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COVID-19 Articles Fast Tracked Articles

Symptom Cluster of ICU Nurses Treating COVID-19 Pneumonia Patients in Wuhan, China

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Abstract

Background. In treating highly infectious coronavirus disease-19 (COVID-19) pneumonia, intensive care unit (ICU) nurses face a high risk of developing somatic symptom disorder (SSD). The symptom clusters in one population may show overlaps and involvements, a phenomenon that should be deliberately resolved to improve the management efficiency.

Objectives. The present study aims to investigate the symptoms and causes of SSD of ICU nurses treating COVID-19 pneumonia. The research results are expected to provide evidence for the establishment of a better management strategy.

Methods. This study enrolled a total of 140 ICU nurses who were selected by Jiangsu Province Hospital to work in Wuhan (the epicenter of the COVID-19 epidemic in China) on February 3, 2020. A questionnaire, Somatic symptom disorders for ICU nurses in Wuhan No. 1 Hospital, was designed based on the International Classification of Functioning, Disability and Health. Exploratory factor analysis was performed to cluster the symptoms and logistic regression analysis to find the risk factors of the symptoms.

Results. Five major symptoms were chest discomfort and palpitation (31.4%), dyspnea (30.7%), nausea (21.4%), headache (19.3%), and dizziness (17.9%). In exploratory factor analysis, the symptoms were classified into three clusters: Cluster A of breathing and sleep disturbances (dizziness, sleepiness, and dyspnea); Cluster B of gastrointestinal complaints and pain (nausea and headache), and Cluster C of general symptoms (xerostomia, fatigue, as well as chest discomfort and palpitation). In Cluster A, urine/feces splash, sex, and sputum splash were independent predictive factors. In Cluster B, fall of protective glasses and urine/feces splash were independent predictive factors. In Cluster C, urine/feces splash and urine/feces clearance were independent predictive factors.

Conclusion. The ICU nurses in Wuhan showed varying and overlapping SSDs. These SSDs could be classified into three symptom clusters. Based on the characteristics of their SSDs, specific interventions could be implemented to safeguard the health of ICU nurses.

Key Words
COVID-19, intensive care units, symptom cluster, symptoms, occupational exposure

Introduction

Coronavirus disease-19 (COVID-19) pneumonia has been listed as Category B infectious disease and is being treated in a category similar to that of Category A by the National Health Commission of China. A large proportion of COVID-19 patients will progress to a critical condition, which needs intensive care. However, given the challenges in treating this disease, intensive care unit (ICU) nurses are highly prone to somatic symptom disorder (SSD), which is associated with the interaction of biology, cognition, emotion, behavior,
and environment. The ICU nurses must manage a heavy workload requiring frequent invasive procedures and high attention levels. Therefore, safeguarding the physical and psychological health of ICU nurses can provide a major contribution to the success of epidemic control. A symptom cluster is a stable group of two or more coexisting symptoms. The symptom clusters in one population may show overlaps and interactions, a phenomenon that should be resolved to improve the efficiency of managing the disorder. Currently, no study has investigated SSDs in ICU nurses fighting at the frontline against the COVID-19 epidemic. Previous studies have confirmed that an individual’s response to SSD is dependent on physical, emotional, and social factors. This study aims to analyze SSDs and associated risk factors in 140 ICU nurses who were sent by Jiangsu Province Hospital to No. 1 Hospital of Wuhan, the epicenter of COVID-19 epidemic.

Methods
Sample
A total of 140 nurses at COVID-19 pneumonia ICUs were selected through convenience sampling. Inclusion criteria included the following: employed as a full-time nurse at Jiangsu Province Hospital; aged 20–50 years; has worked at an ICU for serious/critical COVID-19 pneumonia patients in Wuhan; and presented informed consent. Exclusion criteria included the following: no experience in an ICU in Wuhan and lactation.

