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Aspirin increases the risk of acute kidney injury in critical patients with chest trauma: a retrospective cohort study

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Abstract

Purpose Non-steroidal anti-inflammatory drugs (NSAIDs) are increasingly utilized in trauma patients, particularly those with critical chest trauma who are susceptible to significant blood loss, leading to renal hypoperfusion. Acute kidney injury (AKI) is known to carry a poor prognosis in chest trauma patients. Therefore, investigating the potential association between NSAID use and AKI risk in critical patients with chest trauma is crucial.

Methods We selected patients admitted to the intensive care unit (ICU) with chest trauma from the Medical Information Mart for Intensive Care III (MIMIC-III) dataset (2001–2012) and the Medical Information Mart for Intensive Care IV (MIMIC-IV) dataset (2013–2019). Propensity score matching (PSM) was used to match patients receiving NSAIDs with those not receiving treatment. Logistic regression was employed to assess the association between different types of NSAIDs and AKI in these patients.

Results In MIMIC-IV, NSAID use significantly increased the risk of AKI in critical patients with chest trauma (OR 1.99; 95% CI 1.04 to 3.85). Subgroup analysis revealed that aspirin significantly increased AKI risk in both MIMIC-III (OR 1.81; 95% CI 1.02 to 3.2) and MIMIC-IV (OR 2.47; 95% CI 1.26 to 4.85). However, ibuprofen and ketorolac use were not associated with AKI in these patients.

Conclusion We observed a significant association between aspirin use and an elevated risk of AKI in critical patients with chest trauma. These findings suggest that pain management strategies involving ibuprofen and ketorolac may be more appropriate for this patient population.

Keywords NSAIDs, Chest trauma, AKI, Aspirin, Ibuprofen, Ketorolac

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Background

Trauma is the primary cause of mortality in individuals under 40 years of age residing in developed nations [1]. According to research, approximately 50% of patients with critical trauma are prone to experiencing chest trauma [2]. The most prevalent form of chest wall injury in cases of chest trauma is rib fracture, accounting for over 50% [3]. Pain is the most common symptom in patients with chest trauma [4]. Furthermore, the presence of general or localized pain resulting from rib fractures significantly impacts both the recovery process and the prognosis of patients [5]. Effective pain management not only enhances patients' ventilation function, facilitates airway secretion clearance, and reduces the need for intubation and mechanical ventilation [4], but also significantly mitigates the likelihood of pulmonary complications [6].

Opioids have historically been a cornerstone of acute pain management for trauma patients [7]. However, the association of opioids with adverse effects cannot be overlooked, encompassing central nervous system depression, respiratory depression, nausea, constipation, and dependence, among others [8]. To mitigate the short- and long-term repercussions of opioid utilization for post-traumatic pain, numerous hospitals are augmenting the utilization of non-steroidal anti-inflammatory drugs (NSAIDs) [6, 9]. The efficacy of NSAIDs in alleviating pain has been demonstrated in both emergency department settings and post-surgical populations [10–12]. A study assessing the impact of NSAIDs on opioid utilization and complications revealed a significant 26% reduction in opioid consumption, a notable 30% decrease in occurrences of nausea and vomiting, as well as a substantial 47% decline in sedation levels [13]. However, NSAIDs are also associated with a range of adverse effects, particularly gastrointestinal bleeding and renal dysfunction [14]. Research reported acute kidney injury (AKI) is highly prevalent among patients with critical trauma, with approximately 24% of trauma patients requiring intensive care developing AKI. Furthermore, it has been observed that around 10% of these patients necessitate kidney replacement therapy (RRT) [15].

Several studies have reported no significant association between the use of NSAIDs and the occurrence or progression of AKI in chest trauma patients [16, 17]. This claim is contested by multiple studies conducted on the general population, which have effectively demonstrated a correlation between the utilization of NSAIDs and AKI [18, 19]. Given the lack of categorization in previous studies regarding trauma site, drug type, and drug dose, our study aims to investigate the association between different types of NSAIDs and drug dose with the occurrence of AKI in critical patients specifically diagnosed with rib fractures, which represent the most prevalent form of chest trauma.

Methods

Study design

We conducted a retrospective cohort study utilizing data from two publicly accessible clinical datasets: the Medical Information Mart for Intensive Care III (MIMIC-III) and the Medical Information Mart for Intensive Care IV (MIMIC-IV) [20, 21]. The MIMIC-III dataset comprises identified clinical information from 46,476 patients who underwent intensive care unit (ICU) admissions at Beth Israel Deaconess Medical Center in Boston, Massachusetts between 2001 and 2012. Meanwhile, the MIMIC-IV dataset encompasses data from 76,943 ICU patients admitted during the period from 2008 to 2019. Considering the partial overlap between the two datasets, we specifically opted for patients admitted to MIMIC-IV after 2013. The MIMIC dataset was approved by the Institutional Review Board (IRB) of the Beth Israel Deaconess Medical Center (No. 2001-P-001699/15) and developed in collaboration with the Massachusetts Institute of Technology (MIT). Author H.Y holds a valid Collaborative Institutional Training Program (CITI) license (certification NO.60177697) (Additional file 1: Fig. S1), enabling authorized access to these datasets. This study followed the STROBE Statement Checklist (Additional file S1).

