#### Table 1. Characteristics of ChIP activated (admitted patients), and ChIP-missed groups including baseline data, mechanism and injuries

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **n=453** | **ChIP**  **(n= 440)** | | **CHIP-missed**  **(n= 13)** | | **P-value** | **Change score\* (95% CI)** |
| Age, median (IQR) |  | 69.1 (52.5 - |  | 81.6 (3.7 - | 0.257 | 8.4 (-18.4, 1.4)b |
|  |  | 82.0) |  | 88.8) |  |  |
| Female, n % | 169 | 38.4 | 10 | 76.9 | 0.005 | 38.5 (11.5, 65.5) a |
| ISS, median (IQR) | 9 | (4.0 - 10.0) | 4 | (1.0 - 5.5) | 0.181 | 4.0 (0, 6.0) b |
| CCI score, median (IQR) | 3 | (1.0 - 5.0) | 4 | (2.5 - 5.0) | 0.444 | -1.0 (-2.0, 1.0) b |
| COPD, n % | 68 | 15.5 | 2 | 15.4 | 0.992 | 0.1 (-19.9, 20.1) a |
| Pneumonia on arrival, n % | 35 | 8.0 | 1 | 7.7 | 0.969 | 0.3 (-14.7, 15.3) a |
| Asthma, n % | 37 | 8.4 | 0 | 0 | 0.276 | 8.4 (-6.7, 23.5) a |
| Smoking (past or current), n % | 205 | 46.5 | 7 | 53.9 | 0.598 | 7.4 (-20.1, 34.9) a |
| Trauma call, , n % | 79 | 18.0 | 2 | 15.4 | 0.810 | 2.6 (-18.6, 23.8) a |
| Out of hours presentation c, n % | 292 | 66.4 | 8 | 61.5 | 0.713 | 4.9 (-21.2, 31.0) a |
| Polytraumad, n % | 8 | 1.8 | 1 | 7.7 | 0.131 | 5.9 (-1.8, 13.6) a |
| Sternum injury, n % | 46 | 10.4 | 4 | 30.8 | 0.020 | 20.4 (3.2, 37.7) a |
| Rib fractures <3 (includes clinical) e, n % | 209 | 47.5 | 11 | 84.6 | 0.008 | 37.1 (9.5, 64.7) a |
| Rib fractures ≥3 ribs or flail, n % | 209 | 47.5 | 0 | 0 | <0.001 | 47.5 (20.0,75.0) a |
| Lung injury, any, n % | 111 | 25.2 | 1 | 7.7 | 0.149 | 17.5 (-6.3, 41.3) a |
| Fall f, n % | 277 | 63.0 | 5 | 38.5 | 0.072 | 24.5 (-2.2, 51.2) a |
| Vehicle related injury, n % | 124 | 28.2 | 7 | 53.8 | 0.045 | 25.6 (0.6, 50.6) a |
| Other mechanism g, n % | 39 | 8.8 | 1 | 7.7 | 0.890 | 1.1 (-14.5, 16.7) a |

a P-value, difference and 95% CI based on 2 sample z test

b P-value based on test of sample medians, change score and 95% CIs based on Hodges-Lehmann estimator, which is the median of the set of differences between each value in the first group and each value in the second group and may diverge from the difference obtained by sample median 1 – sample median 2 (Klotz, 2006)

c Out-of-hours presentations include weekdays 4pm-8am, weekends and public holidays.

d Polytrauma= two or more abbreviated injury scores (AIS) greater than 2 in 2 or more body regions.

e Clinical rib fractures include injuries where there is no documented rib fracture on imaging; however, patient has significant pain

f Fall includes standing, height and ladder.

g Other mechanism includes blunt impact from objects or animals, and other mechanisms such as from cough or CPR

Abbreviations: CCI = Charlson Comorbidity Index, ChIP = blunt chest injury care bundle protocol, COPD = Chronic obstructive pulmonary Disease, ISS = injury severity score, IQR = interquartile range

#### Table 2. Documented components of the blunt chest injury care bundle (ChIP) performed for ChIP activated vs ChIP-missed groups

