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Older Adults With Isolated Rib Fractures Do Not Require Routine Intensive Care Unit Admission

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Abstract

Background: Older adults with isolated rib fractures are often admitted to an intensive care unit (ICU) because of presumedly increased morbidity and mortality. However, evidence-based guidelines are limited. We sought to identify characteristics of these patients that predict the need for ICU care.

Materials and methods: We analyzed patients ≥50 y old at our center during 2013–2017 whose only indication for ICU admission, if any, was isolated rib fractures. The primary outcome was any critical care intervention (e.g., intubation) or adverse event (e.g., hypoxemia) (CCIE) based on accepted critical care guidelines. We used stepwise logistic regression to identify characteristics that predict CCIEs.

Results: Among 401 patients, 251 (63%) were admitted to an ICU. Eighty-three patients (33%) admitted to an ICU and 7 (5%) admitted to the ward experienced a CCIE. The most common CCIEs were hypotension (10%), frequent respiratory therapy (9%), and oxygen desaturation (8%). Predictors of CCIEs included incentive spirometry <1 L (OR 4.72, 95% CI 2.14–10.45); use of a walker (OR 2.86, 95% CI 1.29–6.34); increased chest Abbreviated Injury Scale score (AIS 3 OR 5.83, 95% CI 2.34–14.50); age ≥72 y (OR 2.68, 95% CI 1.48–4.86); and active smoking (OR 2.11, 95% CI 1.06–4.20).

Conclusions: Routine ICU admission is not necessary for most older adults with isolated rib fractures. The predictors we identified warrant prospective evaluation for development of a clinical decision rule to preclude unnecessary ICU admissions.

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The authors reported no proprietary or commercial interest in any product mentioned or concept discussed in this article.

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Keywords

Rib fracture; Older adult; Intensive care unit

Introduction

Among patients admitted to a trauma intensive care unit (ICU), rib fractures are the most common injury, and geriatric patients (≥65 y old) with rib fractures have twice the risk of pneumonia and death compared with younger patients.[1,2] Some studies suggest the inflection point for this increased risk may be as low as 45 y old.[3,4] Owing to this increased morbidity and mortality, physicians tend to treat these patients aggressively, which frequently includes admission to an ICU.[5]

For patients in this population who do not already have a relatively clear indication for ICU admission (such as intubation, severe chest wall or other injuries, or vital sign or arterial blood gas abnormalities), the putative purpose of ICU admission is to prevent adverse outcomes such as pneumonia, respiratory failure, and death by focusing care on pain management and pulmonary hygiene. However, it is not fully understood whether and how ICU admission impacts patient care and outcomes in this population. While ICU admission aims to increase the availability of nursing care, pain management, and access to respiratory therapists, there may be unintended consequences of ICU care. About 60% of older trauma patients admitted to an ICU experience delirium,[6] whichdalong with disturbances in the sleep-wake cycle, and increased administration of opiates or sedating medications–may contribute to poor outcomes.[7,8]

Evidence surrounding ICU admission for this population is largely based on observational studies and institutional experience, resulting in wide variability in practice patterns. The 2017 Western Trauma Association guidelines recommended a minimum of 24 h of ICU monitoring for all patients ≥65 y old with ≥2 fractured ribs.[5] However, the authors acknowledged that some patients with good baseline functional status, pain control, and inspiratory volume may not warrant ICU admission.

In this study, we sought to (1) determine how frequently older adults with isolated rib fractures (and no existing clear indication for ICU admission) experience an intervention or event indicative of needing ICU-level care (“critical care intervention or event,” or CCIE); and (2) identify patient and injury characteristics that may predict CCIEs.

Methods

Study design

We performed a retrospective cohort study of patients at the University of California Davis Health (UCDH), a level 1 trauma center in Sacramento, CA, that admits over 4000 trauma patients annually. We used our center’s trauma registry to identify potentially eligible patients and then reviewed medical records to confirm eligibility and complete data collection. The study was approved with a waiver for informed consent by the Institutional Review Board at UCDH.