Study population and data sources

In both datasets, all patients with one or more rib fractures who were admitted to the ICU for the first time underwent evaluation with specific exclusion criteria: (1) Individuals under the age of 18 were excluded. (2) Patients who experienced mortality within 48 h of ICU admission were excluded. (3) Patients with creatinine loss were excluded from analysis. (4) Patients requiring renal replacement therapy (RRT) prior to ICU admission were also excluded. (5) Patients with direct kidney injury were excluded.

Patients who had AKI were identified and categorized according to the highest level of serum creatinine (Scr) and urine output (UO), in accordance with the guidelines provided by Kidney Disease Improving Global Outcomes (KDIGO) [22]. AKI was defined as follows: an increase in Scr to at least 1.5 times the baseline within the previous 7 days; a rise in Scr of at least 0.3 mg/dL within 48 h; or urine volume less than 0.5 mL/kg/h for a minimum duration of 6 h. The baseline Scr was determined as the minimum value within the 7 days prior to admission. In cases where pre-admission Scr data was unavailable, the first Scr measurement upon admission served as the baseline [23]. AKI stages were defined based on both Scr levels and urine output volume (Additional file 1: Table S1).

Data collection and definitions

The ICU patient data, including age, sex, race, height, weight, body mass index (BMI), Sequential Organ Failure Assessment (SOFA) score, route of admission, comorbidities, number of rib fractures, Scr measurements and time points, urine volume measurements and time points, RRT status, use and dose of NSAIDs, rib surgical status, use of ACE inhibitors and ARB drugs, use of vasopressors (norepinephrine, epinephrine and vasopressin), use of nephrotoxic drugs (amphotericin B, streptomycin, gentamicin, tobramycin, amikacin, tacrolimus, tenofovir, and vancomycin) were extracted from these datasets.

The definition of NSAID exposure timing (7 days to 12 h prior to AKI onset) was selected based on previous studies suggesting that NSAIDs can cause renal injury within a specific time window around the onset of AKI [24, 25]. NSAIDs can exert their nephrotoxic effects within a few days of use, and the 12-hour threshold before AKI onset captures the immediate impact of NSAID administration that may contribute to the acute kidney injury process [25]. We quantified the utilization of aspirin, ketorolac, ibuprofen, indomethacin, naproxen, naproxone, diclofenac, nimesuride, rofecoxib, and celecoxib. All dose units must be converted to mg for consistency and accuracy. The administration of nephrotoxic drugs, vasopressors, ACE inhibitors, and ARB drugs was considered to have occurred prior to the onset of AKI.

Outcomes

The primary outcome of this study was the incidence of AKI, while the secondary outcome was defined as the incidence of AKI in different stages based on KDIGO criteria.

Statistical analysis

Since the MIMIC database is very detailed, the missing data for all variables did not exceed 5%.

Missing data was considered missing at random and imputed using Multivariable Imputation by Chained Equations with five iterations [26]. The continuous variables are represented by the interquartile range (IQR) and median, while the categorical variables are presented as frequencies and percentages. The Wilcoxon rank sum and t-test were employed to compare continuous demographic variables, while Pearson's $\chi 2$ tests were utilized for analyzing disaggregated demographic data. To reduce the impact of confounding factors, logistic regression was employed to score patients for propensity matching at a 1:2 ratio (Additional file 1: Fig. S2 and S3). The model incorporated the following variables: age, height, weight, BMI, number of rib fractures, initial creatinine levels, SOFA scores, nephrotoxic drugs, vasopressors, ACE inhibitors, and ARB drugs. The effect of NSAIDs on AKI was evaluated using a logistic regression model. Subgroup analysis was conducted to explore potential variations in the association between NSAIDs and AKI based on age, comorbidities, number of rib fractures, BMI, rib surgical intervention, and drug type. After determining that there was no duplication of aspirin use among patients in both datasets, the four knots (20th, 40th, 60th, and 80th percentiles of aspirin dose) were used to model the exposure dose-response curves for aspirin exposure and the occurrence of AKI by performing the restricted cubic spline. Information on the dose of aspirin used by the patients, as well as the variables that need to be adjusted for in the dose-response curves, is provided in (Additional file 1: Table S2). In the sensitivity analysis, we excluded hypertensive patients with the highest number of comorbidities and subsequently employed a logistic regression model to evaluate the impact of aspirin on the development of AKI. Statistical analysis was performed using STATA/MP 18.0 version and RStudio 4.2.3. Statistical significance was set at $P < 0.05$.

