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Original Article

Relevant Factors and Intervention Measures of Psychological Stress-Induced Hyperthermia among Medical Staff in Temporary COVID-19 Negative Pressure Wards

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Abstract

Background: Medical staff working in COVID-19 wards must be isolated and observed for 14 days upon the occurrence of psychological stress-induced hyperthermia (PSH). Such measures could result in great psychological pressure and incur considerable losses in anti-disease resources.

Methods: In this study, the psychological conditions of medical staff were assessed over a period of 7 days in COVID-19 isolation wards of the People's Hospital of Guangxi Zhuang Autonomous Region, China and 7 days after leaving the wards by using the Pittsburgh Sleep Quality Index (PSQI), Generalized Anxiety Disorder Scale (GAD-7), Patient Health Questionnaire-9 (PHQ-9), Impact of Event Scale-Revised (IES-R), and Post-traumatic Stress Disorder (PTSD) Checklist-Civilian Version (PCL-C). The relevant factors of PSH were analyzed by *t*- and rank sum tests.

Results: A total of 10 females with an average body temperature of 37.36 ± 0.07 ℃ were included in the PSH group. Another 103 females and 53 males with an average body temperature of 36.66 ± 0.21 ℃ were included in the control group. The PSQI, GAD-7, PHQ-9, IES-R, and PCL-C scores of the PSH group were higher than those of the control group. Binary regression analysis indicated that the odds ratios of the PSQI and GAD-7 scores were 12.98 and 3.81, respectively ($P < 0.05$). After positive intervention, the body temperature and psychological scale scores of both groups returned to normal ranges.

Conclusion: Working in COVID-19 wards could cause susceptible medical staff to suffer from PSH. Female sex, somnipathy, and GAD are independent risk factors of PSH.

Keywords: Psychological stress-induced hyperthermia; Somnipathy; Generalized anxiety disorder; COVID-19

Introduction

Psychological stress is a tension state that can cause various human diseases via the interactions of the nervous, endocrine, and immune systems as a result of adverse events (1-3). Psychological

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stress-induced hyperthermia (PSH) refers to an increase in body temperature in response to various stress events (4). The body temperature usually increases by less than 1 ℃ and it is lower than the upper limit of the normal body temperature (36.5℃ < T_{PSH} < 37.5℃). Females are more susceptible to PSH than males (5).

COVID-19 has spread rapidly worldwide in the short period since it was first discovered in December 2019. The WHO defines the disease as "a global sudden public health event" (6,7). The outbreak and prevalence of infectious diseases, such as SARS, avian flu, and Ebola, in the past have proven that epidemics bring about not only remarkable effects on human health, economy, and society but also short-term and/or even permanent damage to the human psychology (8). The COVID-19 pandemic is an important human psychological stress source. The risk of infection by COVID-19, increased social distancing, and uncertainties related to income could increase the psychological pressure experienced by individuals and promote feelings of fear, anxiety, and even psychological stress (9,10). The results of some research on the psychological health of different groups including medical staff in the current epidemic have been published. However, most studies on the psychological health of medical staff in COVID-19 isolation ward focus on psychological stress, anxiety, and depression (11-15). Thus far, few studies on PSH among medical staff in temporary CONVID-19 negative pressure wards has yet been reported.

As the sole provincial fixed hospital for the treatment of patients with COVID-19 in Guangxi Zhuang Autonomous Region, the People's Hospital of Guangxi Zhuang Autonomous Region operated the temporary COVID-19 negative pressure ward for 3 months in 2019, recruited 167 frontline medical staff, and treated 108 patients in total, including 81 confirmed cases. Some frontline medical staff of the People's Hospital of Guangxi Zhuang Autonomous Region showed body temperatures of ≥37.3 ℃ soon after entering the COVID-19 isolation wards. However, the body temperature of these staff decreased to normal levels approximately 1 day after leaving the wards for isolation, and subsequent throat swab nucleic acid tests for COVID-19 were negative. The staff were subsequently considered to have suffered from PSH after a review of these findings. During the operation of the COVID-19 negative pressure wards, medical administrators were required to observe medical staff suffering from PSH in separate rooms for over 14 days to determine whether they had been infected by COVID-19. This protocol, however, incurs considerable losses in anti-epidemic resources. Moreover, frontline medical staff with PSH experience great psychological pressure during their isolation.

Therefore, the present study discusses the relationships between PSH and gender, somnipathy, GAD, depression, and PTSD. Effective intervention measures are recommended to improve the psychological stress state of frontline clinical medical staff with the aim of protecting psychological health and saving anti-epidemic resources.

