



# Analysis of Occurrence Characteristics and Influencing Factors of out-of-Hospital Induced Stress Injury in Patients with Community-Acquired Pneumonia in Respiratory Intensive Care Unit

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## Abstract

**Background:** We aimed to evaluate the characteristics of a stress injury in community-acquired pneumonia (CAP) patients in the respiratory intensive care unit (RICU) and analyze the risk factors, to provide evidence for clinical prevention and treatment.

**Methods:** This retrospective study was conducted in RICU at Qilu Hospital of Shandong University, China. We selected 85 patients with traumatic CAP who were brought in from January 2019 to December 2020 as the case group and 167 patients without traumatic CAP hospitalized in the same period as the control group. Multivariate binary Logistic regression analysis was used to explore the influencing factors.

**Results:** The incidence rate of a stress injury in 252 patients was 33.73%. The most affected region found in these patients was the sacrococcygeal region (24.26%). Most of the patients were presented in stage one (49.50%). Factors associated with a stress-induced injury in RICU, CAP patients were CURB-65 combined with cerebrovascular disease, fever combined with heart disease and albumin was found as an independent risk factor.

**Conclusion:** Attempts to improve stress injury in CAP patients through setting measurable process of care standards are to be encouraged. An approach including the patient's clothes and bedding should be changed frequently, nutrition should be managed and the skin of the patient should be kept clean and dry. The occurrence of stress can further be reduced by the use of protective tools and the timely participation of the family members in patient management.

**Keywords:** Community-acquired pneumonia; Stress injury; Risk factors; Site; Staging

## Introduction

Stress-induced injury is a common and serious condition because it not only hurt patient but also create problems for medical staff. In clinical practice family members, physicians, and nursing staff should not only pay attention to the skin of

the patient's body surface, but also pay great attention to the mucosal stress injury caused by the improper use of medical devices (1).

On admission to the respiratory intensive care unit (RICU) efforts have been made to establish



guidelines to reduce patient's problems by prescribing analgesics and sedative medicines. Stress-induced injury is an important public health problem that affects several organs i.e, decline patients' circulatory and respiratory vital functions, severe inflammation, nutritional imbalance. Collectively all these reasons have increased the percentage of stress-induced injury patients from 4%–49% (2). The tolerance of subcutaneous soft tissues to pressure and shearing force is affected by sensation, humidity, nutrition, microenvironment, perfusion, soft tissue condition, age, friction, shearing force, activity ability, movement ability, and other complications (3). However, during the process of nursing pressure injury and preventing pressure injury, besides paying attention to frequent turnover, nutritional support is more important with the proper applications of vasoactive and sedatives drugs .

At the same time, the bed unit where the patient is located should be clean, free of debris, and dry. Whether the incidence of stress injury can reach the expected ideal standard is a very important index for evaluating the level of hospital care. Understanding and mastering the occurrence characteristics of a stress injury in RICU patients and the related high and medium risk factors as well as taking reasonable, accurate, and targeted measures to prevent stress injury can reduce the incidence of a stress injury in patients by 20%-30% (4). Therefore, it is of great significance to understand and master the high and medium risk factors related to stress injury in patients with RICU, to reduce the occurrence of stress injury and effectively prevent stress injury.

Therefore, for nursing managers, the focus of nursing is very important to identify correctly, timely, and reasonably high-risk environmental factors, causing stress-induced injury and reasonably predicting the risk of stress-induced injury so that appropriate and targeted preventive measures can be taken to achieve standard of nursing control and reduce the suffering and burden of patients.

We used a case-control study to explore the incidence of out-of-hospital stress injuries in patients with community-acquired pneumonia in respira-

tory intensive care unit with biological characteristics and its influencing factors, to provide a theoretical basis for clinical prevention and treatment.

## Methods

### *General Information*

This retrospective investigation was performed on patients admitted to Qilu Hospital of Shandong University (Jinan Shandong, China) in RICU from January 2019 to December 2020. All the patients were agreed to the informed consent in this study. This study was conducted by the approval of the Ethics Research Committee of Qilu Hospital of Shandong University.

Patients included in this study should have met the following criteria:

- 1) All patients had community-acquired pneumonia and were confirmed by chest CT;
- 2) Those patients who had complete data.

Exclusion criteria were concomitant skin diseases such as burns, pyrosis, and systemic lupus erythematosus.