Subject identification

We included patients ≥50 y old with acute, isolated rib fractures who were admitted to the Trauma Surgery service between September 2013 and June 2017. We chose patients ≥50 y old as the target population because some studies suggest that the risks of adverse outcomes begin to increase at ages <65 y. We selected patients with rib fracture(s) using International Classification of Diseases, ninth Revision, Clinical Modification (ICD-9-CM) or International Classification of Diseases, 10th Revision, Clinical Modification (ICD-10-CM) diagnosis codes (Supplement), and we required that these diagnoses be confirmed in the attending radiologist report. We excluded patients who presented more than 24 h after injury because the main outcome of our study, CCIEs, may have already occurred before presentation. We excluded patients with a penetrating mechanism of injury because their management might differ from patients with blunt injury. Because our focus was on patients with isolated chest wall injuries, we excluded patients with a significant injury not related to the chest wall (Abbreviated Injury Scale [AIS] score >2 in any region other than the thorax). We also excluded patients with an indication for ICU admission other than management of the rib fractures, such as those with a high injury burden (Injury Severity Score [ISS] ≥16, including patients with AIS Chest scores of 4 or 5 corresponding to severe chest wall injuries [Table 1]), those with GCS <14, those with concern for ongoing bleeding, those suspected of experiencing alcohol withdrawal, those who required frequent neurologic monitoring, and those with a CCIE before the time clinicians placed admission orders. At our center, patients ≥65 y old with any rib fractures are typically admitted to an ICU; we ascertained other indications for ICU admission (i.e., reasons for exclusion) from the admission note.

Patient characteristics

We collected information from admission, procedure, progress, and physical therapist notes using a standardized, pilot-tested abstraction instrument. Baseline information included age, sex, height, weight, comorbidities (chronic obstructive pulmonary disease, asthma, congestive heart failure, current smoking, and dementia), use of an assistive device for mobility (i.e., cane, walker, wheelchair, or none), mechanism of injury, number and location of rib fractures, ISS, AIS scores, presence of pulmonary contusion, and placement of tube thoracostomy during the initial workup. We collected the number and location of rib fractures from the attending radiologist report. If the radiologist did not include these details in the report, then we reviewed the images to complete data collection.

We recorded emergency department (ED) disposition as ICU or ward. At UCDH, there is no dedicated step-down unit; when necessary, telemetry monitoring can be provided in the ward setting. We ascertained times of admission, transfers to a different level of care, and hospital discharge as the date and time at which clinicians placed the orders. We recorded ED discharge as the date and time the patient physically left the ED. We defined ED boarding as the time from admission orders to ED discharge.

Outcomes

The primary outcome was a critical care intervention or event (CCIE) between the time of admission (placement of orders) and hospital day 14. We derived the list of CCIEs based on concepts identified by the Task Force of the American College of Critical Care Medicine, which have been used in studies with similar methodology.[9,10] "Interventions" included placement of a central or arterial line for hemodynamic monitoring, vasopressor or inotropic medication use, respiratory therapy more frequent than every 4 h, use of continuous positive airway pressure (CPAP) or bilevel positive airway pressure (BiPAP), intubation, or transfer to an ICU. "Events" included evidence of respiratory failure on an arterial blood gas (pCO_2 >50 mmHg or pO_2 < 60 mmHg), oxygen desaturation (two episodes of pulse oximetry reading <90% within 12 h), hypotension (two episodes of systolic blood pressure <90 mmHg within 12 h), unstable arrhythmia, or pneumonia. We defined pneumonia based on both an attending physician diagnosis and the initiation of antibiotic therapy. We chose to ascertain CCIEs only during the initial 14 d because we considered it unlikely that these early markers of a problem would be attributable to the chest wall injury if they first occurred after this time frame.

Secondary outcomes included the frequency of CCIEs, ICU length of stay, ED length of stay, and ED boarding.

Statistical analysis

We performed univariate analysis of patient and injury characteristics, comparing patients who experienced a CCIE *versus* those who did not. We used stepwise logistic regression to identify patient and injury characteristics that were associated with the occurrence of a CCIE. We defined the criteria for entry into the model as $P = 0.2$ and the criteria to stay in the model as $P = 0.05$. We assessed the optimal cutoff for age as a binary predictor using the Youden Index. Because we considered our analysis as a hypothesis-generating study, we did not formally calculate a necessary sample size, nor did we partition the data set into derivation and testing portions. We planned to include approximately 400 patients to allow for at least 10 outcome events per predictor included in the regression model.

We used SAS 9.4 (SAS Institute Inc, Cary, NC) for all statistical analyses, and defined statistical significance as $P < 0.05$.

Results

Of 1904 patients we evaluated, 401 met inclusion criteria (Figure). Ninety patients (22.4%) had at least one CCIE: 83 of 251 patients admitted to an ICU (33%) and 7 of 150 patients admitted to the ward (5%). Patients who had a CCIE were older (73 ± 13 y *versus* 67 ± 12 y, $P < 0.001$) and more likely to have chronic obstructive pulmonary disease or asthma (21.1% *versus* 11.9%, $P = 0.026$) and congestive heart failure (14.4% *versus* 4.5%, $P < 0.001$; Table 2). Those who had a CCIE also had a higher ISS (10.1 ± 3.3 *versus* 8.8 ± 3.9, $P = 0.004$) and were more likely to have fractures of the middle ribs (5–8) (83.3% *versus* 71.7%, $P = 0.026$). In addition, they had a lower incentive spirometry volume in the ED before admission (1000 ± 550 mL *versus* 1500 ± 700 mL, $P < 0.001$).