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **n=453** | **CHIP**  **n = 440** | | **ChIP-missed n = 13** | | **P-value** | **Change Score\* (95% CI)** |
|  | **n** | **%** | **n** | **%** |  |  |
| Initial vital signs | 434 | 98.6 | 13 | 100 | 0.668 | 1.4 (-5.0, 7.8) |
| Respiratory assessment prior to analgesia | 311 | 72.0 | 8 | 61.5 | 0.408 | 10.5 (-14.4, 35.4) |
| Analgesia in emergency department | 385 | 87.5 | 11 | 84.6 | 0.756 | 2.9 (-15.4, 21.2) |
| Vital signs (15-90min post-analgesia) | 270 | 61.4 | 6 | 46.2 | 0.268 | 15.2 (-11.7, 42.1) |
| Respiratory assessment post-analgesia (15-90min) | 137 | 32.1 | 1 | 7.7 | 0.062 | 24.4 (-1.2, 50.0) |
| Analgesia plan (regular, as required, regional, IV or PCA) | 432 | 98.2 | 13 | 100 | 0.626 | 1.8 (-5.4, 9.0) |
| Reviewed by acute pain service | 380 | 86.4 | 5 | 38.5 | <0.001 | 47.9 (28.2, 67.6) |
| Regular analgesia charted day 1 | 404 | 91.8 | 12 | 92.3 | 0.948 | 0.5 (-14.6, 15.6) |
| As required (PRN) Analgesia charted | 362 | 82.3 | 12 | 92.3 | 0.349 | 10.0 (-10.9, 30.9) |
| Regional analgesia | 54 | 20.2 | 0 | 0 | 0.071 | 20.2 (-1.7, 42.1) |
| Patient controlled analgesia (PCA) charted | 201 | 45.7 | 1 | 7.7 | 0.007 | 38 (10.6, 65.4) |
| Intravenous (IV) continuous analgesia used | 18 | 4.1 | 0 | 0 | 0.456 | 4.1 (-6.7, 14.9) |
| Reviewed by surgery | 417 | 94.8 | 6 | 46.2 | <0.001 | 48.6 (34.9, 62.3) |
| Admit general surgery | 391 | 88.9 | 6 | 46.2 | <0.001 | 42.7 (24.6, 60.8) |
| ICU liaison nurse review | 242 | 55.0 | 1 | 7.7 | <0.001 | 47.3 (19.8, 74.8) |
| ICU doctor review | 267 | 60.7 | 1 | 7.7 | <0.001 | 53.0 (25.9, 80.1) |
| Physiotherapy review (chest) | 422 | 96.0 | 9 | 69.2 | <0.001 | 26.8 (15.0, 38.6) |
| High flow nasal cannulae | 315 | 71.6 | 3 | 23.1 | <0.001 | 48.5 (23.3, 73.7) |
| Incentive spirometry | 187 | 42.6 | 2 | 15.4 | 0.050 | 27.2 (-0.04, 54.4) |

Education 408 92.7 6 46.2 <0.001 46.5 (31.0,62.0)

\*P-value, difference and 95% CI based on 2 sample z test

Abbreviations: ChIP = blunt chest injury care bundle protocol, ICU = intensive care unit, IV = intravenous PCA = Patient controlled analgesia

