Elevated Blood Urea Nitrogen are associated with Recurrence of post-operative Chronic Subdural Hematoma

Ning Wang
Wenzhou medical university https://orcid.org/0000-0002-5206-1636
Jiangnan Hu
University of North Texas Health Science Center
Anthony Oppong-Gyebi
University of North Texas Health Science Center
Xuanhao Zhu
Wenzhou Medical University
Yihao Li
Wenzhou Medical University
Jianjing Yang
Wenzhou Medical University First Affiliated Hospital
Qichuan Zhuge
Wenzhou Medical University First Affiliated Hospital
Linhui Ruan
Wenzhou Medical University First Affiliated Hospital
Sheng Ye (yesheng342@163.com)
https://orcid.org/0000-0003-1281-1735

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Abstract

BACKGROUND Chronic subdural hematoma (CSDH) is fundamentally treatable with about 2-31% recurrence rate. Recently, there has been renewed interest in the association between Blood Urea Nitrogen (BUN) and intracranial lesion. Therefore, this paper attempts to show the relationship between BUN and CSDH recurrence.

METHODS A total of 661 CSDH cases with Burr-hole Irrigation (BHI) were enrolled from December 2014 to April 2019. The analyzed parameters included age, gender, comorbidities, laboratory investigations, medication use and hematoma location. The cases were divided into recurrence and non-recurrence groups while postoperative BUN concentration was further separated into quartiles (Q1 ≤ 4.0 mmol/L, 4.0 < Q2 ≤ 4.9 mmol/L, 4.9 < Q2 ≤ 6.4 mmol/L, Q4 > 6.4 mmol/L). Restricted cubic spline regressions and logistic regression models were performed to estimate the effect of BUN on CSDH recurrence.

RESULTS CSDH recurrence was observed in 97(14.8%) cases. Significant distinctions were observed between recurrence and non-recurrence groups in BUN quartiles of cases (P =0.004). After adjusting for the potential confounders, the odds ratio of recurrence was 3.124 (95%CI =1.509–6.468, p = 0.002) for the highest quartile of BUN compared with the lowest quartile. In multiple-adjusted spline regression, high BUN level visually showed significantly high OR value of recurrence risk.

CONCLUSIONS Elevated BUN at post-operation is significantly associated with the recurrence of CSDH, and it is indicated that high levels of serum BUN after evacuation may be served as a risk factor for CSDH recurrence.

Background

Chronic subdural hematoma (CSDH) is a frequently encountered neurosurgical disorder which is common to the old people. The incidence of CSDH is estimated to be 8.2–17.6 per 100,000 persons per year which increases along with increasing age[1–3]. Burr-hole irrigation (BHI) is most widely used to treat CSDH with a relatively good outcome, but about 2%-31% of patients relapse after the initial operation[1].

Factors found to influence CSDH recurrence have been reported in several studies, including age, Glasgow coma score (GCS), antiplatelet or anticoagulant agents, bilateral hematomas, postoperative pneumocephalus, and other certain relative computed tomography (CT) findings[4–7]. However, the findings about the connection between laboratory investigation and CSDH recurrence is still scarce.

Blood urea nitrogen (BUN) concentration is an easily overlooked investigation. Interestingly, there is a growing amount of literature that recognizes high BUN/creatinine(Cr) as an independent risk factor of poor outcomes in acute ischemic stroke (AIS) patients[8–10]. Furthermore, elevated BUN concentration was revealed to increase in-hospital mortality in AIS patients[11]. These studies indicated that BUN was

associated with intracranial disorders. But very little attention has been paid to the relationship between BUN and CSDH recurrence so far.

In this paper, variables associated with CSDH recurrence were investigated, focusing on the postoperative BUN concentrations of patients with CSDH who underwent evacuation at a single facility from 2014 to 2019. The aim of this research was to explore the relationship between serum BUN levels and CSDH recurrence and may provide a new orientation to study the pathophysiology of CSDH.

Methods

Patients and parameters

This study enrolled patients with the diagnosis of CSDH admitted to the First Affiliated Hospital of Wenzhou Medical University, Zhejiang province, China, between December 2014 and April 2019. Patients with CSDH were diagnosed by head magnetic resonance imaging (MRI) and computed tomography (CT). Following exclusive criteria were used:(1) without surgical treatment;(2) younger than18 years old;(3) severe epilepsy;(4) severe renal or blood diseases;(5) hematoma organized or bad operation result;(6) craniotomy or evacuated by other departments;(7) lack of laboratory investigation;(8) hospital mortality. Patient with twice operations was defined as two cases.