Data Analysis
The data were analyzed with SPSS, Version 25.0 (https://www.ibm.com/analytics/spss-statistics-software). Descriptive analysis was performed for the data on general characteristics and SSDs. Enumeration data were presented as frequencies and percentages, measurement data in normal distributions as mean ± SD, and measurement data in skewed distributions as medians and interquartile ranges. Exploratory factor analysis was performed to assess the presence of correlations between particular types of symptoms, which might reflect symptom complexes. To express the symptoms accurately, this study included the variables ranking in the top 10 in both frequency and severity. Factor loading was calculated through principal component analysis and rotation through varimax. The factors were selected according to

Table 1
ICF Categories and Symptoms

| Symptom                  | ICF Categories                                                                 |
|--------------------------|--------------------------------------------------------------------------------|
| Sleepiness               | b134—Sleep functions                                                          |
| Dry eyes                 | b220—Sensations associated with seeing and adjacent structure function         |
| Dizziness                | b240—Sensation associated with hearing and vestibular functions                |
| Stomachache              | b280—Sensation of pain                                                         |
| Headache                 |                                                                               |
| Waist pain               |                                                                               |
| Neck pain                |                                                                               |
| Dyspnea                  | b440—Respiration functions                                                    |
| Cough                    | b450—Additional respiratory functions                                          |
| Fatigue                  | b455—Exercise tolerance functions                                             |
| Chest discomfort         | b460—Sensations associated with cardiovascular and respiratory functions       |
| and palpitation          |                                                                               |
| Emesis                   | b510—Ingestion functions                                                      |
| Diarrhea                 | b525—Defecation functions                                                     |
| Nausea                   | b535—Sensations associated with the digestive system                           |
| Xerostomia               | b545—Water, mineral, and hydroelectrolyte balance functions                    |

ICF = International Classification of Functioning, Disability and Health.
the following criteria: eigenvalue > 1 (Kaiser criterion); suitable for Cattell’s 16 Personality Factors Test; containing at least two within-factor variance; having psychological implications; and loadings of 0.5 or higher. Logistic regression analysis was used to explain the interrelationships of symptom clusters and variables in three data sets (demographic data, career data, and data about ICU work); $\alpha = 0.05$.

**Results**

**Sample Characteristics**

During one week (February 15–22, 2020) after the nurses started the work in ICUs in Wuhan No. 1 Hospital, 63 person-times of COVID-19 pneumonia cases were admitted, including 35 serious/critical cases (55.56%) and three deaths (4.76%). A total of 140 nurses started the work in ICUs in Wuhan No. 1 Hospital, 63 person-times of COVID-19 pneumonia cases were dyspnea (0.74 ± 1.17), chest discomfort and palpitation (0.62 ± 1.02), headache (0.40 ± 0.90), fatigue (0.30 ± 0.77), xerostomia (0.30 ± 0.75), dizziness (0.29 ± 0.71), nausea (0.29 ± 0.61), sleepiness (0.19 ± 0.66), dry eyes (0.14 ± 0.56), and diarrhea (0.13 ± 0.61).

**Scores of SSD Symptoms**

Each nurse showed a median of 1.5 (mean 2.04 ± 2.11) SSD symptoms and a median of 2 (3.88 ± 6.13) symptom onsets. The 10 most frequent symptoms were chest discomfort and palpitation (31.4%), dyspnea (30.7%), nausea (21.4%), headache (19.3%), dizziness (17.9%), xerostomia (15.7%), fatigue (15.0%), sleepiness (9.3%), sweating (8.6%), and waist pain (7.1%). The 10 most severe symptoms were dyspnea (0.74 ± 1.17), chest discomfort and palpitation (0.62 ± 1.02), headache (0.40 ± 0.90), fatigue (0.30 ± 0.77), xerostomia (0.30 ± 0.75), dizziness (0.29 ± 0.71), nausea (0.29 ± 0.61), sleepiness (0.19 ± 0.66), dry eyes (0.14 ± 0.56), and diarrhea (0.13 ± 0.61).

**Symptom Clusters**

Exploratory factor analysis was performed based on eight SSDs, the frequency and severity of which both ranked in the top 10, including nausea, chest discomfort and palpitation, dyspnea, sleepiness, dizziness, fatigue, xerostomia, and headache. Kaiser-Meyer-Olkin value of 0.694 and $P < 0.001$ (Bartlett’s Sphericity Test) indicated that these factors were suitable for factor analysis. The results showed three common factors (eigenvalue >1) explaining 55.75% of common variance. After rotation with varimax, the factor loadings were calculated, as shown by the matrix in Table 3. Finally, three symptom clusters were defined: Cluster A of breathing and sleep disturbances (dizziness, sleepiness, and dyspnea); Cluster B of gastrointestinal complaints and pain (nausea and headache); and Cluster C of general symptoms (xerostomia, fatigue, as well as chest discomfort and palpitation). The score of each cluster was the total of each symptom score (Table 3).