There were a total of 161 CCIEs among the 90 patients with at least one CCIE (Table 3). The most common CCIEs were hypotension ($n = 40$, 10.0%), respiratory therapy more frequent than every 4 h ($n = 36$, 9.0%), and oxygen desaturation ($n = 34$, 8.5%). Among

CCIEs, the 13 instances of transfer to the ICU occurred exclusively among patients initially admitted to the ICU (i.e., "bounce-backs"). The median time to bounce-back was 3 d (IQR 3, 4), and none of these patients were identified as having a pulmonary contusion on their initial or subsequent chest imaging. Few patients had an arterial line placed ($n = 6$, 1.5%), required CPAP/BiPAP ($n = 5$, 1.3%), had a central line placed ($n = 3$, 0.8%), were intubated ($n = 3$, 0.8%), or had an unstable arrhythmia ($n = 2$, 0.5%). Most CCIEs (85%) occurred within 2 d of admission.

Two patients died; both were initially admitted to an ICU and experienced a CCIE before death. In one case, the patient developed delirium and subsequent pneumonia requiring unplanned ICU transfer, leading shortly thereafter to his death. In the other, the patient developed pulmonary emboli and pneumonia requiring intubation. Although he recovered from these acute pulmonary events, he later died suddenly from a suspected air embolus after he removed his internal jugular venous catheter, suggesting no direct relationship to his rib fractures.

The stepwise logistic regression model identified five characteristics that predicted occurrence of a CCIE: age ≥72 y, increasing AIS chest score, use of a walker for mobility, ED incentive spirometry volume, and active smoking (Table 4).

Of patients admitted to an ICU, 41 (16.3%) were transferred out within 12 h, and 123 (49.0%) were transferred out within 24 h. Eighteen patients admitted to an ICU (7.2%) were discharged directly from the ICU, and 68 patients admitted to an ICU (27.1%) spent over half of their ICU length of stay boarding in the ED.

Discussion

In this study, we describe critical care interventions or events among adults ≥50 y old with isolated rib fractures. We used this age cutoff to capture patients <65 y old who may benefit from ICU care because of their comorbidities or severity of injury but not be so young that they had minimal risk of a CCIE occurring. CCIEs occurred for 33% of patients admitted to an ICU and 5% of patients admitted to the ward. Most (66%) patients admitted to an ICU had no CCIE, suggesting that our center may be overusing this limited resource for these patients.

The most common CCIEs were hypotension, respiratory therapy more frequently than every 4 h, and oxygen desaturation. As pulmonary hygiene is a focus for patients with rib fractures, frequent respiratory therapy is an expected intervention. Similarly, oxygen desaturation indicates worsening pulmonary function that may be due to inadequate pain control or pulmonary hygiene, and is an expected marker for adverse outcomes such as pneumonia or respiratory failure. However, we did not expect hypotension to occur so frequently in this cohort. These patients did not have serious injuries other than the fractured ribs, and we excluded those for whom clinicians had concern for ongoing bleeding. Potentially, hypotension was the result of opiates or sedating medications, to which older adults may be more sensitive. The low rate of pneumonia (2.2%) we observed is consistent with nationwide cohort studies of patients with isolated minor rib fractures (1.6%).[11]

Patients who were ≥72 y old, had a greater AIS Chest score, used a walker, had an ED incentive spirometry volume <1 L (or no value recorded), or who were active smokers were more likely to warrant ICU care. Because our aim was to identify patient and injury characteristics that may predict the need for ICU care, we focused on incentive spirometry volume before admission. Vital capacity within the first 48 h has been shown to predict pulmonary complications. In a retrospective review of older adults with rib fractures, vital capacity <30% was associated with a 2.36 (95% CI 1.40–3.98) times greater odds of pneumonia, intubation, transfer to ICU, pulmonary readmission, or new home oxygen requirement.[12,13] In another study of adults with an admission vital capacity of at least 1 L, patients with subsequent decrease in vital capacity to <1 L had an increased risk of pneumonia, intubation, and unplanned ICU transfer.[13]