The following clinical characteristics were analyzed: age, gender, demographic parameters, comorbidities, postoperative laboratory investigations, postoperative medication use, and location of hematoma.

Surgery procedure and follow-up

All patients underwent BHI with general anesthesia. After burr-hole exposure, dura incision and irrigation, we used closed system drainage with a subdural catheter connected to a vacuum plastic bag. Most catheters were withdrawn within 72 h after the operation. Head CT was enforced within the first 48 hours and on day 6 or 7 postoperatively. For good measure, patients were followed up with head CT at 3 months at the outpatient service.

Definition of recurrence and grouping

CSDH recurrence was evaluated by radiological criteria which included an increased volume of the subdural collection, both in bilateral sides within 3 months compared with those first measured after surgery through CT scans. At first, the cases were divided into 2 groups with recurrence and non-recurrence to investigate the risk factors for CSDH recurrence. For the sake of identifying the specific effect of BUN, it was further divided into quartiles to explore the different influences on the CSDH recurrence in each category. The local ethics committee ruled that no formal ethics approval was required in this particular study.

Statistical analysis

Data for continuous variables were showed as mean ± standard deviation or medians and interquartile range. To verify whether the data follows a normal distribution or not, Kolmogorov-Smirnov test was enforced. Categorical variables were showed as relative frequencies and percentages. Normally distributed variables were compared by Student's t-test, wheras the Mann–Whitney U test used for the asymmetrically distributed continuous variables. χ^2 test was used to compare categorical variables. Statistical comparisons among BUN concentrations stratification were estimated by one-way analysis of variance (ANOVA) or Kruskal–Wallis test for continuous variables, and Pearson's chi-square test for categorical variables where appropriate. Odds ratio (OR) and 95% confidence interval (CI) for recurrence risk were calculated by performing multivariate-adjusted binary logistic regression. Restricted cubic spline regressions model was built to examine the linear relation between serum BUN concentration and the risk of recurrence. In this study, a two-tailed p-value less than 0.05 ($P < 0.05$) was considered as statistical significance. All statistical analyses were implemented using SPSS (version 23.0, IBM Corp.) and STATA software (version 12, StataCorp LP) was performed to analyze the restricted cubic spline regressions.

Results

Baseline characteristics of all cases in the recurrence group and Non-recurrence group

A total of 661 CSDH cases were enrolled in this study at last (Fig. 1). This study group included 567 male cases (85.8%) and 94 female cases (14.2%). Patient’s age ranged from 21 to 100 years with a median of 72 years (interquartile range 64 to 80 years). (Table 1).

The descriptive characteristics between groups with and without recurrence are exhibited in Table 1, including the demographics, laboratory, imaging, medication and comorbidity characteristics. In this study, 97 (14.8%) cases were diagnosed as CSDH recurrence, including 16 patients who needed a second operation. Compared with non-recurrence, the cases in the group of recurrence were more likely to be older and have lower baseline BDP, serum leukocyte, neutrophil and platelet counts. In the meanwhile, lower serum fibrinogen concentration was examined in recurrence cases ($p < 0.05$). Moreover, there was a statistical difference exhibited for serum BUN concentration between two groups ($p < 0.001$).

Baseline characteristics of all cases in BUN quartiles

For further exploration, the cases were divided into 4 groups on the basis of quartiles of the BUN concentration. The cut-off points for this stratification of the BUN concentration into quartiles were: $Q1 \leq 4.0$ mmol/L, $4.0 < Q2 \leq 4.9$ mmol/L, $4.9 < Q2 \leq 6.4$ mmol/L and $Q4 > 6.4$ mmol/L. Table 2 summarized the characteristics of the CSDH cases by the quartiles of BUN. Cases with different BUN concentration appeared to be similar in most features except for age, Cr, erythrocyte and hemoglobin. These factors would be adjusted for multivariate-adjusted binary logistic regression for good measure.

Association between the BUN concentrations and recurrence

Significant differences were got between the recurrence and non-recurrence groups in BUN concentration quartiles of cases (P = 0.004). The proportion of cases in the lowest quartile (≤ 4.0 mmol/L) was dramatically low in the recurrence group (P = 0.026), whilst the proportion of cases in the highest quartile (> 6.4 mmol/L) was significantly high in the recurrence group (P = 0.018) (Table 3).

