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Healthcare utilisation outcomes in patients with blunt chest wall trauma following discharge from the Emergency Department: a retrospective, observational data-linkage study

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Authorship: All authors contributed to study design. CB and HT completed the data collection. CB, HH, AA, JR, AW contributed to the data interpretation. AW, JR, and CB contributed to data analysis. CB, HH, JR, AA contributed to the writing, and all authors completed critical revision of the final manuscript.

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protecting safe haven and remote access system referred to as the SAIL Gateway. SAIL has established an application process to be followed by anyone who would like to access data via SAIL at: https://www.saildatabank.com/application-process/

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ABSTRACT

Background: Whilst much is published reporting clinical outcomes in the patients with blunt chest wall trauma who are admitted to hospital from the ED, less is known about the patients' recovery when they are discharged directly without admission. The aim of this study was to investigate the healthcare utilisation outcomes in adult patients with blunt chest wall trauma, discharged directly from ED in a trauma unit in the UK.

Methods: This was a longitudinal, retrospective, single-centre, observational study incorporating analysis of linked datasets, using the Secure Anonymised Information Linkage (SAIL) databank for admissions to a trauma unit in the Wales, between 1st January 2016 and 31st December 2020. All patients aged ≥16 years with a primary diagnosis of blunt chest wall trauma discharged directly home were included. Data was analysed using a negative binomial regression model.

Results: 3205 presentations to the ED were included. Mean age was 53 years, 57% were male, with the predominant injury mechanism being a low velocity fall (50%). 93% of the cohort sustained between 0-3 rib fractures. 4% of the cohort were reported to have COPD, and 4% using pre-injury anticoagulants. On regression analysis, inpatient admissions, outpatient appointments and primary care contacts all significantly increased in the 12-week period post-injury, compared with the 12-week period pre-injury (OR: 1.63 95% CI: 1.33-1.99, $p<0.001$; OR: 1.28, 95% CI: 1.14-1.43, $p<0.001$; OR: 1.02. 95% CI: 1.01-1.02, $p<0.001$ respectively). Risk of healthcare resource utilisation increased significantly with each additional year of age, COPD and pre-injury anti-coagulant use (all $p<0.05$). Social deprivation and number of rib fracture did not impact outcomes.

Conclusion: The results of this study demonstrate the need for appropriate signposting and follow-up for patients with blunt chest wall trauma presenting to the ED, not requiring admission to the hospital.

Study type and level of evidence: Prognostic / epidemiological. Level IV

Key words: Rib fractures; Outcomes; Data linkage

INTRODUCTION

Difficulties in the management of patients with blunt chest wall trauma are well-recognised.(1-4) The patient often presents to the Emergency Department (ED) early following their injury, only to develop complications such as pneumonia up to approximately 72 hours later, once discharged home.(1) Later complications have also been reported, for example, delayed haemothorax has been shown to develop one to two weeks following injury.(5-7) Accurate prognostication of the development of complications is important but complex, as many predictor variables have been shown to influence the outcomes in this patient group.(8) Numerous pathways and prediction models are used in clinical practice that attempt to guide the management decisions of this patient cohort.(4, 9-14) Whilst much is published reporting clinical outcomes in the patients with blunt chest wall trauma who are admitted to hospital from the ED, less is known about the patient's recovery when discharged directly home without admission.

Shields et al. (2010) reported that 10% of the patients with minor thoracic injuries in their study developed important delayed complications within 14 days of discharge from ED, with 18.6% of patients having unplanned follow-up visits in the ED, with inadequate pain relief as the principal reason for consultation.(15) They concluded that patient age did not impact management or follow-up recommendations.(15) A prospective cohort study of non-hospitalised patients with minor chest trauma reported a low incidence of delayed pneumonia, although the authors concluded there was a need for tailored follow-up for patients with blunt chest trauma and asthma or chronic obstructive pulmonary disease.(16) Longer-term complications in non-hospitalised patients with blunt chest trauma were investigated in another study, in which it was concluded that severe to moderate disabilities were present in nearly one patient out of five at 90 days post-injury, but again age had no impact on the findings.(17)

Data regarding the impact of social deprivation is lacking in patients with blunt chest wall trauma. In a large retrospective study conducted in Scotland, a higher incidence of trauma amongst a socioeconomically deprived population was reported, which is in keeping with other areas of the world, however mortality was not associated with socioeconomic deprivation.(18) Social deprivation was reported to be a risk factor for prolonged length of stay following blunt chest wall trauma in a single centre retrospective study in [country], but further good quality research is needed regarding patients discharged directly home from the ED.(19)

Due to this lack of evidence, the primary aim of this study was to investigate the healthcare utilisation outcomes in the 12-week post-injury period in adult patients with blunt chest wall trauma discharged directly from ED in a trauma unit in the UK. Secondary aims were to investigate the impact of age, number of rib fractures, pre-injury chronic lung disease, pre-injury anticoagulant use and social deprivation on healthcare utilisation outcomes in the same patient cohort.

