

# World Journal of *Clinical Cases*

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**ABOUT COVER**

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## Prospective Study

# Correlation between crowdedness in emergency departments and anxiety in Chinese patients

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## Abstract

### BACKGROUND

Emergency department (ED) overcrowding is a severe health care concern, while anxiety and depression rates among ED patients have been reported to be substantially higher compared to the general population. We hypothesized that anxiety due to over crowdedness may lead to adverse events in EDs.

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## **AIM**

To investigate correlations between crowdedness in EDs and anxiety of patients and nurses, and to identify factors affecting their anxiety.

## **METHODS**

In this prospective observational study, a total 43 nurses and 389 emergency patients from two tier III hospitals located in Beijing were included from January 2016 to August 2017. Patients were grouped into inpatients when they were hospitalized after diagnoses, or into outpatients when they were discharged after treatments. The State Trait Anxiety Inventory (STAI Form Y) questionnaire was used to investigate patient and nurse anxieties, while crowdedness of EDs was evaluated with the National Emergency Department Over Crowding Score.

## **RESULTS**

The present results revealed that state anxiety scores ( $49.50 \pm 6.00$  vs  $50.80 \pm 2.80$ ,  $P = 0.005$ ) and trait anxiety scores ( $45.40 \pm 5.70$  vs  $46.80 \pm 2.70$ ,  $P = 0.002$ ) between inpatients ( $n = 173$ ) and outpatients ( $n = 216$ ) were significantly different, while the state anxiety of nurses ( $44.70 \pm 5.80$ ) was different from those of both patient groups. Generalized linear regression analysis demonstrated that multiple factors, including crowdedness in the ED, were associated with state and trait anxieties for both inpatients and outpatients. In addition, there was an interaction between state anxiety and trait anxieties. However, multivariable regression analysis showed that while overcrowding in the ED did not directly correlate with patients' and nurses' anxiety levels, the factors that did correlate with state and trait anxieties of inpatients were related to crowdedness. These factors included waiting time in the ED, the number of patients treated, and the number of nurses in the ED, whereas for nurses, only state and trait anxieties correlated significantly with each other.

## **CONCLUSION**

Waiting time, the number of patients treated, and the number of nurses present in the ED correlate with patient anxiety in EDs, but crowdedness has no effect on nurse or patient anxiety.

**Key words:** Emergency department; Overcrowding; State anxiety; Trait anxiety; Anxiety; Prospective studies

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**Core tip:** Emergency department (ED) overcrowding is a severe concern and an important manifestation of dysfunction in the medical system, resulting in a decline in the quality of emergency medical services. In the present study, ED overcrowding did not directly correlate with patient or nurse anxiety levels, but anxiety of inpatients correlated with the waiting time, the number of patients treated, and the number of nurses in the ED. Reducing unnecessary ED visits and optimizing the procedures for emergency patients' diagnoses and treatments are likely to reduce the anxiety of patients in EDs.

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## **INTRODUCTION**

Emergency department (ED) overcrowding is a severe worldwide concern and is an important manifestation of dysfunction in the medical system, which indicates that the supply of medical resources cannot effectively meet the demands of patients, resulting in a decline in the quality of emergency medical services<sup>[1-3]</sup>. Internationally, the "Canadian Medical Association Journal" in 1974 and "Health Week" from the United

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States in 1979 briefly reported on ED overcrowding<sup>[4,5]</sup>. By the late eighties and early nineties, ED overcrowding began to receive attention in the field of emergency medicine<sup>[6]</sup>. In 1991, the American Institute of Public Health and Hospital Management reported that ED overcrowding was not an isolated phenomenon and had become a national issue<sup>[7]</sup>. In 2006, the Institute of Medicine noted ED overcrowding as the most pressing of five major issues facing emergency medicine in the future<sup>[8]</sup>.

In China, EDs serve not only acute and severely ill patients but also some patients who choose to go to the ED because it is more convenient than visiting a clinic<sup>[9-11]</sup>. Usually, these patients only have headaches, colds, other mild symptoms, or diseases that do not require emergency treatment. However, due to China's national laws, emergency doctors cannot refuse to treat them. Therefore, EDs in Beijing have been forced to become a "For Everything Department", because so many demands and roles have been forced upon them to the point that they cannot function as efficient EDs. These ever-growing demands and roles have paralyzed EDs and led to severe overcrowding<sup>[9]</sup>.

Overcrowding can lead to dysfunction of the ED because of the excessive number of patients waiting to be seen, undergoing assessments and treatments, or waiting to be discharged, in relation to the hospital's physical or staffing capacity<sup>[1]</sup>. ED overcrowding has resulted in poor performance regarding waiting times and length of stays<sup>[12]</sup>. It has also resulted in increased mortality rates, treatment delays, inadequate pain control, and general patient dissatisfaction<sup>[13,14]</sup>. Anxiety and depression rates among ED patients are substantially higher compared to the general population<sup>[15]</sup>. Additionally, the patients with mental health issues often have difficulty accessing care. Unfortunately, issues of anxiety and depression are frequently not addressed in the ED, due to competing care priorities<sup>[15]</sup>.

