



Risk Factors and Prognostic Implications of Post-Intubation Hypotension in Emergency Department Critical Care Patients: A Retrospective Cohort Study

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Abstract

Objective: To investigate the risk factors and patient prognosis after the implementation of tracheal intubation in critically ill patients in the emergency department and to provide a theoretical basis for the development of clinical decisions for the treatment of critically ill patients in the emergency department.

Methods: According to the inclusion and exclusion criteria, the clinical data of tracheal intubation patients admitted to the Emergency Department of Huaxi Shangjin Nanfu Hospital during the period of 1 January 2020–2022 were collected and analyzed. The patients were divided into the hypotensive group and the normotensive group according to whether hypotension occurred after tracheal intubation. A univariate analysis was used to analyze the risk factors for the development of hypotension in patients after intubation, and a multifactorial logistic regression analysis was performed to determine the independent risk factors for hypotension after intubation. The efficacy of each variable in predicting the development of hypotension in intubated patients was analyzed using a subject's work characteristics (ROC) curve. The 28-day mortality rate, number of days in the ICU, and number of days in the hospital were compared between the two groups.

Results: Hypotension occurred in 48 of 155 patients after tracheal intubation. Univariate analysis showed statistically significant differences between groups for 18 factors, including body mass index, preintubation systolic blood pressure, preintubation diastolic blood pressure, preintubation heart rate, postintubation diastolic blood pressure, postintubation heart rate, preintubation hemoglobin, preintubation creatinine, preintubation albumin, preintubation potassium, preintubation glucose, preintubation pH, postintubation neutrophil percentage, postintubation blood glucose, postintubation blood pH, postintubation PCO₂, postintubation HCO₃, and preintubation inducer use ($P < 0.05$). Logistic regression analysis showed that body mass index and pre-tracheal intubation systolic blood pressure were the independent risk factors for the development of hypotension in patients after tracheal intubation ($P < 0.05$). ROC analysis showed that the area under the curve (AUC) of body mass index predicting post-tracheal intubation hypotension was 0.734, with a 95% CI of 0.657–0.802 ($P < 0.05$), and the sensitivity and specificity of prediction were 52.08% and 84.11%, respectively. The area under the curve (AUC) of pre-tracheal systolic blood pressure predicting post-tracheal intubation hypotension was 0.894, with a 95% CI of

0.835–0.938 ($P < 0.05$), the optimal threshold was 90, the sensitivity of prediction was 87.50%, and the specificity was 83.18%. The area under the curve (AUC) of body mass index combined with preintubation systolic blood pressure to predict post-tracheal intubation hypotension was 0.934, with a sensitivity of prediction of 89.60% and a specificity of 83.20%. The 28-day mortality rate was significantly higher in the hypotensive group than in the non-hypotensive group (41.67% vs. 19.63%, $P = 0.004$), and the number of ICU days (4.804 ± 1.321 vs. 9.896 ± 2.868 , $P < 0.001$) and the number of days of hospitalization (20.598 ± 5.297 vs. 25.354 ± 5.602 , $P < 0.001$) were significantly prolonged in the hypotensive group compared with the non-hypotensive group.

Conclusion: Hypotension after tracheal intubation in critically ill patients is more common in patients with low body weight or low systolic blood pressure before intubation, and hypotension after intubation increases the number of days in the ICU, the number of hospitalization days, and the 28-day mortality rate.

Keywords

Critically Ill Patients, Hypotension, Tracheal Intubation, Risk Factors, Prognosis

Introduction

The Emergency Department (ED) functions as the initial point of contact in the hospital, where rapid patient triage and prompt recognition and management of critical conditions are imperative. Commonly encountered critical conditions in the ED include cardiac arrest, respiratory failure, coma, and severe multiple traumas, often requiring endotracheal intubation (ETI). While recent advancements have significantly enhanced the safety and efficacy of ETI, complications remain prevalent, with post-intubation hypotension (PIH) being particularly common. This study examines the clinical data of 155 patients who underwent ETI at Huaxi Shangjin South Mansion Hospital between January 1, 2020, and January 1, 2022, aiming to identify risk factors for PIH and evaluate its prognostic impact [1].

