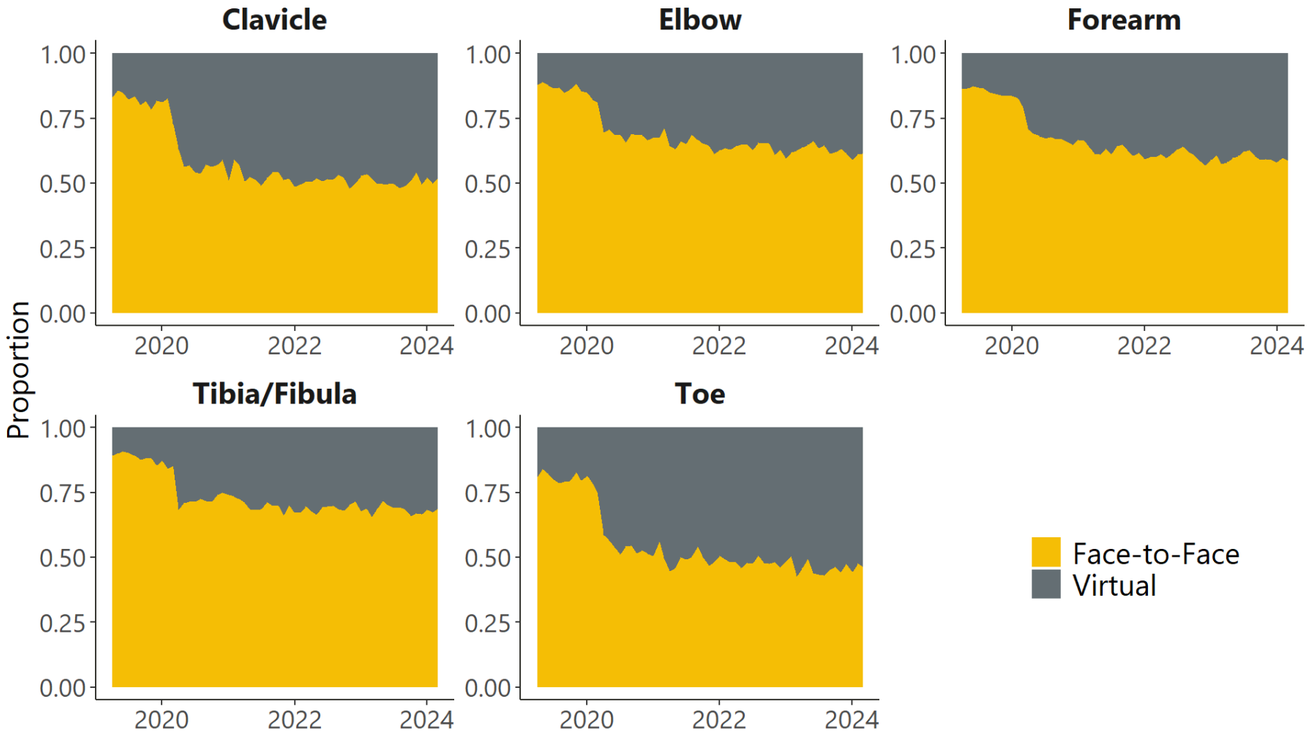


These data give the proportion of children with fractures that receive at least one follow-up appointment, which could be either an outpatient department appointment or physiotherapy appointment.

Follow-up rates are lower for toe and clavicle fractures, and highest for tibia/fibula and elbow fractures.

In the past 5 years, there has been over a 10% reduction in the proportion of emergency department attendances for clavicle and forearm where a follow-up appointment is given.

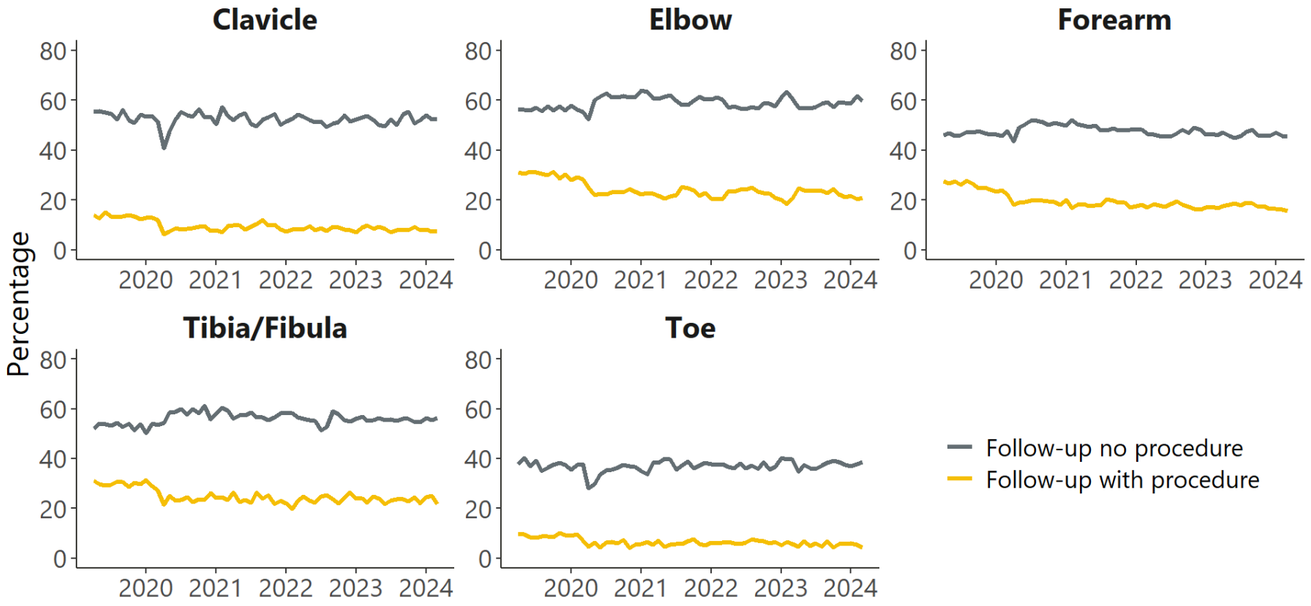
Proportion of face-to-face vs virtual follow-up appointments



During the COVID-19 pandemic the proportion of follow up appointments conducted face-to-face significantly decreased, and this reduction in face-to-face follow-ups has been maintained.

Only showing data for the first outpatient attendance

Follow-up outpatient appts with and without procedures

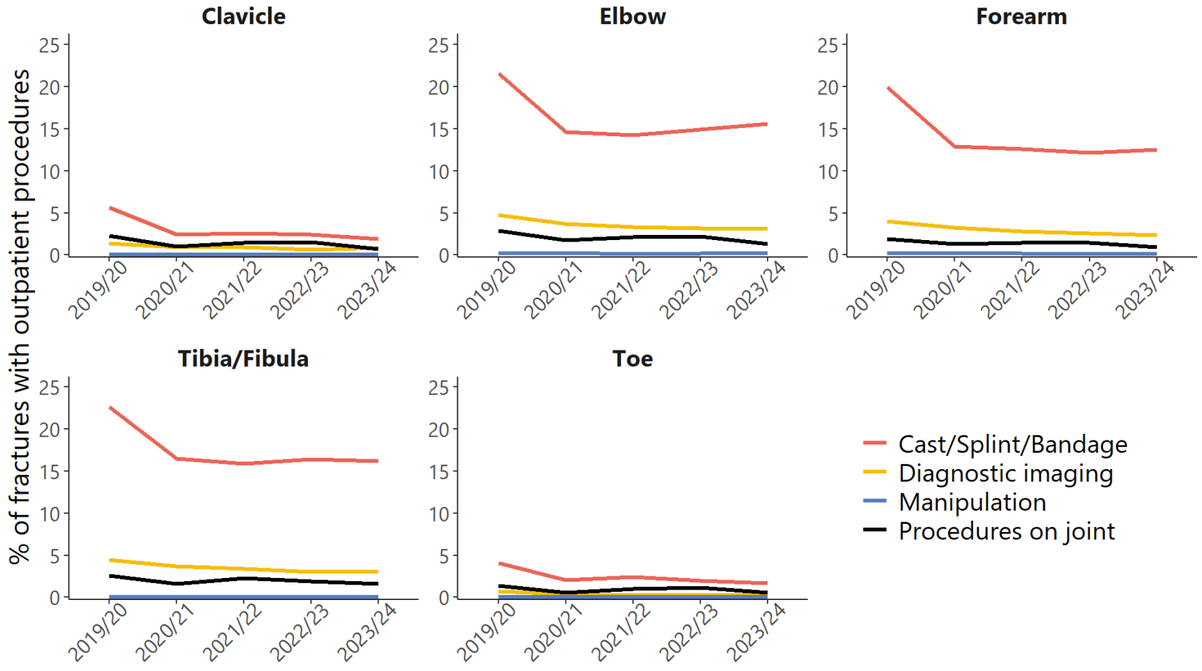


Only showing data for the first outpatient attendance

Over the last 5 years the proportion of children with a fracture that had a follow-up outpatient appointment where a procedure was recorded has decreased, especially following COVID-19.

The proportion of follow-up outpatient appointments with no procedures recorded has remained relatively stable over time. Although for tibia/fibula and elbow fractures there was a slight increase in the proportion of these follow-ups at the start of the pandemic which has remained in the post-pandemic.

Outpatient procedures recorded following ED attendance



Only showing data for the first outpatient attendance and the most common types of procedures

The majority of procedures are related to casts/bandages/splints, and the numbers of these have decreased post-pandemic, as has the number of diagnostic imaging procedures during follow-up appointments. This likely indicates a move towards more conservative management of fractures, and to be expected with an increased proportion of follow-ups being conducted virtually.

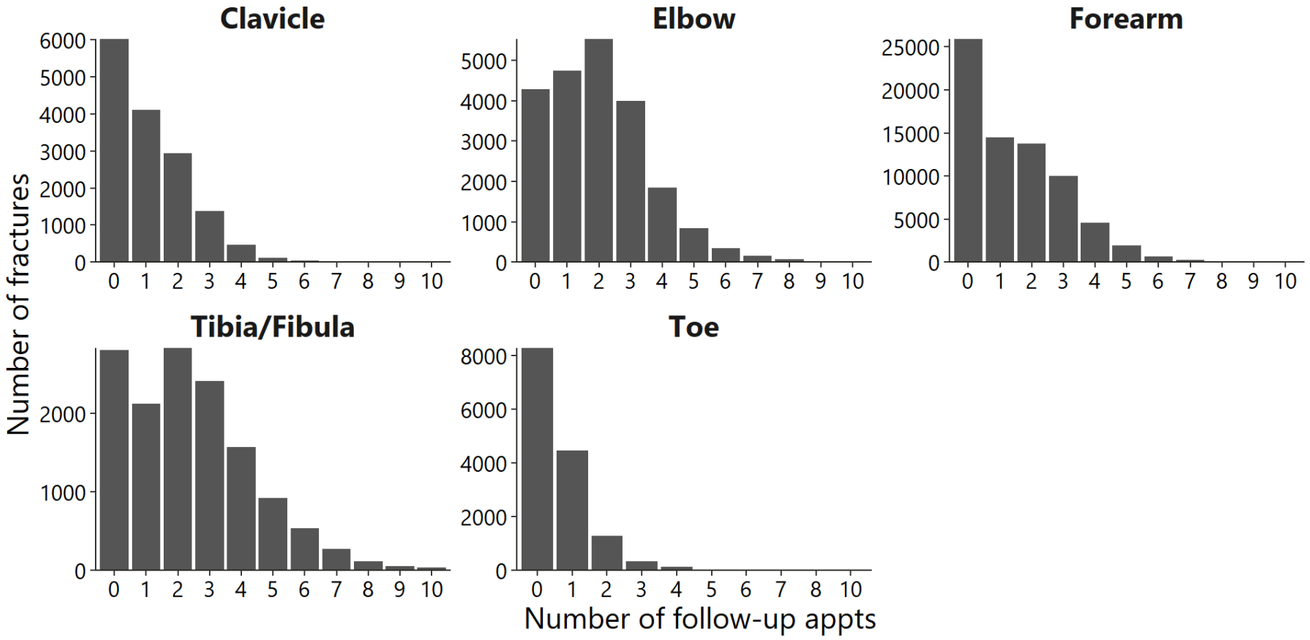
There are also some procedures of joint (OPCS code W92) recorded in these outpatient follow-up appointments (this code includes procedures such as: distension of joint, examination of joint including under image intensifier or anaesthetic, chemical or radiation synovectomy)

The number of manipulations recorded during outpatient appointments is extremely small.

It is fairly common for more than one procedure to be recorded.