Anxiety is defined as a state of fear and uneasiness<sup>[16]</sup>, and it is divided into state anxiety and trait anxiety. Spielberger<sup>[17]</sup> began to work on the preparation of the State-Trait Anxiety Inventory (STAI) in 1964 and printed the first version of the STAI Form X in 1970. The final version of STAI, namely STAI Form Y, was developed in 1979<sup>[18]</sup>. Trait anxiety refers to a relatively stable personality characteristic, whereas state anxiety refers to a person's temporary and passive state, which develops rapidly and has a certain level of intensity. Emergency patients often have acute-onset, rapid changes in their medical conditions and diverse disease types, and many patients do not know the cause of their illness when they first enter the hospital. As they are eager to seek medical treatment, anxiety is a common negative emotion that they are experiencing<sup>[19]</sup>. Anxiety creates psychological and physical discomfort for the patient, and the anxiety of the patient and family members may lead to conflicts between the doctor and patient. However, due to ED overcrowding, there are many patients in the ED and the emergency medical staff devote more attention to the organic nature of illnesses. The diagnosis and treatment of a disease itself override many other concerns, such as a patient's psychological state<sup>[20]</sup>.

A series of studies have also shown that ED overcrowding can lead to anxiety among medical staff and that ED overcrowding is related to adverse events in EDs<sup>[21,22]</sup>. Therefore, anxiety is a potentially important factor in the occurrence of adverse events due to ED overcrowding. In this prospective study, emergency patients and nurses were used as research subjects to explore the association between crowdedness in EDs and anxiety in patients. We hypothesized that there is a correlation between crowdedness in the ED and anxiety among emergency patients and nurses, and that anxiety adversely affects the outcome of emergency events. Additionally, we aimed to identify other potential risk factors that may have been associated with anxiety levels, which could provide potentially useful ideas for improving the quality of emergency care.

## MATERIALS AND METHODS

### *Patients and nurses*

This prospective observational study investigated a total of 389 patients and 43 ED nurses using data from EDs of two tier 3 hospitals in Beijing from January 2016 to August 2017. The data were collected by four investigators of the research team, who were nurses with 1-5 years of working experience, trained in collecting data from questionnaires. The emergency departments comprised 109 beds, which were divided into 22 emergency room beds, 57 observation room beds, and 30 intensive care unit beds. The medical staff was comprised of 75 physicians and 203 nurses with an average annual patient flow of 332200 cases. The patients' diseases included upper

respiratory tract infections, bronchitis, pneumonia, coronary heart disease, trauma, arrhythmia, cerebrovascular disease, hypertension, gastroenteritis, and urinary tract infections, which are common conditions among emergency patients in Beijing<sup>[9]</sup>. The inclusion criteria were: (1) Patients who voluntarily agreed to participate in the study; (2) Patients over 18 years of age, with a primary school education and above; (3) Patients with normal cognition; and (4) Patients who had been in the ED for more than 1 h. The exclusion criteria were: (1) Patients taking psychotropic drugs; (2) Patients with brain trauma; and (3) Patients with deafness or aphasia.

### **Crowdedness score**

The National Emergency Department Over Crowding Score (NEDOCS) was used to evaluate crowdedness in the EDs. Other possible factors associated with anxiety, including gender, age, ethnicity, economic status, educational level, marital status, waiting time for hospital visit, and hospitalization costs, were also collected. NEDOCS<sup>[23]</sup>, which is intended to be a simple screening tool, was selected to evaluate crowdedness in EDs. This instrument was developed in order to quickly and easily determine the crowdedness of EDs in busy teaching hospitals, and can thus be used as an indicator of crowdedness in any ED. In addition, the data required for the NEDOCS are easy to collect and have good real-time performance, which is consistent with this study. The formula for calculating the NEDOCS is as follows:  $NEDOCS = (P_{bed} / B_t) \times 85.8 + (P_{admit} / B_h) \times 600 + W_{time} \times 5.64 + A_{time} \times 0.93 + R_n \times 13.4 - 20$ , where  $P_{bed}$  is the total number of patients in the emergency room (including patients treated in the ED lobby and infusion chairs, excluding patients in the waiting area);  $B_t$  is the number of emergency treatment beds (beds approved by the health administrative department);  $P_{admit}$  is the number of patients admitted to a bed (number of patients in emergency visits);  $B_h$  is the total number of beds in the hospital;  $W_{time}$  is the last emergency patient's waiting time for hospitalization;  $A_{time}$  is the longest waiting time for hospitalization; and  $R_n$  is the number of patients with mechanical ventilation.

For the NEDOCS, 0 to 20 indicated "not busy", 20 to 60 "busy", 60 to 100 "very busy but not crowded", 100 to 140 "overcrowded", 140 to 180 "seriously overcrowded", and greater than 180 "dangerously overcrowded".

### **Anxiety score**

To investigate the anxiety of patients and nurses, the STAI Form Y<sup>[18]</sup> questionnaire was completed by patients between 8:00 and 20:00 before they received medical treatment, and also by included nurses.

The STAI Form Y prepared by Spielberger *et al.*<sup>[18]</sup>, which includes a total of 40 items, was used to evaluate the anxiety levels of patients and nurses. Items 1-20 comprise the State Anxiety Inventory (S-AI), which is mainly used to assess fears, tensions, anxieties, and neurotic experiences or feelings that are immediate, occurring at a specific time, or arising during a specific situation. It also could be used to evaluate anxiety in emergency situations. Items 21-40 comprise the Trait Anxiety Inventory (T-AI), which is used to assess people's regular emotional experiences. The cumulative scores of the S-AI and T-AI were calculated separately to reflect the levels of state or trait anxiety ([Supplementary Appendix 1](#)).