In Table 4, with all cases taken as a whole, the condition that CSDH recurrence was interpreted as a dependent variable and the lowest quartile was interpreted as the reference was used for BUN in the binary logistic regression models. The highest quartile of BUN concentration (> 6.4 mmol/L) was independently estimated as a risk factor of CSDH recurrence with an unadjusted OR of 3.230 (95%CI = 1.668–6.252, p = 0.001). After adjusting for the confounders including sex, age, current alcohol drinking, current smoking, comorbidities (hypertension, diabetes mellitus, coronary heart disease), medicine (Atorvastatin and PAMBA), baseline SBP, baseline DBP and laboratory investigation (platelet, fibrinogen, leukocyte, erythrocyte, hemoglobin, Cr), the highest quartile of BUN remained significantly and independently associated with CSDH recurrence (model 1: OR = 2.823, 95%CI = 1.428–5.579, p = 0.003; model 2: OR = 2.885, 95%CI = 1.452–5.730, p = 0.002; modal 3: OR = 3.122, 95%CI = 1.507–6.464, p = 0.002). There was no multicollinearity between the independent variables in model 3. Furthermore, restricted cubic spline regressions were used to explore the linear relationship between BUN concentration and the risk of CSDH recurrence (Fig. 2). Most importantly, it could be observed visually that the highest quartile had significantly high OR value.

Discussion

To the best of our knowledge, this is the first study to investigate the association between BUN concentration and the recurrence of CSDH after evacuation. Our results indicated that high postoperative BUN concentration was related to the prevalence of CSDH recurrence within 3 months after operation. Therefore, our findings revealed the postoperative BUN concentration could be an available risk factor for CSDH recurrence.

BUN is a waste product of protein catabolism which has been found to be linked with poor outcome and mortality in acute or chronic heart failure[12]. In addition, a study of 3355 AIS patients by You et al observed that higher BUN had a 3.75-fold higher risk of in-hospital mortality[11]. In reviewing the literature, little data was found on the relationship between BUN and recurrence of CSDH. In this study, we observed that cases with a higher BUN exhibited a trend toward a higher recurrence rate of CSDH. Furthermore, elevated BUN was significantly in accord with an enhancive risk of CSDH recurrence and cases with highest BUN (> 6.4 mmol/L) seemed to have a 3.124-fold increase in danger of CSDH recurrence exactly after adjusting for the potential confounders.

The precise mechanisms underlying the association between elevated BUN and CSDH recurrence remained unclear. A potential explanation for this might be that a systemic increase in serum BUN induces intracranial multiple responses, which in turn can produce hematoma expansion and bring out CSDH recurrence. Some studies have revealed that the predictive value of BUN may be induced by its

connection with other variables, such as protein intake, protein catabolism, nitrogen production and neurohormonal activation[12, 13]. On the other hand, CSDH was recently suggested to be formatted through complex processes including angiogenesis, fibrinolysis and inflammation[14], and the recurrence of CSDH follows the same process as formation. Strong evidence has been provided that vascular endothelial growth factor (VEGF) was related to the generation and steady increase of CSDH fluid volume[15–17] as well as the risk of CSDH recurrence[18]. Interestingly, Lin et al observed VEGF expression was positively correlated with BUN[19]. These discoveries might explain the relatively good correlation between elevated BUN and CSDH recurrence.

Compared with CSDH cases without recurrence, our result also showed that CSDH cases with recurrence had significantly high age, which is consistent with the reports of previous studies[7, 20]. However, we found that the older cases were associated with higher BUN and the difference of patient age was not statistically significant after multivariate logistic regression analysis (supplementary table 1). It is indicated that age affects the recurrence of CSDH through the change of BUN.

In addition, reduced fibrinogen was found to be associated with the CSDH recurrence rate (OR = 0.755, 95%CI = 0.575–0.993, P = 0.044) (supplemental table 1). In fact, fibrinogen has been proven to be a potentially available risk factor for postoperative intracranial bleeding[21, 22]. Elevating serum fibrinogen was considered as a valid therapy for intracranial hemorrhage[23]. Moreover, high levels of fibrinogen degradation products (FDPs) have been examined in CSDH fluid[24, 25] and fresh red cells were clearly identified within CSDH fluid[24], suggesting that bleeding is an essential part of CSDH formation. On the other hand, this study did not reveal significant difference between postoperative atorvastatin use and CSDH recurrence, which is contrary to existing studies[26, 27]. The relationship between atorvastatin administration and CSDH recurrence is still puzzling.