Methods

General data

The clinical monitoring data of 167 frontline medical staff who worked at the temporary COVID-19 negative pressure wards of the People's Hospital of Guangxi Zhuang Autonomous Region, China from July 22 to April 20, 2020 were reviewed and analyzed. The data collected included: 1) daily reported maximum auxiliary temperatures; 2) throat swab nucleic acid tests for COVID-19, hematology test, hepatorenal function test, and lung CT examination before and after recruitment to the wards; and 3) various psychological health monitoring scales.

Informed consent was taken from the participants before the study. Ethics Committee of the university approved the study.

Inclusion criteria: 1) frontline medical staff, including clinicians, radiologists, doctors of clinical laboratories, and nursing staff who may have had contact with the body fluid and/or blood of patients in the temporary COVID-19 negative pres-

sure wards, and 2) volunteered to participate in this survey. Exclusion criteria: 1) hyperthermia caused by organic diseases, such as COVID-19, and 2) pregnancy. A total of 167 respondents, including 113 females (67.7%) and 54 males (32.3%), with an average age of 31.2 ± 5.5 years, participated in the study. The participants had an educational background of junior college or higher.

Ten female frontline medical staff had transient body temperatures higher than 37.3 ℃ within 1 week after recruitment and rested for 14 days in the separated-room isolation area according to regulations. These staff left the temporary COVID-19 negative pressure ward after psychological assessment and received the necessary psychological inventions from qualified psychologists (PSH group). The rest of the 157 medical staff showed no hyperthermia over the course of the study period and rested for 14 days in the isolation area after the local COVID-19 epidemic was relieved. These staff also left the temporary COVID-19 negative pressure ward after psychological assessment and received the necessary psychological inventions from qualified psychologists (the control group). The demographic characteristics of the PSH and control groups were compared in terms of gender, age, occupation, education, and maximum body temperature 1 week after recruitment, and the results are shown in Table 1.

Table 1: Demographic characteristics of 167 medical staff

Variables	*Total number (%)*	*Individuals with PSH N(%)*	*Individuals without PSH N(%)*	*p*
Gender				
Male	54 (32.3%)	0(0.0%)	54 (34.4%)	
Female	113 (67.7%)	10 (100%)	103 (65.6%)	<0.05
Age (years)	31.2±5.5	28.9±4.7	31.4±5.6	>0.05
Occupation				
Doctors	55 (32.9%)	2 (20%)	53 (33.8%)	
Nurses	90 (53.9%)	7 (70%)	83 (52.9%)	>0.05
Technicians	22 (13.2%)	1 (10%)	21 (13.4%)	
Education				
Junior college	45 (26.9%)	4 (40%)	41 (26.1%)	
Bachelor	66 (39.5%)	3 (30%)	63 (40.1%)	>0.05
Master	53 (31.7%)	3 (30%)	50 (31.8%)	
PhD	3 (1.8%)	0 (0%)	3 (1.9%)	
Body temperature(℃)	36.7±0.26	37.36±0.07	36.66±0.21	<0.001

Research methods

Data Collection

The following five sets of questionnaires were sent to all study participants in the first week of recruitment into the temporary COVID-19 negative pressure wards and 7 days after leaving the wards (and staying in the isolation area). In total, 1670 valid questionnaires were returned (recovery rate, 100%).

Evaluation tools

The Pittsburgh Sleep Quality Index (PSQI) was used to evaluate the sleep quality of respondents in the last 1 month (16) according to the following scores: 0–5, very good sleep quality; 6–10, acceptable sleep quality; 11–15, moderate sleep quality; 16–21, poor sleep quality.

The Generalized Anxiety Disorder Scale (GAD-7) was used to evaluate the GAD degree of respondents in the last 2 weeks (17) according to

the following scores: 0–4, no GAD; 5–9, mild GAD; 10–14, moderate GAD; 15–21, severe GAD.

The Patient Health Questionnaire-9 (PHQ-9) was used to evaluate the major depressive disorder (MDD) degree of respondents in the last 2 weeks (18) according to the following scores: 0–4, no MDD; 5–9, mild MDD; 10–14, moderate MDD; >15, severe MDD.

The Impact of Event Scale-Revised (IES-R) was used to evaluate the psychological stress response degree of respondents and preliminarily screen for post-traumatic stress disorder (PTSD) (19) according to the following scores: 0–8, subclinical PTSD, 9–25, mild PTSD; 26–43, moderate PTSD; 44–88, severe PTSD.