Materials and Methods

Study Population:

This study involved the collection of clinical data from patients over 18 years of age who underwent endotracheal intubation in the Emergency Department of Huaxi Shangjin South Mansion Hospital between January 1, 2020, and January 1, 2022. Inclusion criteria encompassed patients requiring endotracheal intubation for various reasons. Exclusion criteria were as follows: (1) patients presenting with hypotension prior to intubation; (2) patients who had received fluid resuscitation or inotropic agents before intubation; and (3) patient's post-cardiopulmonary resuscitation.

Methods:

Patients were classified into two groups based on the occurrence of hypotension within 60 minutes post-intubation: those without hypotension and those with hypotension. Hypotension was defined according to the 2016 Sepsis and Septic Shock Management Guidelines as a systolic blood pressure (SBP) less than 90 mmHg or a decrease in SBP of more than 40 mmHg from baseline, absent other causes of hypotension. All intubations were conducted by attending physicians or senior doctors in the Emergency Department. Observational parameters included age, gender, weight, height, primary and comorbid diseases, use of mechanical ventilation, administration of anesthetic agents during intubation, and changes in systolic and diastolic blood pressures, heart rate, respiratory rate, oxygen saturation, and arterial blood pH before and after intubation. Prognostic indicators included the length of ICU stay, total hospital stay, and the 28-day mortality rate.

Statistical Analysis

Data analysis was conducted using SPSS software version 26.0. Quantitative data were evaluated using independent samples t-tests, while categorical data were assessed using the Chi-square test, with a significance threshold set at $P < 0.05$. Statistically significant univariate factors underwent further analysis using a logistic multivariate regression model to predict risk factors for hypotension following endotracheal intubation. Additionally, receiver operating characteristic (ROC) curves were employed to determine the optimal prediction threshold.

Results

General Data and Risk Factors:

This study comprised 155 patients with complete data, including 110 males and 45 females. Hypotension occurred in 48 cases, representing an incidence rate of 30.96%. Patients experiencing hypotension received aggressive fluid resuscitation or vasopressor agents to maintain blood pressure. Statistical analysis revealed significant differences between the hypotension and normotensive groups across several parameters: Body Mass Index (BMI), pre-intubation systolic and diastolic blood pressures, pre-intubation heart rate, post-intubation diastolic blood pressure and heart rate, and levels of pre-intubation hemoglobin, creatinine, albumin, potassium, glucose, and pH, as well as post-

intubation neutrophil percentage, glucose, pH, PCO_2 , and HCO_3^- , in addition to pre-intubation inducer use ($P < 0.05$). No significant differences were observed in gender, age, other chronic conditions, pre-intubation efficacy, respiratory rates before and after intubation, pre-intubation white blood cell and neutrophil percentages, hematocrit, sodium, PO_2 , PCO_2 , lactate, HCO_3^- , post-intubation white blood cell count, hematocrit, hemoglobin, albumin, potassium, sodium, PO_2 , lactate, and mechanical ventilation use ($P > 0.05$), as detailed in **Table-1**. Logistic regression analysis of univariate results identified patient BMI and pre-intubation systolic blood pressure as independent risk factors for post-intubation hypotension ($P < 0.05$), as detailed in **Table-2**.

Table-1: Comparison of General Data Between Non-Hypotension and Hypotension Groups in Endotracheal Intubation Patients

Variables	Non-Hypotension Group (n=107)	Hypotension Group (n=48)	t/ χ^2	P
Age	59.433 ± 17.146	64.739 ± 18.316	1.711	0.089
BMI (kg/m ²)	21.644 ± 3.162	18.694 ± 3.311	5.292	<0.001
Gender (n,%)			0.128	0.72
Female	32 (29.907)	13 (27.083)		
Male	75 (70.093)	35 (72.917)		
Hypertension (n,%)			0.003	0.959
Yes	33 (30.841)	15 (31.250)		
No	74 (69.159)	33 (68.750)		
Diabetes (n,%)			0.004	0.952
Yes	16 (14.953)	7 (14.583)		
No	91 (85.047)	41 (85.417)		
COPD (n,%)			0.494	0.482
Yes	13 (12.150)	4 (8.333)		
No	94 (87.850)	44 (91.667)		
Chronic Renal Failur (n,%)			1.242	0.265
Yes	3 (2.804)	4 (8.333)		
No	104 (97.196)	44 (91.667)		
Spesis (n,%)			0.166*	0.683
Yes	1 (0.943)	0 (0.00)		
No	105 (99.057)	48 (100.000)		
Pre-intubation Systolic BP (mmHg)	115.944 ± 36.383	62.021 ± 19.125	12.06	<0.001
Pre-intubation Diastolic BP (mmHg)	71.224 ± 18.852	36.229 ± 8.701	15.811	<0.001
Pre-intubation Heart Rate (beats/min)	68.019 ± 18.777	62.312 ± 21.525	1.671	0.097
Pre-intubation Respiratory Rate (breaths/min)	13.346 ± 3.105	13.250 ± 3.900	0.164	0.87
Post-intubation Systolic BP (mmHg)	148.738 ± 37.736	46.333 ± 12.785	25.048	<0.001

