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Symptom Cluster of ICU nurses treating COVID-19 pneumonia patients in Wuhan, China

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Somatic Symptom Disorders of ICU Nurses treating COVID-19 pneumonia patients in Wuhan, China

Abstract

Objective. In treating highly infectious COVID-19 pneumonia, ICU nurses face a high risk of developing somatic symptom disorder (SSD). 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 3rd February 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" (ICF). 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, dyspnea); Cluster B of gastrointestinal complaints and pain (nausea, headache), and Cluster C of general symptoms (xerostomia, fatigue, 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

COVID-19 pneumonia has been listed 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, ICU nurses are highly prone to somatic symptom disorder (SSD) which is associated with the interaction of biology, cognition, emotion, behavior and environment[1]. 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 [2,3]. A symptom cluster is a stable group of two or more co-existing 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 [4,5]. 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 [6]. 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: (1) Employed as a full-time nurse at Jiangsu Province Hospital; (2) Aged 20-50 years; (3) Has worked at an ICU for serious/critical COVID-19 pneumonia patients in Wuhan; (4) Presented informed consent. Exclusion criteria: (1) No experience in an ICU in Wuhan; (2) Lactation.

The Symptom Scale

A questionnaire "Somatic Symptom Disorders for ICU Nurses in Wuhan No.1 Hospital" was designed based on "International Classification of Functioning, Disability and Health" (ICF) [7]. The questions were set out during an expert meeting attended by team leaders, rehabilitation therapists, psychologists, and ICU nurses. Twelve second-level ICF categories were selected from the component of "Body Function" in ICF (Table 1). At this step, standardized ICF-linking rules were used [8]. Finally, a list of ICF categories was compiled that was intended to cover 16 symptoms that ICU nurses could reasonably have experienced when treating COVID-19 pneumonia patients in Wuhan, China (Table 1). The frequency and severity of each symptom were scaled (0, no; 1, mild; 2, moderate; 3, severe).

Another questionnaire was designed to evaluate the possible risk factors. Included in this questionnaire were three datasets: demographic data (sex, age, educational background, marriage, etc.), career data (working years, working years in a particular department, previous in-hospital rotation, title, position, technical level, etc.), and data about ICU work in Wuhan (frequency and time in ICU, extra work, exposure to contaminants and treatment, invasive procedures, etc.).

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-and-palpitation	b460-Sensations associated with cardiovascular and respiratory functions
emesis	b510-Ingestion functions
diarrhea	b525-Defecation functions
nausea	b535-Sensations associated with the digestive system
xerostomia	b545-Water, mineral and electrolyte balance functions
sweating	

Procedures

The questionnaires were handed out through WeChat, an online APP. Participants who met the study criteria logged onto a website (http://www.wjx.cn) to complete the survey. The investigators informed the nurses of the details of the research. All the questionnaires were completed and returned (an efficiency of 100%) 5-7 days after the first group of ICU nurses started work in Wuhan The study was approved by the ethics committee of Jiangsu Province Hospital (2020-SR-101).

Data Analysis

The data were analyzed with SPSS 25.0. 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 the following criteria: (1) eigenvalue>1 (Kaiser criterion); (2) suitable for Cattell's 16 Personality Factors Test; (3) containing at least two within factor variance; (4) having psychological implications; (5) loadings of 0.5 or higher. Logistic regression analysis was used to explain the interrelationships of symptom clusters and variables in three datasets (demographic data, career data, and data about ICU work), α=0.05.

Results

Sample Characteristics

During one week (15-22 February 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 3 deaths (4.76%). A total of 140 nurses were surveyed, including 118 females (84.3%), and 63 married nurses (45%). The mean age was 29.35±4.92 years (range 22-43 years). The nurses had worked for a mean of 7.03±5.44 years (range 1-23 years), and a mean of 3.66±3.70 years (range 1-18 years) in a particular department (such as ICU, emergency, respiratory department, infectious disease department). Other general data are shown in Table 2.

Table 2 General data of the nurses

		Number	（%）
Educational background	Junior college degree	30	21.4
	Bachelor's degree	109	77.9
	Master's degree	1	0.7
Title	Nurse	23	16.4

Position	Senior nurse	81	57.9
	Supervisor nurse	32	22.9
	Co-chief superintendent nurse	4	2.9
	Nurse	136	97.1
	Head nurse	4	2.9
Technical level	N0-N1	74	52.9
	N2	36	25.7
	N3	28	20
	N4	2	1.4
In-hospital rotation（x±s）		2.14±1.38	

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. KMO value of 0.694 and $P<0.001$ (Bartlett's sphericity test) indicated 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, dyspnea); Cluster B of gastrointestinal complaints and pain (nausea, headache); and Cluster C of general symptoms (xerostomia, fatigue, chest-discomfort-and-palpitation). The score of each cluster was the total of each symptom score (Table 3).