The PTSD Checklist-Civilian Version (PCL-C) was another tool used to evaluate PTSD among respondents (20) according to the following scores: 17–37, no obvious PTSD symptoms; 38–49, slight PTSD symptoms; 50–85, obvious PTSD symptoms (possible PTSD).

Statistical method

Statistical analysis was carried out using SPSS 23.0 (Chicago, IL, USA). Measurement data with a normal distribution were expressed as mean ± standard deviation (x ± s). Inter-group comparison was performed using independent-sample and paired *t*-tests. Measurement data with a skewed distribution were expressed as median [inter-quartile range].Inter-group comparison was performed using the Mann–Whitney U rank sum test. Enumeration data were expressed as percentages (%), and inter-group comparison was conducted using the χ^2 test. Inter-group comparison of ranked data was carried out using the rank sum test. Risk factors for PSH were identified via binary logistic regression analysis, and $P < 0.05$ was considered to indicate statistically significant differences.

Results

Table 2 shows that ten women among 167 medical staff developed transient hyperthermia within 1 week after recruitment to the temporary COVID-19 negative pressure wards (average body temperature, 37.36 ± 0.07 ℃) and the rest of the 157 medical staff reported no PSH in the same period (average body temperature of 36.66 ± 0.21 ℃). The difference between the two groups was statistically significant ($P < 0.001$). After psychological intervention, the body temperatures of both groups returned to the normal range after leaving the ward and entering the isolation area. Inter-group comparison revealed no statistically significant difference.

Table 2: Comparison of average body temperatures between the two groups before and after intervention [n, (x ± s)]

Groups	*Cases*	*Before*	*After*
PSH group	10	37.36 ± 0.07 ℃	36.72 ± 0.14 ℃*
Control group	157	36.66 ± 0.21 ℃	36.63 ± 0.15 ℃
Z/*t*	–	10.782	1.922
P	–	<0.01	>0.05

Notes: Compared with that before intervention, * $P < 0.05$

Table 3 shows that the PSQI scores of the PSH group within 1 week after recruitment to the temporary COVID-19 negative pressure wards were higher than those of the control group in the same period (14 [12–15] vs. 8 [7–10], $P < 0.001$). In terms of PSQI grade, the respective proportions of moderate and poor sleep quality were 90% and 10% in the PSH group and 15.3% and 1.3% in the control group. Differences observed were statistically significant ($P<0.001$). After positive psychological intervention, the PSQI scores of both groups returned to the

normal range after leaving the ward and entering the isolation area. Inter-group comparison revealed no statistically significant difference.

Table 3: Comparison of PSQI scores and grades between the two groups before and after intervention

Groups	*Cases*	*PSQI scores*		*PSQI grade before (n,%)*				*PSQI grade after (n,%)*			
		Before	After	Good	Acceptable	Moderate	Poor	Good	Acceptable	Moderate	Poor
PSH group	10	14 [12-15]	5[5-9]*	0(0)	0(0)	9(90)	1(10)	6(60)	3(30)	1(10)	0(0)
Control group	157	8 [7-10]	3[2-6]*	2(1.3)	129(82.1)	24(15.3)	2(1.3)	114(72.6)	30(19.1)	13(8.3)	0(0)
Z	–	-7.531	-1.720		-6.088				-0.809		
P	–	<0.001	> 0.05		<0.001				> 0.05		

Notes: Compared with that before intervention, * $P < 0.05$

Table 4 shows that the GAD-7 scores of the PSH group within 1 week after recruitment to the temporary COVID-19 negative pressure wards were higher than those of the control group in the same period (15 [14–17] vs. 5 [3–8], $P < 0.001$). In terms of GAD-7 grade, the respective proportions of moderate and severe GAD were 30% and 60% in the PSH group and 11.5% and 2.5% in the control group. Differences observed were statistically significant ($P<0.001$). After positive psychological intervention, the GAD-7 scores of both groups returned to the normal range after leaving the ward and entering the isolation area. Inter-group comparison revealed no statistically significant difference.