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Post-intubation Diastolic BP (mmHg)	79.860 ± 22.474	28.000 ± 9.077	20.441	<0.001
Post-intubation Heart Rate (beats/min)	112.206 ± 32.775	68.167 ± 22.179	9.777	<0.001
Post-intubation Respiratory Rate (breaths/min)	21.841 ± 6.393	21.021 ± 3.564	1.02	0.309
Pre-intubation White Blood Cell Count (×10 ⁹ /L)	13.431 ± 2.909	12.665 ± 2.501	1.582	0.116
Pre-intubation Neutrophil Percentage (%)	68.813 ± 11.350	67.615 ± 22.522	0.349	0.728
Pre-intubation Hematocrit	0.971 ± 0.323	1.121 ± 0.475	1.984	0.051
Pre-intubation Hemoglobin (g/L)	124.258 ± 34.459	106.813 ± 37.947	2.823	0.005
Pre-intubation Creatinine (μmol/L)	131.131 ± 34.607	155.384 ± 43.952	3.701	<0.001
Pre-intubation Albumin (g/L)	39.032 ± 8.541	34.118 ± 7.316	3.456	<0.001
Pre-intubation Potassium (mmol/L)	4.917 ± 1.005	5.477 ± 1.536	2.314	0.024
Pre-intubation Sodium (mmol/L)	138.726 ± 28.931	139.219 ± 28.506	0.098	0.922
Pre-intubation Glucose (mmol/L)	11.370 ± 3.395	13.444 ± 2.259	4.484	<0.001
Pre-intubation Blood pH	7.524 ± 1.761	13.892 ± 4.302	9.89	<0.001
Pre-intubation PO ₂ (mmHg)	94.271 ± 17.854	91.896 ± 27.836	0.543	0.589
Pre-intubation PCO ₂ (mmHg)	49.140 ± 14.481	48.188 ± 28.918	0.216	0.829
Pre-intubation Lactate (mmol/L)	6.996 ± 1.930	7.011 ± 2.846	0.035	0.972
Pre-intubation HCO ₃ ⁻	17.540 ± 4.578	16.057 ± 3.965	1.941	0.054
Post-intubation White Blood Cell Count (×10 ⁹ /L)	13.318 ± 3.855	13.556 ± 3.915	0.354	0.724
Post-intubation Neutrophil Percentage (%)	69.962 ± 35.844	80.170 ± 18.887	2.315	0.022
Post-intubation Hematocrit	0.729 ± 0.240	0.666 ± 0.229	1.529	0.128
Post-intubation Hemoglobin (g/L)	114.278 ± 33.005	107.411 ± 32.278	1.206	0.23
Post-intubation Creatinine (μmol/L)	142.394 ± 37.059	152.950 ± 42.941	1.56	0.121
Post-intubation Albumin (g/L)	29.538 ± 5.796	26.986 ± 8.764	1.844	0.07
Post-intubation Potassium (mmol/L)	4.770 ± 1.234	4.771 ± 0.965	0.006	0.996
Post-intubation Sodium (mmol/L)	143.966 ± 37.696	151.767 ± 54.132	0.905	0.369
Post-intubation Glucose (mmol/L)	11.156 ± 3.503	8.420 ± 1.442	6.883	<0.001
Post-intubation Blood pH	8.320 ± 2.763	7.287 ± 1.667	2.872	0.005
Post-intubation PO ₂ (mmHg)	125.318 ± 27.962	123.062 ± 31.646	0.445	0.657
Post-intubation PCO ₂ (mmHg)	49.813 ± 14.530	57.875 ± 12.378	3.338	0.001
Post-intubation Lactate (mmol/L)	5.589 ± 1.607	5.860 ± 1.693	0.957	0.34
Post-intubation HCO ₃ ⁻	39.217 ± 7.689	19.737 ± 6.568	15.23	<0.001
Pre-intubation Inducer Usage, n (%)			10.591	0.001
0	39 (36.449)	31 (64.583)		
1	68 (63.551)	17 (35.417)		