Use of an ambulatory assist device has also been identified as a risk factor for intubation or pneumonia (OR, 2.9; 95% CI, 1.04–8.12),[14] consistent with our findings. One potential explanation is that use of an ambulatory assist device may be a surrogate for frailty in older adults, and these patients have less reserve after an injury. We did not attempt to retrospectively calculate frailty scores for patients in this study, but granular information about the components of such scores may be important characteristics to collect in prospective studies. Patients who use an assistive device may be more dependent on nurses or physical therapists to get out of bed, and therefore may become more deconditioned than others. Our hospital provides patients with assistive devices, but they are not always available on hospital day 1. In a qualitative study, 70% of nurses reported lack of assistive devices as a deterrent to mobilizing patients.[15] In addition, it may be more challenging for patients who already have limited mobility to compensate for pain, especially if they need to support their upper body with a cane or walker. While we did not assess early mobility in this study, we suspect it may be an important component of successful management for older adults with rib fractures.

Many investigators have focused on patients aged ≥65 y with rib fractures because of their well-known increased morbidity and mortality, but we expanded the age criteria in our study to ≥50 y to capture slightly younger adults also at risk for poor outcomes due to the baseline comorbidities or specific injury characteristics. Based on our findings, routine ICU admission does not seem necessary for all older adults with isolated rib fractures. Because we identified age ≥72 y as a predictor of CCIEs, routine ICU admission for all patients ≥65 y with isolated rib fractures may also be unnecessary. In a single-institution retrospective study, Shi *et al.*[16] found a low mortality rate among geriatric patients with isolated rib fractures and concluded they may be overusing ICU admission. By contrast, in a pre-post study, Pyke *et al.*[17] showed that after implementing a policy to admit all geriatric patients with significant blunt thoracic trauma to an ICU, they had decreased inpatient complications. However, their cohort did not have isolated injuries, and they excluded patients discharged within 48 h. In our analysis, the primary reasons for ICU admission were pain management and pulmonary hygiene. Rather than preventing pneumonia or intubation, ICU admission may have unintentionally led to delirium, potentially increasing the likelihood of these outcomes.

Half of patients admitted to an ICU were transferred out within 24 h. Because ICU length of stay can be influenced by bed availability, we recorded the time transfer orders were placed, which should not be affected by hospital resources. It is possible that this short amount of time was sufficient to optimize pain management and pulmonary hygiene, but another possibility is that overnight ICU admissions were transferred after morning rounds without any meaningful impact of the ICU status on patient care. The Western Trauma Association guidelines support transferring patients without respiratory deterioration after 24 h of ICU monitoring to floor status; however, they did not describe specific goals of ICU admission or define readiness for ward care.[5] Over a quarter of patients spent at least 50% of their ICU length of stay boarding in the ED. During that time, although the patients technically receive ICU level of care based on nurse ratios and capabilities, they do not have the same access to respiratory therapists or the standard cohort of ICU nurses. Relocation (i.e., transferring from ICU to ward) can cause significant distress to patients and families. In a qualitative study, patients reported a feeling of communication breakdown during transfers resulting in a perception of worsened care and difficulty in adjustment.[18,19] Limiting unnecessary relocations by ensuring an appropriate initial ED disposition may decrease patient distress and reduce the risk of medical errors during patient handoffs.

There were 13 bounce-backs among patients initially admitted to an ICU, but no patients who were initially admitted to the ward were upgraded to ICU level of care. This suggests that some CCIEs can be managed safely in a non-ICU setting. Respiratory failure is the leading cause of bounce-backs among trauma patients, and rib fractures are one of the most commonly associated injuries.[20] This finding suggests that, while clinicians at our center were conservative in their initial decision of where to admit patients, they may have transferred some patients out of the ICU before they were truly ready. Optimal criteria for transfer from an ICU are another important topic in understanding how best to treat these patients.

There are several limitations of this study. First, we were unable to characterize key information about baseline characteristics that might predict CCIEs, why patients were admitted to an ICU, and what interventions occurred in that setting. The utility of AIS Chest scores as a predictor of CCIEs may be limited if some injury characteristics (e.g., lung contusion) are not known at the time of admission. We were limited to using data initially recorded without this study in mind. We lacked information about some contributors to frailty which was not well-characterized in the medical record. ED incentive spirometry volume was not recorded for 44% of patients. In some cases, patients may not have been able to perform incentive spirometry due to inadequate pain control or poor understanding of instructions, which might explain the increased odds of a CCIE associated with lack of documentation of incentive spirometry performance. In other cases, incentive spirometry may never have been checked. We advocate for routine evaluation of incentive spirometry and encourage its documentation, including whether a patient refused or was unable to participate. Second, we could not identify circumstances or interventions that prevented CCIEs from occurring. It is possible that a patient who was admitted to an ICU and did not have a CCIE may have had a CCIE if admitted to the ward, or vice versa. Third, collecting data from a single hospital limits the generalizability of our results. Although ICU size and staffing at our center seem similar to other level 1 centers, there may be considerable variation in the use of protocols and diagnostic methods.[21] Certain aspects of care–for example, ICU transfer, which was a CCIE outcome–might be peculiar to our center. Fourth, because we did not partition our data set into derivation and testing subsets, our results should be considered hypothesis-generating and validated before implementation in decision aids. A prospective, multicenter study evaluating predictors of needing ICU care should collect information on the aforementioned missing characteristics and could help address these limitations.