Results

Study participants

After exclusion and matching, a total of 459 patients in MIMIC-III and 364 patients in MIMIC-IV were identified (Fig. 1). The characteristics and outcomes of patients are presented in (Table 1). NSAIDs were administered to 34% of patients in MIMIC-III and 41% in MIMIC-IV. The incidence of AKI was 16% in patients with MIMIC-III and 11% in those with MIMIC-IV.

Based on the dataset records, most patients in our study used only one type of NSAID. After performing propensity score matching, only three patients used multiple NSAIDs, and the dose of aspirin for these three patients was significantly higher than that of ketorolac and ibuprofen. This had almost no impact on the primary and secondary outcome; To avoid any potential influence on the results, we excluded these three patients from both the subgroup analysis based on different NSAIDs and the dose-response relationship analysis.

Primary and secondary outcome

A logistic regression model was employed to evaluate the correlation between the utilization of NSAIDs and the risk of AKI. There was a potential increased risk of AKI (OR 1.54; 95%CI 0.92 to 2.55, $p = 0.091$), AKI stage 1 (OR 1.13; 95%CI 0.61 to 2.13, $p = 0.692$), AKI stage 2 (OR 2.73; 95%CI 0.93 to 8.01, $p = 0.070$) and AKI stage 3 (OR 1.72; 95%CI 0.57 to 5.22, $p = 0.331$) in the MIMIC-III dataset, but the outcome was not statistically significant (Fig. 2). In the MIMIC-IV dataset, NSAID use was associated with an increased risk of AKI (OR 1.99; 95%CI 1.04 to 3.85, $p = 0.039$) and AKI stage 1 (OR 2.32; 95%CI 1.08 to 4.98, $p = 0.030$), but no significant result was observed

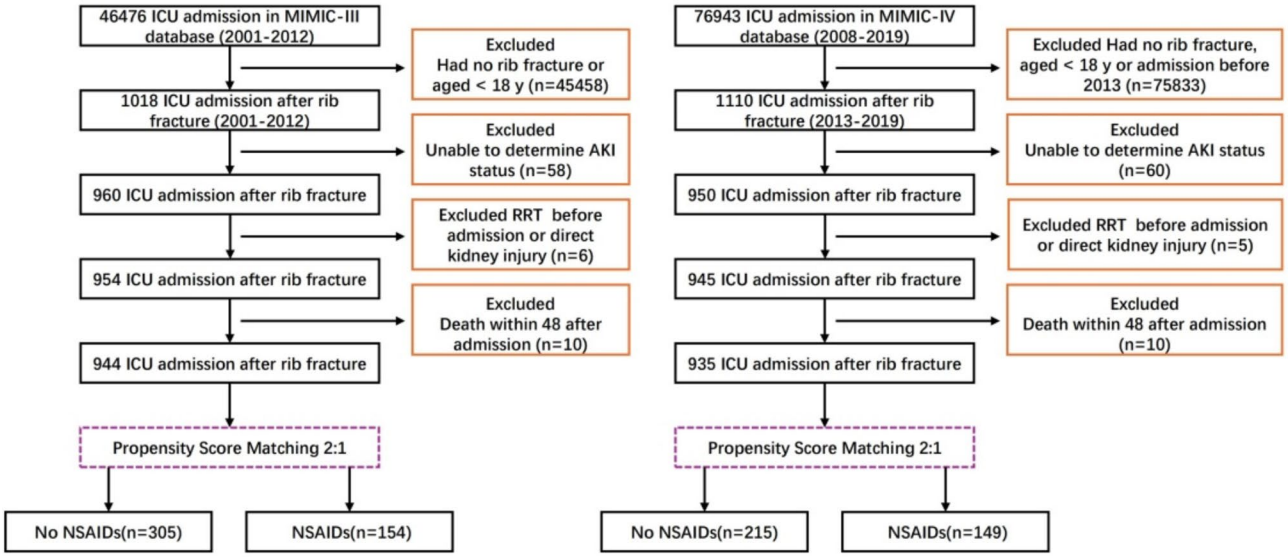

Fig. 1 Participant flowcharts for the MIMIC- III and MIMIC-IV cohorts. Abbreviations: MIMIC-III, Medical Information Mart for Intensive Care III; MIMIC-IV, Medical Information Mart for Intensive Care IV; ICU, Intensive Care Unit; AKI, acute kidney injury; NSAIDs, Nonsteroidal Anti-inflammatory Drugs; RRT, renal replacement therapy

for AKI stage 2 (OR 1.45; 95%CI 0.42 to 5.13, $p=0.561$) (Fig. 2).

