The Relationship Between PaO_2/FiO_2 and Delirium in Intensive Care: A Cross-Sectional Study

Fang Gong
the first people's hospital of Changde City
Yuhang Ai (ayhicu1978@126.COM)
Xiangya Hospital Central South University https://orcid.org/0000-0001-7682-7782
Lina Zhang
Xiangya Hospital Central South University
Qianyi Peng
Xiangya Hospital Central South University
Quan Zhou
the First People's Hospital of Changde City
Chunmei Gui
chang de shi di yi ren min yi yuan: First People's Hospital of Changde City

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Abstract

Background: Studies investigating the association of delirium with ratio of partial pressure of arterial oxygen to fraction of inspired oxygen (PaO_2/FiO_2) have been limited. The main purpose of the our study was to explore the relationship between PaO_2/FiO_2 and the risk of delirium in intensive care units (ICUs).

Methods: This was a cross-sectional study that involved the collection of data from patients admitted to the Xiang Ya Hospital Cardiothoracic Surgical Care Unit and Comprehensive Intensive Care Unit from September 1st, 2016, to December 10th, 2016. Delirium was diagnosed by the simplified version of the Chinese Confusion Assessment Method for the ICU (CAM-ICU). The PaO_2/FiO_2 of each patient was recorded at the first 24 h after admission to the ICU.

Results: There was a non-linear relationship between the PaO_2/FiO_2 and delirium, after adjusting for the following potential confounders: gender, age, hypertension, heart disease, history of a cerebral vascular accident, diabetes, smoking habits, drinking habits, chronic pulmonary dysfunction, blood pressure at admission, postoperative surgery, mechanical ventilation, mechanical ventilation time, $PaCO_2$, sedation, APACHE II score, and SOFA score. We used a two-piecewise linear regression model to calculate the threshold of 247 mmHg. On the left side of the threshold, the odds ratio (OR) was 0.91 (95% CI [0.84, 0.98]), while the OR on the right side was 1.03 (95% CI [1.00, 1.06]).

Conclusions: The relationship between PaO_2/FiO_2 and risk of delirium was non-linear. The PaO_2/FiO_2 was negatively associated with the risk of delirium when the PaO_2/FiO_2 was less than 247 mmHg. As a readily available laboratory indicator, PaO_2/FiO_2 has potential value in the clinical evaluation risk of delirium in ICU patients. Of course, our conclusions need further confirmation from other studies, especially large prospective studies.

Background

Delirium is an acute occurrence of brain dysfunction that is characterized by an acute onset, fluctuating course of disorganized thinking, lack of attention, and an altered state of consciousness [1]. The prevalence of delirium is estimated to be 20–87% [2–5]; the differences in results among epidemiological studies may be related to differences in evaluation methods, types of sedation/analgesic drugs used, and the study populations. Delirium has been shown to prolong mechanical ventilation [6, 7] and the length of hospitalization in intensive care units (ICUs) [3, 6–8] and can also lead to long-term cognitive dysfunction [9, 10], increased risk of mortality [8, 11], and increased ICU costs[12].Postoperative delirium was confirmed to be associated with increased perioperative mortality and prolonged hospital stays[13].

Previous studies have shown that sepsis, shock, sedation, age, and alcohol consumption are risk factors for delirium [7, 14]. Additionally, hypoxemia is associated with cognitive impairment [15–20]. Studies investigating the association of delirium with the ratio of the partial pressure of arterial oxygen to the

fraction of inspired oxygen (PaO_2/FiO_2) have been limited. Hence, the aim of the present study was to investigate the potential association between PaO_2/FiO_2 and delirium.

Methods

Study population

This was a cross-sectional study that involved data from all of the patients admitted to the Cardiothoracic Surgical Care Unit (15 beds) and Comprehensive ICU (34 beds) at Xiangya Hospital from September 1st, 2016, to December 10th, 2016. For inclusion in the study, all patients were required to have stayed in the ICU for over 24 h and to have been at least 18 years old during their stay in the ICU. Exclusion criteria were as follows: a lack of competency in Mandarin; a persistent disorder of consciousness before the entry into the ICU (e.g., cerebrovascular accident, brain injury, brain death, intracranial infection, coma caused by cardiac arrest); uncontrolled mental illness; mental retardation; neuromuscular disorders; or the patients or family members did not agree to participate in the survey.