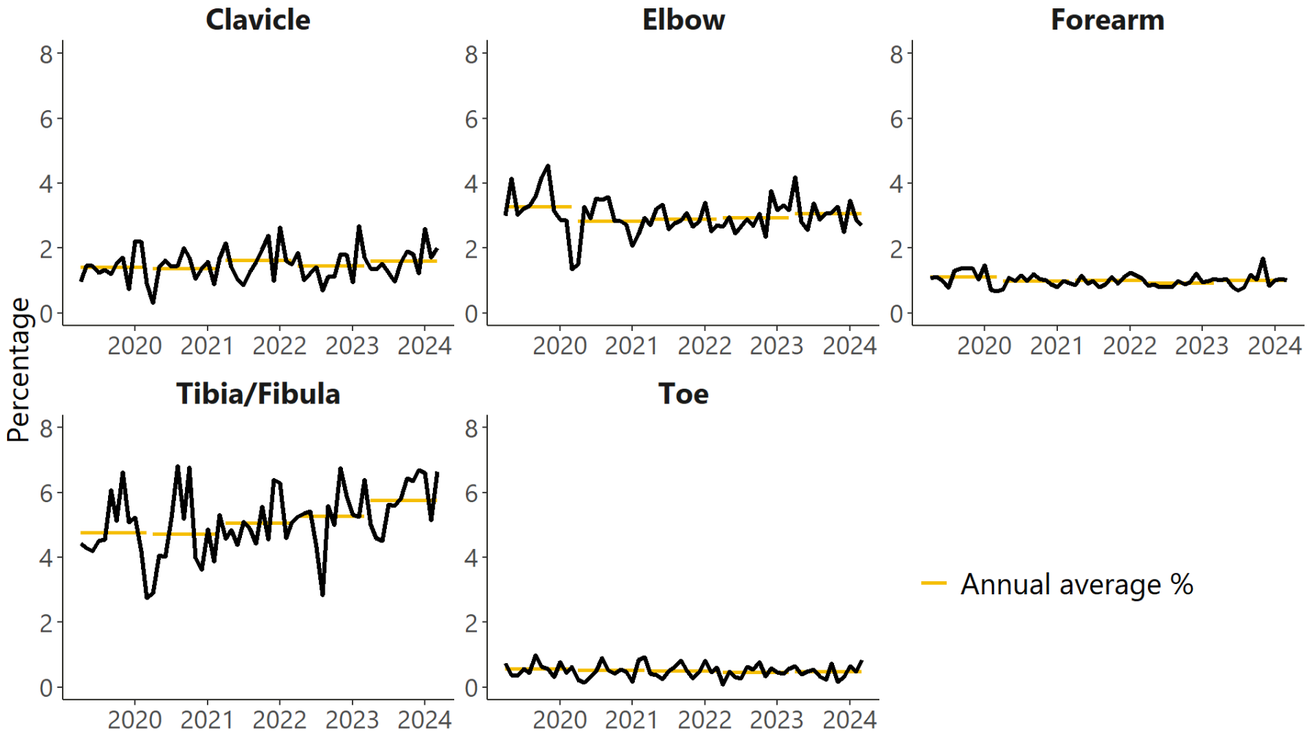
Number of follow-up appointments (2022/23)

Includes all outpatient attendances, including physiotherapy appointments, in the 3 months post-fracture.



	Mean	Median
Clavicle	1.1	1
Elbow	2.0	2
Forearm	1.5	1
Tibia/Fibula	2.4	2
Toe	0.6	0

Percentage of fractures referred for physiotherapy



The percentage of fractures with a referral/outpatient attendance for physiotherapy in the 3-months post-fractures are higher for those with elbow and tibia/fibula fractures, but generally very low for the other fracture types.

Generally the proportion referred to physiotherapy has remained relatively stable, but there is a trend towards an increase the proportion of tibia/fibula fractures referred.

Factors influencing whether a follow-up appointment is given

	Odds Ratio	Confidence Intervals	P value
(Intercept)	2.20	2.15 to 2.25	<0.001*
Sex			
Female	1.00		Reference
Male	1.12	1.11 to 1.13	<0.001*
Age			
5-10 yrs	1.00		Reference
0-4 yrs	0.96	0.94 to 0.97	<0.001*
11-16 yrs	1.15	1.13 to 1.16	<0.001*
Ethnicity			
White	1.00		Reference
Asian or Asian British	1.05	1.03 to 1.08	<0.001*
Black or Black British	1.14	1.1 to 1.19	<0.001*
Mixed	1.01	0.98 to 1.05	0.34
Other Ethnic Groups	1.00	0.97 to 1.04	0.86
Missing/Unknown	0.97	0.95 to 0.98	<0.001*
IMD Quintiles			
1- Most deprived	1.00		Reference
2	1.08	1.07 to 1.1	<0.001*
3	1.03	1.01 to 1.04	<0.001*
4	1.05	1.04 to 1.07	<0.001*
5- Least deprived	1.08	1.06 to 1.1	<0.001*
Department type			
Major Emergency Department	1.00		Reference
Urgent Treatment Centre/Walk in centre	0.96	0.95 to 0.98	<0.001*
Day of the week			
Week	1.00		Reference
Weekend	1.06	1.05 to 1.08	<0.001*
Time of day			
Day 7am-7pm	1.00		Reference
Night 7pm to 7am	1.12	1.1 to 1.13	<0.001*
Time of year			
Autumn	1.00		Reference
Winter	0.94	0.93 to 0.96	<0.001*
Spring	0.95	0.94 to 0.97	<0.001*
Summer	0.99	0.97 to 1	0.06
Year			
2019/20	1.00		Reference
2020/21	0.85	0.83 to 0.86	<0.001*
2021/22	0.79	0.77 to 0.8	<0.001*
2022/23	0.72	0.71 to 0.73	<0.001*
2023/24	0.72	0.71 to 0.73	<0.001*
Fracture type			
Clavicle	0.79	0.78 to 0.8	<0.001*
Forearm	1.00		Reference
Elbow	2.47	2.43 to 2.52	<0.001*
Tibia/Fibula	2.09	2.05 to 2.14	<0.001*
Toe	0.37	0.36 to 0.37	<0.001*

Logistic regression was used to determine which variables are independently associated with a follow-up appointment being given. This allows us to identify which characteristics and thus which groups of children are more or less likely to be given a follow-up appointment. An odds ratio of greater than 1 indicates an increased chance of having a follow-up appointment compared to the reference group, while an odds ratio below 1 indicates a reduced chance of a follow-up.

Children are more likely to be given a follow-up appointment (outpatient/physiotherapy) if they are

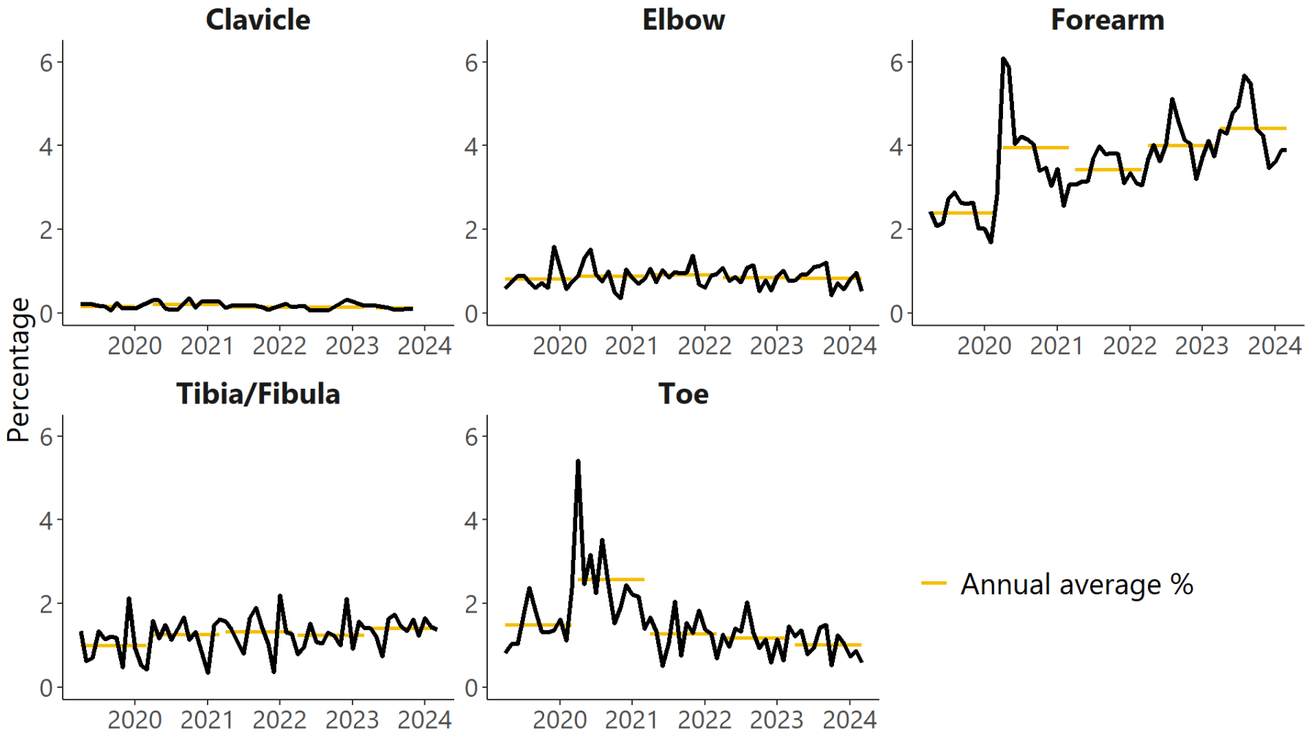
- male
- 11-16 years old
- from an asian or black background
- living in a less deprived area

They are also more likely to have a follow-up appointment if they attended

- an emergency department
- on a weekend
- at nighttime

Those attending in more recent years were less likely to have a follow-up appointment, even after attempting to adjust for case-mix, further indicating there has been a move towards fewer follow-up appointments.

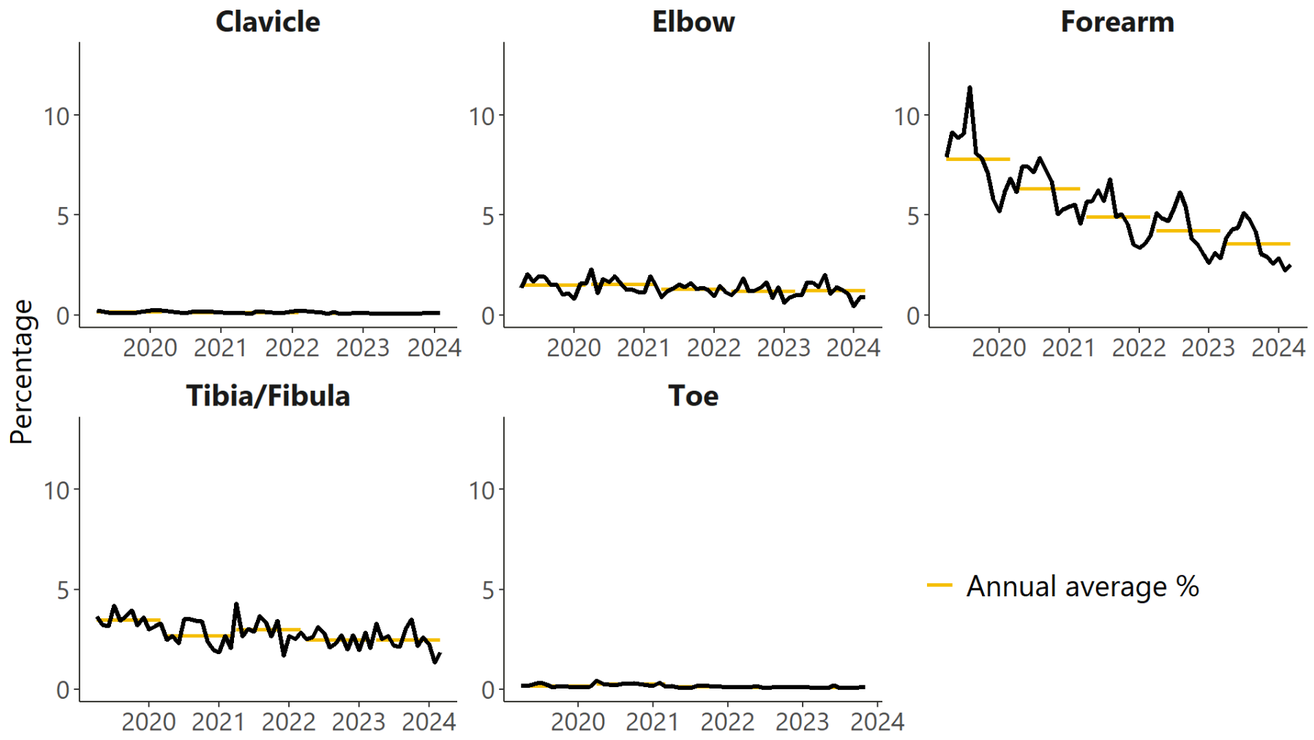
Percentage of fractures manipulated in the ED



The percentage of forearm fractures manipulated in the emergency department has increased over the last 5 years, with a large increase seen during the COVID-19 pandemic. There is also a noticeable seasonal trend with a greater percentage of fractures manipulated in the emergency department during the summer months.

The percentage of tibia/fibula fractures manipulated in the emergency department has also increased, but there is little change in the other fracture types over time.

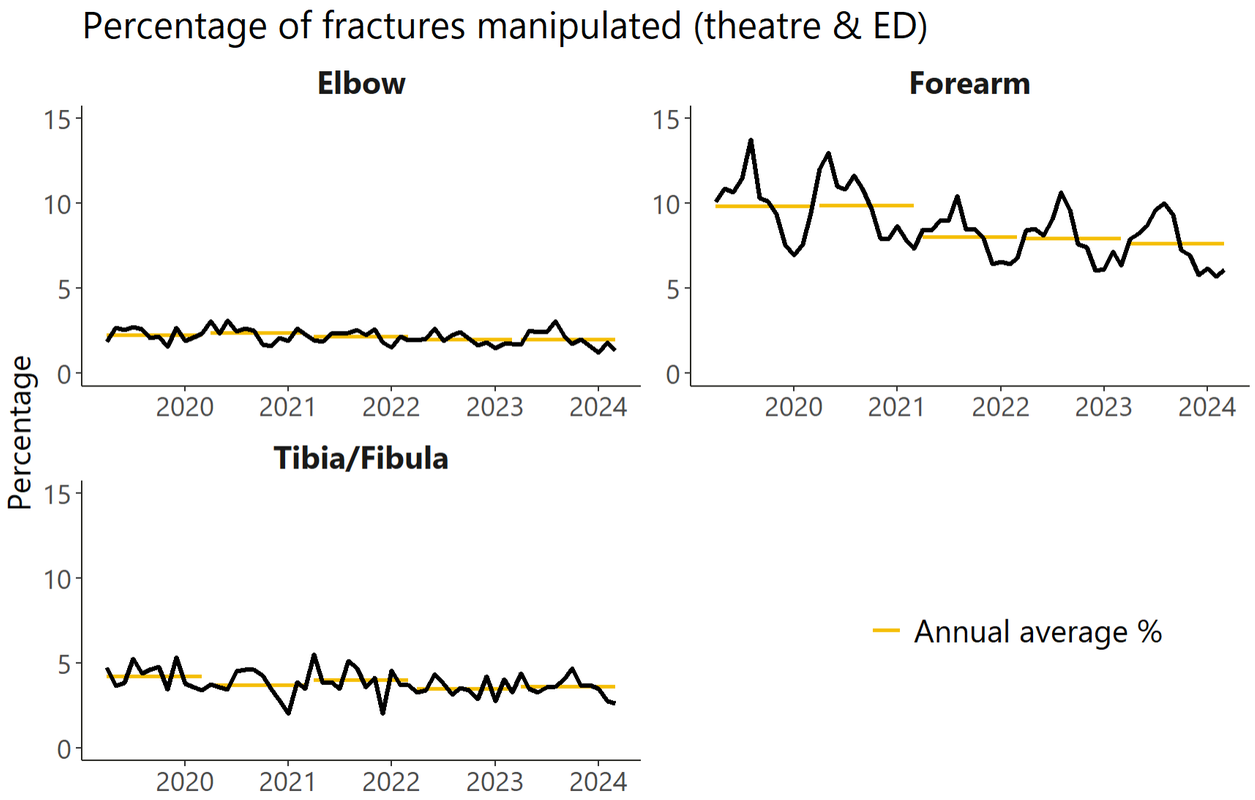
Percentage of fractures manipulated in theatre



The percentage of forearm fractures manipulated in theatre has decreased significantly over the last 5 years (by over 50%), with a greater percentage of fractures manipulated in theatre during the summer months.