There were also some limitations recognized in the present study. Firstly, this study is a retrospective study and the selection bias is inevitable. Secondly, this is only a single-center clinical finding, which may impact the generalization of the results, thus a further prospective research with planty of patients might be required. Finally, considering that the role BUN played in the CSDH recurrence is still confusing, more studies need to be persued to further and better delineate CSDH formation in the future.

Conclusion

The most obvious finding to emerge from this study was that elevated BUN at post-operation was independently associated with the recurrence of CSDH. The result suggested that high levels of postoperative BUN might be served as a risk factor of CSDH recurrence, so the determination of serum BUN after evacuation is important for patients with CSDH. Further prospective studies need to be undertakn in order to validate the causal relationship between BUN and CSDH recurrence.

Abbreviations

CSDH: chronic subdural hematoma; BUN: Blood Urea Nitrogen; BHI: burr-hole irrigation; GCS: glasgow coma score; CT: computed tomography; MRI: magnetic resonance imaging; AIS: acute ischemic stroke ; ANOVA: analysis of variance; OR: odds ratio; CI: confidence interval; Cr: creatinine; PAMBA: para-aminomethylbenzoic acid; SBP: systolic blood pressure; DBP: diastolic blood pressure; INR: international normalized ratio; VEGF: vascular endothelial growth factor; FDPs: fibrinogen degradation products

Declarations

Acknowledgements

Not applicable.

Authors' contributions

NW, JH and AO wrote the manuscript. AO revised the manuscript. NW performed the statistical analyses. NW, XZ and YL gathered the data and are responsible for the integrity of registered data. LR, JY and QZ designed and coordinated the study. SY contributed to the analysis and interpretation of data. All authors read and approved the submitted version.

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Availability of data and materials

The datasets used and analysed during the current study are available from the corresponding author on reasonable request.

Ethical approval and consent to participate

The ethics committee of Wenzhou Medical University First Affiliated Hospital ruled that no formal ethics approval was required in this retrospective study and determined that informed consent was not required.

Consent for publication

Not applicable.

Competing interests

All authors certify that they have no affiliations with or involvement in any organization or entity with any financial interest (such as honoraria; educational grants; participation in speakers' bureaus; membership, employment, consultancies, stock ownership, or other equity interest; and expert testimony or patent-licensing arrangements), or non-financial interest (such as personal or professional relationships, affiliations, knowledge or beliefs) in the subject matter or materials discussed in this manuscript.

Author details

[1]Zhejiang Provincial Key Laboratory of Aging and Neurological Disorder Research, The First Affiliated Hospital of Wenzhou Medical University, Wenzhou 325000, China;

[2]Department of Neurosurgery, The First Affiliated Hospital of Wenzhou Medical University, Wenzhou, Zhejiang 325000, China;

[3]Department of Pharmacology and Neuroscience, University of North Texas Health Science Center, Fort Worth, Texas 76107, USA

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Tables

Table 1

Clinical and Demographic Characteristics of Patients With and Without Recurrence of CSDHs after initial evacuation.