Table 4: Comparison of GAD-7 scores and grades between the two groups before and after intervention

Groups	*Cases*	*GAD-7 scores*		*GAD-7 grade before (n,%)*				*GAD-7 grade after (n,%)*			
		Before	After	Good	Acceptable	Moderate	Poor	Good	Acceptable	Moderate	Poor
PSH group	10	15 [14-17]	6 [2-8]*	1(10)	0(0)	3(30)	6(60)	3(30)	7(70)	0(0)	0(0)
Control group	157	5 [3-8]	4 [2-7]*	66(42)	69(44)	18(11.5)	4(2.5)	84(54)	73(46)	0(0)	0(0)
Z	–	-6.662	-1.185		-4.43				-0.419		
P	–	<0.001	>0.05		<0.001				>0.05		

Notes: Compared with that before intervention, * $P < 0.05$

Table 5 shows that the PHQ-9 scores of the PSH group within 1 week after recruitment to the temporary COVID-19 negative pressure wards were higher than those of the control group in the same period (11 [10–18] vs. 5 [3–8], $P<0.001$). In terms of PHQ-9 grade, the respective proportions of moderate and severe MDD are 30% and 50% in the PSH group and 12.1% and 3.8% in the control group. Differences observed were statistically significant ($P < 0.001$). After positive psychological intervention, the PHQ-9 scores of both groups returned to the normal range after leaving the ward and entering the isolation area. Inter-group comparison revealed no statistically significant difference.

Table 5: Comparison of PHQ-9 scores and grades of the two groups before and after intervention

Groups	*Cases*	*PHQ-9 scores*		*PHQ-9 grade before (n,%)*				*PHQ-9 grade after(n,%)*			
		Before	After	Good	Acceptable	Moderate	Poor	Good	Acceptable	Moderate	Poor
PSH group	10	11 [10–18]	4 [3–5]*	1(10)	1(10)	3(30)	5(50)	7(70)	3(30)	0(0)	0(0)
Control group	157	5 [3–8]	3 [2–5]*	79(50.3)	53(33.8)	19(12.1)	6(3.8)	106(68)	51(32)	0(0)	0(0)
Z	–	−6.890	−0.939		−3.568				−0.162		
P	–	<0.001	>0.05		<0.001				>0.05		

Notes: Compared with that before intervention, * $P < 0.05$

Table 6 shows that the IES-R scores of the PSH group within 1 week after recruitment to the temporary COVID-19 negative pressure wards were higher than those of the control group in the same period (30 [22–46] vs. 15 [5–21], $P<0.001$). In terms of IES-R grade, the respective proportions of moderate and severe PTSD were 40% and 30% in the PSH group and 14% and 1.3% in the control group. Differences observed were statistically significant ($P < 0.001$). After positive psychological intervention, the IES-R scores of both groups returned to the normal range after leaving the ward and entering the isolation area. Inter-group comparison revealed no statistically significant difference.

Table 6: Comparison of IES-R scores and grades of the two groups before and after intervention

Groups	*Cases*	*IES-R scores*		*IES-R grade before(n,%)*				*IES-R grade after(n,%)*			
		Before	After	Good	Acceptable	Moderate	Poor	Good	Acceptable	Moderate	Poor
PSH group	10	30 [22–46]	7.5 [6–8]*	1(10)	2(20)	4(40)	3(30)	8(80)	2(20)	0(0)	0(0)
Control group	157	15 [5–21]	6 [4–8]*	57 (36.3)	76 (48.4)	22 (14)	2(1.3)	124(79)	33(21)	0(0)	0(0)
Z	–	−5.886	−1.713		−3.017				−0.077		
P	–	< 0.01	> 0.05		< 0.01				>0.05		

Notes: Compared with that before intervention, * $P < 0.05$

Table 7 shows that the PCL-C scores of the PSH group within 1 week after recruitment to the temporary COVID-19 negative pressure wards were higher than those of the control group in the same period (51 [47–64] vs. 29 [21–35], $P<0.001$). In terms of PCL-C grade, the proportion of obvious PTSD was 70% in the PSH group and 5.1% in the control group. Differences observed were statistically significant ($P < 0.001$). After positive psychological intervention, the PCL-C scores of both groups in the isolation area returned to the normal range after leaving the ward. Inter-group comparison revealed no statistically significant difference.

Table 8 shows that the odds ratios (OR) of the PSQI and GAD-7 scores are 12.98 and 3.81, respectively.