METHODS

Study design and setting

The STROBE checklist was followed for the completion of this study (Supplementary File 1, http://links.lww.com/TA/D161). This longitudinal, retrospective, single-centre, observational study incorporates analysis of linked data sources using the Secure Anonymised Information Linkage (SAIL) Databank for admissions to [insert hospital name here], UK, between 1st

January 2016 and 31st December 2020. [insert hospital name here] a [insert type of hospital here] serving [insert region here] and has approximately 50,000 presentations to its ED annually.

Study population

All patients aged 16 years or more with a primary diagnosis of blunt chest wall trauma discharged directly home from [insert hospital name here] ED between 1st January 2016 and 31st December 2020 were included. Exclusion criteria were patients admitted to hospital following presentation to the ED with blunt chest wall trauma, patients with no NHS number where matching and anonymisation were not possible, and patients aged <16 years.

Data sources

The data sources used for this study were available within SAIL Databank, a trusted research environment (TRE) established and managed by [insert institution] in [insert country]. Anonymised individual-level, population-scale routinely-collected linked health and administrative data sources describing the Welsh population. In this study, patients with blunt chest wall trauma were first identified from the [insert hospital name] Information Department database. This dataset was cleaned using the pre-defined inclusion and exclusion criteria and then provided to SAIL using a split file process (in which demographic data including name, address, date of birth and sex were separated from clinical data relating to the index presentation at the ED and the injury).(20, 21) The clinical data (file 2) was sent direct to SAIL. The demographic details (file 1) were sent to Digital Health and Care [insert country], who act as a trusted third party and complete the matching and anonymisation process. This process creates a third file (file 3), replacing the identifiable data in file 1 with an Anonymous Linking Field (ALF). This file 3 was sent directly from DHCW to SAIL, where it was re-linked with the clinical data in file 2. The ALF field was further encrypted at SAIL to create an ALF-E (Anonymous Linkage File - Encrypted), which permits linkage with other anonymised data sources held within the SAIL Databank.

The population-scale data sources approved and accessible for use for this study were the Annual District Death Extract (ADDE), Emergency Department Data Set (EDDS), Patient Episode Database for Wales (PEDW), Welsh Demographic Service Dataset (WDSD) and Welsh Longitudinal General Practice (WLGP). For all the above data sources, there is 100% coverage, aside from the WLGP, which is 86% coverage currently available. Deciles of social deprivation using the Welsh Index of Multiple Deprivation (WIMD) version 2019 were used for this study, based on the Lower-layer Super Output Area (LSOA) version 2011 of the patient's residence. A full list of variables and their definitions can be found in Supplementary File 2, http://links.lww.com/TA/D162.

Statistical analysis

Summary statistics for the cohort were calculated using numbers (percentages) means (standard deviations) and median (interquartile ranges) and presented for pre and post admission outcomes were compared with univariate analysis. For our multivariate analysis, we compared the two 12-week periods prior to and following admission to ED for blunt chest trauma using negative binomial modelling. The outcome was the number of times the patient presented to a healthcare provider (primary care and secondary care admissions were treated separately). Model assumptions were checked to ensure the model choice was appropriate. In particular, count data often feature zero inflation and where this was found, a zero inflated negative binomial model was used. Predictors for the zero part of zero inflated models were selected using a forward stepwise process, with model fit evaluated using the Akaike

Information Criterion. The same set of predictors were used for negative binomial models and the count part of zero inflated models for comparison purposes. Only individuals with complete sets of data were included in the multivariate analysis, so the patients with missing data were excluded from the cohort. Statistical analysis was performed using R version 4.1.3, PSCL 1.5.5 and MASS 7.3-58.1.

Ethics

Approval was obtained from the [insert ethics information] project reference 1014.

RESULTS

A total of 3,205 presentations were identified for inclusion in the final analysis (Figure 1 in Supplementary File 3, http://links.lww.com/TA/D163). The mean age was 54 (SD: 20.8), 57% were male, with the predominant injury mechanism being a low velocity fall (48%). 93% of the cohort sustained less than three rib fractures. Only 4% of the cohort reported having Chronic Obstructive Pulmonary Disease (COPD), and 4% used pre-injury anticoagulants. 85% of cases were referred to primary care for follow-up on discharge from the ED. Only 1% of the cohort died in the 12-week period following the index presentation at the ED. The full baseline characteristics of the patients included in this study are outlined in Table 1.

Table 1: Baseline characteristics

The results indicate that there was a statistically significant increase in the overall number of healthcare resource contacts in the 12-week period post-injury. The number of unplanned ED attendances, inpatient admissions, outpatient appointments and primary care contacts all increased in the 12-week period post-injury compared to the 12-week period pre-injury.