#### Table 3. Comparison of pre and post-implementation groups for patient characteristics, mechanism, injuries

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Total**  **n = 735** | **PRE**  **n = 282** | |  | **POST**  **n = 453** | |  | **P-value** | **Change Score (95% CI)** |
|  | **n** | | **%** | **n** | | **%** |  |  |
| (unless otherwise (unless otherwise specified\*) specified\*) | | | | | | | | |
| Female n % | 103 | 36.5 | | 179 | 39.5 | | 0.416 | 3.0 (-4.2, 10.2)a |
| Age median (IQR) | 67.9 | [50.6 - 81.4]\* | | 69.3 | [54.6 - 81.3]\* | | 0.51 | -1.8 (-4.5, 1.1)b |
| CCI median (IQR) | 3 | [1.0 - 6.0]\* | | 3 | [1.0 - 5.0]\* | | 0.642 | 0 (0, 0)b |
| ISS median (IQR) | 5 | [3.0 - 10.0]\* | | 9 | [4.0 - 10.0]\* | | 0.005 | 0 (-1.0, 0)b |
| Chronic Obstructive Pulmonary Disease | 60 | 21.3 | | 70 | 15.5 | | 0.045 | 5.8 (0.1, 11.5) a |
| Asthma | 28 | 9.9 | | 37 | 8.2 | | 0.430 | 1.7 (-2.5, 5.9) a |
| Smoking (current or past) | 143 | 50.7 | | 212 | 46.8 | | 0.304 | 3.9 (-3.5, 11.3) a |
| Recent pneumonia | 23 | 8.2 | | 36 | 7.9 | | 0.884 | 0.3 (-3.7, 4.3) a |
| Trauma call | 89 | 31.6 | | 81 | 17.9 | | <0.001 | 13.7 (7.4, 20.0) a |
| Out of hours presentation | 179 | 63.5 | | 300 | 66.2 | | 0.455 | 2.7 (-4.4, 9.8) a |
| Polytrauma | 5 | 1.8 | | 9 | 2.0 | | 0.848 | 0.2 (-1.8, 2.2) a |
| Sternum injury | 34 | 12.0 | | 50 | 11.1 | | 0.709 | 0.9 (-3.8, 5.6) a |
| Rib fractures <3 (includes clinical) | 169 | 60.0 | | 220 | 48.6 | | 0.003 | 11.4 (4.0, 18.8) a |
| Rib fractures >= 3 ribs or flail | 104 | 37.0 | | 209 | 46.1 | | 0.015 | 9.1 (1.8, 16.5) a |
| Lung injury, any | 70 | 24.8 | | 112 | 24.7 | | 0.976 | 0.1 (-6.3, 6.5) a |
| Fall | 157 | 55.7 | | 282 | 62.3 | | 0.076 | 6.6 (-0.7, 13.9) a |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Vehicle related injury | 95 | 33.7 | 131 | 28.9 | 0.170 4.8 (-2.1, 11.7) a |
| Other mechanism | 30 | 10.7 | 40 | 8.8 | 0.394 1.9 (-2.5, 6.3) a |

a P-value, difference and 95% CI based on 2 sample z test

b P-value based on test of sample medians, change score and 95% CIs based on Hodges-Lehmann estimator, which is the median of the set of differences between each value in the first group and each value in the second group and may diverge from the difference obtained by sample median 1 – sample median 2 (Klotz, 2006)

\*Median (IQR)

Abbreviations: CCI = Charlson comorbidity Index, IQR = interquartile range, ISS = injury severity score

#### Table 4. Comparison of pre and post-implementation groups on components relating to blunt chest injury care bundle (ChIP) implementation