Variables	All patients	Recurrence（n=97）	Non-Recurrence （n=564）	*p*-value
BUN (mmol/L)	4.9 (4,6.4)	5.9 (4.4,6.9)	4.9 (3.9,6.3)	<0.001
Demographic parameters				
Age (years)	72 (64,80)	75 (69,82)	72 (63,80)	0.012
Gender				0.232
Male, n (%)	567 (85.8%)	87 (89.7%)	480 (85.1%)	
Female, n (%)	94 (14.2%)	10 (10.3%)	84 (14.9%)	
Current drinking, n (%)	237 (35.9%)	34 (35.1%)	203 (36%)	0.858
Current smoking, n (%)	240 (36.3%)	33 (34.0%)	207 (36.7%)	0.612
Baseline SBP (mmHg)	140.3 ± 20.2	135 (124,151)	140 (127,154)	0.133
Baseline DBP (mmHg)	79.02 ± 11.4	76.86 ± 11.62	79.39 ± 11.31	0.043
Laboratory investigation				
Blood glucose（mmol/L)	5.5 (4.7,6.6)	5.7 (5,6.7)	5.4 (4.7,6.6)	0.268
Cr (μmol/L)	67 (58,77)	68 (60.5,79.5）	66 (57,76.8）	0.086
Leukocyte (X10^9/L)	6.94 (5.82,8.42)	6.51 (5.52,7.57)	7.01 (5.86,8.61)	0.011
Neutrophil (X10^9/L)	4.62 (3.69,6.18)	4.30 (3.52,5.36)	4.71 (3.71,6.27)	0.013
Lymphocyte (X10^9/L)	1.46 (1.10,1.80)	1.45 (1.18,1.82)	1.47 (1.1,1.8)	0.643
Erythrocyte (X10^12/L)	4.23 ± 0.51	4.19 ± 0.52	4.24 ± 0.51	0.399
Hemoglobin (g/L)	132 (120,142)	132 (119,141)	132 (120,142)	0.536
Platelet (X10^9/L)	210 (171,249)	193 (163,237)	213 (174,251)	0.008
Prothrombin Time(s)	13.3 (12.8,13.9)	13.4 (12.8,14.1)	13.3 (12.8,13.9)	0.584
INR	1.02 (0.97,1.08)	1.02 (0.98,1.11)	1.02 (0.97,1.07)	0.679
Fibrinogen (g/L)	3.63 (3.1,4.29)	3.5 (2.90,4.15)	3.66 (3.15,4.31)	0.031
Comorbidities				
Hypertension, n (%)	256 (38.7%)	40 (41.2%)	216 (38.3%)	0.583
Diabetes mellitus, n (%)	79 (12.0%)	11 (11.3%)	68 (12.1%)	0.841
Cardiovascular disease, n (%)	43 (6.5%)	6 (6.2%)	37 (6.6%)	0.890
Medication use				
Atorvastatin therapy, n (%)	481 (72.8%)	75 (77.3%)	406 (72.0%)	0.276
PAMBA therapy, n (%)	191 (28.9%)	26 (26.8%)	165 (29.3%)	0.623
Hematoma location				0.965
Unilateral left, n (%)	295 (44.6%)	43 (44.3%)	252 (44.7%)	
Unilateral right, n (%)	216 (32.7%)	31 (32.0%)	185 (32.8%)	
Bilateral, n (%)	150 (22.7%)	23 (23.7%)	127 (22.5%)	

NOTE. SBP, systolic blood pressure; DBP, diastolic blood pressure; Cr, creatinine; INR, international normalized ratio; PAMBA, para-aminomethylbenzoic acid; BUN, blood urea nitrogen.

Table 2

Baseline Characteristics of Patients with Chronic Subdural Hematoma according to BUN quartile.