Delirium assessment and sedation assessment

Delirium diagnoses were conducted by two trained physicians according to the simplified version of the Chinese Confusion Assessment Method (CAM-ICU)[21], which was originally developed as a clinical assessment for non-psychiatric doctors [22]. The CAM-ICU was then further improved by another group [5]. In the present study, we evaluated four key delirium features: (1) acute onset and fluctuating course; (2) inattention; (3) disorganized thinking; and (4) altered level of consciousness. Delirium was diagnosed if features (1) and (2) were present in addition to either feature (3) or (4). Two study assistants (ICU doctors) received training in the use of protocols for delirium detection and evaluated each patient for delirium at two fixed times (10:00–12:00 AM, 4:00–6:00 PM) every day until each patient was discharged. The level of consciousness was assessed by the Richmond Agitation–Sedation Scale (RASS) [23], which is based on a 10-point scale from − 5 to + 4. A RASS score of 0 indicates that the patient is awake and cooperative. A positive RASS score indicates agitation or aggression, ranging from + 1 (mild agitation) to + 4 (dangerous agitation). Negative RASS scores from − 1 to−3 reflect responses to verbal commands, a score of−4 reflects responses only to physical stimuli, while a RASS score of−5 reflects no responses to either sound or physical stimuli. The CAM-ICU could not be administered when the RASS score was − 4 or− 5.

Compliance and reliability of assessors

Before the study was initiated, all assessors received training on the CAM-ICU and RASS. The study assistants diagnosed some patients to obtain prior experience and receive interrater reliability evaluations from senior members of the group.

Data collection

Data were recorded for all patients who met the inclusion criteria. Demographic and medical data were obtained within 24 h of each patient entering the ICU and consisted of the following: gender, age, past medical history, Acute Physiology and Chronic Health Evaluation (APACHE) II scores, Sequential Organ Failure Assessment (SOFA) scores, and time of mechanical ventilation. We measured the arterial partial pressure of carbon dioxide ($PaCO_2$) and the PaO_2 via an arterial blood gas analyzer at 24 h after admission to the ICU. The FiO_2 was also recorded.

Statistical analysis

Continuous variables were analyzed using descriptive statistics (mean [± *SD*] or median [interquartile range]). Categorical data were analyzed as frequencies (percentages) via chi-square tests. Categorical data were analyzed as frequencies (percentages) via chi-square tests. The PaO_2/FiO_2 data were divided into four groups: normal group ($PaO_2/FiO_2 \geq 300$ mmHg), slightly low ($200 \leq PaO_2/FiO_2 < 300$ mmHg), moderately low ($100 \leq PaO_2/FiO_2 < 200$ mmHg), and severely low ($PaO_2/FiO_2 < 100$ mmHg). We compared baseline characteristics between the groups. The results of the unadjusted model, minimally adjusted model, and fully adjusted model were also presented considering the recommendations of the STROBE statement[24]. Next, we used generalized additive models (GAM) to explore non-linear relationships between PaO_2/FiO_2 and delirium, after adjusting for confounders. A two-piecewise linear regression model was used to calculated the threshold effect of PaO_2/FiO_2 on delirium based on a smoothing plot. A recursive method was used to automatically calculate the inflection point if the ratio between the PaO_2/FiO_2 and delirium was notable in the smoothed curve and gave the maximum model likelihood. All data were analyzed with R software (http://www.R-project.org) and EmpowerStats software (www.empowerstats.com, X&Y Solutions, Inc., Boston, MA, USA). A *P* value < 0.05 was considered statistically significant.

Ethical considerations

Each patient who participated in the survey provided a signed informed consent form or had a family member sign an informed consent form. This study was approved by the Ethics Committee of Xiangya Hospital of Central South University, but there was no committee's reference number.

Results And Discussion

Participants

In total, 813 patients were admitted to the two ICUs during our enrollment period. After excluding patients who did not meet the enrollment criteria, a total of 407 patients were included in the survey (Fig 1).