Conclusions

Most older adults with isolated rib fractures did not require ICU care. Those who were ≥72 y old had an increased AIS Chest score, used a walker, had an incentive spirometry volume <1 L, or were active smokers were more likely to experience a critical care intervention or event. These characteristics, along with others that we were not able to reliably collect or that were clinically plausible even if not statistically associated with CCIEs in this retrospective study, should be evaluated further in prospective studies to develop a simple clinical decision rule for ED disposition as well as standardized guidelines to optimize inpatient management.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgment

Authors' contributions: Study conception and design was contributed by J.A.B., G.J.J., D.K.N., and G.H.U. Acquisition of data was carried out by J.A.B. Analysis and interpretation of data was carried out by J.A.B. and G.H.U. Drafting of manuscript was performed by J.A.B. and G.H.U. Critical revision was carried out by J.A.B., G.J.J., D.K.N., and G.H.U.

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REFERENCES

1. Bergeron E, Lavoie A, Clas D, et al. Elderly trauma patients with rib fractures are at greater risk of death and pneumonia. J Trauma. 2003;54:478–485. [PubMed: 12634526]
2. Michetti CP, Fakhry SM, Brasel K, Martin ND, Teicher EJ, Newcomb A. Trauma ICU Prevalence Project: the diversity of surgical critical care. Trauma Surg Acute Care Open. 2019;4:e000288. [PubMed: 30899799]
3. Adams SD, Cotton BA, McGuire MF, et al. Unique pattern of complications in elderly trauma patients at a Level I trauma center. J Trauma Acute Care Surg. 2012;72:112–118. [PubMed: 22310124]
4. Holcomb JB, McMullin NR, Kozar RA, Lygas MH, Moore FA. Morbidity from rib fractures increases after age 45. J Am Coll Surg. 2003;196:549–555. [PubMed: 12691929]
5. Brasel KJ, Moore EE, Albrecht RA, et al. Western trauma association critical decisions in trauma: management of rib fractures. J Trauma Acute Care Surg. 2017;82:200–203. [PubMed: 27779590]
6. Bryczkowski SB, Lopreiato MC, Yonclas PP, Sacca JJ, Mosenthal AC. Risk factors for delirium in older trauma patients admitted to the surgical intensive care unit. J Trauma Acute Care Surg. 2014;77:944–951. [PubMed: 25248058]