### *Data collection method*

The studied sample consisted of 252 consecutive patients. All the patients were allocated into two groups. Community-acquired pneumonia patients with stress injury (85 cases) were included in the 'case group' while patients without stress injury were in the 'control group' (167 cases). On admission, detailed information (including the location, stage, and some stress-injury) of all patients were collected through the nursing and medical electronic system.

The stress-induced injury was divided into 4-stages (from stage 1- 4) as well as deep tissue injury and non-staging.

The contents of clinical data collection included ① general data. ② Clinical data: admission evaluation form (including BMI and fever). ③ Accompanying diseases: combined heart disease and cerebrovascular disease. ④ Laboratory examinations: Blood samples (hemoglobin, albumin, pre-albumin, etc.) were taken on an empty

stomach on the following morning of admission.  
 ⑤CURB65 classification (disorder of consciousness, urea nitrogen, respiratory frequency, blood pressure, and age).

**Statistical method**

SPSS 17.0 software (Chicago, IL, USA) was used for data entry. Independent sample *t*-test, rank-sum test,  $\chi^2$  test, and multivariate binary Logistic regression analysis were used.

**Results**

**Patient general data**

A total of 252 patients with RICU CAP were enrolled. The average age in the control group was (64.81 17.15) yr, the average age of the case group was (71.04 12.98) yr old, with 90 males (53.9%) and 77 females (46.1%) in the control group.

Among the 252 patients with CAP, 85 cases (33.73%) were diagnosed with stress-induced injury with a total of 202 stress-induced injuries. Out of 85 cases, 31 cases (36.47%) were diagnosed with injury at one point while 54 cases (63.53%) with injuries at more than two points (Table 1).

**Table 1:** The location and staging of stress injury

Position	Stages						Total
	I stage	II stage	III stage	IV stage	Non Tissue damage		
Sacrococcygeal	26(12.87%)		15(7.43%)	3(1.49%)	1(0.50%)	2(0.99%)	49(24.26%)
Heel	18(8.91%)		1(0.50%)	0	0	7(3.46%)	26(12.87%)
Pinna	14(6.93%)		9(4.46%)	0	0	0	23(11.39%)
Spine	7(3.46%)		8(3.96%)	0	1(0.50%)	3(1.49%)	20(9.90%)
Lateral malleolus	6(2.98%)		2(0.99%)	1(0.50%)	0	2(0.99%)	15(7.43%)
Nostril	5(2.48%)		9(4.46%)	0	0	0	14(6.93%)
Ridge of the nose	5(2.48%)		5(2.48%)	0	0	1(0.50%)	11(5.45%)
Lateral femoral side	3(1.49%)		5(2.48%)	0	0	1(0.50%)	11(5.45%)
Buttock	2(0.99%)		6(2.98%)	0	0	0	8(3.96%)
Ischial tuberosity	4(1.98%)		2(0.99%)	0	0	0	6(2.97%)
Root of the ear	4(1.98%)		1(0.50%)	0	0	0	5(2.48%)
Toe	2(0.99%)		0	0	0	3(1.49%)	5(2.48%)
Knees	1(0.50%)		0	0	0	2(0.99%)	3(1.49%)
Finger	1(0.50%)		0	0	0	1(0.50%)	2(0.99%)
Hip	2(0.99%)		0	0	0	0	2(0.99%)
TotalBack of a hand	0		0	0	0	1(0.50%)	1(0.50%)
Elbow	0		1(0.50%)	0	0	0	1(0.50%)
Total	100(49.5%)		64(31.68%)	4(1.98%)	2(0.99%)	6(2.97%)	202

Independent sample *t* test, rank sum test,  $\chi^2$  test and multivariate binary Logistic regression analysis were used. Pre-albumin, albumin and CURB65 were tested using non-parametric rank

sum test. The results of the comparison between the control group and the case group are shown in Table 2.

**Table 2:** Comparison of prealbumin, albumin and CURB65 between two groups of CAP patients

<i>Item</i>	<i>Stress injury</i>		<i>T</i>	<i>P</i>
	Control Group	Case Group		
CURB-65	1.00 (0.00, 2.00)	2.00 (1.00, 2.00)	-3.735	0.00
Prealbumin	12.65 (8.55, 17.90)	12.70 (7.65, 15.90)	-0.89	0.374
Albumin	32.90 (29.30, 35.95)	30.50 (27.80, 33.40)	-2.837	0.05

Hemoglobin showed normal distribution and was tested with independent sample *t* test. The level of hemoglobin in case group and control group was  $110.23 \pm 21.412$  vs.  $107.82 \pm 22.842$ , respectively ( $p=0.412$ ).