Characteristics of the study population by different PaO_2/FiO_2 levels

The average age of the participants was 54.40 years (standard deviation, 16.08 years), and 237 participants (58.2%) were male. Of the 407 patients, 184 (45.2%) developed delirium in this study. The characteristics of the study population at different PaO_2/FiO_2 levels are listed in Table 1. There were no statistical differences in age, gender, heart disease, history of cerebral vascular accident (CVA), diabetes, smoking habits, drinking habits, blood pressure at admission, mechanical ventilation, $PaCO_2$ at 24 h after admission, or sedation among the different PaO_2/FiO_2 groups. In contrast, SOFA scores, APACHE II scores, and mechanical ventilation durations were significantly higher in lower-PaO_2/FiO_2 groups than in the normal group. Patients with lower PaO_2/FiO_2 were more likely to have complications such as hypertension, chronic pulmonary dysfunction, and delirium compared with those in the normal group.

Table 1
Characteristics of the Study Population by Different PaO_2/FiO_2 Levels.

PaO_2/FiO_2 (mmHg)	Normal (> 300)	Slightly low (200–300)	Moderately low (100–200)	Severely low (< 100)	*P* value
N	203	128	63	9	
Age (years, mean ± *SD*)	52.4 ± 17.1	56.3 ± 15.1	57.2 ± 14.2	59.4 ± 12.0	0.054
SOFA score (median, Q1–Q3)	4.0 (2.0–7.5)	5.0 (2.0–10.0)	8.0 (4.0–12.0)	8.0 (6.0–19.0)	< 0.001
APACHE II score	10.2 ± 5.7	11.2 ± 5.4	13.4 ± 5.2	17.0 ± 7.2	< 0.001
Mechanical ventilation time (median, Q1–Q3)	7.0 (2.0–12.0)	8.0 (2.0–17.2)	12.0 (5.0–38.8)	58.5 (37.0–85.2)	< 0.001
$PaCO_2$ (mean ± *SD*)	37.9 ± 7.1	38.8 ± 9.7	39.4 ± 7.7	42.0 ± 7.3	0.263
Gender (n, %)					0.403
Male	112 (55.2%)	73 (57.0%)	42 (66.7%)	6 (66.7%)	
Female	91 (44.8%)	55 (43.0%)	21 (33.3%)	3 (33.3%)	
Hypertension (n, %)					0.005
No	151 (74.4%)	86 (67.2%)	32 (50.8%)	5 (55.6%)	
Yes	52 (25.6%)	42 (32.8%)	31 (49.2%)	4 (44.4%)	
Heart disease (n, %)					0.488
No	157 (77.3%)	93 (72.7%)	43 (68.3%)	7 (77.8%)	
Yes	46 (22.7%)	35 (27.3%)	20 (31.7%)	2 (22.2%)	
History of CVA (n, %)					0.536

Partial pressure of arterial oxygen (PaO_2), the fraction of inspired oxygen (FiO_2), Acute Physiology and Chronic Health Evaluation II score (APACHE II score), Sequential Organ Failure Assessment (SOFA score), arterial partial pressure of carbon dioxide ($PaCO_2$), cerebral vascular accident (CVA).

PaO_2/FiO_2 (mmHg)	Normal (> 300)	Slightly low (200–300)	Moderately low (100–200)	Severely low (< 100)	*P* value
No	198 (97.5%)	122 (95.3%)	62 (98.4%)	9 (100.0%)	
Yes	5 (2.5%)	6 (4.7%)	1 (1.6%)	0 (0.0%)	
Diabetes (n, %)					0.374
No	186 (91.6%)	111 (86.7%)	59 (93.7%)	8 (88.9%)	
Yes	17 (8.4%)	17 (13.3%)	4 (6.3%)	1 (11.1%)	
Chronic pulmonary dysfunction (n, %)					0.038
No	194 (95.6%)	116 (90.6%)	55 (87.3%)	7 (77.8%)	
Yes	9 (4.4%)	12 (9.4%)	8 (12.7%)	2 (22.2%)	
Smoking habits (n, %)					0.468
No	149 (73.4%)	84 (65.6%)	46 (73.0%)	6 (66.7%)	
Yes	54 (26.6%)	44 (34.4%)	17 (27.0%)	3 (33.3%)	
Drinking habits (n, %)					0.483
No	179 (88.2%)	108 (84.4%)	58 (92.1%)	8 (88.9%)	
Yes	24 (11.8%)	20 (15.6%)	5 (7.9%)	1 (11.1%)	
Postoperative surgery					< 0.001
No	26 (12.8%)	36 (28.1%)	19 (30.2%)	6 (66.7%)	
Yes	177 (87.2%)	92 (71.9%)	44 (69.8%)	3 (33.3%)	