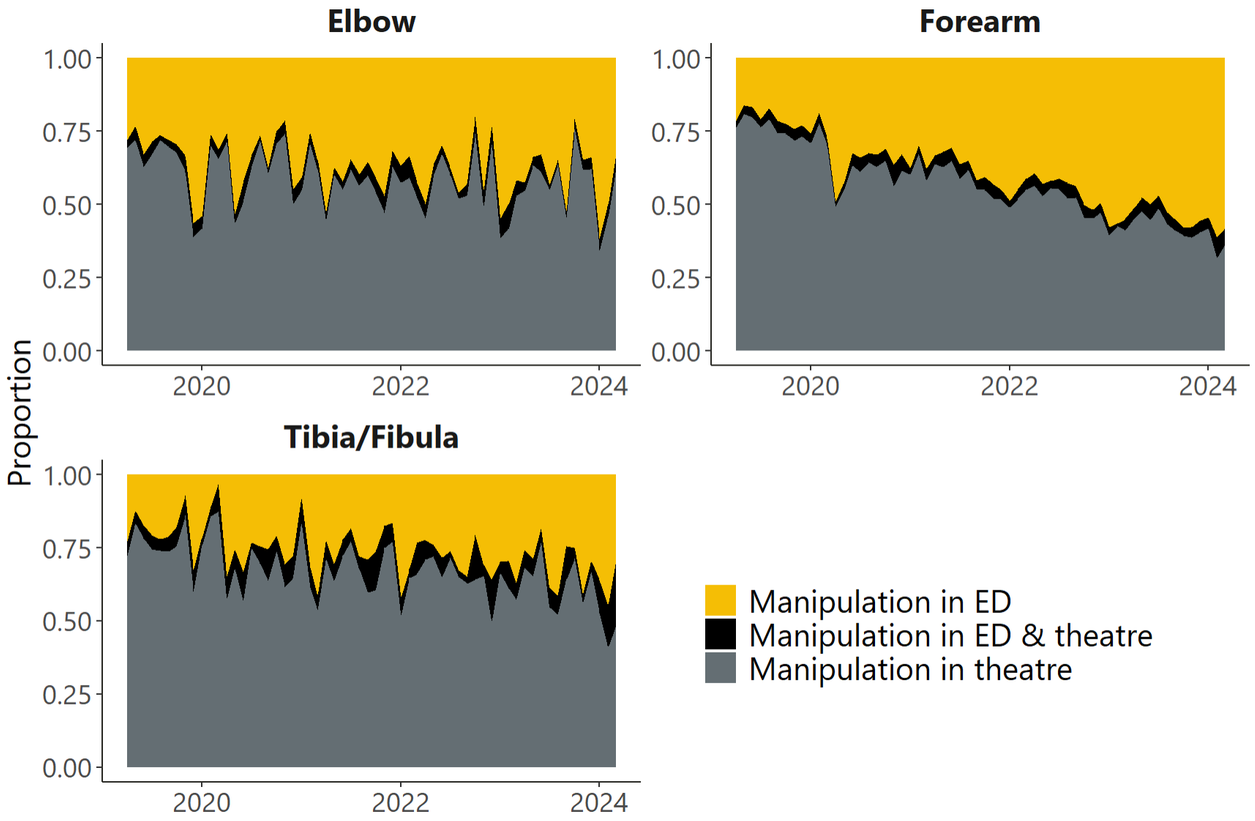
The percentage of tibia/fibula fractures manipulated in theatre as also decreased.

Proportion of fractures manipulated



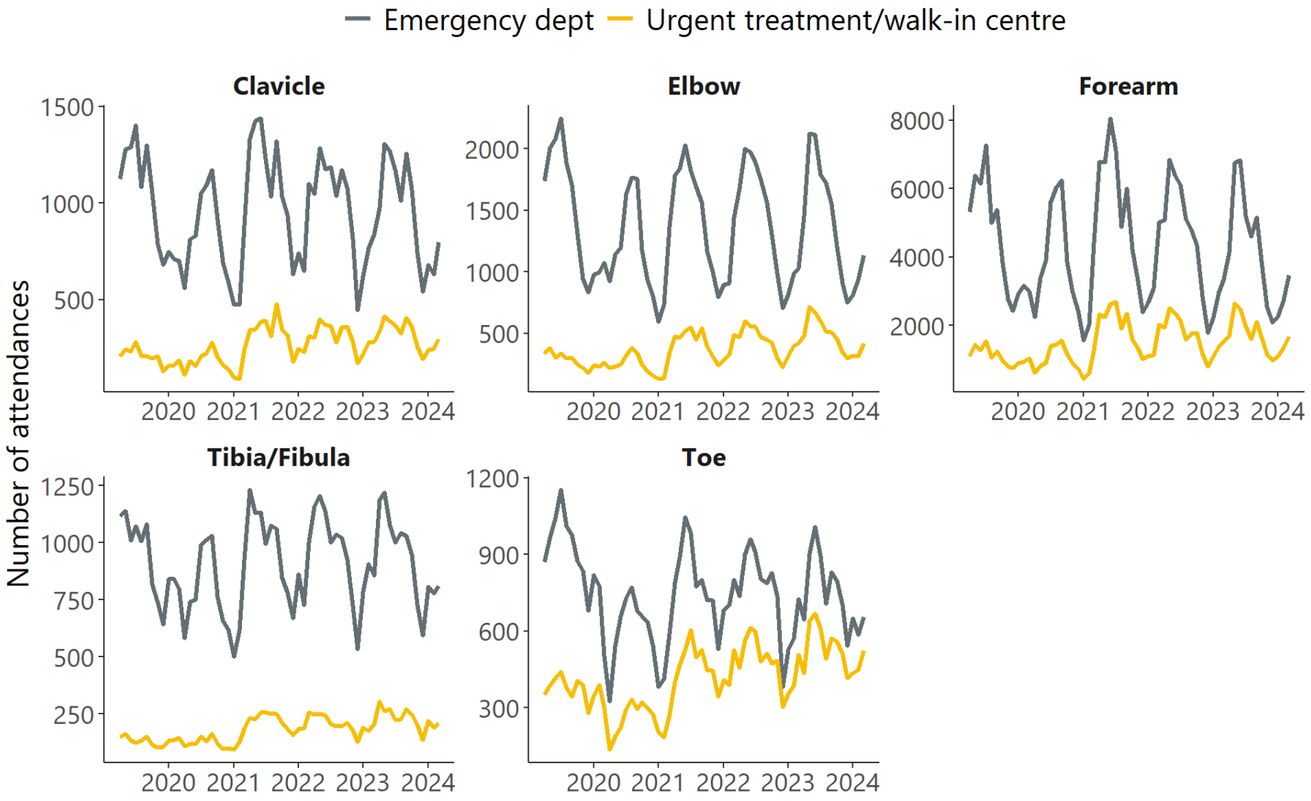
The total number of forearm fractures being manipulated either in the emergency department or theatre has decreased by 22% in the last 5 years.

Proportion of fractures manipulated in ED vs theatre



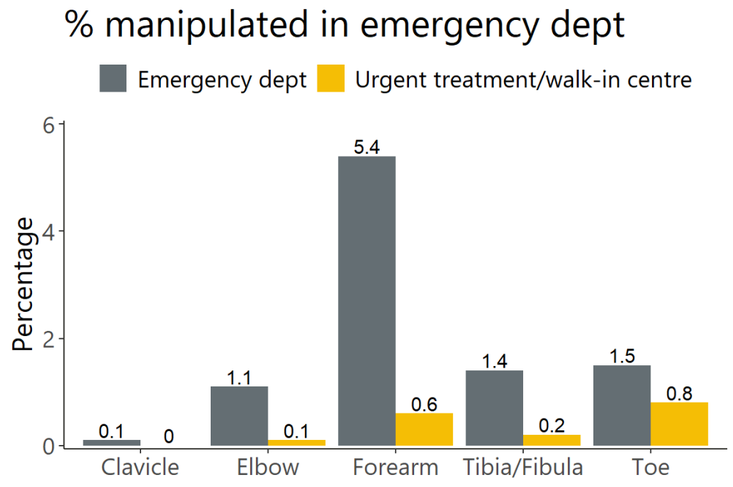
Over the last 5 years the proportion of manipulations that are performed in theatre has decreased mostly notably for forearm fractures where now over half of all manipulations are performed in the emergency department.

Use of emergency depts vs urgent treatment/walk-in centres

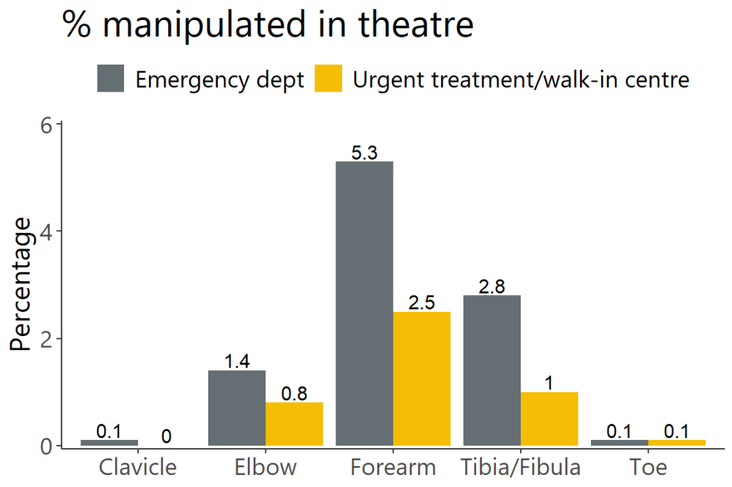


The number of fractures seen in emergency departments is relatively stable over time, however there is an increase in fractures being seen in urgent treatment/walk-in centres, although this may be an artefact of improved recording of fracture attendances in urgent treatment/ walk-in centres.

Manipulations, following ED or UTC attendance (2022/23)



A greater proportion of those attending emergency departments, compared to urgent treatment centres, have their fractures manipulated in the emergency department, which is to be expected given that manipulations would generally not be done within an urgent treatment centres.



However, the percentage of fractures manipulated in theatre is also higher for those attending emergency departments, suggesting those with more obvious/complex fractures that require manipulation are more likely to attend emergency departments, or be sent there from urgent treatment centres (in a small number of cases where a child attended 2 emergency care sites on the same day, we have only included the second attendance).

In 2022/23, 73% of fractures were seen in the emergency department, and 27% in urgent treatment centres.

However, 90% of fractures requiring manipulations were seen in the emergency department and around 10% in urgent treatment centres, further indicating that those with fractures that require manipulation are more likely to attend an emergency department rather than an urgent treatment centre.

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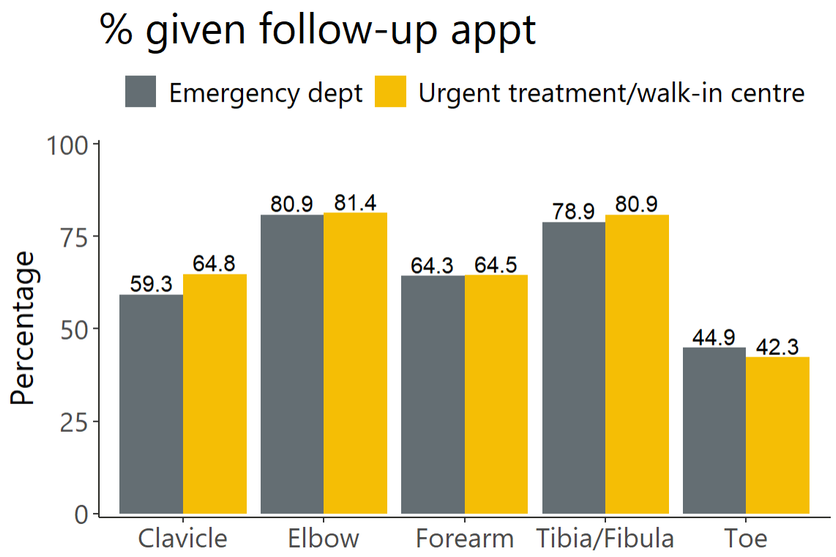
Follow-up appts following ED or UTC attendance (2022/23)



The percentage of fractures where a follow-up appointment is given is broadly similar at urgent treatment centres and emergency departments.