Variables	BUN quartiles quartile 1 n=171（≤4.0）	quartile 2 n=163（>4.0,≤4.9）	quartile 3 n=166（>4.9,≤6.4）	quartile 4 n=161（>6.4)	*P*-value
BUN (mmol/L)	3.4 (3.0,3.7)	4.5 (4.3,4.8)	5.7 (5.3,6.0)	7.4 (6.9,8.3)	<0.001
Demographic parameters					
Age (years)	67 (61,76)	72 (64,79)	73 (66,82)	77 (69,83)	<0.001
Gender, male, n (%)	141 (82.5%)	149 (91.4%)	143 (86.1%)	134 (83.2%)	0.083
Current drinking, n (%)	62 (36.3%)	62 (38.0%)	59 (35.5%)	54 (33.5%)	0.866
Current smoking, n (%)	68 (39.8%)	56 (34.4%)	64 (38.6%)	52 (32.3%)	0.451
Baseline SBP (mmHg)	138.3 ± 19.4	139.3 ± 19.6	140.8 ± 20.7	143.1 ± 21.1	0.158
Baseline DBP (mmHg)	78.77 ± 11.4	79.23 ± 10.7	78.76 ± 11.5	79.33 ± 12.0	0.952
Laboratory investigation					
Blood glucose（mmol/L)	5.5 (4.8,6.5)	5.6 (4.8,6.6)	5.6 (4.7,6.8)	5.4 (4.6,6.7)	0.817
Cr (μmol/L)	60 (54,68)	66 (57,75)	69 (60,80)	74 (63,87)	<0.001
Leukocyte (X10^9/L)	7.00 (6.16,8.41)	6.94 (5.81,8.58)	7.00 (5.74,8.31)	6.79 (5.61,8.37)	0.786
Neutrophil (X10^9/L)	4.78 (3.87,6.30)	4.65 (3.74,6.25)	4.52 (3.6,5.97)	4.60 (3.61,6.02)	0.515
Lymphocyte (X10^9/L)	1.50 (1.10,1.80)	1.40 (1.10,1.70)	1.50 (1.11,1.87)	1.45 (1.10,1.80)	0.586
Erythrocyte (X10^12/L)	4.30 ± 0.51	4.26 ± 0.50	4.23 ± 0.50	4.12 ± 0.53	0.009
Hemoglobin (g/L)	133 (120,144)	133 (123,142)	132 (120,144)	130 (116,138)	0.025
Platelet (X10^9/L)	220 (177,259)	206 (174,249)	203 (174,241)	201 (162,249)	0.134
Prothrombin Time (s)	13.3 (12.7,13.8)	13.2 (12.9,14.0)	13.4 (12.9,13.9)	13.4 (12.9,14.1)	0.533
INR	1.01 (0.97,1.07)	1.02 (0.97,1.08)	1.03 (0.97,1.08)	1.03 (0.97,1.10)	0.489
Fibrinogen (g/L)	3.55 (3.12,4.37)	3.72 (3.13,4.33)	3.61 (2.97,4.18)	3.71 (3.15,4.26)	0.673
Comorbidities					
Hypertension, n (%)	61 (35.7%)	61 (37.4%)	61 (36.7%)	73 (45.3%)	0.258
Diabetes mellitus, n (%)	18 (10.5%)	18 (11.0%)	18 (10.8%)	25 (15.5%)	0.456
Cardiovascular disease, n (%)	9 (5.3%)	11 (6.7%)	11 (6.6%)	12 (7.5%)	0.875
Medication use					
Atorvastatin therapy, n(%)	124 (72.5%)	119 (73.0%)	115 (69.3%)	123 (76.4%)	0.552
PAMBA therapy, n(%)	40 (23.4%)	45 (27.6%)	53 (31.9%)	53 (32.9%)	0.198
Hematoma location					0.477
Unilateral left, n(%)	69 (40.4%)	82 (50.3%)	77 (46.4%)	67 (41.6%)	
Unilateral right, n(%)	62 (36.3%)	48 (29.4%)	55 (33.1%)	51 (31.7%)	
Bilateral, n(%)	40 (23.4%)	33 (20.2%)	34 (20.5%)	43 (26.7%)	

NOTE. SBP, systolic blood pressure; DBP, diastolic blood pressure; Cr, creatinine; INR, international normalized ratio; PAMBA, para-aminomethylbenzoic acid; BUN, blood urea nitrogen.

Table 3

BUN quartiles of patients.

Variable	Recurrence (n=97)	Non-Recurrence (n=564)	c□	*p*-value
BUN (mmol/L)			13.543	0.004
Quartile 1□≤4.0□	14 (14.4%)	157 (27.8%)	4.946	0.026
Quartile 2□>4.0,≤4.9□	22 (22.7%)	141 (25.0%)	0.147	0.702
Quartile 3□>4.9,≤6.4□	25 (25.1%)	141 (25.0%)	0.016	0.900
Quartile 4□>6.4)	36 (37.1%)	125 (22.2%)	5.639	0.018

BUN, blood urea nitrogen;

Table 4

Multivariate adjusted odds ratios for the association between BUN levels and Recurrence.

	Quartile	OR[a]	95%CI	*p*-value
Unadjusted	Middle	1.750	0.862-3.550	0.121
	Higher	1.988	0.955-3.975	0.052
	Highest	3.230	1.668-6.252	0.001
Model 1[b]	Middle	1.580	0.773-3.231	0.210
	Higher	1.777	0.877-3.599	0.110
	Highest	2.823	1.428-5.579	0.003
Model 2[c]	Middle	1.605	0.784-3.285	0.196
	Higher	1.842	0.905-3.749	0.092
	Highest	2.885	1.452-5.730	0.002
Model 3[d]	Middle	1.583	0.761-3.295	0.219
	Higher	1.777	0.857-3.686	0.122
	Highest	3.122	1.507-6.464	0.002

OR, odds radio; CI confidence level; Cr, creatinine; SBP, systolic blood pressure; DBP, diastolic blood pressure; Recurrence of postoperative CSDH.

[a] Reference OR (1.000) is the lowest quartile of BUN for Recurrence of CSDH.

[b] Model 1: adjusted for age, sex, current smoking, current alcohol drinking.