Partial pressure of arterial oxygen (PaO_2), the fraction of inspired oxygen (FiO_2), Acute Physiology and Chronic Health Evaluation II score (APACHE II score), Sequential Organ Failure Assessment (SOFA score), arterial partial pressure of carbon dioxide ($PaCO_2$), cerebral vascular accident (CVA).

PaO_2/FiO_2 (mmHg)	Normal (> 300)	Slightly low (200–300)	Moderately low (100–200)	Severely low (< 100)	*P* value
Blood pressure at admission					0.835
Normal	99 (48.8%)	63 (49.2%)	27 (42.9%)	3 (33.3%)	
Low	68 (33.5%)	42 (32.8%)	21 (33.3%)	3 (33.3%)	
High	36 (17.7%)	23 (18.0%)	15 (23.8%)	3 (33.3%)	
Mechanical ventilation					0.217
No	37 (18.2%)	30 (23.4%)	8 (12.7%)	3 (33.3%)	
Yes	166 (81.8%)	98 (76.6%)	55 (87.3%)	6 (66.7%)	
Sedation (n, %)					0.250
No	57 (28.1%)	39 (30.5%)	12 (19.0%)	4 (44.4%)	
Yes	146 (71.9%)	89 (69.5%)	51 (81.0%)	5 (55.6%)	
Delirium (n, %)					0.001
No	121 (59.6%)	73 (57.0%)	24 (38.1%)	1 (11.1%)	
Yes	82 (40.4%)	55 (43.0%)	39 (61.9%)	8 (88.9%)	

Partial pressure of arterial oxygen (PaO_2), the fraction of inspired oxygen (FiO_2), Acute Physiology and Chronic Health Evaluation II score (APACHE II score), Sequential Organ Failure Assessment (SOFA score), arterial partial pressure of carbon dioxide ($PaCO_2$), cerebral vascular accident (CVA).

Risk factor for delirium evaluated by univariate analysis

The association for variables and delirium by univariate analysis are shown in Table 2. The results showed that age(OR = 1.05, 95% CI [1.0, 1.1], $P < 0.001$), SOFA score (OR = 1.1, 95% CI [1.1, 1.2], $P < 0.001$), APACHE II score (OR = 1.2, 95% CI [1.12, 1.2], $P < 0.001$), and mechanical ventilation time (OR = 1.2, 95% CI

[1.0, 1.1], *P*< 0.001),were positively correlated with the development of delirium. Hypertension, heart disease, history of CVA, postoperative surgery, low blood pressure at admission, and sedation were also positively correlated with delirium. The value of PaO_2/FiO_2 was significantly associated with delirium, the OR was 1.0, 95%CI was 1.0 to 1.0, P = 0.005. However, gender, diabetes, chronic pulmonary dysfunction, smoking habits, drinking habits, mechanical ventilation, and $PaCO_2$ were not associated with delirium.

Table 2
Association for Variables and Delirium Evaluated by Univariate Analysis.