### **Statistical analysis**

SPSS statistical software version 23.0 for Windows (SPSS, Inc, Chicago, United States) was used for data analyses. The patient data sets were divided into an inpatient group consisting of emergency cases, which had been hospitalized after their diagnoses, and an outpatient group, which had been discharged after diagnoses and ambulant treatments. A sample size of 148 in each group was considered to provide 80% power for detecting a crowdedness level increase of 35% for inpatients and 20% for outpatients (two-sided,  $\alpha = 5\%$ ). To account for a 5% dropout, 312 patients in total (156 in each group) were included. All descriptive data were tested for a normal distribution prior to analysis and the data are presented as the mean  $\pm$  standard deviation (or median) if appropriate. Categorical variables are expressed as numbers (percentage) and were compared by using the  $\chi^2$  or Fisher's exact tests. The correlation between anxiety and all possible factors, such as the crowdedness score, was assessed using the Spearman rank correlation test. Logistic regression analysis was employed to evaluate the contribution of confounding risk factors (*e.g.*, crowdedness score, age, and state anxiety score) to poor prognosis of patients. Multivariate regression analysis was employed to evaluate the factors that could possibly affect a patient's anxiety score. All results were considered statistically significant if the *P* value was  $< 0.05$ . A professional biomedical statistician conducted a review of the analyses.

## RESULTS

### ***Descriptive characteristic of inpatients and outpatients, as well as nurses in the ED***

A total of 466 patients were enrolled in our study, although 77 subjects were excluded for having an incomplete questionnaire or had produced non-logical answers. Of the remaining 389 subjects, 216 were discharged after receiving emergency treatment and 173 were hospitalized. Detailed information regarding each hospital case is shown in Supplementary Table 1.

In the analysis, 43 nurses and 389 patients were included, of whom 46.8% were male. The mean age of the inpatients and outpatients was  $66.9 \pm 19.4$  years and  $70.2 \pm 17.0$  years, respectively. The average age of the nurses was  $30.1 \pm 8.6$  years. Although there were no significant differences in age, gender, marital status, or education levels between inpatients and outpatients, the numbers of non-drinkers and non-smokers in the inpatient group were greater than those in the outpatient group (Table 1).

### ***Comparison of crowdedness and state and trait anxiety of inpatients, outpatients, and nurses***

The mean crowdedness scores for inpatients, outpatients, and nurses were  $210.70 \pm 155.30$ ,  $172.20 \pm 48.70$  and  $131.60 \pm 17.30$ , respectively, which were significantly different among the three groups ( $P < 0.001$ ). The crowdedness measurement for inpatients was higher than those for outpatients and for nurses, but crowdedness was not significantly different between outpatients and nurses.

The mean state anxiety scores for inpatients, outpatients, and nurses were  $49.50 \pm 6.00$ ,  $50.80 \pm 2.80$ , and  $44.70 \pm 5.80$ , respectively, indicating significant differences among the three groups ( $P < 0.001$ ). The state anxiety for outpatients was higher than that for inpatients, and nurses had the lowest overall state anxiety scores.

Regarding trait anxiety, it was highest in outpatients, and there was a significant difference between inpatients and outpatients ( $P < 0.05$ ). However, the trait anxiety in these two groups showed no difference compared with that of nurses (Table 2).

### ***Comparison of factors influencing state anxiety of inpatients and outpatients in the ED***

Next, we analyzed the factors related to state anxiety in the ED for inpatients and outpatients. Among inpatients, having been drinking was highly associated with state anxiety, whether or not drinking heavily. Other factors associated with state anxiety were the time of admission to the ED, the waiting time in ED, number of patients, number of nurses, hospitalization time, hospitalization costs, as well as dyspnea and gastrointestinal bleeding. In addition, crowdedness of the ED could also increase patients' state anxiety. Among outpatients, the time of admission to ED, waiting time in the ED, number of patients, number of nurses, diabetes, arrhythmia, and coronary heart disease as well as the length of stay in the emergency room were factors influencing state anxiety. Severity grade and trait anxiety were factors for anxiety in both groups. In other words, the factors associated with state anxiety were somewhat different between inpatients and outpatients (Table 3).

Further analysis of the relationship between various factors and trait anxiety demonstrated that similarly to the state anxiety factors for both inpatients and outpatients, time of admission to the ED, waiting time inside the ED, number of patients, and number of nurses were significant factors. In addition, for inpatients, the severity grade and the proportion of females, and for outpatients, stroke, coronary heart disease, malignant tumors, arrhythmia, and dyspnea, and the location in the emergency room were significant factors for trait anxiety. Also, for both patient groups, the degree of crowdedness and state anxiety were positively correlated with trait anxiety (Table 4).

As shown in Table 5, the state anxiety and trait anxiety of emergency room nurses were not related to the crowdedness of the ED; however, there was a correlation between their own state anxiety and trait anxiety.

### ***Independent risk factor analysis using multivariable regression***

Using multivariable regression analysis with a bias adjustment, it was found that the factors affecting the state anxiety of inpatients included time of onset and admission to the ED, waiting time after admission, number of patients during that day, hospitalization time, gastrointestinal bleeding, hospitalization cost greater than ¥ 3000, and a patient's own trait anxiety. For outpatients, the number of nurses, coronary heart disease, and their own trait anxieties influenced state anxiety.