7. Schubert M, Schurch R, Boettger S, et al. A hospital-wide evaluation of delirium prevalence and outcomes in acute care patients - a cohort study. BMC Health Serv Res. 2018;18:550. [PubMed: 30005646]
8. Le A, Friese RS, Hsu CH, Wynne JL, Rhee P, O'Keeffe T. Sleep disruptions and nocturnal nursing interactions in the intensive care unit. J Surg Res. 2012;177:310–314. [PubMed: 22683076]
9. Nishijima DK, Sena MJ, Holmes JF. Identification of low-risk patients with traumatic brain injury and intracranial hemorrhage who do not need intensive care unit admission. J Trauma. 2011;70:E101–E107. [PubMed: 20805765]
10. Guidelines for intensive care unit admission, discharge, and triage. Task Force of the American College of Critical Care Medicine, Society of Critical Care Medicine. Crit Care Med. 1999;27:633–638. [PubMed: 10199547]
11. Ho SW, Teng YH, Yang SF, et al. Risk of pneumonia in patients with isolated minor rib fractures: a nationwide cohort study. BMJ Open. 2017;7:e013029.
12. Carver TW, Milia DJ, Somberg C, Brasel K, Paul J. Vital capacity helps predict pulmonary complications after rib fractures. J Trauma Acute Care Surg. 2015;79:413–416. [PubMed: 26307874]
13. Warner R, Knollinger P, Hobbs G, Lilly C, Grabo D, Wilson A. Forced vital capacity less than 1: a mark for high-risk patients. J Trauma Acute Care Surg. 2018;85:271–274. [PubMed: 30080778]
14. Gonzalez KW, Ghneim MH, Kang F, Jupiter DC, Davis ML, Regner JL. A pilot single-institution predictive model to guide rib fracture management in elderly patients. J Trauma Acute Care Surg. 2015;78:970–975. [PubMed: 25909417]
15. Brown CJ, Williams BR, Woodby LL, Davis LL, Allman RM. Barriers to mobility during hospitalization from the perspectives of older patients and their nurses and physicians. J Hosp Med. 2007;2:305–313. [PubMed: 17935241]
16. Shi HH, Esquivel M, Staudenmayer KL, Spain DA. Effects of mechanism of injury and patient age on outcomes in geriatric rib fracture patients. Trauma Surg Acute Care Open. 2017;2:e000074. [PubMed: 29766084]
17. Pyke OJ Jr, Rubano JA, Vosswinkel JA, McCormack JE, Huang EC, Jawa RS. Admission of elderly blunt thoracic trauma patients directly to the intensive care unit improves outcomes. J Surg Res. 2017;219:334–340. [PubMed: 29078902]
18. Field K, Prinjha S, Rowan K. 'One patient amongst many': a qualitative analysis of intensive care unit patients' experiences of transferring to the general ward. Crit Care. 2008;12:R21. [PubMed: 18294370]
19. de Grood C, Leigh JP, Bagshaw SM, et al. Patient, family and provider experiences with transfers from intensive care unit to hospital ward: a multicentre qualitative study. CMAJ. 2018;190:E669–E676. [PubMed: 29866892]
20. Christmas AB, Freeman E, Chisolm A, et al. Trauma intensive care unit 'bouncebacks': identifying risk factors for unexpected return admission to the intensive care unit. Am Surg. 2014;80:778–782. [PubMed: 25105397]
21. Michetti CP, Fakhry SM, Brasel K, et al. Structure and function of a trauma intensive care unit: a report from the Trauma ICU Prevalence Project (TRIPP). J Trauma Acute Care Surg. 2019;86:783–790. [PubMed: 30741885]