Table 2 indicates the difference in healthcare utilisation (raw values only) between the 12-weeks pre and 12-weeks post-injury periods.

Multivariate analysis

ED attendances

The results of the negative binomial generalised linear model (GLM) analysis for the ED attendances outcome did not show a statistically significant increase in the number of attendances in the 3-month period following the index injury compared to the period before the index injury. There was however an increase in the number of ED attendances for people with COPD and a reduced number of attendances for people in the least deprived WIMD decile, although we note once again that the relationship to deprivation was complicated. The full results for the model of ED contacts are presented in Table 3.

Table 3: Results of multivariate analysis for ED attendances

Inpatient admissions

The results of the GLM analysis for inpatient admissions highlighted a statistically significant increase in the number of inpatient admissions in the 12-week period following the index presentation to the ED when compared with the 12-period pre-index presentation ($p<0.001$). The risk of inpatient admissions increased with each additional year of age ($p<0.001$) if the patient had COPD ($p=0.005$) or used pre-injury anticoagulants ($p=0.014$). The picture regarding socioeconomic deprivation was complicated, but a general trend of people from less deprived areas having fewer inpatient admissions than the most deprived comparator group was observed. The full results for inpatient admissions are outlined in Table 4.

Table 4: Results of multivariate analysis for inpatient admissions

Outpatient attendances

The results of the GLM analysis for outpatient attendances demonstrated a statistically significant increase in the number of attendances in the 12-week period following the index presentation to the ED when compared with the 12-week period pre-index presentation ($p<0.001$). The risk of outpatient attendance increased if the patient was female ($p=0.001$), with each additional year of age (p<0001) and if the patient had COPD ($p=0.017$) or used pre-injury anticoagulants ($p=0.001$). The picture of socioeconomic deprivation was again complicated, but a similar trend of people from less deprived areas having fewer outpatient admissions than the most deprived comparator group was observed. The full results for outpatient admissions are outlined in Table 5.

Table 5: Results of multivariate analysis for outpatient attendances

Primary care contacts

The results of the zero-inflated GLM analysis demonstrated a statistically significant increase in the number of primary care contacts in the 12-week period following the index presentation to the ED compared with the 12-week period pre-index presentation ($p<0.001$). Planned follow-up ED attendances have been removed from the analysis. The risk of primary care contact increased if the patient was female ($p<0.001$), with each additional year of age ($p<0.001$), if the patient had COPD ($p<0.001$) or used anticoagulant therapy ($p<0.001$). Subjects were less likely to have zero primary care contacts in the 12-week period following the index injury the than in the 12-weeks prior to the index injury ($p=0.001$), with each additional year of age ($p<0.001$), if they were female ($p<0.001$) and if they had COPD ($p=0.03$). The full results for primary care contacts are outlined in Table 6.

Table 6: Results of multivariate analysis for primary care contacts

DISCUSSION

Limited research exists examining healthcare resource utilisation outcomes of patients with blunt chest wall trauma presenting to the ED, who are discharged directly home without hospital admission. This study has demonstrated that patients with blunt chest wall trauma have significantly increased healthcare resource utilisation (both in primary care and hospital services) in the 12 weeks following their injury and index presentation to the ED. This significant increase in healthcare resource utilisation was arguably to be expected in patients following major trauma, however, this cohort is comprised of less severely injured patients in whom these outcomes may have been less expected by the ED clinicians. In the absence of more in-depth data however, it is not possible to ascertain what, if any, sequelae of the original chest injury under-pins these follow-up events.

The baseline characteristics for the cohort of patients included in this study are similar to those in other studies evaluating minor blunt chest trauma managed or discharged directly from the ED.(15-17) Low velocity fall is now the most frequently managed injury mechanism in our trauma care systems.(22) Identification and early aggressive management of patients with blunt chest wall trauma at higher risk of developing complications could improve outcomes, however the majority of patients will be discharged directly home without hospital admission.(15, 23) Little is known to date regarding the healthcare resource utilisation outcomes of this cohort of patients once they leave the acute care setting. In this study, the injury severity assessed by the number of rib fractures sustained did not influence healthcare resource utilisation in patients with blunt chest wall trauma discharged directly home from the ED.

In a recent Canadian study, it was reported that 18% of their trauma population had at least one ED return visit within two weeks(24), in contrast to older studies that have reported 14% re-attendance over a 30-day follow-up period.(25, 26) The cohort of patients with blunt chest trauma in our study demonstrated an 18% unplanned re-attendance rate at the ED within 12-weeks. These results may differ due to the inclusion of only patients with blunt chest trauma in our study. A very low proportion of patients in this study (1.1%) were discharged from the ED without a planned follow-up, which is in contrast with a 2010 Canadian study which reported 53% of patients were discharged with no recommendations of follow-up.(15) This change may reflect different healthcare and trauma systems, but also a temporal change in how patients are managed. This also could explain the increased healthcare resource utilisation in the post-injury period reported in this study, as patients were following this discharge plan.