168 Table 3 Symptom clusters of ICU nurses

	NO.1	NO.2	NO.3	Cluster score （x±s）
Dizziness	0.71	-	-	
Sleepiness	0.68	-	-	1.22±1.88
Dyspnea	0.621	-	-	
Nausea	-	0.819	-	0.69±1.17
Headache	-	0.596	-	
Xerostomia	-	-	0.815	
Fatigue	-	-	0.637	1.22±1.89
Chest-discomfort-and-palpitation	-	-	0.51	
Explained variance (%)	21.75	17.1	16.91	-

169

170 Risk factors of symptom clusters

171 Table 4 shows the 15 types of nursing operations and 11 types of exposure. A total of
172 599 person-times of invasive operations (4.28±7.49 times per person) and 46 person-times of
173 body fluid/blood exposure (0.33±0.58 times per person) were reported. On average, one nurse
174 accomplished 2.57±0.95 shifts of ICU work. A total of 16 nurses (11.4%) had taken on extra
175 work.

176

177 Table 4 Nursing operations and types of exposure

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 fixing the endotracheal tube	3	0.50	Blood splash	1	2.17
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			
Urine/feces clearance	116	19.37			
Corpse treatment	5	0.83			
Others	19	3.17			

Taking the occurrence of symptom clusters as a dependent variable and the factors in the three datasets 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).

Table 5 Logistic regression analysis on the risk factors of three symptom clusters

	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
		R=0.669，F=27.306，P=0.000				
Cluster B	（Constant）	0.41	0.092		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
		R=0.789，F=27.547，P=0.000				
Cluster C	Urine/feces splash	1.982	0.17	0.693	11.651	0.000
	Urine/feces clearance	0.32	0.105	0.186	3.06	0.003
		R=0.789，F=31.097，P=0.000				

Discussion

On 30 January 2020, the World Health Organization (WHO) declared COVID-19 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 [9]. 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 [9]. 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 [10].

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 [11]. Previous studies have studied symptom clusters in patients with cancer or chronic disease [10, 12]. 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 and chest-discomfort-and-palpitation in Cluster C. We confirmed that the occurrence of symptom clusters was caused by the environmental and personal stress disorder. 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 [13]. However, accidental events when using this equipment, such as 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 [14]. Interventions, including physical exercise or cognitive behavioral therapy, could relieve the symptoms in the sleepiness-related cluster [15-17].

In Wuhan, most ICU patients required high-flow nasal cannula or higher-level oxygen support to correct hypoxemia [18]. Nursing of critical patients included condition monitoring, sequential oxygen care, sequential treatment nursing, infection prevention, nutrition support, and psychological nursing [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. Firstly, patients' excreta may create aerosols that can allow airborne transmission to those closely involved in the procedure [12]. Secondly, the fecal-oral route of transmission is possible [20]. Thirdly, 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 [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 [23]. This finding shows the importance of PPE. A nurse may develop adverse reactions caused by heavy PPE, including nausea and vomiting [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 [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.

References

1. Seaman JB, Cohen TR, White DB. Reducing the Stress on Clinicians Working in the

ICU.JAMA. 2018,320(19):1981-1982. doi: 10.1001/jama.2018.14285.

2. Huang C, Wang Y, Li X, et al. Clinical features of patients infected with 2019 novel coronavirus in Wuhan, China. Lancet. 2020 ;395(10223):497-506. doi: 10.1016/S0140-6736(20)30183-5.

3.Velavan TP, Meyer CG. The COVID-19 epidemic.Trop Med Int Health. 2020;25(3):278-280. doi: 10.1111/tmi.13383.

4.Kim HJ, McGuire DB, Tulman L, Barsevick AM. Symptom clusters : concept analysis and clinical implications for cancer nursing. Cancer Nurs. 2005;28(4):270-282.

5. Nguyen LT, Yates P, Annoussamy LC, Truong TQ. The effectiveness of non-pharmacological interventions in the management of symptom clusters in adult cancer patients:a systematic review protocol..JBI Database System Rev Implement Rep.2016;14(4):49-59.

6. Spink GL, Jorgensen RS, Cristiano S. Cognitive and affective factors predicting daily somatic complaints in college students.J Couns Psychol. 2018;65(1):110-119. doi: 10.1037/cou0000229.

7. World Health Organization. International Classification of Functioning, Disability and Health (ICF). Geneva: WHO; 2001.

8. Cieza A, Fayed N, Bickenbach J, Prodinger B. Refinements of the ICF Linking Rules to strengthen their potential for establishing comparability of health information. Disabil Rehabil. 2019;;41(5):574-583. doi: 10.3109/09638288.2016.1145258.