Factors influencing manipulation of forearm fractures in theatre

	Odds Ratio	Confidence Intervals	P value
(Intercept)	5.87	5.29 to 6.52	<0.001*
Sex			
Female	1.00		Reference
Male	0.93	0.88 to 0.99	0.01*
Age			
5-10 yrs	1.00		Reference
0-4 yrs	1.62	1.48 to 1.77	<0.001*
11-16 yrs	0.51	0.48 to 0.54	<0.001*
Ethnicity			
White	1.00		Reference
Asian or Asian British	0.81	0.73 to 0.91	<0.001*
Black or Black British	0.49	0.41 to 0.59	<0.001*
Mixed	0.69	0.6 to 0.8	<0.001*
Other Ethnic Groups	0.54	0.46 to 0.62	<0.001*
Missing/Unknown	0.85	0.78 to 0.93	<0.001*
IMD Quintiles			
1- Most deprived	1.00		Reference
2	0.76	0.7 to 0.82	<0.001*
3	0.71	0.66 to 0.77	<0.001*
4	0.68	0.63 to 0.74	<0.001*
5- Least deprived	0.62	0.57 to 0.67	<0.001*
Department type			
Major Emergency Department	1.00		Reference
Urgent Treatment Centre/Walk in centre	5.12	4.58 to 5.74	<0.001*
Day of the week			
Week	1.00		Reference
Weekend	1.09	1.03 to 1.15	<0.001*
Time of day			
Day 7am-7pm	1.00		Reference
Night 7pm to 7am	1.12	1.04 to 1.2	<0.001*
Time of year			
Autumn	1.00		Reference
Winter	0.87	0.8 to 0.95	<0.001*
Spring	1.06	0.99 to 1.14	0.09
Summer	1.17	1.09 to 1.25	<0.001*
Year			
2019/20	1.00		Reference
2020/21	0.43	0.4 to 0.47	<0.001*
2021/22	0.41	0.38 to 0.45	<0.001*
2022/23	0.28	0.26 to 0.3	<0.001*
2023/24	0.20	0.18 to 0.22	<0.001*

Logistic regression was used to allow us to identify which characteristics and thus which groups of children are more or less likely to have their forearm fracture manipulated in theatre.

Includes only forearm fractures that are manipulated, either the emergency department or in theatre (excludes those where manipulation is recorded in both ED and theatre) to determine what factors might be influencing the decision to manipulate a fracture in theatre rather than in the emergency department.

Children are more likely to have a fracture manipulated in theatre if they are

- female
- under the age of 5
- white
- living in a more deprived area

They are also more likely to have a manipulation in theatre if they attended

- an urgent treatment centre
- on a weekend
- at nighttime
- in the summer

Those attending in more recent years were less likely to have their fracture manipulated in theatre, even after attempting to adjust for case-mix, further indicating there has been a move towards manipulating more fractures in the emergency department.

Summary of management of fractures

- For upper limb fractures there has been a slight reduction in the number given a follow up appointment. For all fracture types there there has been a significant increase in the proportion of follow-up appointments conducted virtually since the pandemic.
- Those presenting at night and at weekends were more likely to have follow up appointments and have their fracture manipulated in theatre. While it may be that those with more obvious/complex fractures that require manipulation/follow-up are more likely to present at these times, rather than perhaps waiting until the next day, it may also be the result of less senior staff available at these times.
- There has been a decrease post-pandemic in the number of outpatient procedures involving casts/splints/bandages and a decrease in diagnostic imaging in outpatients.
- Over the last 5 years the proportion of fractures manipulated in theatre has decreased and the proportion manipulated in the emergency department has increased.
- Those attending urgent treatment centres are more likely to have their fractures manipulated in theatre as this would generally not be possible at urgent treatment centres. Although the majority of fractures that require manipulation are seen in emergency departments.
- The overall manipulation rate for forearm fractures has reduced over the last 5 years, which likely reflects a change in the culture, with displaced fractures now less likely to be manipulated. Indeed, the CRAFFT study is currently looking at whether there is a difference in outcomes between surgical reduction versus non-surgical casting for displaced distal radius fractures in children[1].
- Overall, there is a trend towards more conservative management of paediatric fractures.

1. www.CRAFFTstudy.org

Opportunities to reduce hospital activity

Opportunities to reduce hospital activity

We aimed to determine the scale of the potential opportunities to reduce hospital activity and costs if more conservative management of paediatric fractures is adopted.

It is not possible from the data to determine the most appropriate treatment at an individual patient level and exactly which activity could be reduced.

Some trusts are known to have adopted more conservative approaches to fracture management. Therefore, we have compared activity rates across trusts and calculated activity savings if all trusts reduced their levels of activity down to the level of the best performing trusts that may already be using more conservative management approaches.

Potential activity reductions considered:

- reducing the percentage of emergency care attendances for toe and clavicle fractures where an x-ray is performed.
- reducing the percentage of fractures where a follow-up outpatient appointment is given.
- reducing the percentage of forearm and elbow fractures where a manipulation is performed in theatre.

For x-rays and outpatient attendances we have considered a reduction in activity down to the level of the lowest decile of trusts. However, for manipulations in theatre we have used the lowest quartile as there has already been a significant reduction in these over past 5 years and rates of manipulations in theatre are already low at many trusts.

Calculating proportions by trust

Includes only NHS trusts with 120+ attendances for fractures in 2022/23; this resulted in 8 trusts being excluded. Some trusts may have low numbers due to alternative provisions locally e.g. Royal Liverpool had small numbers which is unsurprising given its proximity to a specialist paediatric centre at Alder Hey. Independent providers were also excluded, the majority of these had small numbers of attendances for fractures (<120 per year).

Overall numbers and percentages for 2022/2023

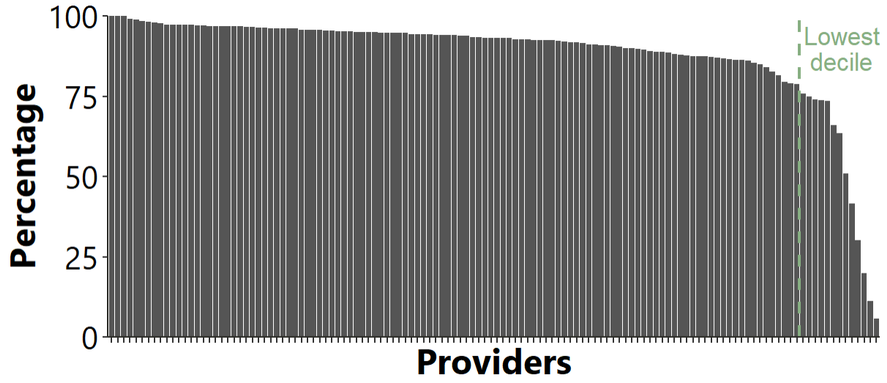
	No. of fractures	X-ray in ED	Follow-up	Follow-up without procedure	Follow-up with procedure	Manipulated in theatre	Manipulated in ED	Manipulated in ED & theatre
Clavicle	15,119	13,149 (87%)	9,171 (60.7%)	8,388 (55.5%)	783 (5.2%)	8 (0.1%)	10 (0.1%)	0 (0%)
Elbow	21,840	19,193 (87.9%)	17,704 (81.1%)	13,658 (62.5%)	4,046 (18.5%)	258 (1.2%)	177 (0.8%)	12 (0.1%)
Forearm	71,844	62,679 (87.2%)	46,217 (64.3%)	35,550 (49.5%)	10,667 (14.8%)	3,024 (4.2%)	2,686 (3.7%)	222 (0.3%)
Tibia/Fibula	13,740	11,709 (85.2%)	10,896 (79.3%)	8,153 (59.3%)	2,743 (20%)	317 (2.3%)	140 (1%)	26 (0.2%)
Toe	14,604	11,117 (76.1%)	6,406 (43.9%)	5,830 (39.9%)	576 (3.9%)	9 (0.1%)	177 (1.2%)	1 (0%)

When considering potential savings in terms of follow-up appointments, we have considered all follow-up appointments (with and without procedures).

X-rays for Clavicle and Toes fractures by trust

Evidence suggests that x-raying clavicle and toe fractures in the emergency department is often unnecessary, as it doesn't add further useful information to a clinician's assessment or alter management.

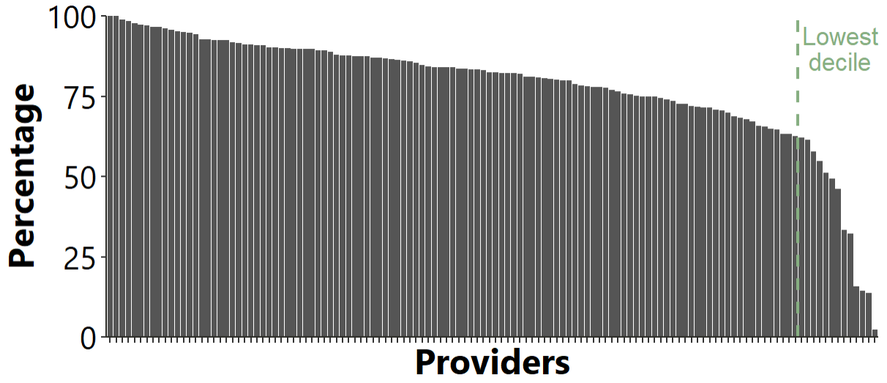
Percentage of clavicle fractures x-rayed



Min	5.9 %
1st quartile	87.7 %
Median	93.2 %
3rd quartile	95.7 %
Max	100 %

There would be an **annual reduction in England of 1,986 (15.5%) x-rays** in emergency care if all trusts reduced the percentage of x-rays to the level of the lowest decile of trusts (77.3%).

Percentage of toe fractures x-rayed

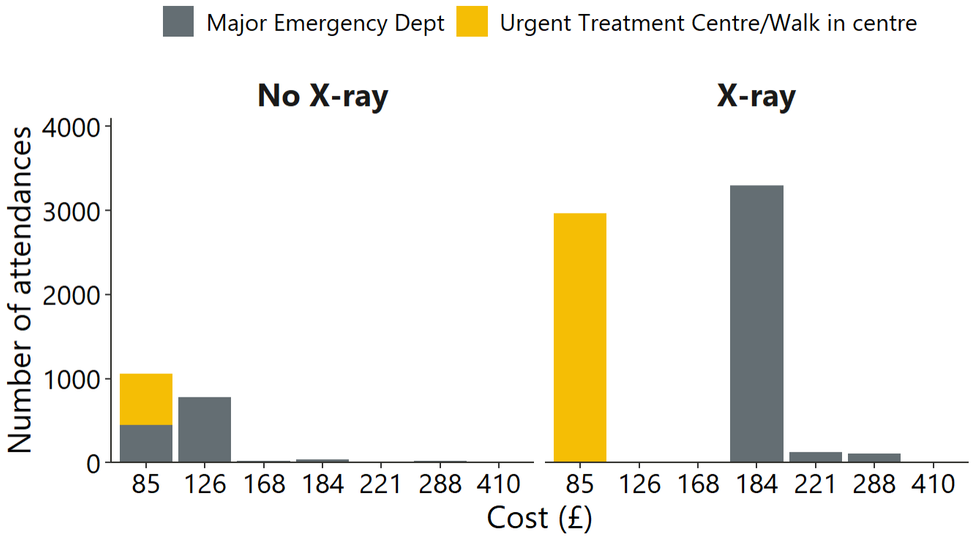


Min	2.4 %
1st quartile	72.6 %
Median	82.4 %
3rd quartile	89.7 %
Max	100 %

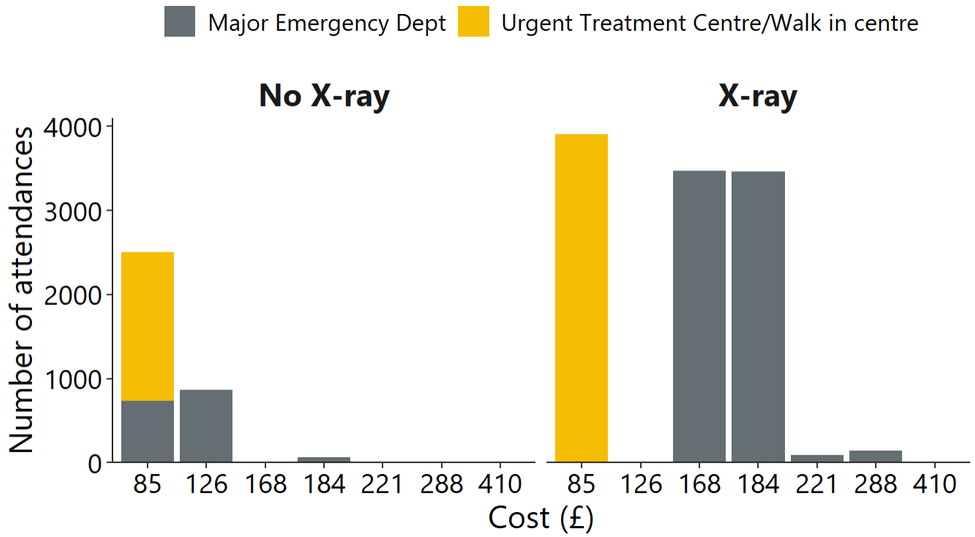
there would be an **annual reduction in England of 2,412 (22.5%) x-rays** in emergency care if all trusts reduced the percentage of x-rays to the level of the lowest decile of trusts (62.3%).

Cost of x-raying clavicle and toe fractures

Clavicle fracture



Toe fractures

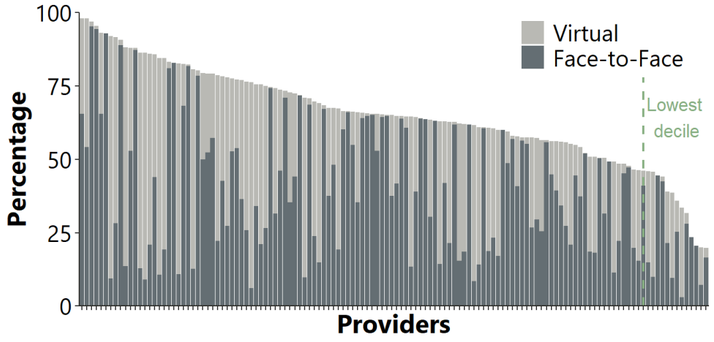


All attendances at urgent treatment centres are costed at £85 regardless on whether a fracture is x-rayed.