The results of this study have demonstrated that healthcare resource utilisation for outpatient, inpatient and primary care services are all significantly increased in the 12-week period post-injury, when compared to the 12-week period pre-injury for patients with blunt chest wall trauma. This need increases with a number of patient characteristics. Females are at higher risk of increased use of both outpatient and primary care services compared with males. Previous research has highlighted that women have higher rates of post-discharge healthcare resource utilisation as women are more compliant with their follow-up advice. (27)

The risk of all healthcare utilisation outcomes increased in this cohort of patients with each additional year of age. This supports previous research, which has reported age to be a predictor of poor hospital-based resource outcomes in patients with blunt chest wall trauma, including delayed upgrade in care, need for critical care admission and mechanical ventilation and prolonged length of stays.(28,29,30-32) Minor blunt chest wall injuries that are typically well tolerated by younger patients can often prove fatal for the older patient, which would explain the increase in healthcare resource utilisation with each year of age, reported in this study. With an ageing demographic, trauma in the older patient will continue to increase most likely with a high volume of rib fractures.(22) It is therefore critical to understand the best course of triage and management for this high-risk population in the emergency care setting.

Chronic lung disease has been reported previously as a predictor of poor in-hospital patient outcomes in patients with blunt chest wall trauma.(8,33-35) In this study, COPD was also a predictor of increased healthcare resource utilisation in patients discharged directly home from the ED. The use of pre-injury anticoagulants has been similarly reported as a predictor of poor outcomes(36-38), which is also supported by our study findings.

Our study found that patients residing in an area of lower social deprivation did not generally have a higher healthcare utilisation rate following minor blunt chest wall trauma. This supports two previous UK-based studies that concluded residing in a more deprived area was not associated with the development of complications following trauma.(18, 19) A recent American study investigated the effect of area social deprivation on healthcare utilisation in an adult trauma population and concluded that patients in the high social deprivation cohort were less likely to be discharged with additional support services.(39) The reasons suggested by the authors for this include a combination of factors related to providers (implicit bias), patients (being offered services and declining them), or the healthcare system (lack of insurance coverage for services).(39)

The strengths of this study are the use of a large five-year cohort of patients, the inclusion of all patients discharged from the ED, near complete follow-up and the use of an integrated data linkage system.(20) The robust nature of utilising multiple data sources within the SAIL Databank from a variety of healthcare services, provides a reasonable degree of certainty that the majority of healthcare encounters have been captured. The inherent benefit of this methodology is that continuous longitudinal follow-up is possible. There were however a number of limitations. As this study methodology relied on the use of the hospital ED dataset, we were unable to include more in-depth data regarding pre and post-injury healthcare resource use, or specific management and treatment strategies undertaken in the ED. As a result, it is not possible to definitively state that our conclusions were solely due to the variables studied and the results should therefore be interpreted with caution. We were also unable to analyse whether there was any association between ED discharge plans and specific predictor variables. We were unable to state the reasons for healthcare resource utilisation in the pre and post-injury period.

Identification of patients for inclusion in this study relied upon the accurate coding of data in the ED, which could result in a degree of error and patients being missed. Recording of some data in the ED by clinicians, in particular ethnicity, led to missing data in the final analysis. The completion and accuracy of data input for all health services captured by SAIL will influence the reliability of study results. Low numbers of outcome events in certain healthcare settings (critical care) resulted in an inability to complete the originally intended analysis, even using the zero inflated negative binomial generalised linear modelling.

In conclusion, the results of this study have demonstrated a significant increase in healthcare resource utilisation by patients with blunt chest wall trauma discharged from the ED without hospital admission, in the 12-week post-injury period compared to the 12-week pre-injury period. This increase in healthcare resource utilisation is compounded by a number of factors, which should be considered when clinicians are deciding the appropriate discharge disposition from the ED.