Table 7: Comparison of PCL-C scores and grades between the two groups before and after intervention

Groups	*Cases*	*PCL-C score*		*PCL-C grade before(n,%)*			*PCL-C grade after(n,%)*		
		Before	After	Good	Moderate	Poor	Good	Moderate	Poor
PSH group	10	51 [47–64]	25 [22–33]*	2(20)	1(10)	7(70)	8(80)	2(20)	0(0)
Control group	157	29 [21–35]	28 [21–34]*	129(82.2)	20(12.7)	8(5.1)	145(92.4)	12(7.6)	0(0)
Z	–	−6.816	−0.402		−3.775			−1.363	
P	–	<0.01	>0.05		<0.01			>0.05	

Notes: Compared with that before intervention, * $P < 0.05$

Table 8: Binary logistic regression analysis results of risk factors of PSH

Variables	*Regression coefficient*	*Standard deviation*	*OR (95%CI)*	P
Constants	−15.293	3.732	-	0
PSQI scores	2.563	1.014	12.98 (1.78–94.72)	<0.05
GAD-7 scores	1.337	0.625	3.81 (1.12–12.96)	<0.05
PCL-C scores	1.189	0.629	3.28 (0.96–11.27)	>0.05

Discussion

Temperature regulation, one of the most complicated functions of the nervous system, is influenced by the circadian rhythm, hormones, age, ambient temperature, exercise intensity, and psychological stress, among others (21). None of the female respondents in the PSH group were pregnant. The group showed PSH within 7 days after recruitment to the temporary COVID-19 negative pressure wards, with an average body temperature of 37.36 ± 0.07 ℃. The respondents were isolated, and their body temperature recovered to the normal range after leaving the stress environment. These findings agree with the results of a previous research (5). The proportion of females in the PSH group was higher than that in the control group, which means female sex is an independent risk factor of PSH.

Psychological stress is a risk factor for many common diseases, such as somnipathy (22), depression (23), coronary heart disease (24), obesity (25), and type-2 diabetes (26). Given the high prevalence and risks associated with COVID-19, frontline medical staff are subject to high levels of psychological stress (27). According to the results of this study, somnipathy and GAD are independent risk factors of PSH.

The IES-R scores of the PSH group were higher than those of the control group 7 days after recruitment to the temporary COVID-19 negative pressure wards. The respective proportions of moderate and severe PTSD were 40% and 30% in the PSH group but only 14% and 1.3% in the control group, thereby indicating that medical staff with PSH are in a higher psychological stress state than medical staff without PSH. The PCL-C scores of the PSH group were also higher than those of the control group, and the proportion of obvious PTSD was 70% in the PSH group but only 5.1% in the control group. This finding reveals that the PTSD state of medical staff with PSH is more obvious than that of medical staff without PSH. Thus, according to the IES-R and PCL-C scores, working in temporary stressed infectious COVID-19 wards may increase the risk of susceptible medical staff for developing psychological stress, which is consistent with other Chinese research results (28-30).

Protection must be regulated to optimize the working environment and rest conditions of frontline medical staff, and the supply of protec-

tive materials should be ensured. Various protective procedures and equipment for medical backup, sufficient sleep, and high-nutrition diets should be strictly implemented for frontline medical staff to strengthen their immunity. Second, smooth online and in-person communication should be established among medical staff and their families, friends and colleagues. An online psychological consultation platform for frontline medical staff and open psychological consulting channels should also be developed. Third, intervention groups to discuss psychological problems and provide group consultation via qualified counselors and therapists should be established. One-to-one conversations should be provided to discuss individual problems. Fourth, mutual psychological support and consolation among medical staff should be encouraged to relieve anxiety and tension.

Finally, medical staff with PSH should be allowed to rest in separate rooms for observation and leave the stress environment after confirmation of no COVID-19 infection. Moreover, these staff should avoid exposure to similar psychological stress sources.

Conclusion

Working in temporary stressed infectious COVID-19 wards could bring about significant psychological stress to susceptible frontline medical staff and promote the development of PSH, which could increase body temperatures to ≥37.3℃. According to the program to protect medical staff who may have had contact with the body fluid or blood of patients in the temporary COVID-19 negative pressure wards, staff must be isolated, observed, and tested for over 14 days in a separated-room isolation area to eliminate the possibility of COVID-19 infection. Female sex, somnipathy, and GAD are independent risk factors of PSH. Hence, medical managers should screen medical staff suspected with somnipathy by using the PSQI scale and assess staff GAD by using the GAD-7 scale. Female medical staff with somnipathy and GAD shall also avoid working in temporary stressed infectious COVID-19 wards. Moreover, medical staff should identify frontline medical staff with PSH as early possible, strengthen anti-epidemic materials and psychological interventions, and avoid exposure to similar psychological stress sources.

Ethical considerations

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

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Conflict of interest

The authors declare that there is no conflict of interest.

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