For both clavicle and toe fractures without an x-ray the median cost of an emergency department attendance is £126 compared to a median cost of £184 when the fracture is x-rayed, suggesting a saving in the region of £58 for each clavicle or toe fracture not x-rayed in the emergency department.

Upper limb fractures with follow-up by trust (2022/23)

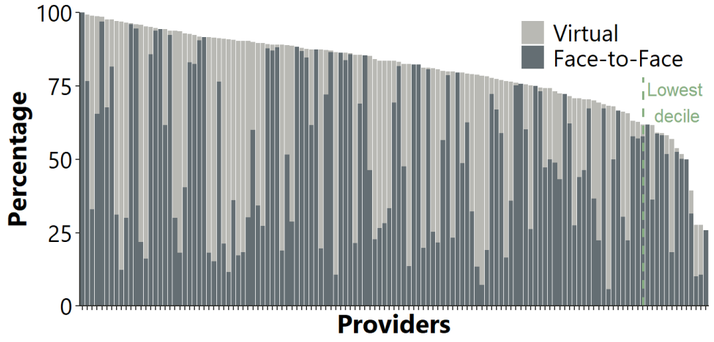
% of forearm fractures with follow-up



Min	19.8 %
1st quartile	56.2 %
Median	65.1 %
3rd quartile	77.2 %
Max	98 %

There would be an **annual reduction in England of 13,768 (30.7%) follow-up appointments** if all trusts reduced the percentage of follow-ups to the level of the lowest decile of trusts (46%).

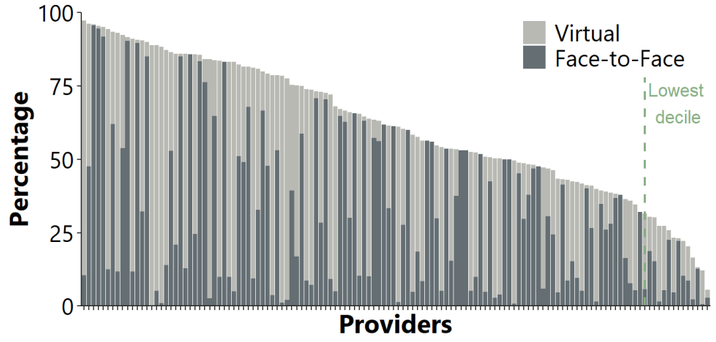
% of elbow fractures with follow-up



Min	25.9 %
1st quartile	74.2 %
Median	83.6 %
3rd quartile	90.4 %
Max	100 %

There would be an **annual reduction in England of 4,486 (25.8%) follow-up appointments** if all trusts reduced the percentage of follow-ups to the level of the lowest decile of trusts (61.8%).

% of clavicle fractures with follow-up

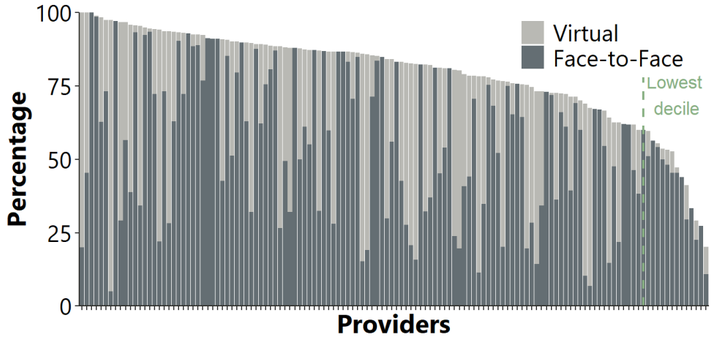


Min	5.6 %
1st quartile	46.5 %
Median	61.2 %
3rd quartile	82.2 %
Max	97.4 %

There would be an **annual reduction in England of 4,440 (49.9%) follow-up appointments** if all trusts reduced the percentage of follow-ups to the level of the lowest decile of trusts (31.4%).

Lower limb fractures with follow-up by trust (2022/23)

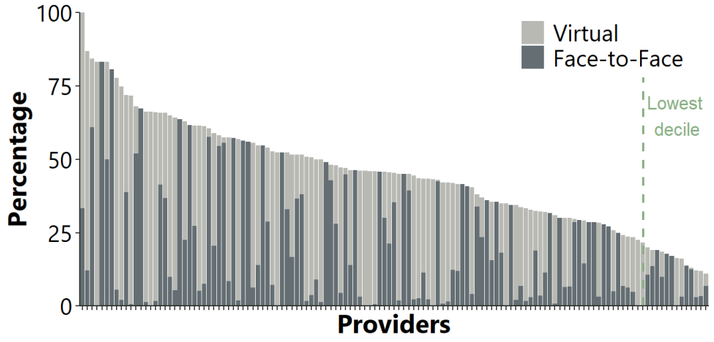
% of tibia/fibula fractures with follow-up



Min	20.2 %
1st quartile	72.8 %
Median	83.7 %
3rd quartile	90.1 %
Max	100 %

There would be an **annual reduction in England of 2,817 (26.4%) follow-up appointments** if all trusts reduced the percentage of follow-ups to the level of the lowest decile of trusts (60%).

% of toe fractures with follow-up



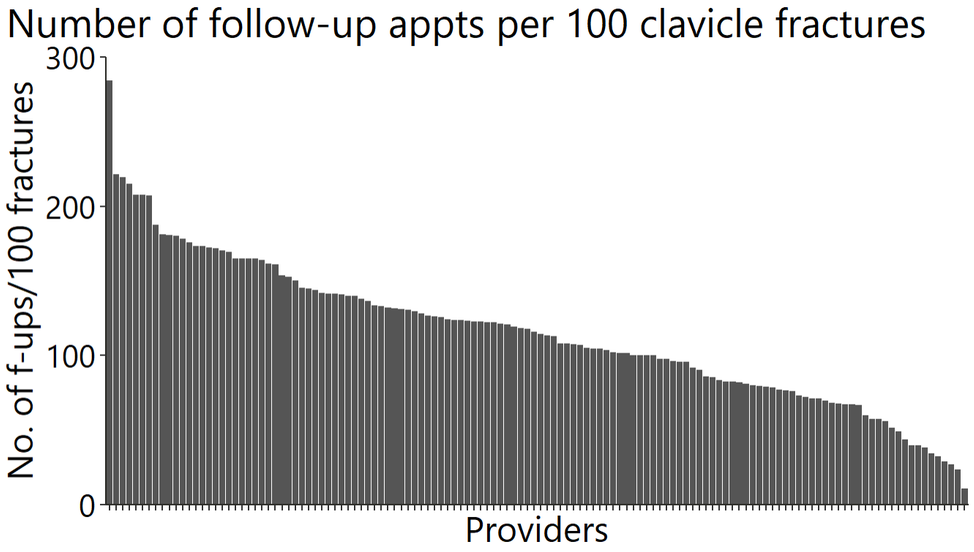
Min	11.1 %
1st quartile	31.7 %
Median	45.4 %
3rd quartile	56.9 %
Max	100 %

There would be an **annual reduction in England of 3,260 (53%) follow-up appointments** if all trusts reduced the percentage of follow-ups to the level of the lowest decile of trusts (21.3%).

Combining the potential reduction in the number of follow-up appointments for all of the fracture types included in this study, there could be a **total annual reduction of 28,771 (33%) follow-up appointments in England**.

This may be an underestimation as some children may have more than one follow-up appointment that could be deemed unnecessary.

Number of clavicle fracture follow-ups by trust (2022/2023)

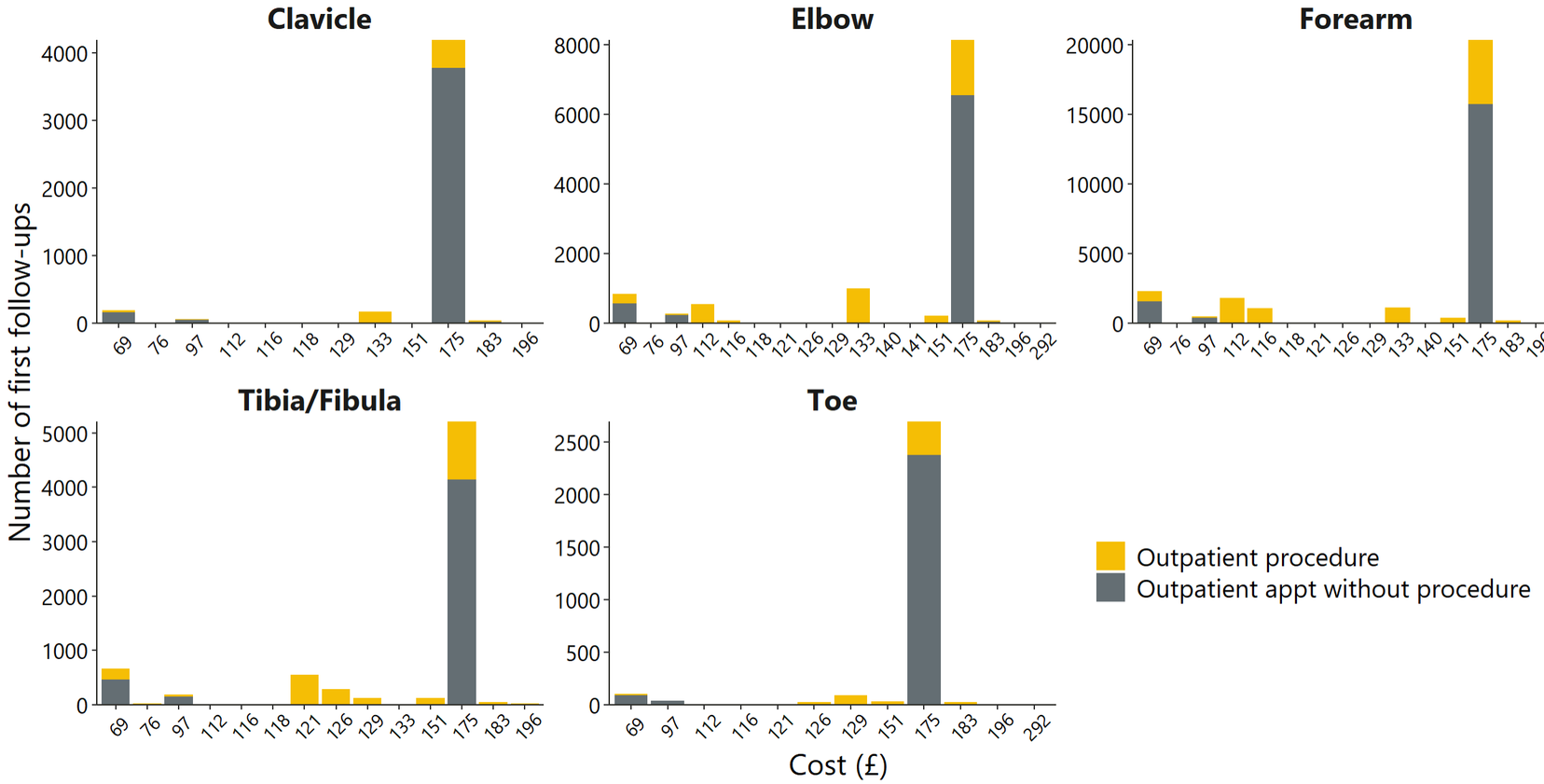


This includes all outpatient attendances, including physiotherapy appointments, in the 3 months post-fracture.

There is significant variability between trusts in the number of follow-up appointments for clavicle fractures.

Many clavicle fractures should not require follow-up yet some trusts are averaging 2-3 follow-up appointments per clavicle fracture, indicating a potential to further decrease follow-up appointments if second and subsequent appointments are considered.

Cost of face-to-face follow-up appointments



For all fracture types the median cost of the first face-to-face outpatient attendance is £175. Prices are not available for virtual follow-up appointments, although the costs will be reduced compared to face-to-face appointments.

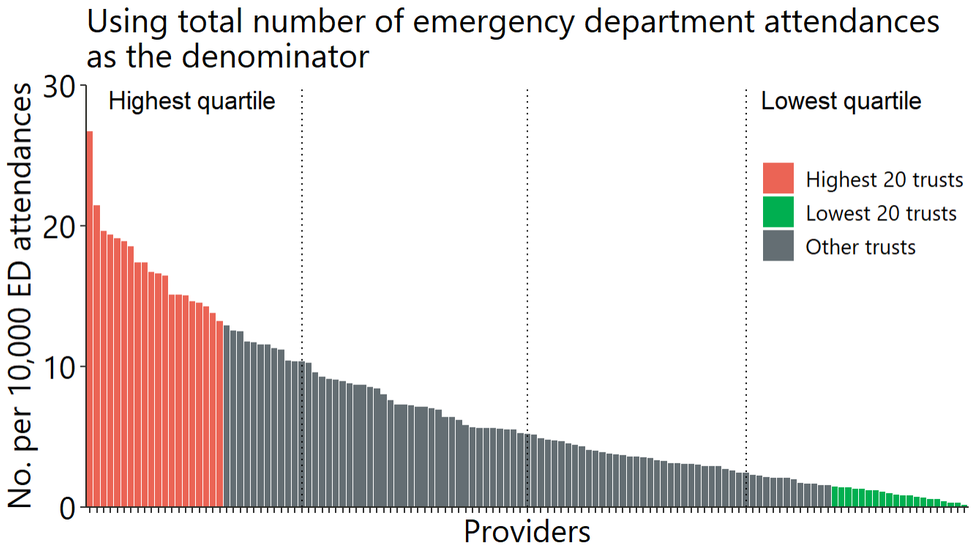
Differences between our approach and the GIRFT metric

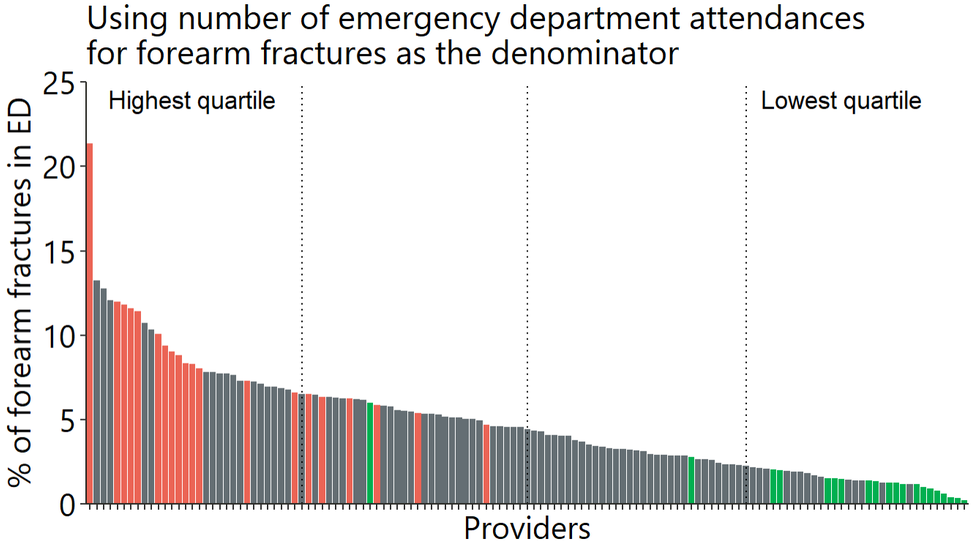
There are some significant differences between the data included by GIRFT/Model Hospital and the data used in this study. GIRFT/Model Hospital:

- include all forearm and wrist fractures, whereas we excluded certain fracture types, e.g open fractures which are assumed to all require treatment in theatre.
- include re-manipulations in theatre, whilst we have excluded those coded as re-manipulations.
- use a 3-year average, whilst we used only the most recent year where follow-up data is available (2022/23).
- use the number of fractures manipulated in theatres taken directly from inpatient data and total A&E attendances for those aged 16 and under as the denominator. We have linked emergency care data to inpatient data and so are only considering manipulations in theatre for patients identified in the emergency care dataset as having a fracture.