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SUPPLEMENTAL DIGITAL CONTENT:

File 1: STROBE Statement Checklist

File 2: Full list of variables and definitions

File 3: Figure 1: flow diagram

Table 1: Baseline characteristics

BASELINE CHARACTERISTIC	
Age (mean / SD)	53 (20.8)
Sex: (n / %)	
Male	1831 (57.1%)
Female	1374 (42.9%)
Ethnicity (n / %)	
Any white background	1857 (57.9%)
Any non-white background	1232 (38.4%)
Not stated	36 (1.1%)
Missing data	80 (2.5%)
Injury mechanism: (n / %)	
Low velocity fall	1521 (49.7%)
High velocity fall	383 (12.5%)
Road traffic collision	469 (15.3%)
Assault	188 (6.1%)
Other	501 (16.4%)
Missing data	143 (4.5%)
COPD (n / %)	
Yes	133 (4.4%)
No	2902 (90.5%)
Missing data	170 (5.3%)
Pre-injury anticoagulants (n / %)	
Yes	138 (4.5%)
No	2896 (90.4%)
Missing data	171 (5.3%)
Social deprivation WIMD 2019 deciles	
Decile 1 (Most deprived)	490 (15.9%)
Decile 2	386 (12.5%)
Decile 3	283 (9.2%)
Decile 4	443 (14.4%)
Decile 5	260 (8.5%)
Decile 6	213 (6.9%)
Decile 7	255 (8.3%)
Decile 8	144 (4.7%)
Decile 9	286 (9.3%)
Decile 10 (Least deprived)	316 (10.3)
Missing data	129 (4.0%)
Follow-up plan (n / %)	
No planned follow-up	33 (1.0%)
Planned ED follow-up appointment	357 (11.1%)
Referred to GP	2718 (84.8%)
Referred to outpatient department	75 (2.3%)
Referred to other healthcare professional	9 (0.3%)
Patient self-discharged without clinical consent	13 (0.4%)
Deaths (n / %)	
Yes	33 (1.0%)
No	3172 (99.0%)
Number of rib fractures (n / %)	
0	2150 (67.1%)
1	652 (20.3%)
2	163 (5.1%)
3	52 (1.6%)
4 or more	18 (0.6%)
Missing data	170 (5.3%)

N: number of cases; %: percentage of cases; Mean and SD: standard deviation; Median and IQR = interquartile range; WIMD: Welsh Index of Multiple Deprivation; COPD: chronic obstructive pulmonary disease

Table 2: Healthcare utilisation outcomes 12-weeks pre and post index injury

Healthcare utilisation outcomes	12 weeks pre-injury	12 weeks post-injury	X^2 test statistic	p-value
No reported healthcare resource utilisation	697 (21.7%)	559 (17.4%)	18.59	<0.001
Number of unplanned attendances at ED	528 (16.5%)	591 (18.4%)	6.56	0.510
Number of inpatient admissions	204 (6.4%)	336 (10.5%)	38.65	<0.001
Number outpatient attendances	846, 26.4%	1012 (31.6%)	40.96	<0.001
Number of primary care contacts	2451 (76.6%)	2582 (80.6%)	58.79	0.002

NB: The index ED attendance is not included in either 12-week pre- or post-injury counts

Table 3: Results of multivariate analysis for ED attendances

	Exp(coef) (95%CI)	p-value
(Intercept)	0.321 (0.251, 0.411)	<0.001
12-week period post-injury	1.019 (0.878, 1.184)	0.801
Age	0.997 (0.993, 1.001)	0.146
Female sex (comparator: male sex)	1.038 (0.899, 1.200)	0.608
WIMD decile (comparator: 1, most deprived)		
Decile 2	0.933 (0.727, 1.198)	0.588
Decile 3	0.922 (0.698, 1.217)	0.566
Decile 4	0.838 (0.657, 1.070)	0.157
Decile 5	0.748 (0.558, 1.002)	0.051
Decile 6	0.652 (0.469, 0.901)	0.010
Decile 7	0.651 (0.477, 0.884)	0.006
Decile 8	0.619 (0.415, 0.913)	0.016
Decile 9	0.673 (0.499, 0.906)	0.010
Decile 10, least deprived	0.613 (0.456, 0.820)	0.001
COPD	1.477 (1.070, 2.040)	0.017
Anticoagulant use	1.337 (0.962, 1.856)	0.084
Number of rib fractures	1.022 (0.899, 1.159)	0.740

WIMD: Welsh Index of Multiple Deprivation; COPD: chronic obstructive pulmonary disease

Table 4: Results of multivariate analysis for inpatient admissions

	Exp(coef) (95%CI)	p-value
(Intercept)	0.027 (0.018, 0.039)	<0.001
12-week period post-injury	1.631 (1.333, 1.997)	<0.001
Age	1.025 (1.020, 1.030)	<0.001
Female sex (comparator: male sex)	1.135 (0.935, 1.376)	0.201
WIMD decile (comparator: 1, most deprived)		
Decile 2	0.834 (0.590, 1.174)	0.296
Decile 3	0.620 (0.415, 0.920)	0.018
Decile 4	0.593 (0.416, 0.843)	0.004
Decile 5	0.701 (0.474, 1.029)	0.072
Decile 6	0.574 (0.364, 0.892)	0.015
Decile 7	0.950 (0.654, 1.377)	0.789
Decile 8	0.486 (0.281, 0.819)	0.008
Decile 9	0.673 (0.454, 0.991)	0.045
Decile 10, least deprived	0.556 (0.379, 0.810)	0.003
COPD	1.711 (1.180, 2.486)	0.005
Anticoagulant use	1.594 (1.100, 2.314)	0.014
Number of rib fractures	0.918 (0.774, 1.080)	0.320