**Table 1** Baseline characteristics of subjects

|                         | Inpatients (n = 173) | Outpatients (n = 216) | Nurses (n = 43) | P value between inpatients and outpatients |
|-------------------------|----------------------|-----------------------|-----------------|--|
| Number (n, %)           | 173 (40.05)          | 216 (50.00)           | 43 (9.95)       |  |
| Age (mean ± average)    | 66.9 ± 19.4          | 70.2 ± 17.0           | 30.1 ± 8.6      | 0.075                                      |
| Gender (n, %)           |                      |                       |                 | 0.309                                      |
| Male                    | 86 (49.71)           | 96 (44.44)            | 3 (6.98)        |  |
| Female                  | 87 (50.29)           | 120 (55.56)           | 40 (93.02)      |  |
| Education level (n, %)  |                      |                       |                 | 0.184                                      |
| Primary school          | 39 (22.54)           | 49 (22.7)             |                 |  |
| Middle school           | 70 (40.46)           | 105 (48.61)           |                 |  |
| College or university   | 52 (30.06)           | 55 (25.46)            |                 |  |
| Master's degree         | 12 (6.94)            | 7 (3.24)              |                 |  |
| Marriage (n, %)         |                      |                       |                 | 0.057                                      |
| Not married             | 9 (5.20)             | 7 (3.24)              |                 |  |
| Married                 | 111 (64.16)          | 122 (56.48)           |                 |  |
| Divorced                | 5 (2.89)             | 2 (0.93)              |                 |  |
| Widowed                 | 43 (24.86)           | 81 (37.50)            |                 |  |
| Had a partner           | 5 (2.89)             | 4 (1.85)              |                 |  |
| Alcohol drinking (n, %) |                      |                       |                 | < 0.001                                    |
| Abstaining              | 106 (61.27)          | 58 (26.85)            |                 |  |
| Social drinking         | 14 (8.09)            | 9 (4.17)              |                 |  |
| Heavy drinking          | 16 (9.25)            | 34 (15.74)            |                 |  |
| Occasional drinking     | 31 (17.92)           | 115 (53.24)           |                 |  |
| Alcoholism              | 6 (3.47)             | 0 (0.00)              |                 |  |
| Smoking (n, %)          |                      |                       |                 | < 0.001                                    |
| Never smoked            | 102 (58.96)          | 64 (29.63)            |                 |  |
| Current smoker          | 46 (26.59)           | 29 (13.43)            |                 |  |
| Stopped smoking         | 25 (14.45)           | 123 (56.94)           |                 |  |

**Table 2** Comparison of crowdedness, state anxiety, and trait anxiety in inpatients and outpatients as well as nurses

|                           | Inpatients (n = 173)         | Outpatients (n = 216)       | Nurses (n = 43)             | P value between inpatients and outpatients | P value among three groups |
|---------------------------|------------------------------|-----------------------------|-----------------------------|--|----------------------------|
| Crowdedness (mean ± SD)   | 210.70 ± 155.30 <sup>a</sup> | 172.20 ± 48.70 <sup>c</sup> | 131.60 ± 17.30 <sup>c</sup> | 0.006                                      | < 0.001                    |
| State anxiety (mean ± SD) | 49.50 ± 6.00 <sup>a</sup>    | 50.80 ± 2.80 <sup>c</sup>   | 44.70 ± 5.80 <sup>e</sup>   | 0.005                                      | < 0.001                    |
| Trait anxiety (mean ± SD) | 45.40 ± 5.70 <sup>a</sup>    | 46.80 ± 2.70 <sup>c</sup>   | 45.80 ± 6.20 <sup>ac</sup>  | 0.002                                      | < 0.001                    |

<sup>a,c,e</sup>Different upper-case letters denote a significant difference at  $P < 0.05$  between different groups. SD: Standard deviation.

The factors that led to trait anxiety were much fewer than that for state anxiety. The factors affecting trait anxiety of inpatients included the number of patients during that day, severity of illness, and their own state anxieties. For outpatients, trait anxiety was significantly correlated with waiting time after entering the ED and their own state anxiety (Table 6). However, crowdedness was not a factor that influenced the state anxiety and trait anxiety of either inpatients or outpatients in the ED.

**Table 3** Factors influencing state anxiety of inpatients and outpatients in emergency departments analyzed by generalized linear regression method

|                         | State anxiety        |          |                       |         |
|-------------------------|----------------------|----------|-----------------------|---------|
|                         | Inpatients (n = 173) |          | Outpatients (n = 216) |         |
|                         | Estimate (SE)        | P value  | Estimate (SE)         | P value |
| Age                     | -0.005 (0.024)       | 0.827    | 0.015 (0.011)         | 0.190   |
| Gender                  |                      |          |                       |         |
| Male                    | -1.151 (0.907)       | 0.204    | 0.071 (0.379)         | 0.852   |
| Female (ref.)           |                      |          |                       |         |
| Education level         |                      |          |                       |         |
| Primary school          | -2.385 (1.956)       | 0.223    | 1.735 (1.109)         | 0.118   |
| Middle school           | -3.071 (1.852)       | 0.097    | 1.171 (1.071)         | 0.274   |
| College or university   | -2.373 (1.901)       | 0.212    | 0.938 (1.101)         | 0.394   |
| Master's degree (ref.)  |                      |          |                       |         |
| Marriage                |                      |          |                       |         |
| Not married             | 3.067 (3.304)        | 0.353    | -1.214 (1.684)        | 0.471   |
| Married                 | -0.291 (2.708)       | 0.915    | -1.213 (1.366)        | 0.374   |
| Divorced                | -1.600 (3.746)       | 0.669    | -3.000 (2.327)        | 0.197   |
| Widowed                 | -0.088 (2.799)       | 0.975    | 0.068 (1.376)         | 0.961   |
| Had a partner (ref.)    |                      |          |                       |         |
| Alcohol drinking        |                      |          |                       |         |
| Abstaining              | -5.072 (2.456)       | 0.039    | 0.573 (0.444)         | 0.197   |
| Social drinking         | -4.381 (2.856)       | 0.125    | -0.360 (0.953)        | 0.706   |
| Heavy drinking          | -7.167 (2.802)       | 0.011    | 0.329 (0.538)         | 0.540   |
| Occasional drinking     | -5.800 (2.618)       | 0.027    | (ref.)                |         |
| Alcoholism (ref.)       |                      |          |                       |         |
| Smoking                 |                      |          |                       |         |
| Never smoked            | 0.036 (1.334)        | 0.978    | 0.852 (0.421)         | 0.053   |
| Current smoker          | 0.466 (1.484)        | 0.753    | 0.912 (0.564)         | 0.106   |
| Stopped smoking (ref.)  |                      |          |                       |         |
| Time of admission to ED | -0.038 (0.014)       | 0.006    | -0.011 (0.002)        | < 0.001 |
| Waiting time in ED      | 0.116 (0.028)        | < 0.001  | -0.049 (0.013)        | < 0.001 |
| Number of patients      | 0.010 (0.003)        | 0.002    | -0.008 (0.004)        | 0.050   |
| Number of nurses        | 0.002 (0.001)        | 0.004    | -0.005 (0.002)        | < 0.001 |
| Hospitalization time    | 0.007 (0.002)        | 0.002    | -0.010 (0.007)        | 0.134   |
| Hospitalization cost    |                      |          |                       |         |
| ≤ 1000                  | -4.421 (1.405)       | 0.002    | 0.376 (0.649)         | 0.562   |
| 1001-3000               | -5.321 (1.236)       | < 0.0001 | 0.382 (0.617)         | 0.536   |
| 3001-20000              | -2.508 (1.037)       | 0.0156   | -0.743 (0.700)        | 0.289   |
| ≥ 20000 (ref.)          |                      |          |                       |         |
| Hypertension control    |                      |          |                       |         |
| 0                       | -1.177 (2.862)       | 0.681    | -0.833 (1.084)        | 0.442   |
| 1                       | -0.767 (2.955)       | 0.795    | -1.641 (1.085)        | 0.131   |