**Risk Factors of Symptom Clusters**

Table 4 shows the 15 types of nursing operations and 11 types of exposure. A total of 599 person-times of invasive operations (4.28 ± 7.49 times per person) and 46 person-times of body fluid/blood exposure (0.33 ± 0.58 times per person) were reported. On average, one nurse accomplished 2.57 ± 0.95 shifts of ICU work. A total of 16 nurses (11.4%) had taken on extra work.

Taking the occurrence of symptom clusters as a dependent variable and the factors in the three data sets as independent variables, the univariate Cox regression analysis showed that sex, sputum splash, urine/
feces splash, and urine/feces clearance were risk factors for the occurrence of symptom clusters ($P < 0.05$). Using these risk factors as independent variables and the occurrence of symptom clusters as a dependent variable, the multiple linear regression analysis showed that urine/feces splash, female, and sputum splash were independent predictive factors for Cluster A; fall of protective glasses and urine/feces splash were independent predictive factors of Cluster B; and urine/feces splash and urine/feces clearance were independent predictive factors for Cluster C (Table 5).

**Discussion**

On January 30, 2020, the World Health Organization declared COVID-19 as a public health emergency of international concern. The infection, with a route of human-to-human transmission, caused clusters of severe respiratory illness that was associated with ICU admission and high mortality. China has quickly pooled medical personnel into Wuhan, the origin of the epidemic in China. A major workforce are ICU nurses, who are exposed to a broad range of mental and physical health disorders. Particular efforts to mitigate these challenges must be directed to the ICU nurses under the greatest workload. By investigating the symptom clusters experienced by nurses and associated risk factors, a better management model may be developed to relieve the SSDs in ICU nurses.

We found that the ICU nurses reported symptoms, which could be grouped into three symptom clusters and that the median number of symptoms in each nurse was 1.5. A night shift could be expected to lead to sleepiness and fatigue. Previous studies have studied symptom clusters in patients with cancer or chronic disease. The present study is the first to investigate symptom clusters in ICU nurses in an epidemic.

Our study showed that dizziness, sleepiness, and dyspnea co-occurred in Cluster A; headache and nausea in Cluster B; xerostomia, fatigue, as well as chest discomfort and palpitation in Cluster C. We confirmed that the occurrence of symptom clusters was caused by the environmental and personal stress disorders. For infection control, personal protective equipment (PPE), such as a fluid-resistant gown, gloves, eye protection, full face shield, and fit-tested N95 respirators, should be worn. However, accidental events when using this equipment, such as

| Operation                        | Person-Times | Proportion | Exposure                      | Person-Times | Proportion |
|----------------------------------|--------------|------------|-------------------------------|--------------|------------|
| Endotracheal intubation          | 6            | 1.00       | Fall of protective glasses    | 12           | 26.09      |
| Deep vein catheterization        | 3            | 0.50       | Fall of mask                  | 4            | 8.70       |
| Venous indwelling needle         | 26           | 4.34       | Fall of shield                | 1            | 2.17       |
| Artery indwelling needle         | 0            | 0.00       | Glove fall                    | 8            | 17.39      |
| Open suction                     | 21           | 3.51       | Glove broken                  | 8            | 17.39      |
| Close suction                    | 137          | 22.87      | Protective garment broken     | 0            | 0.00       |
| Clearing oral and nasal secretions | 84          | 14.02      | Protective garment contaminated| 3            | 6.52       |
| Replacing the instruments        | 3            | 0.50       | Blood splash                  | 1            | 2.17       |
| fixing the endotracheal tube     |              |            |                               |              |            |
| Sputum sample collection         | 16           | 2.67       | Sputum splash                 | 3            | 6.52       |
| Blood sample collection          | 35           | 5.84       | Urine/feces splash            | 1            | 2.17       |
| Venous transfusion               | 91           | 15.19      | Others                        | 5            | 10.87      |
| Venous injection                 | 35           | 5.84       | Others                        | 5            | 10.87      |
| Urine/feces clearance            | 116          | 19.37      |                               |              |            |
| Corpse treatment                 | 5            | 0.83       |                               |              |            |
| Others                           | 19           | 3.17       |                               |              |            |