WIMD: Welsh Index of Multiple Deprivation; COPD: chronic obstructive pulmonary disease

Table 5: Results of multivariate analysis for outpatient attendances

	Exp(coef) (95%CI)	p-value
(Intercept)	0.151 (0.123, 0.185)	<0.001
12-week period post-injury	1.277 (1.143, 1.426)	<0.001
Age	1.024 (1.021, 1.026)	<0.001
Female sex (comparator: male sex)	1.194 (1.074, 1.328)	0.001
WIMD decile (comparator: 1, most deprived)		
Decile 2	0.765 (0.626, 0.935)	0.009
Decile 3	0.832 (0.670, 1.034)	0.097
Decile 4	0.903 (0.747, 1.091)	0.292
Decile 5	0.880 (0.708, 1.095)	0.251
Decile	0.710 (0.556, 0.906)	0.006
Decile 7	0.996 (0.801, 1.240)	0.970
Decile 8	0.844 (0.641, 1.115)	0.226
Decile 9	0.795 (0.639, 0.990)	0.040
Decile 10, least deprived	0.803 (0.652, 0.989)	0.039
COPD	1.331 (1.054, 1.692)	0.017
Anticoagulant use	1.465 (1.171, 1.845)	0.001
Number of rib fractures	1.025 (0.943, 1.118)	0.583

WIMD: Welsh Index of Multiple Deprivation; COPD: chronic obstructive pulmonary disease

Table 6: Results of multivariate analysis for primary care contacts

	Exp(coef) (95%CI)	p-value
Count model		
(Intercept)	2.612 (2.392, 2.852)	<0.001
12-week period post-injury	1.016 (1.014, 1.017)	<0.001
Age	1.106 (1.058, 1.156)	<0.001
Female sex (comparator: male sex)	1.111 (1.061, 1.164)	<0.001
WIMD decile (comparator: 1, most deprived)		
Decile 2	0.892 (0.821, 0.970)	0.007
Decile 3	0.955 (0.872, 1.046)	0.325
Decile 4	0.961 (0.887, 1.041)	0.329
Decile 5	0.890 (0.809, 0.979)	0.016
Decile 6	0.838 (0.757, 0.929)	0.001
Decile 7	0.962 (0.877, 1.054)	0.404
Decile 8	0.889 (0.790, 0.999)	0.048
Decile 9	0.824 (0.752, 0.903)	<0.001
Decile 10, least deprived	0.820 (0.751, 0.895)	<0.001
COPD	1.270 (1.153, 1.400)	<0.001
Anticoagulant use	1.403 (1.274, 1.545)	<0.001
Number of rib fractures	1.006 (0.970, 1.044)	0.730
Zero model		
(Intercept)	1.075 (0.767, 1.507)	0.675
12-week period following index injury	0.728 (0.603, 0.880)	0.001
Age	0.965 (0.960, 0.970)	<0.001
Female sex (comparator: male sex)	0.558 (0.451, 0.690)	<0.001
WIMD decile (comparator: 1, most deprived)		
Decile 2	1.047 (0.727, 1.509)	0.806
Decile 3	1.534 (1.056, 2.227)	0.025
Decile 4	1.277 (0.918, 1.778)	0.147
Decile 5	2.170 (1.521, 3.096)	0.000
Decile 6	1.539 (1.024, 2.314)	0.038
Decile 7	0.955 (0.609, 1.498)	0.842
Decile 8	1.476 (0.902, 2.416)	0.121
Decile 9	0.796 (0.482, 1.314)	0.372
Decile 10, least deprived	1.130 (0.743, 1.720)	0.567
COPD	0.310 (0.108, 0.895)	0.030

WIMD: Welsh Index of Multiple Deprivation; COPD: chronic obstructive pulmonary disease

Suppl file 1 STROBE-checklist SAIL study

STROBE Statement—Checklist of items that should be included in reports of ***cohort studies***

	Item No	Recommendation	Page no.
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	Abstract document
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	1-2
Objectives	3	State specific objectives, including any prespecified hypotheses	2
Methods			
Study design	4	Present key elements of study design early in the paper	2
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	2-3
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up	3
		(*b*) For matched studies, give matching criteria and number of exposed and unexposed	n/a
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	3-4
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	3-4 & suppl file 2
Bias	9	Describe any efforts to address potential sources of bias	n/a
Study size	10	Explain how the study size was arrived at	n/a
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	4-5
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	4-5
		(*b*) Describe any methods used to examine subgroups and interactions	n/a
		(*c*) Explain how missing data were addressed	5