Table-2: Logistic Regression Analysis of Risk Factors for Post-Intubation Hypotension

Variables	β	SE	Wald χ^2	P-value	OR	95% CI Lower	95% CI Upper
BMI ≥ 19.5 kg/m ²	1.267	0.672	5.069	0.007*	6.381	2.691	10.594
Pre-intubation SBP ≤ 90 mmHg	0.956	0.328	4.158	<0.001*	5.289	2.384	8.916
Pre-intubation DBP	0.315	0.223	1.995	0.079	1.37	0.885	2.121
Pre-intubation HR	0.223	0.333	0.448	0.252	1.25	0.651	2.401
Post-intubation DBP	0.335	0.231	2.103	0.073	1.398	0.889	2.198
Post-intubation HR	0.225	0.425	0.28	0.298	1.252	0.544	2.881
Pre-intubation Hemoglobin	0.396	0.569	0.484	0.243	1.486	0.487	4.532
Pre-intubation Creatinine	0.367	0.672	0.298	0.292	1.443	0.387	5.388
Pre-intubation Albumin	0.256	0.328	0.609	0.218	1.292	0.679	2.457
Pre-intubation Potassium	0.249	0.428	0.338	0.28	1.283	0.554	2.968
Pre-intubation Glucose	0.145	0.267	0.295	0.294	1.156	0.685	1.951
Pre-intubation pH	0.235	0.431	0.297	0.293	1.265	0.543	2.944
Post-intubation Neutrophil %	0.295	0.234	1.589	0.104	1.343	0.849	2.125
Post-intubation Glucose	0.194	0.283	0.47	0.247	1.214	0.697	2.114
Post-intubation pH	0.534	0.376	2.017	0.078	1.706	0.816	3.564
Post-intubation PCO ₂	0.302	0.341	0.784	0.188	1.353	0.693	2.639
Post-intubation HCO ₃ ⁻	0.235	0.183	1.649	0.1	1.265	0.884	1.811
Pre-intubation Induction Agent Use	0.153	0.264	0.336	0.281	1.165	0.695	1.955

Predictive Value of BMI, Pre-intubation Systolic Blood Pressure, and Their Combined Use for Post-Intubation Hypotension:

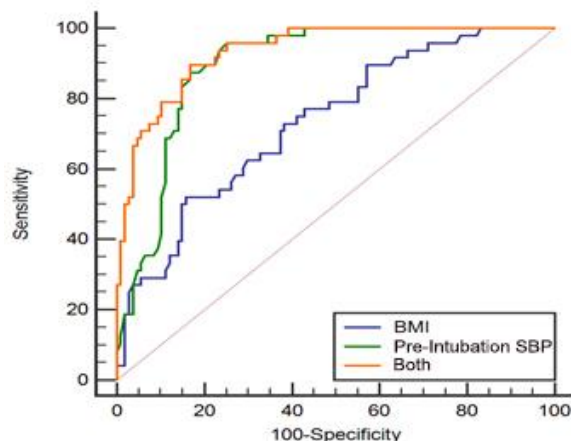


Fig-1: ROC Curves for Predicting Post-Intubation Hypotension Using BMI, Pre-intubation SBP, and Their Combination

The area under the curve (AUC) for predicting post-intubation hypotension using BMI was 0.734, achieving statistical significance with a P-value of 0.007 (test level <0.05). The 95% confidence interval (CI) for this AUC ranged from 0.657 to 0.802 (P<0.05), confirming its

statistical significance. The optimal threshold for BMI was identified at 19.50, with a sensitivity of 52.08% and a specificity of 84.11%. For pre-intubation systolic blood pressure, the AUC was 0.894, also significant with a P-value of 0.000 (test level <0.05) and a 95% CI from 0.835 to 0.938 (P<0.05), indicating a statistically significant difference. The optimal threshold was established at 90 mmHg, featuring a sensitivity of 87.50% and a specificity of 83.18%. Combining BMI with pre-intubation systolic blood pressure resulted in an AUC of 0.934, with a sensitivity of 89.60% and a specificity of 83.20% (**Fig-1**).