|                           |                |       |                |       |
|---------------------------|----------------|-------|----------------|-------|
| 2 (ref.)                  |                |       |                |       |
| Diabetes                  |                |       |                |       |
| No                        | -1.881 (1.074) | 0.080 | -0.693 (0.348) | 0.046 |
| Yes (ref.)                |                |       |                |       |
| Stroke                    |                |       |                |       |
| No                        | 2.551 (1.390)  | 0.067 | -1.157 (0.621) | 0.062 |
| Yes (ref.)                |                |       |                |       |
| Coronary heart disease    |                |       |                |       |
| No                        | -0.046 (0.945) | 0.961 | -0.898 (0.280) | 0.001 |
| Yes (ref.)                |                |       |                |       |
| Thyroid disease           |                |       |                |       |
| No                        | 1.652 (5.645)  | 0.770 | -0.603 (1.436) | 0.674 |
| Yes (ref.)                |                |       |                |       |
| Malignant tumor           |                |       |                |       |
| No                        | 0.110 (5.723)  | 0.985 | 1.174 (0.684)  | 0.086 |
| Yes (ref.)                |                |       |                |       |
| Arrhythmia                |                |       |                |       |
| No                        | -1.196 (1.309) | 0.361 | -1.034 (0.440) | 0.019 |
| Yes (ref.)                |                |       |                |       |
| Severity grade            |                |       |                |       |
| 0                         | 11.950 (3.917) | 0.002 | -1.943 (0.905) | 0.032 |
| 1                         | 10.060 (3.946) | 0.011 | (ref.)         |       |
| 2                         | 11.136 (4.041) | 0.006 |                |       |
| 3 (ref.)                  |                |       |                |       |
| Location                  |                |       |                |       |
| Emergency room            | 3.315 (5.678)  | 0.559 | -1.943 (0.905) | 0.032 |
| Observing area            | 2.103 (5.752)  | 0.715 | (ref.)         |       |
| Infusion area (ref.)      |                |       |                |       |
| Disease                   |                |       |                |       |
| Headache                  |                |       |                |       |
| No                        | -0.001 (1.316) | 0.100 | -0.621 (0.727) | 0.393 |
| Yes (ref.)                |                |       |                |       |
| Chest pain                |                |       |                |       |
| No                        | -0.718 (1.042) | 0.491 | 0.411 (0.347)  | 0.236 |
| Yes (ref.)                |                |       |                |       |
| Abdominal pain            |                |       |                |       |
| No                        | 1.449 (1.224)  | 0.237 | 0.125 (0.559)  | 0.823 |
| Yes (ref.)                |                |       |                |       |
| Dyspnea                   |                |       |                |       |
| No                        | -2.715 (0.927) | 0.003 | -0.506 (0.346) | 0.144 |
| Yes (ref.)                |                |       |                |       |
| Gastrointestinal bleeding |                |       |                |       |
| No                        | 5.286 (1.918)  | 0.006 | 1.080 (0.774)  | 0.163 |

|                        |                |         |                |         |
|------------------------|----------------|---------|----------------|---------|
| Yes (ref.)             |                |         |                |         |
| Palpitation            |                |         |                |         |
| No                     | 0.493 (0.993)  | 0.619   | -0.515 (0.354) | 0.145   |
| Yes (ref.)             |                |         |                |         |
| Syncope                |                |         |                |         |
| No                     | -1.029 (1.431) | 0.472   | -0.390 (0.625) | 0.532   |
| Yes (ref.)             |                |         |                |         |
| Hemoptysis             |                |         |                |         |
| No                     | 2.472 (3.328)  | 0.458   | 0.911 (1.435)  | 0.526   |
| Yes (ref.)             |                |         |                |         |
| Cough and sputum       |                |         |                |         |
| No                     | -0.833 (1.209) | 0.491   | 0.470 (0.485)  | 0.332   |
| Yes (ref.)             |                |         |                |         |
| Trauma                 |                |         |                |         |
| No                     | 1.052 (5.728)  | 0.854   | 0.000 (0.000)  | NA      |
| Yes (ref.)             |                |         |                |         |
| Cardiovascular disease |                |         |                |         |
| No                     | -0.959 (2.075) | 0.644   | 0.414 (1.025)  | 0.686   |
| Yes (ref.)             |                |         |                |         |
| Degree of crowdedness  | 0.006 (0.003)  | 0.049   | -0.004 (0.004) | 0.259   |
| Trait anxiety          | 0.367 (0.076)  | < 0.001 | 0.632 (0.054)  | < 0.001 |

ED: Emergency department.