	Statistics	OR (95% CI), *P* value
Gender		
Male	237 (58.2%)	1.0
Female	170 (41.8%)	1.32 (0.9, 2.0), 0.165
Age	54.4 ± 16.1	1.05 (1.0, 1.1), < 0.001
Hypertension		
No	278 (68.3%)	1.0
Yes	129 (31.7%)	1.9 (1.2, 2.9), 0.004
Heart disease		
No	304 (74.7%)	1.0
Yes	103 (25.3%)	1.6 (1.0, 2.5), 0.048
History of CVA		
No	395 (97.1%)	1.0
Yes	12 (2.9%)	6.2 (1.3, 28.5), 0.020
Diabetes		
No	368 (90.4%)	1.0
Yes	39 (9.6%)	1.6 (0.8,3.1), 0.171
Chronic pulmonary dysfunction		
No	376 (92.4%)	1.0
Yes	31 (7.6%)	2.0 (0.9, 4.2), 0.079
Smoking habits		
No	286 (70.3%)	1.0
Yes	121 (29.7%)	0.7 (0.5, 1.1), 0.152
Drinking habits		
No	355 (87.2%)	1.0
Yes	52 (12.8%)	1.0 (0.6, 1.8), 0.974
Postoperative surgery		

	Statistics	OR (95% CI), *P* value
No	90 (22.1%)	1.0
Yes	317 (77.9%)	2.2 (1.4, 3.6), 0.001
SOFA score	6.1 ± 5.0	1.1 (1.1, 1.2), < 0.001
APACHE II score	11.2 ± 5.8	1.2 (1.12, 1.2), < 0.001
Blood pressure at admission		
Normal	195 (47.9%)	1.0
Low	135 (33.2%)	1.7 (1.1, 2.6), 0.019
High	77 (18.9%)	1.6 (0.9, 2.7), 0.095
Mechanical ventilation		
No	77 (18.9%)	1.0
Yes	330 (81.1%)	1.5 (0.9, 2.5), 0.107
Mechanical ventilation time	18.40 ± 36.05	1.0 (1.0, 1.1), < 0.001
Sedation		
No	112 (27.5%)	1.0
Yes	295 (72.5%)	2.5 (1.6, 3.9), < 0.001
$PaCO_2$	38.5 ± 8.1	1.0 (1.0, 1.1), 0.131
PaO_2/FiO_2	306.1 ± 121.4	1.0 (1.0, 1.0), 0.005

The relationship between PaO_2/FiO_2 and delirium

Multivariate regression analysis models were used to analyze the association between PaO_2/FiO_2 and delirium. The non-adjusted, minimally adjusted, and fully adjusted models are shown in Table 3. In the non-adjusted model, the PaO_2/FiO_2 showed a significant correlation with delirium (OR = 1.0, 95% CI [1.0, 1.0], P = 0.006). The effect size showed no obvious change (OR = 1.0, 95% CI [1.0, 1.0], P = 0.038) in the minimally adjusted model (i.e., we adjusted for age and sex). However, we did not detect a significant correlation in the fully adjusted model (OR = 1.0, 95%CI [1.0,1.0], P = 0.854), which we adjusted for the following covariates: gender, age, hypertension, heart disease, history of CVA, diabetes, smoking habits, drinking habits, chronic pulmonary dysfunction, infection, blood pressure at admission, postoperative

surgery, mechanical ventilation, mechanical ventilation time, $PaCO_2$, sedation, APACHE II score, and SOFA score.

Table 3
Relationship between PaO2/FiO2 and Delirium in Different Models.

Variable	Crude model, OR (95% CI), *P* value	Minimally adjusted model, OR (95% CI), *P* value	Fully adjusted mode, OR (95% CI), *P* value
PaO_2/FiO_2 group	1.0, (1.0, 1.0), 0.006	1.0, (1.0, 1.0), 0.038	1.0, (1.0, 1.0), 0.854
Normal	Ref	Ref	Ref
Mild lower	1.11, (0.7, 1.7), 0.643	0.93, (0.6, 1.5), 0.785	0.83, (0.5, 1.5), 0.486
Moderate lower	2.4, (1.34, 4.29), 0.003	2.31, (1.24, 4.33), 0.009	1.18, (0.57, 2.43), 0.658
Severe lower	11.8, (1.45, 96.18), 0.021	11.6, (1.34, 100.85), 0.026	6.0, (0.53, 67.91), 0.148
Crude model: We did not adjust other covariates.			
Minimally adjusted model: We adjusted for age and sex.			
Fully adjusted model: We adjusted for sex, age, hypertension, heart disease, history of CVA, diabetes, smoking habits, drinking habits, chronic pulmonary dysfunction, blood pressure at admission, postoperative surgery, mechanical ventilation, mechanical ventilation time, sedation, $PaCO_2$, APACHE II score, and SOFA score (CI: confidence interval; Ref: reference).			