**PRE**

**POST**

**OR (95% CI) P-valuea**

**n=282 n = 453**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **n** | | |  | **%** | **n** | **%** |  | |
| **Components Before Activation** | | |  |  |  |  |  |  |
| Initial vital signs 278 | | | 98.6 |  | 447 | 98.7 | 1.1 (0.3, 4.1) | 0.887 |
| Initial respiratory assessment 195 | | | 70.1 |  | 319 | 71.7 | 1.1 (0.8, 1.5) | 0.627 |
| Initial analgesia in emergency 251 | | | 89.0 |  | 396 | 87.4 | 1.0 (0.6, 1.7) | 0.869 |
| Vital signs attended post analgesia 187  (15-90 minutes) | | | 66.3 |  | 276 | 60.9 | 0.9 (0.7, 1.2) | 0.542 |
| Respiratory assessment post 146 | | | 52.1 |  | 138 | 31.4 | 0.4 (0.3, 0.6) | <0.001 |
| analgesia |  |  |  |  | |  |  |  |
| **After activation** |  |  |  |  | |  |  |  |
| **Analgesia** |  |  |  |  | |  |  |  |
| Regular analgesia charted |  | 235 | 83.3 | 416 | | 91.8 | 2.4 (1.5, 3.8) | <0.001 |
| PRN analgesia |  | 239 | 84.8 | 374 | | 82.6 | 0.8 (0.5, 1.2) | 0.201 |
| Regional analgesia |  | 14 | 7.4 | 54 | | 19.3 | 2.8 (1.5, 5.3) | 0.001 |
| PCA |  | 94 | 33.3 | 202 | | 44.6 | 1.8 (1.3, 2.4) | 0.001 |
| Any analgesia |  | 269 | 95.4 | 445 | | 98.2 | 2.5 (1.0, 6.4) | 0.049 |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Team review** |  | | | | | |
| Surgical review | 193 | 68.4 | 417 | 92.1 | 9.9 (6.1, 16.1) | <0.001 |
| Pain team review | 113 | 40.1 | 385 | 84.9 | 9.0 (6.2, 12.9) | <0.001 |
| Physiotherapist review | 218 | 77.3 | 431 | 95.1 | 4.8 (2.9, 8.1) | <0.001 |
| ICU liaison | 27 | 9.6 | 237 | 52.3 | 10.7 (6.9, 16.7) | <0.001 |
| ICU doctor review | 72 | 25.6 | 268 | 59.2 | 4.5 (3.2, 6.3) | <0.001 |
| **Respiratory Support** |  |  |  |  |  |  |
| HFNC | 73 | 25.9 | 318 | 70.2 | 6.8 (4.8, 9.6) | <0.001 |
| Incentive spirometry | 54 | 19.1 | 189 | 41.8 | 3.0 (2.1, 4.3) | <0.001 |
| Incentive spirometry commenced in  ED | 7 | 12.7 | 98 | 51.9 | 7.5 (3.2, 17.6) | <0.001 |
| Education | 168 | 59.6 | 414 | 91.4 | 6.8 (4.5, 10.3) | <0.001 |

a odds ratio (OR), 95% CI, and P-value adjusted for ISS and trauma call

No multicollinearity detected for each test: all Tolerance >0.1, all VIF <5.0 (Field, 2017)

Independence of errors for each test assessed using scatterplot of standardised residuals and predicted values and found to be appropriate

Abbreviations: ChIP = blunt chest injury care bundle protocol, ED=emergency department, HFNC = High flow nasal cannulae, ICU = intensive care unit, PCA = Patient-controlled analgesia, PRN = pro re nata (as needed)

#### Table 5. Time in minutes to receipt of components of the blunt chest injury care bundle (ChIP) for pre and post patient groups

**Time (minutes) PRE POST P-value Change Score (95%**

**CI)a**

**Estimated Marginal Estimated Marginal**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **Mean (SE)** |  | **Mean (SE)** |  | | |
| Time to initial analgesia | 87.6 | (5.15) | 76.0 | (4.0) | 0.060 | 11.6 (-.4, 23.5) |
| Time to regular analgesia | 542.1 | (27.1) | 425.5 | (18.4) | <0.001 | 116.5 (56.6, 176.4) |
| Time to PCA | 689.6 | (60.9) | 482.2 | (31.3) | 0.002 | 207.4 (75.0, 339.8) |
| Time to Surgical review | 347.6 | (23.4) | 204.3 | (10.2) | <0.001 | 143.3 (94.9, 191.6) |
| Time to Pain team | 1394.7 | (117.3) | 680.7 | (36.7) | <0.001 | 714.0 (480.7, 947.3) |
| Time to Physiotherapist  review | 1801.6 | (92.9) | 975.4 | (40.0) | <0.001 | 826.2 (641.7, 1010.7) |
| Time to ICU doctor | 770.0 | (85.6) | 343.0 | (23.2) | <0.001 | 427.0 (257.0, 597.0) |
| Time to ICU liaison | 1413.7 | (249.1) | 1026.0 | (76.5) | 0.130 | 387.7 (-113.7, 889.1) |

aEstimated marginal means: adjusted for ISS and trauma call

No multicollinearity detected for each test: all Tolerance >0.1, all VIF <5.0 (Field, 2017)

Independence of errors for each test assessed using scatterplot of standardised residuals and predicted values and found to be appropriate

Abbreviations: ChIP = blunt chest injury care bundle protocol, ICU = intensive care unit, PCA = Patient- controlled analgesia