## DISCUSSION

Trait anxiety is a personality characteristic that reflects the anxiety of a person in a non-stressed state. In contrast, state anxiety is the anxiety of a person in a specific environment, which in our case was the ED<sup>[24,25]</sup>. Trait anxiety and state anxiety are highly correlated and widely considered as useful predictors in clinical treatment<sup>[25-28]</sup> and assessment<sup>[24]</sup>.

In our study, the average state anxiety score for 389 emergency patients was 50.22 and the average trait anxiety score 46.18. The average trait anxiety score was similar to those of other participants in previous studies in China<sup>[29]</sup>. In addition, there was a significant correlation between the state anxiety score and trait anxiety score ( $r = 0.490$ ,  $P < 0.001$ ), with the state anxiety score being significantly higher than the trait anxiety score ( $P < 0.001$ ). Therefore, the scores for the same individual should be significantly related, and this was confirmed in our work. In addition, we found that the state anxiety scores were significantly higher than trait anxiety scores, indicating that a patient's anxiety was significantly increased after entering the ED.

There are many forms of crowdedness and the following situations can lead to a perception of crowdedness: (1) There are temporary extra beds everywhere in the ED corridors and halls; (2) The waiting time for patients and the duration of the emergency stay are essentially prolonged; (3) The number of patients who leave the ED without a doctor's visit is significantly increased; (4) When a new critically ill patient arrives, there is no available bed; (5) When a patient needs to be hospitalized, he/she must be in the ED for a long time; and (6) An ambulance containing a critically ill patient is forced to leave because of a crowded ED<sup>[22]</sup>. However, our study showed that crowdedness of the ED is not an independent factor that directly relates to the state anxiety and trait anxiety of patients. This may be due to the differential understanding of crowdedness between Chinese patients and those in other countries. In Beijing, with a population of 22000000 people and a limited number of hospitals with EDs and without private clinics, crowdedness in hospitals is not unusual and Chinese patients may underestimate the crowdedness of an ED. Therefore, a modified

**Table 4** Factors associated with trait anxiety of inpatients and outpatients in emergency departments analyzed using a generalized linear regression model

|                         | Trait anxiety        |         |                       |         |
|-------------------------|----------------------|---------|-----------------------|---------|
|                         | Inpatients (n = 173) |         | Outpatients (n = 216) |         |
|                         | Estimate (SE)        | P value | Estimate (SE)         | P value |
| Age                     | 0.034 (0.022)        | 0.120   | 0.010 (0.011)         | 0.351   |
| Gender                  |                      |         |                       |         |
| Male                    | -1.988 (0.848)       | 0.019   | -0.077 (0.374)        | 0.837   |
| Female (ref.)           |                      |         |                       |         |
| Education level         |                      |         |                       |         |
| Primary school          | 2.942 (1.840)        | 0.110   | 1.225 (1.091)         | 0.262   |
| Middle school           | 1.074 (1.742)        | 0.538   | 0.210 (1.054)         | 0.842   |
| College or university   | 0.721 (1.789)        | 0.687   | 0.460 (1.083)         | 0.671   |
| Master's degree (ref.)  |                      |         |                       |         |
| Marriage                |                      |         |                       |         |
| Not married             | 1.867 (3.106)        | 0.548   | -0.393 (1.681)        | 0.815   |
| Married                 | -0.882 (2.546)       | 0.729   | -0.783 (1.363)        | 0.566   |
| Divorced                | -3.200 (3.522)       | 0.364   | -3.750 (2.323)        | 0.106   |
| Widowed                 | 0.642 (2.631)        | 0.807   | 0.059 (1.374)         | 0.966   |
| Had a partner (ref.)    |                      |         |                       |         |
| Alcohol drinking        |                      |         |                       |         |
| Abstaining              | -0.560 (2.356)       | 0.812   | 1.308 (0.430)         | 0.002   |
| Social drinking         | -0.762 (2.740)       | 0.781   | 1.114 (0.924)         | 0.228   |
| Heavy drinking          | -1.833 (2.688)       | 0.495   | 0.346 (0.521)         | 0.507   |
| Occasional drinking     | -2.033 (2.511)       | 0.418   | (ref.)                |         |
| Alcoholism (ref.)       |                      |         |                       |         |
| Smoking                 |                      |         |                       |         |
| Never smoked            | 1.538 (1.245)        | 0.217   | 1.174 (0.413)         | 0.005   |
| Current smoker          | -0.531 (1.384)       | 0.701   | 0.573 (0.553)         | 0.300   |
| Stopped smoking (ref.)  |                      |         |                       |         |
| Time of admission to ED | -0.027 (0.013)       | 0.041   | -0.016 (0.003)        | < 0.001 |
| Waiting time in ED      | 0.046 (0.027)        | 0.050   | -0.072 (0.012)        | < 0.001 |
| Number of patients      | -0.007 (0.003)       | 0.031   | -0.014 (0.005)        | 0.004   |
| Number of nurses        | -0.001 (0.001)       | 0.042   | -0.005 (0.002)        | 0.002   |
| Hospitalization time    | 0.001 (0.002)        | 0.677   | -0.005 (0.008)        | 0.566   |
| Hospitalization cost    |                      |         |                       |         |
| ≤ 1000                  | -0.551 (1.414)       | 0.697   | 0.973 (0.640)         | 0.128   |
| 1001-3000               | -0.386 (1.244)       | 0.756   | 0.727 (0.608)         | 0.232   |
| 3001-20000              | 0.649 (1.043)        | 0.534   | -0.214 (0.690)        | 0.756   |
| ≥ 20000 (ref.)          |                      |         |                       |         |
| Hypertension control    |                      |         |                       |         |
| 0                       | 0.660 (2.497)        | 0.791   | -0.033 (1.309)        | 0.980   |
| 1                       | 0.767 (2.578)        | 0.766   | 0.026 (1.310)         | 0.984   |