The  $\chi^2$  test was performed on BMI classification, heart disease, cerebrovascular disease, and fever, and the comparison was made between the control group and the case group, as shown in Table 3.

**Table 3:** Results of  $\chi^2$  test

<i>Item</i>	<i>Control group</i>		<i>Case group</i>		<i>T</i>	<i>P</i>	
	Number	%	Number	%			
Complicated with cerebrovascular disease	Without	127	76%	37	43.50%	26.21 0	0.000
	Exist	40	24%	48	56.50%		
Complicated with cardiovascular disease	Without	97	58.1%	30	35.30%	11.70 3	0.001
	Exist	70	41.90%	55	64.70%		
Fever	Without	96	57.5%	25	29.4%	17.78	0.000
	Exist	71	42.5%	60	70.60%	5	
BMI	18.5-23.9	69	45.1%	29	47.50%	0.105	0.746
	<18.5 or >23.9	84	54.9%	32	52.50%		

With the occurrence of stress-induced injury as the dependent variable (0= none, 1= yes), the variables ( $P<0.05$ ) in Tables 2 and 3 were included in the multi-factor binary Logistic regression

analysis. The diagnosis by multi-collinearity showed that there was no colinearity, and all factors were included in the analysis. The variables finally entering the equation as shown in Table 4.

**Table 4:** Multivariate Logistic regression analysis of risk factors of patients with stress injury in RICU CAP

<i>Item</i>	<i>B</i>	<i>S.E</i>	<i>Wals</i>	<i>p</i>	<i>EXP (B)</i>	<i>Exp(B) 95% C.I.</i>	
						Minimum	Maximum
CURS-65	0.306	0.155	3.913	0.048	1.358	1.003	1.838
Fever (1)	1.039	0.309	11.302	0.001	2.827	1.543	5.183
Cerebrovascular diseases (1)	1.080	0.324	11.106	0.001	2.944	1.560	5.556
albumin	-0.073	0.031	5.636	0.018	0.930	0.875	0.987
Cardiovascular diseases (1)	0.681	0.312	4.777	0.029	1.976	1.073	3.641
constant	-0.189	1.025	0.034	0.854	0.828		

0, without; 1, exist

## Discussion

In this study, the incidence of stress-induced injury in RICU CAP patients was 33.73% with a total of 202 stress-induced injuries in 85 patients brought to the hospital.

Our results showed that the two most affected regions were sacrococcygeal (24.26%) and heel region (12.87%) which is consistent with the previous results (5). One of the reason could be that most patients with severe CAP were bedridden for a long time. Buttocks were vulnerable to pressure and shear forces during lateral decubitus position, however, nurses and family members showed uneven execution force for turning over; which results injury in sacrococcygeal and buttocks regions. Therefore, nursing staff should actively strengthen the skin in sacrococcygeal and hip areas with high incidence of pressure injury in patients with CAP by closely observing the skin condition, keeping the skin clean and dry, and using appropriate local decompression tools.

Most of the CAP patients (49.505) enrolled in our study were in stage 1 stress injury (Table 2) which is consistent with the previous study (6). Among all the stages of stress-induced injury, stage 1 was the most sensitive to nursing intervention, and therefore, ideal curative effects could be achieved by timely relieving stress and minimizing risk factors. Thus, training of nursing staff on relevant knowledge play an important role. Their ability to identify stage 1 stress-induced injury should be improved, and the correct intervention methods should be mastered in order to reduce the incidence of stress-induced injury.

This study showed that for every 1-point increase in the CURB-65 score in patients with RICU CAP, the risk of stress-related injury increased by 35.8%. In the domestic and foreign guidelines for diagnosis and treatment of CAP, the CURB-65 score is often used to initially predict and evaluate the severity of pneumonia in patients (7). CURB-65 for patients includes patients' consciousness, urea nitrogen, respiratory frequency, blood pres-

sure, and age. The higher the CURB-65 score, the more serious will be the CAP patients. Similarly high CURB-65 score affects the lifestyle of the patients and that's why they have a low ability to take care of themselves.