Other analysis

In the MIMIC-III, we observed a significant association between the use of aspirin and an increased risk of AKI (OR 1.81; 95%CI 1.02 to 3.2, $p=0.04$). A significant association between the use of NSAIDs and AKI was observed in patients who did not undergo rib surgery (OR 1.75; 95%CI 1.02 to 2.98, $p=0.041$) (Fig. 3). The administration of aspirin was also found to be associated with an increased risk of AKI in the MIMIC-IV (OR 2.47; 95%CI 1.26 to 4.85, $p=0.009$). The use of NSAIDs was found to significantly elevate the risk of AKI in patients aged 18–65 years in the MIMIC-IV (OR 4.11; 95%CI 1.31 to 12.95, $p=0.016$) (Fig. 4). We did not observe statistically significant findings for age, comorbidities, number of rib fractures, BMI, rib surgery status, ibuprofen, and ketorolac subgroups in both datasets. The dose of aspirin ranged from 81 mg to 2031 mg. After adjusting for age, sex, BMI, height, and weight, a dose-response relationship was observed, suggesting no association between aspirin dose and the risk of AKI. (Fig. 5). In the sensitivity analysis, individuals with hypertension were excluded, yet the observed association between aspirin and increased risk of AKI remained significant in the MIMIC-III (OR 2.56; 95%CI 1.13 to 5.84, $p=0.025$) and MIMIC-IV (OR 2.95; 95%CI 1.23 to 7.09, $p=0.016$) (Additional file 1: Table S3).

Although the number of events was relatively small in certain subgroups of this study, post hoc power calculations indicated that for both the primary and secondary outcomes, as well as the subgroup analyses with statistical significance in both datasets (including the aspirin group), the study had sufficient statistical power (> 80%) to detect clinically meaningful differences.

Discussion

Research indicates that NSAIDs are associated with an elevated risk of AKI in the general population [18, 19]. However, in the chest trauma population under investigation, there was no observed association between the utilization of NSAIDs and AKI [16, 17]. To investigate the association between different types of NSAIDs and AKI in critical patients with chest trauma, we conducted an analysis using the MIMIC-III and MIMIC-IV datasets. We recruited patients who were admitted to the ICU and matched them based on covariates, ensuring enhanced homogeneity in terms of disease severity. Previous studies have not been able to effectively classify different NSAIDs. In our study, we conducted subgroup analysis and dose analysis based on specific drug usage. However, clinical decisions regarding the choice of NSAIDs may still be influenced by various factors, which could lead to indication bias. For instance, aspirin may be more likely to be used in patients at higher risk of thromboembolic events [27], while ibuprofen and ketorolac may be used in patients with less severe trauma who do not require intensive anti-inflammatory therapy [28]. This is an issue that we need to consider more carefully in future studies.

NSAIDs alleviate pain by inhibiting the activity of cyclooxygenase enzyme 1 (COX-1) and reducing the synthesis of prostaglandins [29]. This mechanism also underlies the nephrotoxicity induced by NSAIDs [30, 31].

Table 1 Baseline characteristics of study participants

Characteristics	NSAIDS (*n* = 154)	MIMIC-III		MIMIC-IV		
		NON NSAIDS (*n* = 305)	*P* value	NSAIDS (*n* = 149)	NON NSAIDS (*n* = 215)	*P* value
Age(year)	67(53–79)	65(49–77)	0.171	76(62–82)	72(59–84)	0.591
18–65	70(45%)	153(50%)		45(30%)	77(36%)	
> 65	84(55%)	152(50%)		104(70%)	138(64%)	
Gender			0.842			0.939
Female	57(37%)	110(36%)		68(46%)	99(46%)	
Male	97(63%)	195(64%)		81(54%)	116(54%)	
Ethnicity			0.206			0.030*
White	123(80%)	227(74%)		117(79%)	158(73%)	
Asian	2(1%)	5(2%)		10(6%)	15(7%)	
Black	7(5%)	9(3%)		15(10%)	13(6%)	
Other	22(14%)	64(21%)		7(5%)	29(14%)	
Admission type			0.032*			0.010*
Emergency	5(3%)	2(1%)		103(69%)	186(87%)	
Elective	149(975)	303(99%)		46(31%)	29(13%)	
Height(cm)	170(167–175)	171(168–175)	0.521	168(160–173)	168(163–174)	0.218
Weight(kg)	81(70–96)	82(70–95)	0.895	73(58–87)	75(61–89)	0.439
BMI(kg/cm^2)	28(25–32)	28(25–32)	0.592	26(22–30)	26(22–30)	0.901
Rib amount			0.768			0.783
1–4	80(52%)	154(50%)		108(72%)	153(71%)	
≥ 5	74(48%)	151(50%)		41(28%)	62(29%)	
SOFA score	3(1–5)	3(2–5)	0.913	3(2–5)	3(1–5)	0.673
Mechanical ventilation	64(42%)	133(27%)	0.676	45(30%)	61(28%)	0.706
Initial creatinine (mg/dL)	0.9(0.7–1.1)	0.8(0.7–1.1)	0.291	0.9(0.7–1.4)	0.9(0.8–1.2)	0.298
Rib surgery	12(7%)	24(8%)	0.977	3(2%)	5(2%)	0.842
AKI	31(20%)	43(14%)	0.097	23(15%)	18(8%)	0.036*
Stage 1	17(11%)	30(10%)		18(12%)	12(5%)	
Stage 2	8(5%)	6(2%)		5(3%)	5(2%)	
Stage 3	6(4%)	7(2%)		0	1	
CO-morbidities	105(68%)	149(49%)	< 0.001*	116(78%)	131(61%)	0.001*
Hypertension	84(55%)	108(35%)	< 0.001*	70(47%)	85(40%)	0.158
Diabetes	31(20%)	51(17%)	0.062	49(33%)	40(19%)	0.002*
COPD	3(2%)	4(1%)	0.591	3(2%)	2(1%)	0.383
CHD	42(27%)	28(9%)	< 0.001*	56(38%)	31(14%)	< 0.010*
CKD	14(9%)	18(6%)	0.205	27(18%)	24(11%)	0.060
BPH	9(6%)	8(3%)	0.080	12(8%)	9(4%)	0.120
Urolithiasis	0	1	0.477	1	0	0.229
NSAIDS						
Aspirin	90(58%)			89(60%)		
Ibuprofen	32(21%)			35(23%)		
Ketorolac	29(19%)			23(16%)		
Others	3(2%)			2(1%)		
Vasopressors	22(14%)	35(11%)	0.389	13(9%)	12(6%)	0.244
ACEI and ARB drugs	21(14%)	33(11%)	0.376	32(21%)	36(17%)	0.255
Nephrotoxic drugs	33(21%)	49(16%)	0.157	35(23%)	46(21%)	0.637