Patient Prognosis:

The difference was statistically significant. Following treatment, 41 patients died within 28 days, resulting in a total mortality rate of 26.45%. The 28-day mortality rate in the hypotension group was significantly higher than that in the normotensive group (P=0.004), suggesting that post-intubation hypotension elevates the risk of 28-day mortality among patients (**Table-3**).

Table-3: Comparison of Patient Outcomes Between Groups

Outcome Variables	Non-hypotensive Group (n = 107)	Hypotensive Group (n = 48)	t/ χ^2	P-value
ICU LOS (days)	4.804 $\pm$ 1.321	9.896 $\pm$ 2.868	11.756	<0.001*
Hospital LOS (days)	20.598 $\pm$ 5.297	25.354 $\pm$ 5.602	5.077	<0.001*
Clinical Outcomes, n (%)			9.81	0.004*
Death	21 (19.626)	20 (41.667)		
Clinical Improvement	58 (54.206)	13 (27.083)		
Discharge Against Medical Advice	23 (21.495)	14 (29.167)		
Transfer to Other Hospital	5 (4.673)	1 (2.083)		

Discussion

Patients in the emergency department with critical illnesses often exhibit severe, rapidly changing, and complex conditions, frequently necessitating ETI to secure their airways. PIH is a common complication following ETI [2,3]. Current research on PIH in critically ill patients is limited, with inconsistent findings reported in the literature. Studies by Li Jiming et al. [4] and Green et al. [5] report PIH incidence rates of 30.19% and 46%, respectively, while Griesdale [6] found a significantly lower incidence rate of only 9.6%. Althunayyan [7] summarized in a review article that PIH incidence ranges from 5% to 45%. This study identified a high incidence rate of 31.0% in ED critical care patients. The variability in PIH rates may be attributed to differences in intubation settings, patient clinical characteristics, and the absence of a standardized definition of PIH. Additionally, this variance could be linked to the adequacy of pre-intubation assessments by practitioners and subsequent post-intubation management.

Previous literature has indicated that patients with low body weight, compared to those with normal weight, experience significantly higher post-intubation mortality rates [4,8]. Research conducted by Lin [9] and others has identified body weight as an independent risk factor for PIH, noting that patients weighing less than 55 kg are 3.27 times more likely to develop hypotension. Our study's logistic regression analysis confirmed BMI as an independent risk factor for PIH, aligning with findings by Pan Pan [10] and Kuriyama et al. [11]. This association may stem from lower blood volume and limited cardiopulmonary

compensatory mechanisms in individuals with lower body weight.

Most patients in the emergency department with critical illnesses exhibit cardiopulmonary dysfunction, and some also present with concurrent infections. These conditions typically lead to a decrease in effective blood volume and hemodynamic instability, resulting in lower-than-usual blood pressure prior to intubation and further declines following the procedure. If not promptly addressed, these conditions can significantly increase mortality risk [12,13]. The causes of PIH in critically ill patients are not well understood but are thought to involve sympathetic inhibition, the effects of positive pressure ventilation from mechanical ventilators, and insufficient blood volume [9,14,15]. In patients with inadequate blood volume, intubation may further compromise physiological attempts to enhance perfusion, and the correlation between hypotension and increased mortality has been well-documented [16]. Thus, pre-intubation hypotension due to low blood volume predisposes patients to PIH symptoms.

Regarding the prognosis of critical care patients following endotracheal intubation in the emergency department, those who do not develop PIH typically experience shorter ICU and hospital stays, and demonstrate a lower 28-day mortality rate, with these differences being statistically significant. This suggests that the occurrence of PIH in critically ill patients is associated with increased mortality rates, potentially due to inadequate tissue perfusion leading to further organ damage; further research is necessary to substantiate these findings.

In conclusion, a low pre-intubation systolic blood pressure and BMI are identified risk factors for developing hypotension after endotracheal intubation in patients with critical illnesses in emergency departments. Therefore, it is crucial for emergency departments to recognize these risk factors prior to intubation, closely monitor hemodynamic changes post-intubation, and intervene promptly to enhance the success rate of patient management and ensure patient safety.

Conflict of Interest

The authors have read and approved the final version of the manuscript. The authors have no conflicts of interest to declare.

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