We explored the non-linear relationship between PaO_2/FiO_2 and the risk of delirium using a generalized additive model (Fig. 2). We found that the relationship between PaO_2/FiO_2 and the probability of delirium was non-linear after adjusting for the following: gender, age, hypertension, heart disease, history of CVA, diabetes, smoking habits, drinking habits, chronic pulmonary dysfunction, blood pressure at admission, postoperative surgery, mechanical ventilation, mechanical ventilation time, $PaCO_2$, sedation, APACHE II score, and SOFA score. We used a two-piecewise linear regression model to calculate the threshold of 247 mmHg. On the left of the inflection point, we found a negative relationship between the PaO_2/FiO_2 and the probability of delirium, where the OR was 0.91 (95% CI [0.84, 0.98]; $P = 0.019$) per 10 mmHg change in PaO2/FiO2. In contrast, we observed a positive relationship between PaO_2/FiO_2 and the probability of delirium on the right side of the inflection point, where the OR was 1.03 (95% CI [1.00, 1.06]; $P = 0.050$ with the PaO_2/FiO_2 per 10 mmHg change; Table 4).

Table 4
Threshold Effect Analysis of the Relationship between PaO2/FiO2 and Delirium Using A Two-Piecewise Linear Regression Model.

Inflection point of PaO_2/FiO_2 (per 10 mmHg change)	OR	95% CI	*P* value
< 247	0.91	0.84–0.98	0.019
≥ 247	1.03	1.00–1.06	0.050

Discussion

In our present study, we clarified the relationship between PaO_2/FiO_2 and delirium in patients admitted to our ICU. The fully adjusted model showed that PaO_2/FiO_2 was not associated with delirium. When we used a GAM and two-piecewise linear regression model, a non-linear relationship was found between PaO_2/FiO_2 and the probability of delirium. There was a negative correlation between PaO_2/FiO_2 and the probability of delirium on the left side of the inflection point (PaO_2/FiO_2 = 247 mmHg).

The pathophysiology of delirium in critically ill patients remains unclear. To our knowledge, delirium is related not only to the disease itself but also related to the interaction between treatments and the ICU environment [25]. Previous studies have shown that hypoxia is an independent risk factor for acute brain injury and may induce long-term cognitive impairment [14, 16, 20]. However, no previous study has investigated the relationship between PaO_2/FiO_2 and delirium. Our study is the first to confirm the relationship between the PaO_2/FiO_2 and delirium. The PaO_2/FiO_2 ratio was first proposed by Horovitz et al. in 1974 [26] to compare the oxygenation of patients with different inhaled oxygen concentrations. Since then, PaO_2/FiO_2 has been demonstrated to be convenient and practical for assessing oxygenation and pulmonary shunting in clinical circumstances. Additionally, the PaO_2/FiO_2 has commonly been used to diagnose adult respiratory distress syndrome (ARDS) for evaluating oxygenation criteria [27] and is the standard for clinical experts to evaluate lung function (with an acceptable threshold being 300 mmHg) [28]. The PaO_2/FiO_2 can reflect pathophysiological changes of hypoxia and assess disease progression and/or treatment outcomes [29].

In the present study, we not only evaluated the linear relationship between PaO_2/FiO_2 and delirium using a generalized linear model but also analyzed their nonlinear relationship using a generalized additive model. Additionally, we adjusted for many confounding factors. We found that when the PaO_2/FiO_2 was less than 247 mmHg, every 10-mmHg increase in the PaO_2/FiO_2 reduced the risk of delirium by 9%. We found that PaO_2/FiO_2 was negatively correlated with the development of delirium only when its value was below this threshold.