		(*d*) If applicable, explain how loss to follow-up was addressed	n/a
		(*e*) Describe any sensitivity analyses	n/a
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	5 & fig 1 in suppl file 3
		(b) Give reasons for non-participation at each stage	n/a
		(c) Consider use of a flow diagram	Suppl file 3
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	5
		(b) Indicate number of participants with missing data for each variable of interest	Table 1
		(c) Summarise follow-up time (eg, average and total amount)	n/a
Outcome data	15*	Report numbers of outcome events or summary measures over time	6-7
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	6-7 and tables 2-6
		(*b*) Report category boundaries when continuous variables were categorized	Table 2-6
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	n/a
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	n/a
Discussion			
Key results	18	Summarise key results with reference to study objectives	7-8
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	10
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	8-10
Generalisability	21	Discuss the generalisability (external validity) of the study results	11

Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	Title page

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at http://www.strobe-statement.org.

Suppl file 2 Data dictionary

Variable	Description
Index presentation	Presentation to the ED with original injury
Gender	Male or Female
Deprivation score in 2019	Quintiles: 1-10 (see explanation below)
Age	Per year
Number of Rib fractures	Number of fractures reported on imaging. Marked as missing if no record
COPD	As stated in medical records. If not mentioned, allocated as NO
Pre-injury anticoagulant use	As stated in medical records. If not mentioned, allocated as NO
Injury mechanism	Fall from standing height High velocity fall Road traffic collision Assault Other If not mentioned, allocated as missing data
Outcome of attendance at ED	Text description of follow-up plan
Death	Yes / No
Ethnic group	White Other: all non-white ethnic groups If not recorded, allocated as missing data
Total number of ED presentations during study period	Numerical
Date of presentation at ED	Date
Attendance category	1 – new attendance 2 – planned follow up attendance
Total number of inpatient admissions during study period	Numerical
Date of inpatient admission	Date
Total number of outpatient contacts during study period	Numerical
Date of outpatient contact	Date
Total number of GP contacts during study period	Numerical
Date of GP contact	Date

Welsh Index of Multiple Deprivation (WIMD):

Welsh Index of Multiple Deprivation, 2019: guidance (gov.wales) states the following:

WIMD is a measure of multiple deprivation. It is both an area-based measure and a measure of relative deprivation.

Deprivation is defined as a lack of access to opportunities and resources which we might expect in our society. Social and material aspects of deprivation are the domains used in WIMD.

Material deprivation relates to having insufficient physical resources, such as food, shelter, and clothing, that is necessary for a certain standard of life.

Social deprivation is defined as an individual's ability to participate in the normal social life of the community.