**Table 5**

| Cluster     | Variables                        | Regression Coefficient | SE  | Standardized Regression Coefficient | t    | P    |
|-------------|----------------------------------|------------------------|-----|------------------------------------|------|------|
| Cluster A   | (Constant)                       | 1.924                  | 0.755 |                                   | 2.55 | 0.012 |
|             | Urine/feces splash               | 1.252                  | 0.195 | 0.457                              | 6.417| 0.000 |
|             | Sex                              | −0.82                  | 0.397 | −0.133                             | −2.063 | 0.041 |
|             | Sputum splash                    | 1.46                   | 0.237 | 0.4                                | 6.16 | 0.000 |
|             | Fall of protective glasses       | 0.609, F = 27.306, P = 0.000 | 0.092 | 0.475                              | 4.475 | 0.000 |
| Cluster B   | (Constant)                       | 0.41                   | 0.092 | 0.519                              | 4.475 | 0.000 |
|             | Fall of protective glasses       | 0.55                   | 0.266 | 0.153                              | 2.066 | 0.041 |
|             | Urine/feces splash               | 0.69                   | 0.106 | 0.48                               | 6.483 | 0.000 |
|             | Fall of protective glasses       | 0.789, F = 27.547, P = 0.000 | 0.17  | 0.693                              | 11.651 | 0.000 |
| Cluster C   | (Constant)                       | 1.982                  | 0.17  | 0.693                              | 11.651 | 0.000 |
|             | Urine/feces splash               | 0.32                   | 0.105 | 0.186                              | 3.06 | 0.003 |
|             | Urine/feces clearance            | 0.789, F = 31.097, P = 0.000 | 0.186 | 0.000                              | 3.06 | 0.003 |
fall of protective glasses, may harm both the physical and mental health of nurses. In this study, we showed an association between PPE failure and Symptom Cluster B. It was previously reported that sleepiness coexisted with other symptoms in a single cluster.\textsuperscript{15} Interventions, including physical exercise or cognitive behavioral therapy, could relieve the symptoms in the sleepiness-related cluster.\textsuperscript{16–18}

In Wuhan, most ICU patients required high-flow nasal cannula or high-level oxygen support to correct hypoxemia.\textsuperscript{2} Nursing of critical patients included condition monitoring, sequential oxygen care, sequential treatment nursing, infection prevention, nutrition support, and psychological nursing.\textsuperscript{19} In our study, 55.56% of patients were in critical condition. Our results showed that supervisor nurses had more exposures to infectious material and a heavier workload (4.28 ± 7.49 invasive operations and 0.33 ± 0.58 exposures per person).

We identified urine/feces splash as an independent risk factor associated with the occurrence of all symptom clusters, which can be explained by three reasons. First, patients’ excreta may create aerosols that can allow airborne transmission to those closely involved in the procedure.\textsuperscript{13} Second, the fecal-oral route of transmission is possible.\textsuperscript{20} Third, the proportion of patients needing urine/feces clearance (116; 19.37%) was high, second only to that of closed sputum aspiration (137; 22.87%). Our finding suggested that it is important to develop standard procedures to prevent ICU nurses from urine/feces splash.

We found that female was a significant factor associated with occurrence of the symptom cluster of breathing and sleep disturbances. Several previous studies showed that female nurses have a higher risk of daytime sleepiness than male nurses.\textsuperscript{21,22} To mitigate this risk, care should be given to female ICU nurses if they suffer from daytime sleepiness.

Finally, our results showed that fall of protective glasses was an independent risk factor for the occurrence of the pain symptom cluster. Blocking transmission is a leading strategy against COVID-19.\textsuperscript{25} This finding shows the importance of PPE. A nurse may develop adverse reactions caused by heavy PPE, including nausea and vomiting.\textsuperscript{24} We suggest identifying infection control nurses as observers to monitor staff compliance with infection control guidance, give clarification and advice where appropriate, and record significant issues relating to infection control procedures.\textsuperscript{25}

Limitations

Our study has several limitations. First, only 140 nurses were included; the findings should be validated with studies covering more professionals. Second, other centers should be included to get a more comprehensive understanding.

Conclusions

The ICU nurses in Wuhan showed varying and overlapping SSDs. These SSDs could be classified into three symptom clusters. Based on the characteristics of their SSDs, specific interventions could be implemented to guarantee the health of ICU nurses. Future research should still focus on the change of SSDs through a long-term outbreak.

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