The results of our study revealed that the risk of a stress injury in patients with RICU CAP combined with heart disease is 1.976 times that of the average CAP patient, therefore, the skincare of the CAP patients combined with heart disease should be improved. Our data showed that severe CAP patients combined with heart disease were prone to heart failure, respiratory fatigue, and massive sweating. The pain perception of the patients was distracted, and attention was focused on dyspnea. The pain caused by pressure, it might be covered by symptoms such as dyspnea. The patients could not feel the pain stimulation caused by excessive pressure, thus affect the skin pain, and cause the local skin of the patient's body to be in a stage of high pressure for a long time, thereby, increasing the risk of stress-induced injury.

The survey finding showed that the risk of a stress injury in patients with RICU CAP combined with the cerebrovascular disease was 2.944 times that of common CAP patients. In most patients with CAP combined with cerebrovascular disease consciousness disorders and imbalance in sensory function were found. The patients would not automatically change the lying position or could not correctly describe to the nursing staff in assisting to change the lying position which affected the skin sensation and perception. The local skin of patients is under high pressure for a long time, which increases the risk of stress injury. Therefore, cluster nursing should be applied to patients with CAP combined with cerebrovascular diseases and consciousness disorder or decreased self-care ability. To improve the grasp of pressure ulcers related knowledge among patients and caregivers further reduce the incidence and severity of pressure ulcers in patients (8).

The results of the survey showed that the incidence of a stress injury in patients with CAP fe-



ver was 2.827% in patients with CAP without fever times. The tolerance of soft tissues to pressure and shear forces may be affected by the microenvironment, nutritional status, perfusion status, concomitant disease, skin and soft tissue conditions (9). Fever is a common symptom in CAP, and great attention should be paid to the care of the skin and the bed unit of the patients with fever. The skin is stimulated due to fever and sweating, and the protection function of the skin is imbalanced due to pH change. Once the tissue is under high pressure for a long time, the skin of the body will suffer from an ischemic and hypoxic environment. In addition, the energy supplied by nutrition from the body is far from enough to maintain the high consumption state of the body due to fever, which will increase the risk of stress injury.

This study also showed that the incidence of stress-related injury increases by 9.30% when the albumin level decreases in patients with CAP. Patients with CAP combined with hypoproteinemia need high nutritional support. As these patients suffer from consciousness disorder or dysphagia due to various reasons, therefore, some patients cannot receive enteral/parenteral nutrition due to refusal of nasogastric feeding, poor vascular condition, or family economic difficulties, which ultimately result in hypoproteinemia. Most patients in intensive care units with dysphagia and disorder of consciousness disorder (10) are in a stress response state because the body consumption rate is high due to the onset of illness. If nutrition supplement is not timely or adequate, the body is in an imbalanced nutritional state, which will affect the skin elasticity and the self-recovery ability of the tissue, and thus the risk of stress injury is greatly increased. Human albumin improves local blood circulation by increasing circulating blood volume, while maintaining plasma osmotic pressure, increasing protein content, and promoting fresh granulation growth. Therefore, the healing of the sore surface is promoted and the pain of patients is reduced (11). Nutritional intake can effectively reduce the occurrence of stress injury, improve nutritional

status and reduce the cost of nutritional support (12).

In this study, we did not find a correlation between our patient's hemoglobin and the occurrence of stress injury. Anemia will reduce the oxygen content in the blood, and the hypoxia of tissues will be more serious under the condition of pressure ischemia. As a result, the tolerance to pressure will be reduced and the risk of stress-induced injury will be increased (13). However, no consistent result has been obtained in this study, which may be related to the insufficient sample size.

## Conclusion

Risk factors for stress-related injury in patients with RICU CAP were CURB-65, concomitant cerebrovascular disease, fever, combined with heart disease and albumin. In all the various stages of stress injury, stage 1 stress injury was found to be the most sensitive stage. Further measures such as eliminating/decreasing pressure and other risk factors, could be helpful to restore the stress-related injury to the normal level. Therefore, training on the prevention of stress injury for nursing staff should be strengthened to improve their identification ability of stage 1 stress-related injury, and to master the correct and targeted intervention methods to avoid the occurrence and further deterioration of -related injury.

## Ethical considerations

Ethical issues (Including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, redundancy, etc.) have been completely observed by the authors.

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## Conflict of interest

The authors declare that there is no conflict of interest.

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