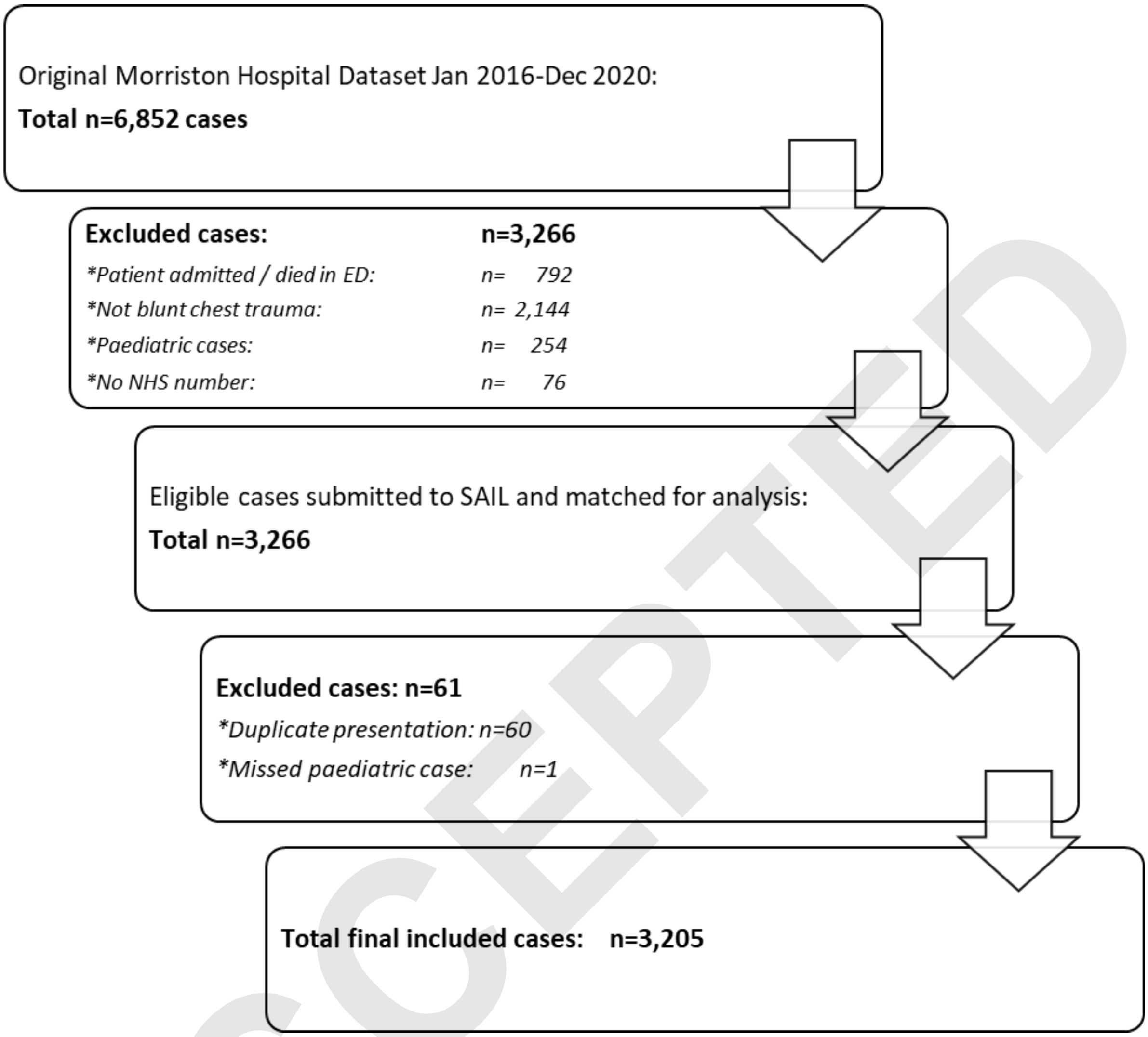
Multiple Deprivation refers to more than one type of deprivation. The WIMD is calculated from eight different deprivation domains, each made up by a range of different indicators. An area is classed as multiply deprived if, for more than one of the domains, the area has a concentration of people experiencing that type of deprivation. The greater the number of domains for which there are high concentrations of deprivation results in the greater the overall deprivation in an area.

Area-based measure: WIMD is calculated for all small areas (Lower layer Super Output Areas – LSOAs) in Wales. There are 1,909 LSOAs in Wales, each with an average population of 1,600 people.

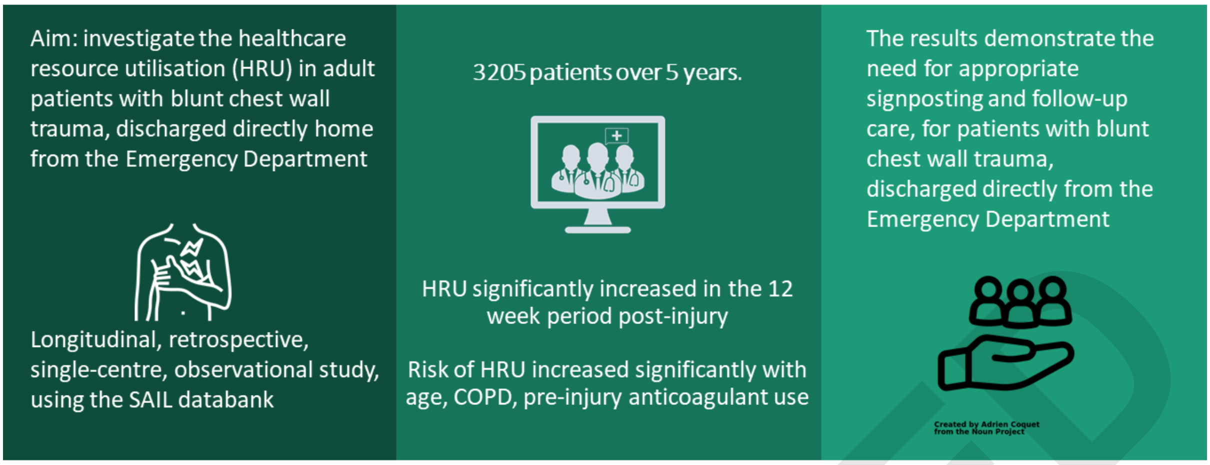
Relative measure: WIMD is used to identify areas in the order of least to most deprived. It does not provide a measure of the level of deprivation in an area, but rather whether an area is more or less deprived relative to all other areas in Wales. It is possible therefore to identify which areas are more (or less) deprived than others, but not by how much.

Suppl file 3 Figure 1_SAIL study

Figure 1: Flow diagram



Healthcare utilisation outcomes in patients with blunt chest wall trauma following discharge from the Emergency Department: an observational, data-linkage study



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