[c] Modal 2: adjusted for covariates from Model 1 and further adjusted for medical history (coronary heart disease, diabetes mellitus, hypertension)and medicine(Atorvastatin and PAMBA)

[d] Modal 3: adjusted for covariates from Model 2 and further adjusted for Baseline SBP, Baseline DBP, Platelet, Fibrinogen, Leukocyte, Erythrocyte, Hemoglobin, Cr.

Figures

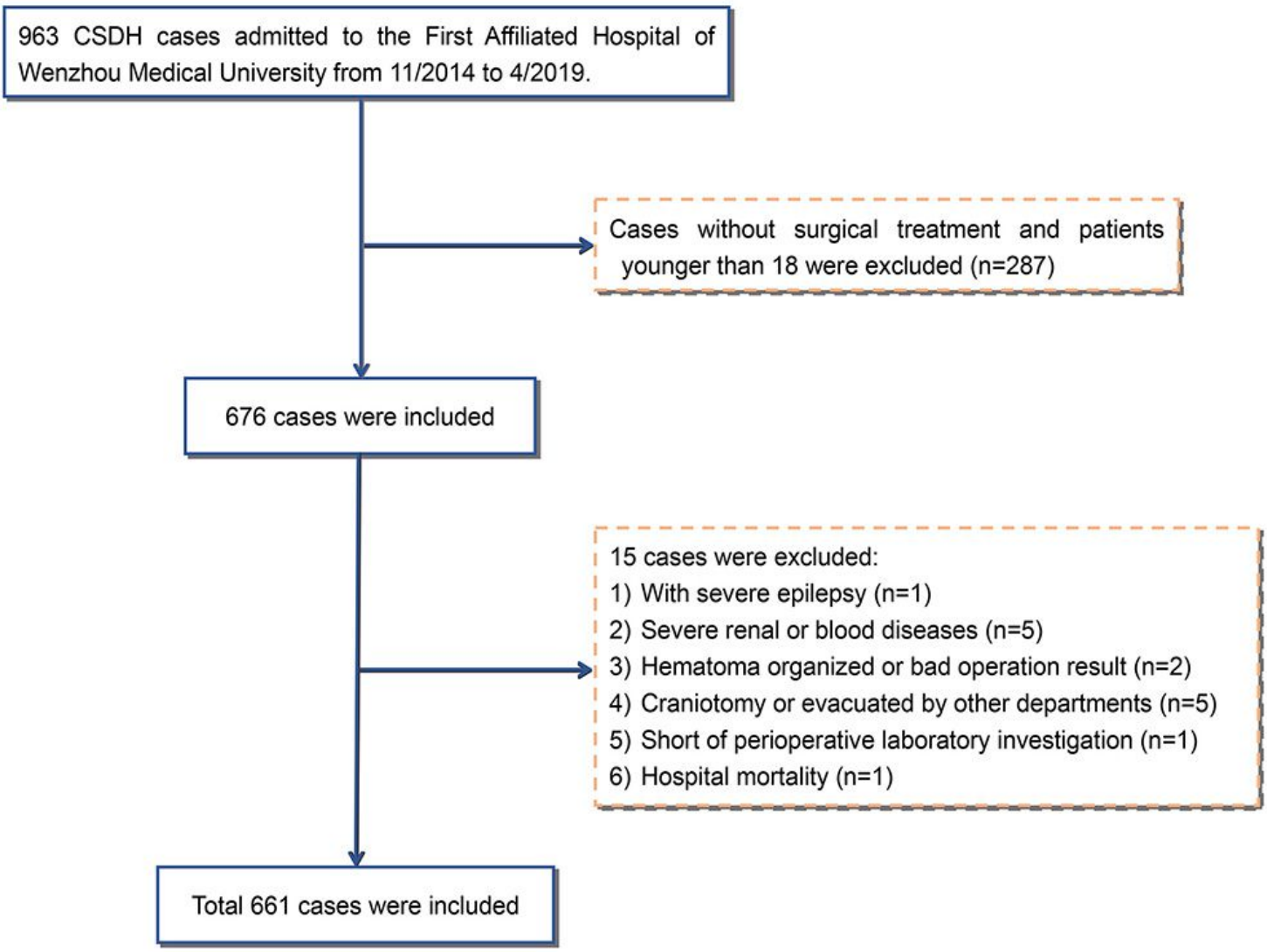

Figure 1

Study flow diagram. CSDH, chronic subdural hematoma