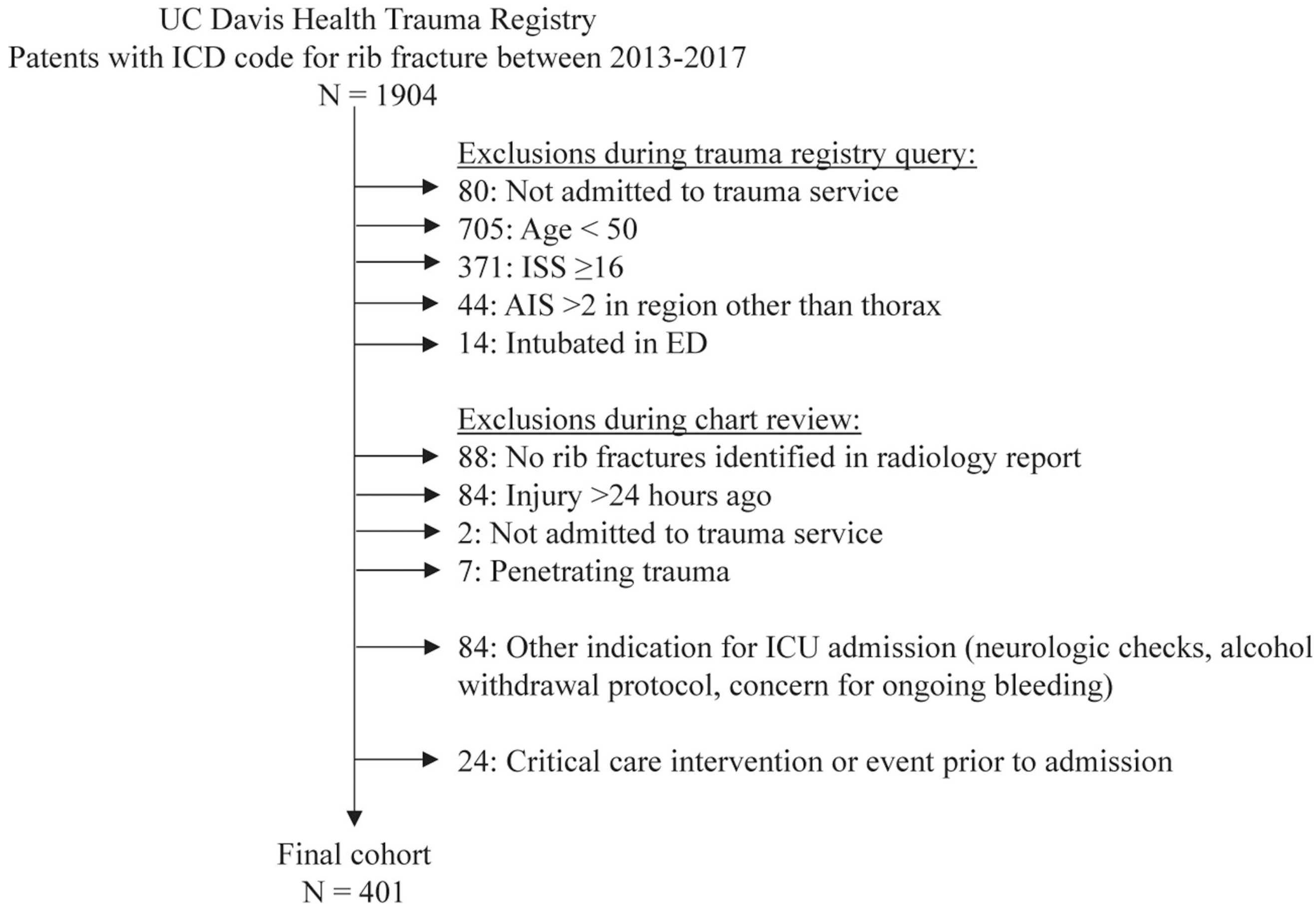

Fig –.
Flow diagram of study patients.

Table 1 –

Description of AIS Chest scores (1998 update of the 1990 version) corresponding to inclusion in (AIS 1–3) and exclusion from (AIS 4–5) the study population.

AIS chest score	Description of injury	Relevance to study population
1	1 rib fracture	
	Multiple rib fractures, not further specified	
2	2–3 rib fractures any location or multiple fractures of a single rib, with stable chest or not further specified	
	>3 ribs on one side and no more than 3 ribs on other side, stable chest or not further specified	
	Open/displaced/comminuted rib fracture(s), any or combination (≥1 rib)	Included
	1 rib fracture, with hemo-/pneumothorax	
3	Multiple rib fractures, with hemo-/pneumothorax	
	2–3 rib fractures, with hemo-/pneumothorax	
	Flail chest, (unstable chest wall, paradoxical chest movement) unilateral or not further specified	
	Flail chest without lung contusion	
	Lung contusion, unilateral or not further specified	
4	>3 ribs on one side and no more than 3 ribs on other side, stable chest or not further specified, with hemo-/pneumothorax	
	>3 ribs on each of two sides, with stable chest or not further specified	
	Open/displaced/comminuted rib fracture(s), any or combination (≥1 rib), with hemo-/pneumothorax	Excluded*
	Flail chest with lung contusion	
	Lung contusion, bilateral	
5	>3 ribs on each of two sides, with stable chest or not further specified, with hemo-/pneumothorax	
	Flail chest bilateral	

*Excluded by virtue of the Injury Severity Score being ≥16.

Table 2 –

Characteristics of patients who experienced a critical care intervention or event (CCIE) *versus* those who did not.

Characteristic	No CCIE, *n* = 311	CCIE, *n* = 90	*P* Value
Age, y, mean ± SD	67.0 ± 12.3	72.9 ± 13.0	<0.001
Age, y, *n* (%)			
50–54	42 (13.5)	8 (8.9)	
55–59	67 (21.5)	8 (8.9)	
60–64	46 (14.8)	12 (13.3)	
65–69	41 (14.8)	10 (11.1)	0.004
70–74	37 (11.9)	9 (10.0)	
75–79	21 (6.8)	11 (12.2)	
80–84	20 (6.4)	8 (8.9)	
≥85	37 (11.9)	24 (26.7)	
Male, *n* (%)	191 (61.4)	45 (50.0)	0.12
Comorbidities, *n* (%)			
COPD/asthma	37 (11.9)	19 (21.1)	0.03
Congestive heart failure	14 (4.5)	13 (14.4)	<0.001
Active smoker*	44 (14.2)	19 (21.1)	0.11
Use of home oxygen	5 (1.6)	1 (1.1)	1.00
Malnutrition†	54 (17.4)	21 (23.3)	0.20
Dementia	23 (7.4)	12 (13.3)	0.08
Assistive devices, *n* (%)			
None‡	255 (82.0)	55 (61.1)	
Cane	17 (5.5)	11 (12.2)	<0.001
Walker	26 (8.4)	19 (21.1)	
Wheelchair	13 (4.2)	5 (5.6)	
Number of fractured ribs, *n* (%)			
1	89 (28.6)	9 (10.0)	
2	60 (19.3)	23 (25.7)	
3	51 (16.4)	17 (18.9)	
4	37 (11.9)	13 (14.4)	