The way the GIRFT metric is calculated means that it does not account for any regional differences in fractures rates, but it is unaffected by the poor recording of diagnoses codes in emergency care. Our measure accounts for regional differences, but does rely on the assumption that the fracture types requiring interventions and fractures that do not are equally likely have a diagnosis code recorded in emergency care, which may not always be the case.

Comparing methods for calculating the rate of manipulations





Graphs show our data for the number of forearm fractures manipulated in theatre in 2022/2023 (identified by linking to emergency care fracture records), but use different denominators to calculate the rate.

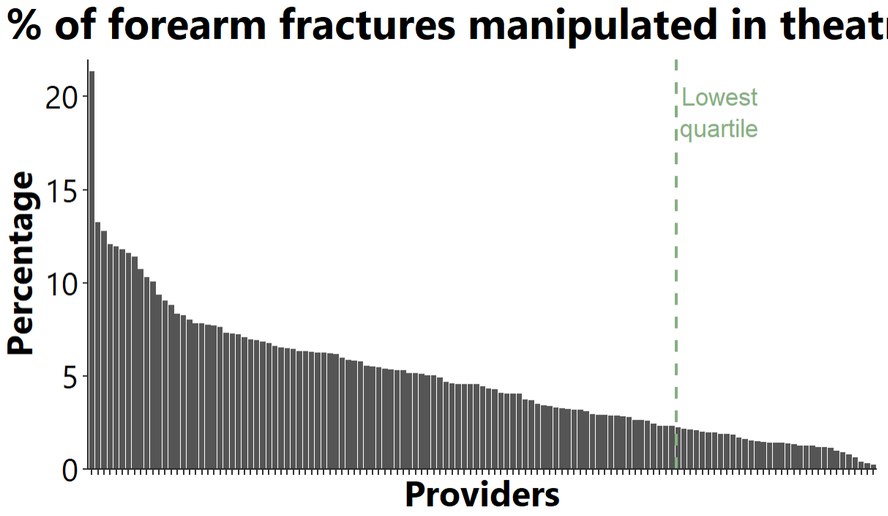
Top figure shows the 20 trusts with the highest (red) and 20 trusts with the lowest (green) rates of manipulations in theatre using total A&E attendances as the denominator.

Bottom figure uses the number of A&E attendances for forearm fractures as the denominator, and the same trusts labelled above are shown in their new positions according to this new metric. We have used this method to calculate manipulation rates in the subsequent slides, as it accounts for differences between trusts in the proportion of emergency department attendances that are for fractures. However, as diagnoses codes are not always recorded using this method we do have to make the assumption that the fractures that are recorded are representative to true case-mix.

Example 1, using total A&E attendances as the denominator The Royal Cornwall Hospitals Trust has a rate of ~16.6 forearm manipulations in theatre/10,000 A&E attendances, which puts it as the 11th highest rate in England. Using the number of forearm fractures as the denominator the manipulation rate of forearm fractures in theatre is 5.9%, moving The Royal Cornwall Hospitals Trust out of the highest quartile down to 43rd highest.

Example 2, Chelsea and Westminster Hospital NHS Foundation trust has a rate of 1.3 forearm manipulations in theatre/10,000 A&E attendances, which is the 16th lowest rate in England. However, when the number of forearm fractures is used as the denominator the rate of forearm manipulations in theatre is 6%, suggesting the trust doesn't actually perform as well as first thought, moving it to the 42nd highest, with a similar rate to The Royal Cornwall Hospitals Trust.

Forearm fractures manipulated in theatre by trust (2022/23)

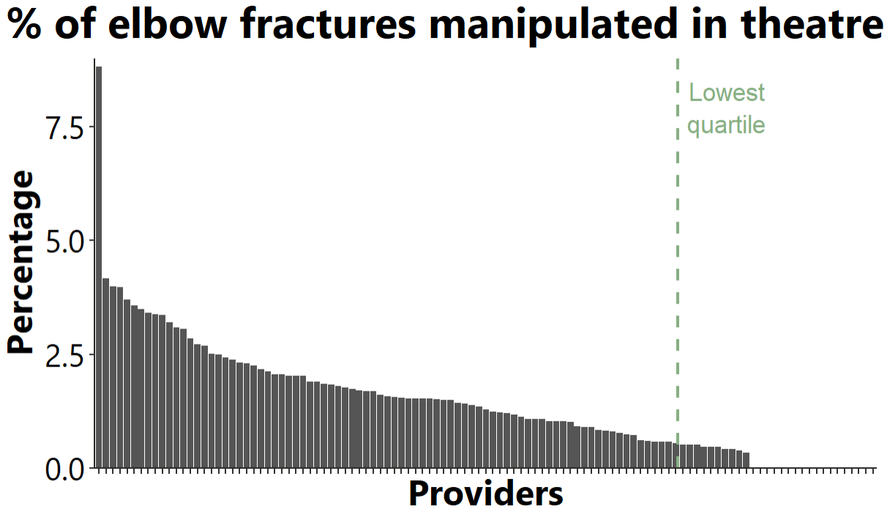


Min	0.2 %
1st quartile	2.3 %
Median	4.4 %
3rd quartile	6.5 %
Max	21.4 %

There could be an **annual reduction in England of 1,747 (54.5 %) manipulations in theatre**, if all trusts reduced their percentage to the level of the lowest quartile (2.3%).

Elbow fractures manipulated in theatre by trust (2022/23)

NOTE: Very low numbers at many providers

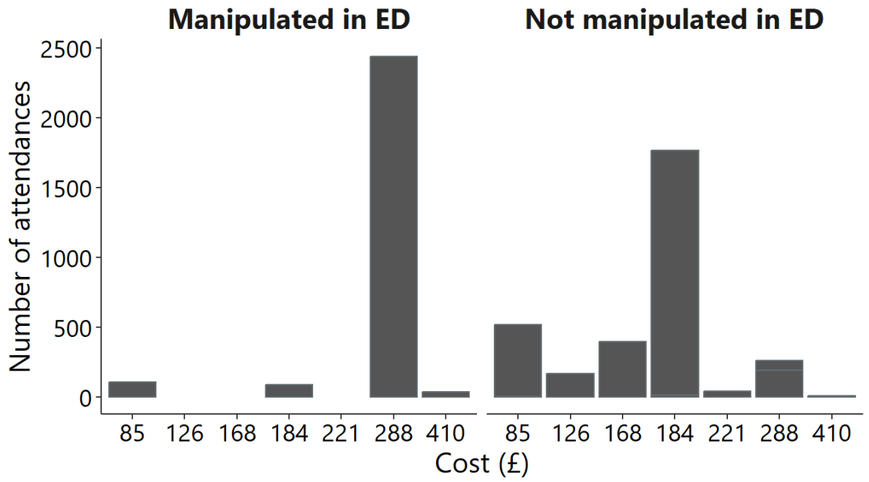


Min	0 %
1st quartile	0.5 %
Median	1.3 %
3rd quartile	2 %
Max	8.8 %

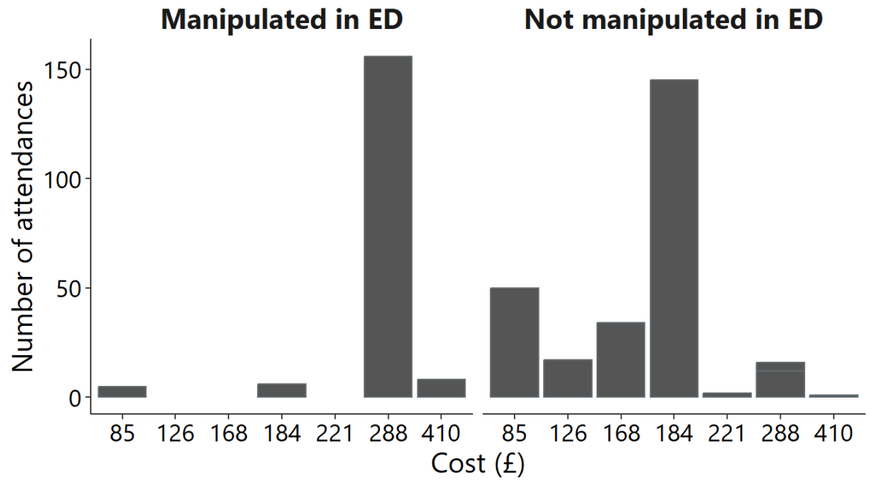
There could be an **annual reduction in England of 177 (67%) manipulations in theatre**, if all trusts reduced their percentage to the level of the lowest quartile (0.5%). This size of reduction is unlikely to have a significant impact in freeing up theatre time.

Cost of manipulations in the emergency department vs theatre

Forearm fractures



Elbow fractures



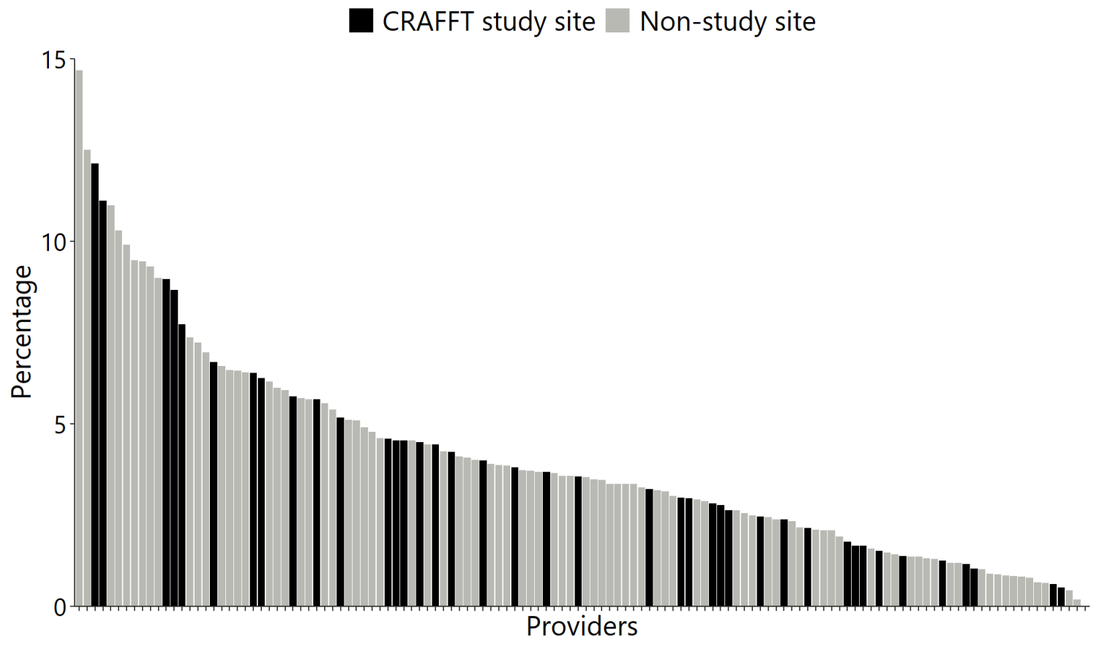
Those not manipulated in the emergency department are those that are manipulated but in theatre.

	Median cost of ED attendance with manipulation (£)	Median cost of ED attendance without manipulation (£)	Calculated cost of manipulation in ED (£)	Median cost of manipulation in theatre (£)	Potential saving per manipulation in ED (£)
Forearm	288	184	104	1,951	1,847
Elbow	288	184	104	2,231	2,127

In addition to the cost savings, manipulating more fractures in the emergency department would free up theatre time.

Sites from CRAFFT study (2023/24)

Manipulations of forearm fractures in theatre



Trusts with hospitals participating in the CRAFFT study[1] are shown in black; it can be seen that they are fairly evenly spread relative to other hospital sites, and aren't clustered towards the lower end.

It should be noted that this chart is showing data from the most recent year, 2023-24, rather than 2022/23 which was used for the previous analysis.