|                           |                |         |                |       |
|---------------------------|----------------|---------|----------------|-------|
| 2 (ref.)                  |                |         |                |       |
| Diabetes                  |                |         |                |       |
| No                        | -0.536 (1.043) | 0.607   | -0.752 (0.403) | 0.062 |
| Yes (ref.)                |                |         |                |       |
| Stroke                    |                |         |                |       |
| No                        | 0.011 (1.350)  | 0.994   | -1.852 (0.713) | 0.009 |
| Yes (ref.)                |                |         |                |       |
| Coronary heart disease    |                |         |                |       |
| No                        | -0.896 (0.907) | 0.323   | -0.733 (0.328) | 0.026 |
| Yes (ref.)                |                |         |                |       |
| Thyroid disease           |                |         |                |       |
| No                        | -3.606 (5.297) | 0.496   | -0.122 (1.662) | 0.942 |
| Yes (ref.)                |                |         |                |       |
| Malignant tumor           |                |         |                |       |
| No                        | 1.290 (5.509)  | 0.815   | 1.729 (0.788)  | 0.028 |
| Yes (ref.)                |                |         |                |       |
| Arrhythmia                |                |         |                |       |
| No                        | -2.265 (1.250) | 0.070   | -1.158 (0.510) | 0.023 |
| Yes (ref.)                |                |         |                |       |
| Severity grade            |                |         |                |       |
| 0                         | 13.388 (3.756) | < 0.001 | -1.967 (1.050) | 0.061 |
| 1                         | 11.160 (3.783) | 0.003   | (ref.)         |       |
| 2                         | 11.864 (3.875) | 0.002   |                |       |
| 3 (ref.)                  |                |         |                |       |
| Location                  |                |         |                |       |
| Emergency room            | -1.419 (5.508) | 0.797   | -2.786 (1.042) | 0.008 |
| Observing area            | -3.103 (5.580) | 0.578   | (ref.)         |       |
| Infusion area (ref.)      |                |         |                |       |
| Disease                   |                |         |                |       |
| Headache                  |                |         |                |       |
| No                        | 2.102 (1.255)  | 0.094   | -0.905 (0.841) | 0.282 |
| Yes (ref.)                |                |         |                |       |
| Chest pain                |                |         |                |       |
| No                        | 0.908 (1.003)  | 0.365   | 0.175 (0.402)  | 0.663 |
| Yes (ref.)                |                |         |                |       |
| Abdominal pain            |                |         |                |       |
| No                        | 0.411 (1.183)  | 0.729   | 0.940 (0.644)  | 0.144 |
| Yes (ref.)                |                |         |                |       |
| Dyspnea                   |                |         |                |       |
| No                        | 0.480 (0.916)  | 0.601   | -0.801 (0.399) | 0.045 |
| Yes (ref.)                |                |         |                |       |
| Gastrointestinal bleeding |                |         |                |       |
| No                        | -1.448 (1.887) | 0.443   | 1.056 (0.896)  | 0.239 |

|                        |                |         |                |         |
|------------------------|----------------|---------|----------------|---------|
| Yes (ref.)             |                |         |                |         |
| Palpitation            |                |         |                |         |
| No                     | 0.107 (0.956)  | 0.911   | -0.370 (0.410) | 0.367   |
| Yes (ref.)             |                |         |                |         |
| Syncope                |                |         |                |         |
| No                     | 0.783 (1.378)  | 0.570   | -0.223 (0.724) | 0.758   |
| Yes (ref.)             |                |         |                |         |
| Hemoptysis             |                |         |                |         |
| No                     | 0.309 (3.209)  | 0.923   | 1.897 (1.657)  | 0.252   |
| Yes (ref.)             |                |         |                |         |
| Cough and sputum       |                |         |                |         |
| No                     | 0.771 (1.164)  | 0.508   | -0.017 (0.562) | 0.976   |
| Yes (ref.)             |                |         |                |         |
| Trauma                 |                |         |                |         |
| No                     | 1.301 (5.537)  | 0.814   | 0.000 (0.000)  | NA      |
| Yes (ref.)             |                |         |                |         |
| Cardiovascular disease |                |         |                |         |
| No                     | 0.979 (1.997)  | 0.624   | -0.124 (1.185) | 0.916   |
| Yes (ref.)             |                |         |                |         |
| Degree of crowdedness  | -0.006 (0.003) | 0.026   | -0.009 (0.004) | 0.013   |
| State anxiety          | 0.328 (0.068)  | < 0.001 | 0.615 (0.053)  | < 0.001 |

ED: Emergency department.

**Table 5** Factors influencing state and trait anxiety of nurses in emergency departments

|               | State anxiety  |       |         | Trait anxiety  |       |          |
|---------------|----------------|-------|---------|----------------|-------|----------|
|               | Estimate value | SD    | P value | Estimate value | SD    | P value  |
| Crowdedness   | 0.021          | 0.044 | 0.627   | -0.015         | 0.050 | 0.766    |
| Trait anxiety | 0.501          | 0.122 | < 0.001 |                |       |          |
| State anxiety |                |       |         | 0.636          | 0.155 | < 0.0001 |

SD: Standard deviation.

questionnaire with detailed items that fit the conditions in China should be used in future studies, which will reflect a realistic situation in Chinese EDs, and provide more useful information to improve the management of EDs in China.