There are several limitations to the present study. First, not all participants received mechanical ventilation, which may have led to limitations in our PaO_2/FiO_2 evaluations. Second, we evaluated for

delirium two times a day. Such discontinuous monitoring and evaluation may have resulted in a lower recorded incidence of delirium than the actual incidence.

Conclusions

In conclusion, there is a non-linear relationship between the PaO_2/FiO_2 and risk of delirium. PaO_2/FiO_2 is negatively correlated with risk of delirium when the PaO_2/FiO_2 is less than 247 mmHg. As a readily available laboratory indicator, PaO2/FiO2 has potential value in the clinical evaluation of patients with delirium in ICU. Of course, our conclusions need further confirmation from other studies, especially large prospective studies.

Abbreviations

PaO_2, partial pressure of arterial oxygen; FiO_2, the fraction of inspired oxygen; ICU, intensive care unit; CAM-ICU , Confusion Assessment Method for the ICU; CVA, cerebral vascular accident; $PaCO_2$, arterial partial pressure of carbon dioxide ; APACHE II, Acute Physiology and Chronic Health Evaluation II; SOFA, Sequential Organ Failure Assessment; OR, Hazard ratio; CI, confidence interval; RASS, Richmond agitation sedation assessment; GMA, generalized additive model; ARDS, adult respiratory distress syndrome.

Declarations

Availability of data and materials

Readers can access the data supporting the conclusions of the study from the Mendeley Data. Ai, Yuhang (2020), “Risk factors for ICU delirium”, Mendeley Data, http://dx.doi.org/10.17632/5gx8j6wgs5.1.

Competing Interests

The authors have no potential conflicts of interest to disclose.

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Author contributions

Study conception and design: Yuhang Ai and Fang Gong; data acquisition, analysis, and interpretation: Fang Gong, Quan Zhou, Lina Zhang, and Qianyi Peng; drafting of the manuscript for important intellectual content: Lina Zhang, Fang Gong, and Chunmei Gui. All authors have read and approved the manuscript.

Consent for publication

All the authors of the manuscript have agreed to publish.

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Figures

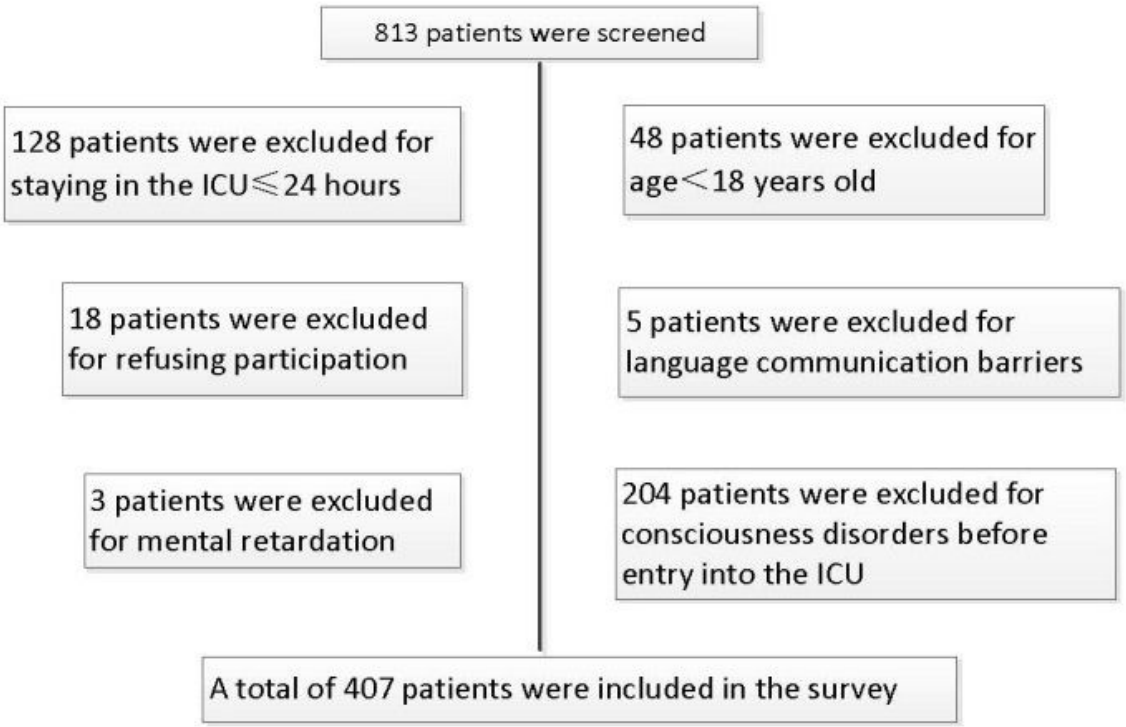

Figure 1

Flow Chart of Study Participants.