1. www.CRAFFTstudy.org

Summary of the potential activity reductions

- There is scope for a 19% reduction in the number of x-rays for clavicle and toe fractures in emergency care in England, equivalent to at least 4,400 x-rays per year.
- The number of follow-up appointments for forearm, elbow, clavicle, tibia/fibula and toe fractures could be reduced by 33%, equivalent to at least 28,800 follow-ups per year in England. This is based on reducing the number of first follow-ups, but it appears a number of children have more than one unnecessary follow-up so this is likely an underestimate of the potential savings.
- The number of forearm and elbow fractures manipulated in theatre could be reduced by an additional 55%, equivalent to a reduction of 1,900 manipulations in theatre in England per year. Assuming manipulation of a forearm/elbow fracture takes on average 45 mins[1,2], this equates to 8.5 weeks of theatre time per year.
- While some trusts have already implemented more conservative management approaches, particularly for manipulations, there appear to be some trusts that could still significantly benefit from adopting this approach. At many trusts there is significant scope to reduce number of x-rays performed for fractured clavicles and toes and the number of follow-up appointments for all fracture types.

	Clavicle	Elbow	Forearm	Tibia/Fibula	Toe	**Total**
Reduction in x-rays in emergency care	1,986 (15.5%)	-	-	-	2,412 (22.5%)	**4,398 (18.7%)**
Reduction in follow-up appts	4,440 (49.9%)	4,486 (25.8%)	13,768 (30.7%)	2,817 (26.4%)	3,260 (53%)	**28,771 (32.7%)**
Reduction in manipulations in theatre	-	177 (67%)	1,747 (54.5%)	-	-	**1,924 (55.4%)**

1. Betham C et al. (2011) Manipulation of simple paediatric forearm fractures: a time-based comparison of emergency department sedation with theatre-based anaesthesia. N Z Med J. 124(1344):46-53.
2. Seefried S et al (2022) Paediatric forearm fractures manipulated in the emergency department: incidence and risk factors for re-manipulation under general anaesthesia. N Z Med J. 135(1560):60-66.

Discussion, Limitations and Future work

Discussion

In agreement with previous studies we find forearm fractures are the most common followed by elbow fractures, and also higher fractures incidences in the summer and older boys due to higher levels of physical activity[1,2]. We find geographical variation in the recorded incidences of fractures in emergency care, some of this is likely the result of poor recording of fractures in emergency care in some areas. However, a previous paper found significant geographical variation with lower rates in London, similar to our results[1]. It is thought that regional variation may be due to levels of physical activity, obesity levels and the ethnic make up of the area; fracture rates were found to be higher in white children compared to those of black or South Asian ethnicity and to correlate with obesity and levels of physical activity[1].

In the Paediatric Trauma and Orthopaedic Surgery GIRFT report it was suggested that there was scope to reduce the number of paediatric forearm manipulations in theatre by 80%[3]. That study used data from 2016-2019, in our study we have found since 2019/2020 the proportion of forearm fractures manipulated in theatre has fallen by 54%, from just over 8% in 2019/20 to under 4% in 2023/24.

It appears that there is the possibility to further reduce manipulations in theatre, particularly at some trusts, although overall at a national level the decrease in manipulation in theatre is likely to start slowing as the numbers get smaller. The switch to manipulating more fractures in the emergency department rather than in theatre will not only would save the NHS money, operating theatre time and resources, but will improve care for children and their families as treatment is quicker and less disruptive.

As highlighted within the Paediatric Trauma and Orthopaedic Surgery GIRFT report there are a number of factors that may be reduce the proportion of manipulations in the emergency department, including concerns about breach times, a lack of space/facilities to perform sedation, and a lack of familiarity with techniques[3]. Concerns around litigation may also lead to less conservative management, especially with elbow fractures which can lead to rare, but severe, complications. It is possible factors related to culture, lack of experience and litigation may also influence conservative management when it comes to reducing x-rays for clavicle and toe fractures and reducing follow-up appointments.

Nottingham University Hospitals NHS Trust, who are known to utilise more conservative management of paediatric fractures including routinely manipulating forearm fractures in the emergency department[3,4], have, as expected, one of the lowest proportions of forearm fractures manipulated in theatre. In 2022/2023 only 0.5% of forearm fractures were manipulated in theatre (while 11.81% were manipulated in the emergency department) meaning only 4% of all forearm fractures requiring manipulation were performed in theatre. In terms of follow-up appointments 57% of forearm fractures receive a follow-up appointment, which is just above the lowest quartile.

1. Moon RJ et al (2016) Ethnic and geographic variations in the epidemiology of childhood fractures in the United Kingdom. Bone. 85:9-14
2. Mamoowala N et al (2019) Trends in paediatric distal radius fractures: an eight-year review from a large UK trauma unit. Ann R Coll Surg Engl. 101(4):297-303
3. Paediatric Trauma and Orthopaedic Surgery. GIRFT Programme National Specialty Report. April 2022. https://gettingitrightfirsttime.co.uk/girft-reports/
4. Bryson D et al. (2016) The lost art of conservative management of paediatric fractures. Bone Joint 360. 5(1):2-8.

Discussion (continued)

While at a national level the scope for significant further reductions in manipulations in theatre is likely to become limited, there is perhaps more scope in the future to reduce activity in terms of reducing unnecessary x-rays in the emergency department for clavicle and toe fractures, and in reducing the number of follow-up appointments.

The total number of forearm fractures that are manipulated has been decreasing, and there is perhaps scope for this to decrease further. Indeed, the CRAFFT study being conducted at over 45 sites in England is investigating whether there are any differences in outcomes between surgical reduction versus non-surgical casting for displaced distal radius fractures in children[1].

The GIRFT report found some trusts have moved towards splinting fractures in the emergency department with a virtual follow-up, rather than a temporary cast and then referral to a fracture clinic[1]. From our data the use of virtual follow-ups appears widespread, but there may be scope to reduce virtual appointments, especially as some trusts with high overall follow-up rates have a particularly high number of virtual appointments.

Evidence suggests that many x-rays of clavicle fractures are unnecessary as they tend to not add significantly to a clinician's assessment or alter management[2]. However, almost all trusts still are x-raying the vast majority of potential clavicle fractures so the proportion of x-rays is still high even for the lowest decile of trusts (77%). Therefore our numbers are likely to be an underestimate of what activity savings could be potentially achieved. The same is likely true for toe fractures. It has been found that while most more experienced clinicians were comfortable treating clavicle fractures without x-rays, more junior clinicians were not[2].

Our absolute number estimates of reductions in activity may be an underestimate, because diagnoses are not reliably being recorded by some trusts in the emergency department. It is also possible that there may be some bias on the types of fractures attending emergency care that are given a diagnosis code. For example, it is possible at trusts that do not consistently record diagnosis codes in emergency care may be more likely to record fractures requiring manipulation than those that do not require manipulation or follow-up. However, when looking at trusts there was no significant relationship between the proportion of emergency care attendances without diagnosis codes and the proportion of fractures manipulated in theatre.

This report does highlight the need for more accurate and consistent recording of diagnoses in emergency care.

1. https://crafft-study.digitrial.com/
2. Lirette MP et al. (2018) Can paediatric emergency clinicians identify and manage clavicle fractures without radiographs in the emergency department? A prospective study. BMJ Paediatr Open. 10;2(1):e000304

Limitations

We are relying on the coding/reporting of fractures, manipulations, x-rays and outpatient appointments within the the SUS datasets. Some of the variability in the number of fractures, x-rays, physiotherapy referrals, follow-up appointments and manipulations between trusts and over time could be due to issues with the coding.

As diagnosis code is not always recorded in the emergency care dataset our incidence rates give the incidence of fractures recorded in emergency care, and only include closed fractures, open fractures were excluded.

The coding of fractures is not specific enough to determine at an individual level which fractures could be managed more conservatively, so we are relying on comparing proportion between trusts, but but we can't be sure whether all trusts have a similar proportion of more complex fractures that do require manipulation and follow-up.

There will be a small number of cases where a child has more than one fracture or other injuries recorded in emergency care (<1%), so it is possible any follow-up appointments or manipulations could potentially be for a different injury/fracture sustained at the same time.

Data is allocated to the trust where the child attended the emergency department, e.g. if a child first attended the emergency department at trust A while on holiday but subsequently received follow-up appointments at trust B the fracture and subsequent follow-up would be included in the data for trust A.

The number of elbow manipulations recorded in theatre appears lower than would be expected, which may be due to coding issues. The lack of detailed coding of fractures makes it difficult to determine what is an elbow fracture and may mean that some are classified as forearm fractures, e.g. the SNOMED code for 'Closed fracture of radius (disorder)' is the most commonly used, and while we have classified these as forearm fractures, fractures of the proximal radius would be considered an elbow fracture. This may in part explain why we see a smaller number of elbow manipulations in theatre than would be expected, as they are included within forearm fractures. Also, HRG groupings for manipulations in theatre do not distinguish between forearm and elbow procedures, so it is not possible to determine from these which are forearm and which are elbow manipulations. We have only considered elbow manipulations in theatre that could be conducted in the emergency department, i.e. those without internal fixation such as wires or pins. Therefore our elbow manipulation number might also be affect by the propensity of individual trusts to use internal fixation for elbow fractures. We have also not included re-manipulations in our data.

These potential reductions in activity are for England only, but there is likely also the potential for activity savings in the other countries of the UK.

Cost savings are calculated from HRG prices and are only indicative estimates of potential cost savings.

Future work

To fully understand the potential cost savings of these reductions in activity a full health economic analysis would be required.

It may be helpful to do some more detailed mapping and analysis of patient pathways to better understand how fractures are being managed, and where further activities savings could be made with more conservative management.

There are currently trends towards more conservative management, particularly regarding increasing manipulations in the emergency department, so there is scope to investigate the extent to which these trends could continue and further activity can be reduced.

Future work could also focus on understanding the degree in variation between trusts in the proportion of forearm and elbow fractures that are manipulated in theatre with the use of internal fixation, and whether there are fractures that could be manipulated without the need for internal fixation.

The current analysis focuses on paediatric fractures, but this work could be extended to include adult fractures too, where there is likely also to be the potential for even further savings.

Appendix A- Forearm and Clavicle fracture SNOMED codes

Forearm

208388003	Fracture at wrist and/or hand level (disorder)
209264008	Closed fracture dislocation of wrist (disorder)
209265009	Closed fracture dislocation distal radioulnar joint (disorder)
209284007	Closed fracture subluxation of distal radioulnar joint (disorder)
67730008	Closed Bennett's fracture (disorder)
307713000	Closed Barton's fracture (disorder)
208324004	Closed dorsal Barton's fracture (disorder)
208323005	Closed volar Barton's fracture (disorder)
209283001	Closed fracture subluxation of the wrist (disorder)
263102004	Fracture subluxation of wrist (disorder)
61653009	Bennett's fracture (disorder)
263103009	Fracture subluxation of distal radioulnar joint (disorder)
1290784005	Stress fracture of bone of wrist region (disorder)
1303397005	Fracture of bone of wrist region (disorder)
1285722006	Fracture of distal end of left ulna (disorder)
14430001000004100	Fracture of distal end of right ulna (disorder)
27094009	Skillern's fracture (disorder)
281530009	Fracture of ulnar styloid (disorder)
41036008	Closed fracture of styloid process of ulna (disorder)
263208005	Fracture of distal end of radius and ulna (disorder)
33192001	Closed fracture of lower end of radius AND ulna (disorder)
50397009	Closed fracture of distal end of ulna (disorder)
208318005	Closed fracture of ulna, lower epiphysis (disorder)
6163002	Closed fracture of head of ulna (disorder)
263199001	Fracture of distal end of radius (disorder)
58722007	Moore's fracture (disorder)
448355005	Greenstick fracture of distal radius (disorder)
737262009	Fracture of lower end of radius with volar tilt (disorder)
737261002	Fracture of lower end of radius with dorsal tilt (disorder)
123972004	Reversed Colles' fracture (disorder)
123618009	Closed reverse Colles' fracture (disorder)
281527002	Fracture of radial styloid (disorder)
208325003	Closed fracture radial styloid (disorder)
426467005	Hutchinson's fracture (disorder)
18310001000004100	Fracture of distal end of right radius (disorder)
16542901000119100	Closed fracture of metaphysis of distal end of right radius (disorder)
1285724007	Fracture of distal end of left radius (disorder)
16542861000119100	Closed fracture of metaphysis of distal end of left radius (disorder)
123971006	Colles' fracture (disorder)
269083002	Closed Colles' fracture (disorder)
17222009	Closed fracture of distal end of radius (disorder)
448838000	Closed extraarticular fracture of distal radius (disorder)
208326002	Closed fracture distal radius, intra-articular, die-punch (disorder)
704212006	Closed fracture of distal epiphysis of radius (disorder)
1279881008	Closed fracture of metaphysis of distal end of radius (disorder)
35442005	Closed fracture of lower end of forearm (disorder)
307172007	Fracture dislocation distal radioulnar joint (disorder)
1264544004	Fracture of bone adjacent to prosthesis of wrist joint (disorder)
12217801000119100	Fracture of bone adjacent to prosthesis of left wrist joint (disorder)
12202711000119100	Fracture of bone adjacent to prosthesis of right wrist joint (disorder)
1303394003	Fracture of bone of left wrist region (disorder)
1303396001	Fracture of bone of bilateral wrist regions (disorder)
1303395002	Fracture of bone of right wrist region (disorder)
46773004	Quervain's fracture (disorder)
3228009	Closed fracture of shaft of radius (disorder)
12676007	Fracture of radius (disorder)
28078000	Closed fracture of shaft of bone of forearm (disorder)
53627009	Closed fracture of radius AND ulna (disorder)
53792000	Closed fracture of shaft of ulna (disorder)
54556006	Fracture of ulna (disorder)
54645004	Barton's fracture (disorder)
54819005	Closed fracture of shaft of radius and ulna (disorder)
65966004	Fracture of forearm (disorder)
71555008	Closed fracture of ulna (disorder)
75857000	Fracture of radius AND ulna (disorder)
91419009	Closed fracture of forearm (disorder)
111640008	Closed fracture of radius (disorder)
208309008	Closed fracture radius and ulna, middle (disorder)
208322000	Closed Galeazzi fracture (disorder)
208513000	Multiple fractures of forearm (disorder)
263198009	Fracture of shaft of radius (disorder)
263200003	Volar Barton's fracture (disorder)
263201004	Dorsal Barton's fracture (disorder)
263204007	Fracture of shaft of ulna (disorder)
263205008	Fracture of distal end of ulna (disorder)
263207000	Fracture of shaft of radius and/or ulna (disorder)
268824003	Fracture of radius and/or ulna due to birth trauma (disorder)
271576001	Galeazzi fracture dislocation (disorder)
281528007	Fracture of olecranon (disorder)
281529004	Fracture of coronoid process of ulna (disorder)
287074009	Fracture malunion - forearm (disorder)
390986009	Torus fracture of radius (disorder)
429655000	Closed torus fracture of radius (disorder)
704056001	Stress fracture of ulna (disorder)
704059008	Stress fracture of radius (disorder)
733235002	Fracture of shaft of ulna and radius (disorder)
1285721004	Fracture of right ulna (disorder)
1303390007	Fracture of bone of left forearm (disorder)
1303391006	Fracture of bone of right forearm (disorder)
446461000124103	Fracture of right radius (disorder)
12960001000004100	Fracture of left radius (disorder)
13270001000004100	Fracture of left ulna (disorder)