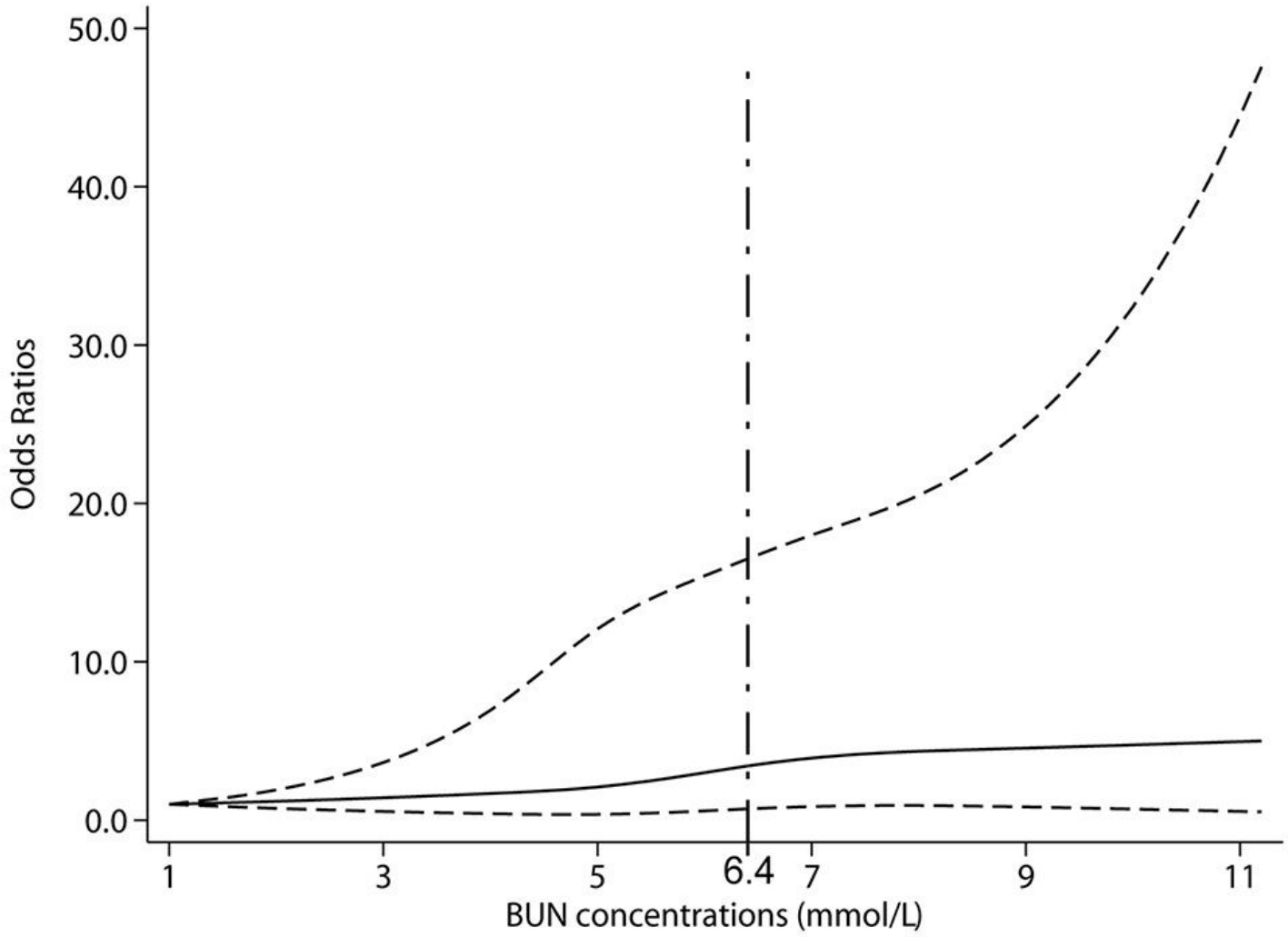

Figure 2

Association of BUN levels with risk of Recurrence. Dashed lines are 95% confidence intervals. Dotted line is where BUN concentration is 6.4 mmol/L. Odds ratios and 95% confidence intervals derived from restricted cubic spline regression. Odds ratios were estimated using logistic regression modeling, adjusting for the same variables as model 3 in Table 4.

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- supplementarytable.docx