8. Grotkamp S, Cibis W, Brüggemann S, et al. Personal Factors of the Bio-Psycho-Social Model (WHO): A Revised Classification by the German Society for Social Medicine and Prevention (DGSMP).Gesundheitswesen..2020;82(1):107-116. doi: 10.1055/a-1011-3161.

9. Shigemura J, Ursano RJ, Morganstein JC, Kurosawa M, Benedek DM. Public responses to the novel 2019 coronavirus (2019-nCoV) in Japan: Mental health consequences and target populations.Psychiatry Clin Neurosci. 2020. doi: 10.1111/pcn.12988.

10. Kwekkeboom KL. Cancer symptom cluster management. Semin Oncol Nurs.2016;32(4):373-382.doi:10.1016/j.soncn.2016.08.004.

11. Oriyama S, Miyakoshi Y, Kobayashi T. Effects of two 15-min naps on the subjective sleepiness, fatigue and heart rate variability of night shift nurses. Ind Health.2014;52(1):25-35.

12.Lim KE, Kim SR, Kim HK, Kim SR.. Symptom Clusters and Quality of Life in Subjects With COPD. Respir Care. 2017; 62(9):1203-1211. doi: 10.4187/respcare.05374..

13. Wax RS, Christian MD. Practical recommendations for critical care and anesthesiology teams caring for novel coronavirus (2019-nCoV) patients.Can J

Anaesth.2020.doi:10.1007/s12630-020-01591-x.

14. Yeh CH, Chien LC, Lin WC, Bovbjerg DH, van Londen GJ. Pilot Randomized Controlled Trial of Auricular Point Acupressure to Manage Symptom Clusters of Pain, Fatigue, and Disturbed Sleep in Breast Cancer Patients.Cancer Nurs.2016;39(5):402-10.doi:10.1097/NCC.0000000000000303.

15. Chan JSM, Ng SM, Yuen LP. Qigong exercise for chronic fatigue syndrome.Int Rev Neurobiol.2019;147:121-153.doi:10.1016/bs.irn.2019.08.002.

16. Joustra ML, Zijlema WL, Rosmalen JGM, Janssens KAM. Physical Activity and Sleep in Chronic Fatigue Syndrome and Fibromyalgia Syndrome: Associations with Symptom Severity in the General Population Cohort LifeLines.Pain Res Manag.2018;2018:5801510. doi: 10.1155/2018/5801510. eCollection 2018.

17. Kwekkeboom K, Zhang Y, Campbell T, et al. Randomized controlled trial of a brief cognitive-behavioral strategies intervention for the pain, fatigue, and sleep disturbance symptom cluster in advanced cancer. Psychooncology. 2018;27(12):2761-2769. doi: 10.1002/pon.4883.

18. Huang C, Wang Y, Li X, et al. Clinical features of patients infected with 2019 novel coronavirus in Wuhan, China. Lancet. 2020;395(10223):497-506. doi: 10.1016/S0140-6736(20)30183-5.

19. Jin YH, Cai L, Cheng ZS, et al. A rapid advice guideline for the diagnosis and treatment of 2019 novel coronavirus (2019-nCoV) infected pneumonia (standard version).Mil Med Res. 2020 ;7(1):4. doi: 10.1186/s40779-020-0233-6.

20. Zhang H, Kang Z, Gong H, et al. The digestive system is a potential route of 2019-nCov infection: a bioinformatics analysis based on single-cell transcriptomes. bioRxiv 2020: 2020 2001;2030:927806.

21. Pereira-Morales AJ, Adan A, Bussi IL, Camargo A. Anxiety symptomatology, sex and chronotype: The mediational effect of diurnal sleepiness.Chronobiol Int. 2018;35(10):1354-1364. doi: 10.1080/07420528.2018.1479713.

22. Jahangiri M, Rostamabadi A, Hoboubi N, Tadayon N, Soleimani A. Needle Stick Injuries and their Related Safety Measures among Nurses in a University Hospital, Shiraz, Iran.Saf Health Work. 2016;7(1):72-7. doi: 10.1016/j.shaw.2015.07.006.

23. She J, Jiang J, Ye L, et al. 2019 novel coronavirus of pneumonia in Wuhan, China: emerging attack and management strategies.Clin Transl Med.2020;20,9(1).doi:10.1186/s40169-020-00271-z.

24. Phin NF, Rylands AJ, Allan J, et al. Personal protective equipment in an influenza pandemic: a UK simulation exercise. J Hosp Infect. 2009;71(1):15-21. doi: 10.1016/j.jhin.2008.09.005.

25. Bacchetta AP, Melloni R, Collino F, et al. Health surveillance for employees who work in "areas suspected of pollution" or confined.G Ital Med Lav Ergon. 2015;37(2):90-100.