Characteristic	No CCIE, *n* = 311	CCIE, *n* = 90	*P* Value
5	28 (9.0)	10 (11.1)	
6	19 (6.1)	7 (7.8)	0.14
7	12 (3.9)	6 (6.7)	
8	5 (1.6)	2 (2.2)	
9	3 (1.0)	1 (1.1)	
10	2 (1.0)	0 (0)	
11	2 (0.6)	2 (2.2)	
12	0 (0)	0 (0)	
13	1 (0.3)	0 (0)	
Not documented	1 (0.3)	0 (0)	
Location(s) of fractured ribs, *n* (%)			
Upper (ribs 1–4)	132 (42.4)	38 (42.2)	0.97
Middle (ribs 5–8)	233 (71.7)	75 (83.3)	0.026
Lower (ribs 9–12)	116 (37.3)	37 (41.1)	0.51
Bilateral rib fractures	32 (10.3)	8 (8.9)	0.70
Pulmonary contusion, *n* (%)	32 (10.3)	10 (11.1)	0.82
Chest tube placement in ED, *n* (%)	17 (5.5)	9 (10.0)	0.12
Injury severity score, mean ± SD	8.8 ± 3.9	10.1 ± 3.3	0.004
Chest AIS score, *n* (%)			
1	67 (21.5)	7 (7.8)	
2	66 (20.9)	15 (16.7)	0.003
3	179 (57.6)	68 (75.6)	
Other minor injury (AIS = 1 or 2), *n* (%)			
Face	10 (3.2)	3 (3.3)	0.96
Head	79 (25.4)	20 (22.2)	0.54
Abdomen	27 (8.7)	9 (10.0)	0.70
Extremity	82 (26.4)	27 (30.0)	0.50
External	149 (47.9)	40 (44.4)	0.56
ED incentive spirometry value, *n* (%)			
≥1000 mL	141 (45.3)	17 (18.9)	<0.001
<1000 mL	35 (11.3)	21 (23.3)	

Characteristic	No CCIE, *n* = 311	CCIE, *n* = 90	*P* Value
Not reported	135 (43.4)	52 (57.8)	
ED incentive spirometry, mL, mean ± SD[§]	1000 ± 550	1500 ± 700	<0.001

COPD = chronic obstructive pulmonary disease.

[*] If there was no documentation of smoking status, we recorded it as “not an active smoker”.

[†] Malnutrition defined as albumin <3.5 mg/dL on admission.

[‡] If there was no documentation of an assistive device, we recorded it as “none”.

[§] Excludes 187 patients who did not have an incentive spirometry value reported before admission.

Table 3 –

Proportion of older adults who had a critical care intervention or event, categorized by ICU *versus* ward admission.

Critical care intervention or event, *n* (%)	**ICU admission, *n* = 251**	**Ward admission, *n* = 150**	***P* Value**
Hypotension	39 (15.5)	1 (0.7)	<0.001
Respiratory therapy more frequently than every 4 h	34 (13.5)	2 (1.3)	<0.001
Oxygen desaturation	29 (11.6)	5 (3.3)	0.004
Transfer to ICU	13 (5.2)	0 (0)	0.003
Respiratory failure by ABG	10 (4.0)	0 (0)	0.016
Pneumonia	9 (3.6)	0 (0)	0.030
Arterial line placement	6 (2.4)	0 (0)	0.09
BiPAP/CPAP	4 (1.6)	1 (0.7)	0.66
Intubation	3 (1.2)	0 (0)	0.30
Central line placement	3 (1.2)	0 (0)	0.30
Arrhythmia	2 (0.8)	0 (0)	0.53
Any CCIE	83 (33.1)	7 (4.7)	<0.001

ABG = arterial blood gas; BiPAP = bilevel positive airway pressure; CPAP = continuous positive airway pressure.

Table 4 –

Patient and injury characteristics that may predict the occurrence of a critical care intervention or event.

Variable	Odds ratio (95% CI)
Age	
<72 y	Reference
≥72 y	2.68 (1.48–4.86)
Chest Abbreviated Injury Scale score	
1	Reference
2	2.77 (0.97–7.91)
3	5.83 (2.34–14.50)
Assistive device	
None*	Reference
Cane	2.50 (0.99–6.30)
Walker	2.86 (1.29–6.34)
Wheelchair	0.78 (0.24–2.56)
ED incentive spirometry volume	
>1000 mL	Reference
<1000 mL	4.72 (2.14–10.45)
Not reported	2.65 (1.41–4.97)
Smoking status	
Not an active smoker†	Reference
Active smoker	2.11 (1.06–4.20)

*If there was no documentation of an assistive device, we recorded it as “none”.

†If there was no documentation of smoking status, we recorded it as “not an active smoker”.