However, anxiety and depression rates among ED patients are substantially higher than those in the general population<sup>[45]</sup>. Other factors influenced state and trait anxiety of ED patients in the present study, including waiting time in the ED, as well as the number of patients and nurses and the severity of symptoms, especially for the inpatients visiting the ED.

In our study, the hospital with the highest number of consultations received up to 700 visits in 24 h, but crowdedness was not a factor for trait or state anxiety of the nurses and only individuals with a high trait anxiety also exhibited a high trait anxiety. However, stress induced by crowdedness may lead to different symptoms than enhanced anxiety for nurses working in EDs.

A limitation of the present study was that besides its observational design, environmental factors such as a low ceiling, ventilation, and lighting conditions could have contributed to patient anxiety scores<sup>[40]</sup> but were not included in the analyses.

**Table 6** Factors influencing state and trait anxiety of inpatients and outpatients in emergency departments analyzed by multivariable regression method

| Variable                           | State anxiety  |       |         | Trait anxiety  |       |         |
|------------------------------------|----------------|-------|---------|----------------|-------|---------|
|                                    | Estimate value | SD    | P value | Estimate value | SD    | P value |
| <b>Inpatients</b>                  |                |       |         |                |       |         |
| Trait anxiety                      | 0.403          | 0.066 | < 0.001 |                |       |         |
| State anxiety                      |                |       |         | 0.401          | 0.073 | < 0.001 |
| Time of onset and admission        | -0.040         | 0.013 | 0.003   |                |       |         |
| Waiting time after admission       | 0.098          | 0.025 | 0.0001  |                |       |         |
| Number of patients during that day | 0.011          | 0.003 | 0.001   | -0.011         | 0.003 | 0.001   |
| Hospitalization time               | 0.005          | 0.002 | 0.003   |                |       |         |
| <b>Gastrointestinal bleeding</b>   |                |       |         |                |       |         |
| No                                 | 4.305          | 1.509 | 0.004   |                |       |         |
| Yes (ref.)                         |                |       |         |                |       |         |
| <b>Hospitalization cost</b>        |                |       |         |                |       |         |
| ≤ 1000                             | -2.316         | 1.405 | 0.099   |                |       |         |
| 1001-3000                          | -1.643         | 1.210 | 0.175   |                |       |         |
| 3001-20000                         | -1.824         | 0.895 | 0.042   |                |       |         |
| ≥ 20000 (ref.)                     |                |       |         |                |       |         |
| <b>Illness severity grade</b>      |                |       |         |                |       |         |
| 0                                  |                |       |         | 8.995          | 3.493 | 0.010   |
| 1                                  |                |       |         | 8.548          | 3.490 | 0.014   |
| 2                                  |                |       |         | 8.749          | 3.584 | 0.015   |
| 3 (ref.)                           |                |       |         |                |       |         |
| <b>Outpatients</b>                 |                |       |         |                |       |         |
| Trait anxiety                      | 0.307          | 0.054 | < 0.001 |                |       |         |
| State anxiety                      |                |       |         | 0.558          | 0.052 | < 0.001 |
| Number of nurses                   | -0.004         | 0.001 | 0.007   |                |       |         |
| Waiting time after entering the ED |                |       |         | -0.045         | 0.010 | < 0.001 |
| <b>Coronary heart disease</b>      |                |       |         |                |       |         |
| No                                 | -0.640         | 0.254 | 0.012   |                |       |         |
| Yes (ref.)                         |                |       |         |                |       |         |

ED: Emergency department; SD: Standard deviation.

In summary, although the crowdedness of the ED is not an independent factor that directly relates to state and trait anxiety, our results revealed that the factors that correlate with the state and trait anxiety of inpatients are waiting time, as well as the numbers of patients and nurses in the ED. Therefore, we believe that effectively implementing a national policy for reducing unnecessary ED visits and optimizing the procedures for emergency patient diagnosis and treatment will be indispensable and effective means to solve these problems. Further prospective studies with a larger sample size are expected to demonstrate that improving emergency room congestion will effectively improve anxiety in patients.

## ARTICLE HIGHLIGHTS

### Research background

Previous publications noted that overcrowding can lead to dysfunction of the ED because of the excessive number of patients waiting to be seen, undergoing assessment and treatment, or waiting to be discharged, in relation to the hospital's physical or staffing capacity.

### Research motivation

Emergency department (ED) overcrowding is a severe concern and an important manifestation of dysfunction in the medical system, resulting in a decline in the quality of emergency medical services.

### Research objectives

To investigate correlations between crowdedness in EDs and anxiety in ED visiting Chinese inpatients and outpatients and nurses, and to identify potential factors affecting their anxiety level.

### Research methods

The State Trait Anxiety Inventory (STAI Form Y) questionnaire was used to investigate patients' and nurses' anxieties, while crowdedness of EDs was evaluated with the National Emergency Department Over Crowding Score (NEDOCS).

### Research results

ED overcrowding did not directly correlate with patients' and nurses' anxiety level, but anxiety of inpatients correlated with waiting time, number of patients treated, and number of nurses in the ED.

### Research conclusions

The anxiety of patients in EDs correlates with patient to staff ratio.

### Research perspectives

Effectively implementing a national policy for reducing unnecessary ED visits and optimizing the procedures for emergency patient diagnosis and treatment might become effective means to reduce the anxiety of patients in EDs.

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