Abbreviations: MIMIC-III, Medical Information Mart for Intensive Care III; MIMIC-IV, Medical Information Mart for Intensive Care IV; AKI, acute kidney injury; NSAIDs, Nonsteroidal Anti-inflammatory Drugs; OR, odds ratio; CI, Confidence Interval; CHD, coronary heart disease; CKD, Chronic Kidney Disease; BPH, benign prostatic hyperplasia; COPD, chronic obstructive pulmonary disease; BMI, Body Mass Index; SOFA, Sequential Organ FailureAssessment; ACEI, ACE inhibitors. Note: *, P value < 0.05 indicates statistical significance

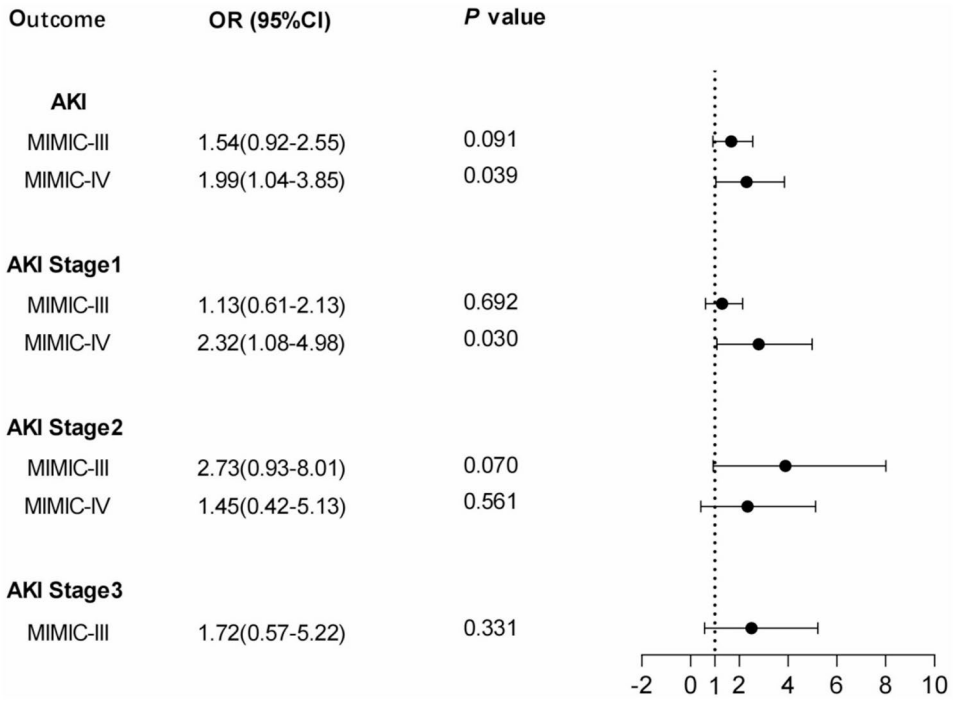

Fig. 2 Relationship between NSAIDs use and primary and secondary outcomes. Abbreviations: MIMIC-III, Medical Information Mart for Intensive Care III; MIMIC-IV, Medical Information Mart for Intensive Care IV; AKI, acute kidney injury; NSAIDs, Nonsteroidal Anti-inflammatory Drugs; OR, odds ratio; CI, Confidence Interval