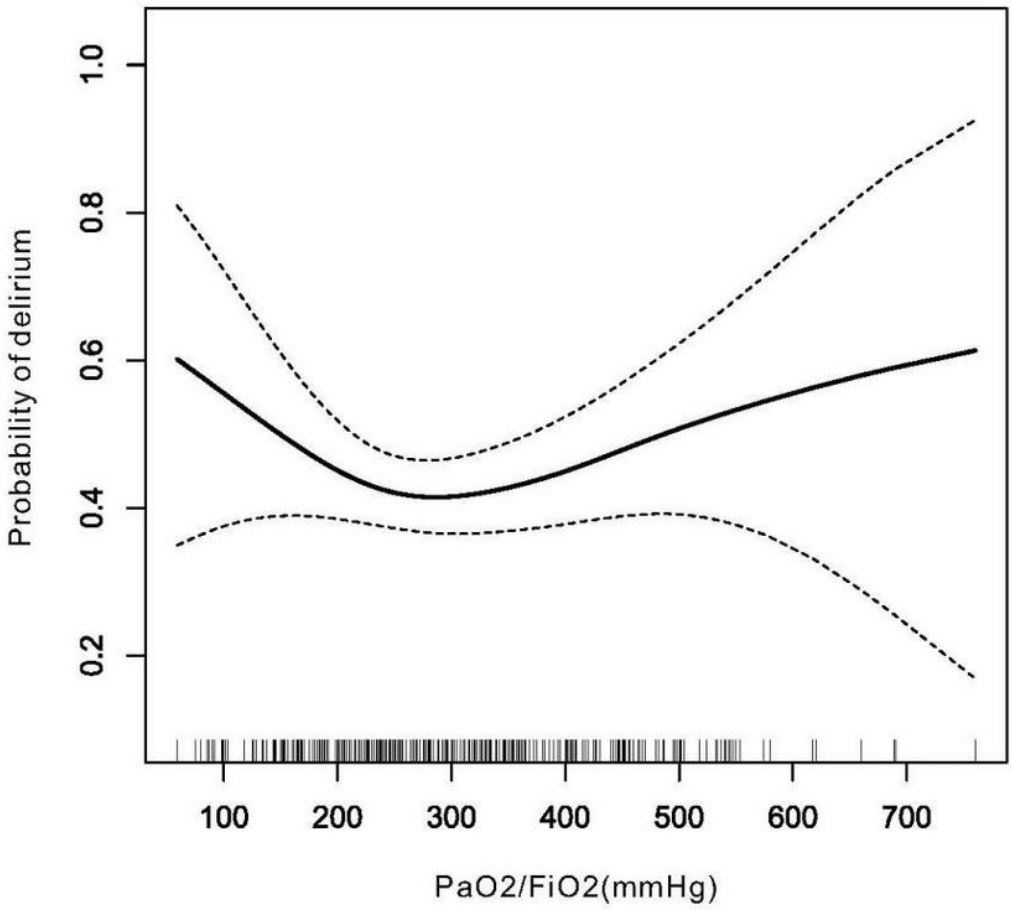

Figure 2

Relationship between PaO2/FiO2 and the Probability of Delirium. There was a nonlinear relationship between PaO2/FiO2 and the probability of delirium after adjusting for the following: gender, age, hypertension, heart disease, history of CVA, diabetes, smoking habits, drinking habits, chronic pulmonary dysfunction, blood pressure at admission, postoperative surgery, mechanical ventilation, mechanical ventilation time, PaCO2, sedation.

Supplementary Files

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