Clavicle

58150001	Fracture of clavicle
33173003	Closed fracture of clavicle
1658003	Closed fracture of acromial end of clavicle
87376003	Closed fracture of shaft of clavicle
48561006	Closed fracture of sternal end of clavicle
88196000	Fracture of interligamentous part of clavicle (disorder)
1303380004	Fracture of left clavicle (disorder)
1303379002	Fracture of bone of bilateral clavicles (disorder)
1303381000	Fracture of right clavicle (disorder)
41972004	Fracture of shaft of clavicle (disorder)
56642004	Fracture of sternal end of clavicle (disorder)
733403004	Multiple fractures of clavicle (disorder)
208510002	Multiple fractures of clavicle, scapula and humerus (disorder)
431011000	Nonunion of fracture of clavicle (disorder)
704069002	Stress fracture of clavicle (disorder)

Appendix B- Elbow fracture SNOMED codes

Elbow

123973009	Monteggia's fracture (disorder)
1303382007	Fracture of left olecranon (disorder)
1303383002	Fracture of right olecranon (disorder)
1303392004	Fracture of bone of left elbow joint region (disorder)
1303393009	Fracture of bone of right elbow joint region (disorder)
16866431000119100	Closed fracture of capitellum of right humerus (disorder)
16867081000119100	Closed fracture of capitellum of left humerus (disorder)
19259001	Closed fracture of upper end of radius AND ulna (disorder)
208267005	Closed fracture distal humerus, lateral condyle (disorder)
208270009	Closed fracture of distal humerus, trochlea (disorder)
208271008	Closed fracture distal humerus, lateral epicondyle (disorder)
208272001	Closed fracture distal humerus, capitellum (disorder)
208273006	Closed fracture distal humerus, bicondylar (T-Y fracture) (disorder)
208274000	Multiple closed fractures of distal humerus (disorder)
208294009	Closed fracture olecranon, extra-articular (disorder)
208295005	Closed fracture of proximal ulna, comminuted (disorder)
208296006	Closed fracture proximal radius, comminuted (disorder)
208298007	Closed fracture olecranon, intra-articular (disorder)
209252000	Closed fracture dislocation elbow joint (disorder)
209253005	Closed fracture dislocation superior radioulnar joint (disorder)
209258001	Closed fracture subluxation of elbow joint (disorder)
209259009	Closed fracture subluxation superior radioulnar joint (disorder)
21419000	Closed fracture of medial condyle of humerus (disorder)
2295008	Closed fracture of upper end of forearm (disorder)
263078002	Fracture dislocation of elbow joint (disorder)
263100007	Fracture subluxation of elbow joint (disorder)
263101006	Fracture subluxation of superior radioulnar joint (disorder)
263192005	Fracture of distal end of humerus (disorder)
263193000	Supracondylar fracture of humerus (disorder)
263195007	Fracture of proximal end of radius (disorder)
263196008	Fracture of radial head (disorder)
263197004	Fracture of radial neck (disorder)
263203001	Fracture of proximal end of ulna (disorder)
263206009	Fracture of proximal end of radius and ulna (disorder)
269080004	Closed fracture of the distal humerus (disorder)
281525005	Fracture of the lateral humeral epicondyle (disorder)
281526006	Fracture of the medial humeral epicondyle (disorder)
29045004	Closed Monteggia's fracture (disorder)
302222008	Elbow fracture - closed (disorder)
309464009	Elbow fracture (disorder)
33041006	Closed fracture of proximal end of ulna (disorder)
440366004	Closed fracture of the medial epicondyle of humerus (disorder)
441496000	Transcondylar fracture of distal humerus (disorder)
442448003	Fracture of head of radius with dislocation of distal radioulnar joint and interosseous membrane disruption (disorder)
58580000	Closed supracondylar fracture of humerus (disorder)
5895007	Closed multiple fractures of upper end of radius (disorder)
64902007	Closed fracture of olecranon process of ulna (disorder)
68819003	Closed fracture of coronoid process of ulna (disorder)
68854005	Closed fracture of head of radius (disorder)
700147004	Avulsion fracture of medial epicondyle of humerus (disorder)
704208000	Closed fracture of proximal epiphysis of radius (disorder)
704410001	Closed transcondylar fracture of distal humerus (disorder)
705076001	Closed fracture of epiphyseal plate of distal humerus (disorder)
71139009	Closed fracture of proximal end of radius (disorder)
72497001	Closed fracture of neck of radius (disorder)
733408008	Fracture of lateral condyle of humerus (disorder)
733409000	Fracture of medial condyle of humerus (disorder)
7341005	Closed multiple fractures of upper end of ulna (disorder)
80767005	Closed fracture of condyle of humerus (disorder)

Appendix C- Tibia/Fibula and Toe fracture SNOMED codes

Tibia/Fibula

31978002	Fracture of tibia (disorder)
6698000	Closed trimalleolar fracture (disorder)
6990005	Fracture of shaft of tibia (disorder)
15385006	Closed fracture of medial malleolus (disorder)
20433007	Fracture of upper end of tibia (disorder)
23900009	Closed fracture of upper end of tibia (disorder)
25899002	Closed bimalleolar fracture (disorder)
28012007	Closed fracture of shaft of tibia (disorder)
47848000	Closed fracture of condyle of tibia (disorder)
71830006	Supination-adduction injury of ankle, stage 2 (disorder)
87905008	Gosselin's fracture (disorder)
123975002	Trimalleolar fracture (disorder)
208610006	Closed fracture proximal tibia, medial condyle (plateau) (disorder)
208611005	Closed fracture proximal tibia, lateral condyle (plateau) (disorder)
208612003	Closed fracture proximal tibia, bicondylar (disorder)
208613008	Closed fracture intercondylar spine of tibia (disorder)
208629000	Closed fracture of tibia and fibula, shaft (disorder)
208634001	Closed fracture distal tibia (disorder)
208635000	Closed fracture distal tibia, extra-articular (disorder)
208636004	Closed fracture distal tibia, intra-articular (disorder)
208662008	Closed fracture ankle, bimalleolar, low fibular fracture (disorder)
208663003	Closed fracture ankle, bimalleolar, high fibular fracture (disorder)
208666006	Closed fracture ankle, trimalleolar, low fibular fracture (disorder)
208667002	Closed fracture ankle, trimalleolar, high fibular fracture (disorder)
263237009	Closed fracture of tibial tuberosity (disorder)
263240009	Pilon fracture (disorder)
263241008	Tillaux fracture (disorder)
263244000	Bimalleolar fracture of ankle (disorder)
271577005	Fracture of shaft of tibia and fibula (disorder)
278537006	Fracture of distal end of tibia (disorder)
281531008	Fracture of medial malleolus (disorder)
281532001	Fracture of posterior malleolus (disorder)
281843000	Fracture of tibial spine (disorder)
413877007	Closed fracture of tibia AND fibula (disorder)
414293001	Fracture of tibia AND fibula (disorder)
428256003	Fracture of condyle of tibia (disorder)
428257007	Fracture of tibial plateau (disorder)
428797006	Closed osteochondral fracture of proximal tibia (disorder)
428798001	Closed fracture of tibial plateau (disorder)
442205007	Stress fracture of tibia (disorder)
445410003	Closed fracture of distal tibia and distal fibula (disorder)
446298003	Closed pilon fracture (disorder)
447139008	Closed fracture of tibia (disorder)
703998005	Closed bicondylar fracture of tibial plateau (disorder)
705080006	Closed fracture of epiphyseal plate of distal tibia (disorder)
705092006	Closed fracture of epiphyseal plate of proximal tibia (disorder)
733295004	Avulsion of tibial tuberosity (disorder)
735669008	Fracture of metaphysis of proximal tibia (disorder)
735671008	Fracture of lateral condyle of tibia (disorder)
735672001	Fracture of medial condyle of tibia (disorder)
735846008	Avulsion of ligament with bony fragment of medial malleolus (disorder)
39541000087106	Fracture of medial condyle of left tibia (disorder)
39551000087109	Fracture of medial condyle of right tibia (disorder)
40031000087104	Fracture of left tibial plateau (disorder)
40041000087105	Fracture of right tibial plateau (disorder)
40051000087108	Fracture of lateral condyle of left tibia (disorder)
40061000087106	Fracture of lateral condyle of right tibia (disorder)
40071000087102	Fracture of left medial malleolus (disorder)
40081000087100	Fracture of right medial malleolus (disorder)
10924841000119100	Closed fracture of medial condyle of right tibia (disorder)
10924881000119100	Closed fracture of medial condyle of left tibia (disorder)
75591007	Fracture of fibula (disorder)
21867001	Fracture of upper end of fibula (disorder)
28359007	Closed fracture of head of fibula (disorder)
34268009	Closed fracture of lateral malleolus (disorder)
59639009	Closed fracture of upper end of fibula (disorder)
67394003	Fracture of shaft of fibula (disorder)
77803008	Closed fracture of shaft of fibula (disorder)
208615001	Closed fracture fibula, neck (disorder)
208657007	Closed fracture ankle, lateral malleolus, low (disorder)
208658002	Closed fracture ankle, lateral malleolus, high (disorder)
263242001	Fracture of distal end of fibula (disorder)
281533006	Fracture of head of fibula (disorder)
281534000	Fracture of neck of fibula (disorder)
281535004	Fracture of lateral malleolus (disorder)
308153009	Closed fracture of distal fibula (disorder)
315643003	Dupuytren's fracture dislocation ankle (disorder)
442538002	Stress fracture of fibula (disorder)
447395005	Closed fracture of fibula (disorder)
704209008	Closed fracture of epiphysis of proximal fibula (disorder)
705082003	Closed fracture of epiphyseal plate of distal fibula (disorder)
733296003	Avulsion of head of fibula (disorder)
735842005	Fracture of lateral malleolus below syndesmosis (disorder)
735844006	Avulsion of ligament with bony fragment of lateral malleolus (disorder)
735845007	Fracture of lateral malleolus at syndesmosis (disorder)
735847004	Fracture of distal fibula above syndesmosis (disorder)
736517000	Avulsion fracture of anterior fibula (disorder)
19350001000004100	Stress fracture of tibia and fibula (disorder)

Toe

21351003	Fracture of phalanx of foot (disorder)
81576005	Closed fracture of phalanx of foot (disorder)
302036006	Closed fracture dislocation of interphalangeal joint of toe (disorder)
209361003	Closed fracture dislocation of interphalangeal joint of multiple toes (disorder)
209378007	Closed fracture subluxation of interphalangeal joint of multiple toes (disorder)
209359007	Closed fracture dislocation of interphalangeal joint of single toe (disorder)
208712008	Closed fracture distal phalanx, toe (disorder)
705067008	Closed fracture of distal phalanx of lesser toe (disorder)
208711001	Closed fracture middle phalanx, toe (disorder)
705068003	Closed fracture of epiphyseal plate of lesser toe (disorder)
208713003	Closed fracture of multiple phalanges of toe (disorder)
208710000	Closed fracture proximal phalanx, toe (disorder)
704057005	Stress fracture of phalanx of foot (disorder)
11314801000119100	Stress fracture of phalanx of left foot (disorder)
11314761000119100	Stress fracture of phalanx of right foot (disorder)
263093003	Fracture dislocation of toe joint (disorder)
263117000	Fracture subluxation of interphalangeal joint of toe (disorder)
209375005	Closed fracture subluxation of interphalangeal joint of single toe (disorder)

Appendix D

Manipulations in emergency department were identified using A&E Treatment Code:

10- Reduction

Manipulations in theatre were identified by one of the following OPCS codes recorded during an inpatient episode in the 3 months post-emergency care attendance.

- W262 Manipulation of fracture of bone NEC
- W268 Other specified
- W269 Unspecified
- W663 Primary manipulative closed reduction of fracture dislocation of joint NEC
- W252 Closed reduction of fracture of bone and fixation using functional bracing system

X-rays in the emergency department were identified using A&E Investigation Code:

01- X-ray

Physiotherapy appointments were identified by one of the following:

- SNOMED referral code for physiotherapy in ECDS- 306170007 Referral to physiotherapy service (procedure)
- Treatment Function Code for physiotherapy in the outpatient dataset in the 3 months post-emergency care attendance- 650 Physiotherapy Service

Outpatient follow up appointments were identified using the following codes in the outpatient dataset in the 3 months post-emergency care attendance

Treatment function code was one of:

- 110 Trauma and Orthopaedic service
- 111 Orthopaedic Service
- 115 Trauma Surgery Service
- 214 Paediatric Trauma and Orthopaedic Service

Or 420 Paediatrics provided that the outpatient referral source was either: 10- initiated following an emergency care attendance (including minor injuries, walk in centres and urgent treatment centres) OR 04- not initiated following a referral from an emergency care department (including minor injuries, walk in centres and urgent treatment centres)

It was also required that the emergency care attendance discharge information did NOT have the SNOMED code- 3780001 Routine patient disposition, no follow-up planned (procedure)