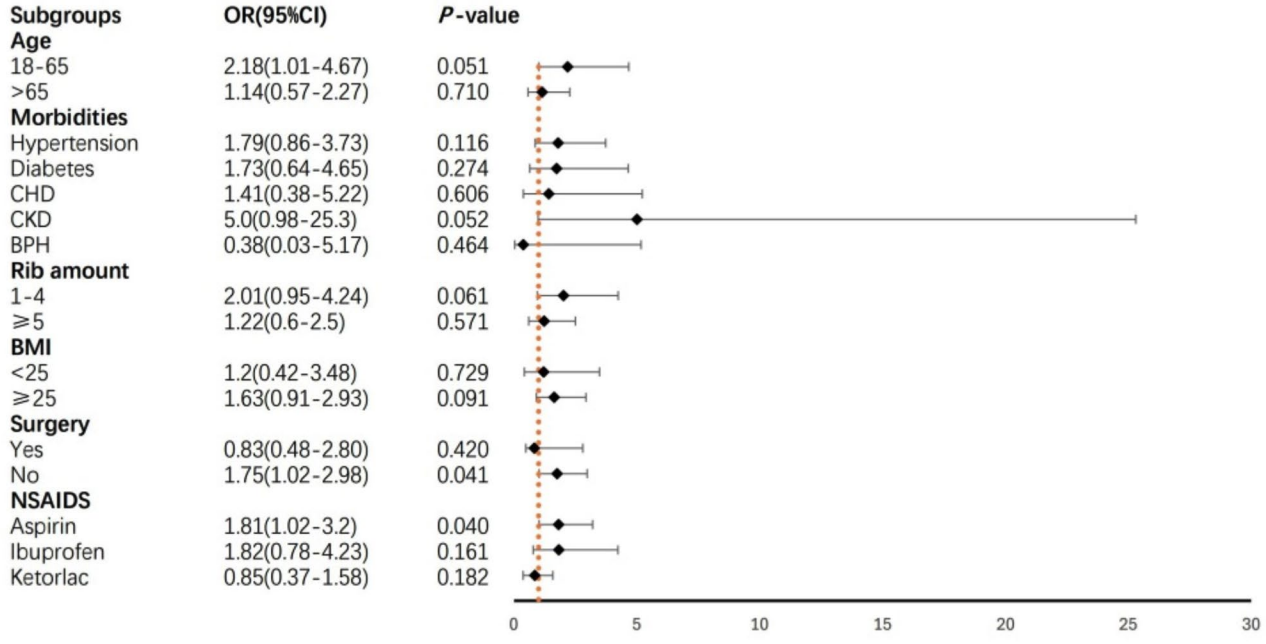

Fig. 3 Subgroup analysis for the risk of AKI in the MIMIC-III. Abbreviations: MIMIC-III, Medical Information Mart for Intensive Care III; AKI, acute kidney injury; NSAIDs, Nonsteroidal Anti-inflammatory Drugs; OR, odds ratio; CI, Confidence Interval; CHD, coronary heart disease; CKD, Chronic Kidney Disease; BPH, benign prostatic hyperplasia; BMI, Body Mass Index

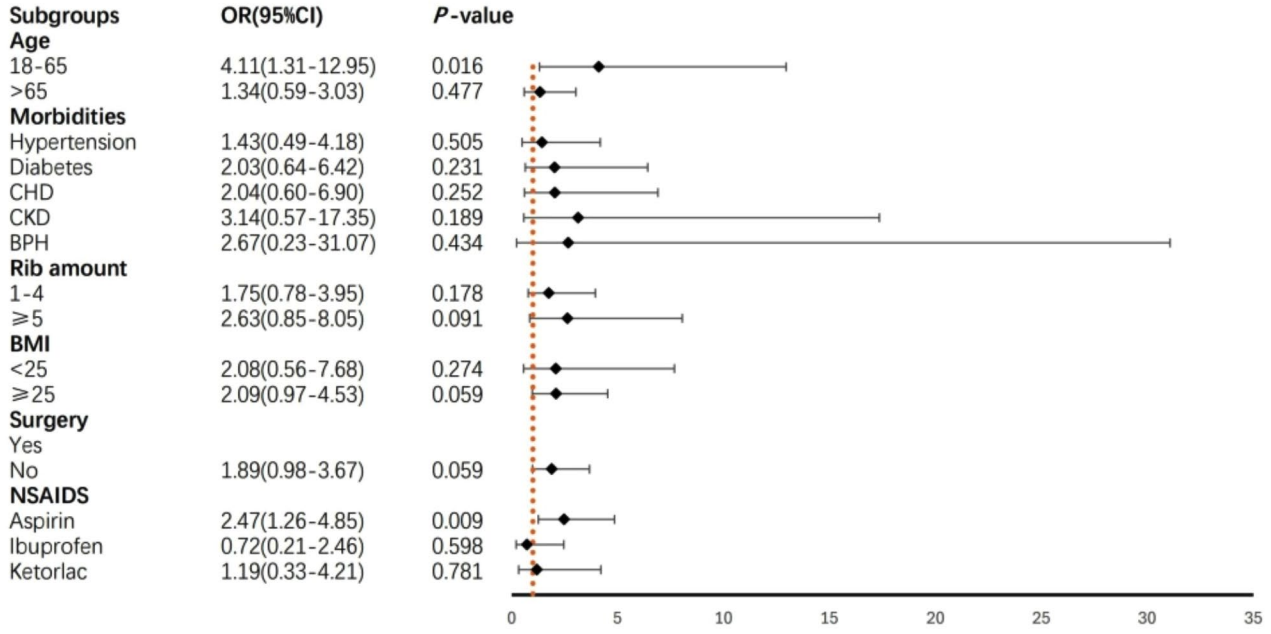

Fig. 4 Subgroup analysis for the risk of AKI in the MIMIC-IV. Abbreviations: MIMIC-IV, Medical Information Mart for Intensive Care IV; AKI, acute kidney injury; NSAIDs, Nonsteroidal Anti-inflammatory Drugs; OR, odds ratio; CI, Confidence Interval; CHD, coronary heart disease; CKD, Chronic Kidney Disease; BPH, benign prostatic hyperplasia; BMI, Body Mass Index

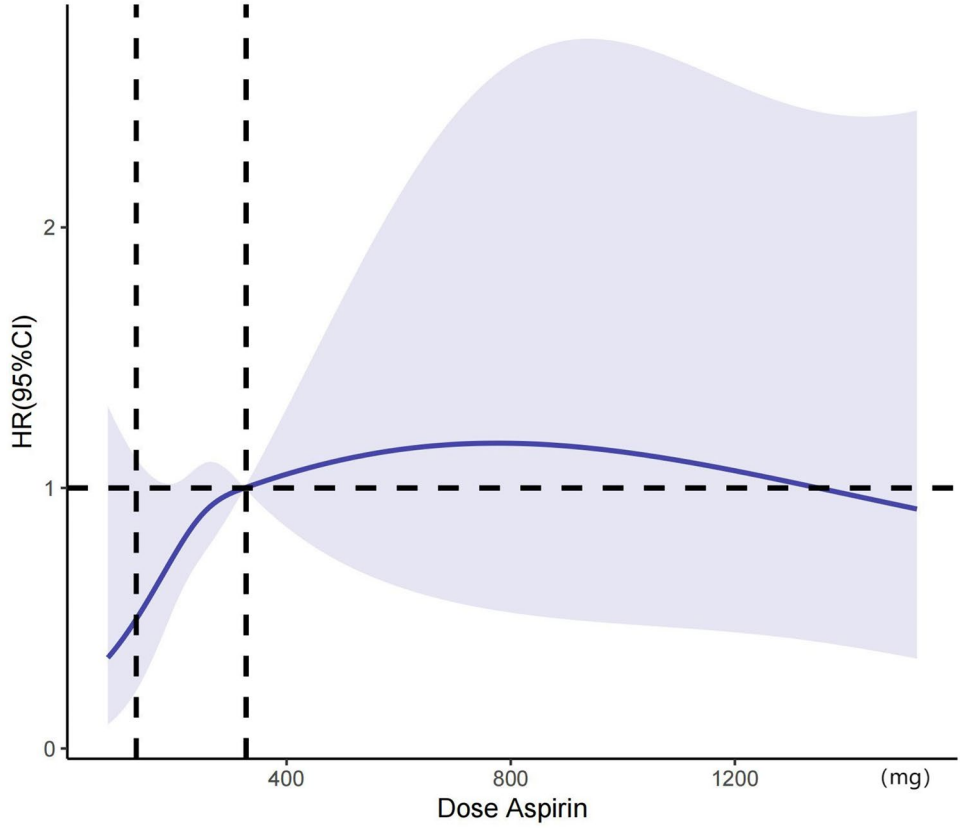

Fig. 5 Dose-response curves for the association between aspirin dose and incident AKI. Abbreviations: AKI, acute kidney injury; HR, Hazard Ratio; CI, Confidence Interval

Prostaglandins play an indispensable role in maintaining renal blood flow in situations where reduced blood volume leads to renal vasoconstriction [32, 33]. Studies have reported a significant increase in the risk of AKI when NSAIDs are co-administered with diuretics, which can potentially induce hemodynamic alterations in renal function [19, 30]. Considering the propensity of chest trauma patients to experience significant blood loss leading to renal hypoperfusion, and given the established association between AKI and unfavorable prognosis in this population, It is imperative to investigate whether the utilization of NSAIDs in critical patients with chest trauma escalates the risk of AKI [15, 34–37].

Kidney injury in trauma patients is influenced by various factors, with potential causes encompassing hemorrhagic shock following the injury and rhabdomyolysis [38]. Simultaneously, trauma treatment may also exacerbate renal damage. The therapeutic process commences with airway protection, often achieved through endotracheal intubation and mechanical ventilation. Positive end-expiratory pressure induces alterations in intrathoracic physiology, leading to diminished venous return and cardiac output, heightened venous congestion, as well as impairment of the kidney's microcirculation [31]. Subsequently, renal impairment may ensue during the maintenance of hemodynamic stability due to excessive perfusion and heme-induced cytotoxicity [39–41]. Following the acute phase, vasopressin administration is initiated in certain patients, thereby eliciting a concomitant reduction in renal blood flow [42]. In addition, the use of nephrotoxic antibiotics and iodine contrast agents are also potential risk factors for kidney injury.

Our study revealed a significant association between NSAIDs and AKI in MIMIC-IV, while this relationship did not reach statistical significance in MIMIC-III. Compared to the baseline characteristics of the patients, we hypothesized that this discrepancy may be attributed to age disparity, since age has been reported as a risk factor for post-traumatic AKI [43, 44]. Specifically, in the MIMIC-III, the median ages for NSAIDs and NON-NSAIDs groups were 67 and 65 years old respectively, whereas in the MIMIC-IV they were 76 and 72 years old.

The NSAIDs utilized by more than three patients encompassed aspirin, ibuprofen, and ketorolac, all of which function as non-selective inhibitors of COX. We observed an increased risk of AKI in patients with chest trauma who were admitted to the ICU and received aspirin. However, no significant association was found between ketorolac or ibuprofen use and AKI, which is consistent with previous studies that did not include aspirin [16, 17]. We propose the following potential factors: (1) Aspirin, compared to ibuprofen and ketorolac, has a unique mechanism of action due to its strong inhibition of COX-1 [30]. COX-1 is constitutively expressed in the kidneys, where it plays a critical role in maintaining renal blood flow. By inhibiting COX-1, aspirin reduces the synthesis of prostaglandins. In states of low blood volume or hypotension, this can exacerbate renal hypoperfusion, increasing the risk of AKI [31]. In contrast, ibuprofen and ketorolac, while also non-selective COX inhibitors, may have less impact on renal hemodynamics due to their relatively lower COX-1 selectivity [45]; (2) discrepancies in the dose required to achieve analgesic efficacy; (3) differences in renal drug metabolism rates; (4) aspirin, when compared to ibuprofen and ketorolac, may elevate the risk of bleeding within internal organs such as the brain and gastrointestinal tract, consequently leading to reduced effective blood circulation and diminished renal perfusion [46, 47]. Therefore, we posit that the administration of ketorolac and ibuprofen is feasible in critical patients with chest trauma, without concomitant augmentation of AKI risk. To identify the populations most susceptible to NSAIDs, we subsequently conducted subgroup analysis in individuals with chronic kidney disease (CKD) and individuals with common kidney disease triggers, including hypertension, diabetes, and urolithiasis. However, no statistically significant differences were observed.

The study also had certain limitations. Firstly, due to the application of exclusion criteria and propensity matching, only aspirin, ibuprofen, and ketorolac were eligible for analysis, thus precluding systematic comparisons with other drugs. Consequently, further studies should investigate whether other NSAIDs, such as selective COX-2 inhibitors, could also contribute to an increased risk of AKI in critically ill patients with chest trauma. Secondly, both datasets did not provide explicit data regarding the specific types of NSAIDs used, despite their widespread application in pain management and fever reduction, which could have introduced unmeasured confounding variables. The lack of information on NSAID types may limit the ability to fully account for variations in drug effects. Thirdly, this study's data is derived from a single center, and thus, further research conducted across diverse centers and populations would enhance the generalizability of these findings.

Conclusions

In summary, our analysis of two datasets reveals that aspirin usage is associated with an increased risk of AKI in critical patients with chest trauma; however, no significant association was observed between the dose of aspirin and AKI. Based on our study and the findings from previous research, we recommend the utilization of ketorolac and ibuprofen for effective pain management in critical patients with chest trauma due to their proven efficacy without posing an increased risk of AKI development.

Abbreviations

MIMIC-III	Medical Information Mart for Intensive Care III
MIMIC-IV	Medical Information Mart for Intensive Care IV
AKI	Acute kidney injury
NSAIDs	Nonsteroidal Anti-inflammatory Drugs
OR	Odds ratio
CI	Confidence Interval
CHD	Coronary heart disease
CKD	Chronic Kidney Disease
BPH	Benign prostatic hyperplasia
COPD	Chronic obstructive pulmonary disease
BMI	Body Mass Index
SOFA	Sequential Organ Failure Assessment
COX-1	Cyclooxygenase enzyme 1

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12245-025-00835-1.

Supplementary Material 1

Supplementary Material 2

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Author contributions
Study conception and design: HY and XF; data acquisition and analysis: HY, MYC, and XHC; drafting the manuscript and figures: HY and FW; reviewing the manuscript: HY, MYC, FW, and JLY. The authors read and approved the final manuscript.

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Data availability
All the data used in the present study had been publicly available, and the source of the data had been described in the main text.

Declarations

Ethics approval and consent to participate
Not applicable.

Competing interests
The authors declare no competing interests.

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