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ORIGINAL RESEARCH

Effect of Sleep Duration on Blood Pressure in Patients with SARS-CoV-2 Infection and Hypertensive Urgencies in Shanghai Fangcang Shelter Hospital

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Objective: To evaluate the effect of sleep duration on blood pressure in patients with hypertension urgencies combined with SARS-CoV-2 infection in a Fangcang shelter hospital.

Methods: From April 10, 2020 to May 20, 2022, we statistically analyzed the blood pressure and sleep conditions of 52 patients with combined hypertension urgencies and SARS-CoV-2 infection admitted in Shanghai National Convention and Exhibition Center Fangcang shelter hospital. They were divided into the short-term (daily sleep duration: <7 h) and normal sleep group (7–9 h). We performed a comparison of the control effects of basic antihypertensive drugs. Additionally, patients in the short-term sleep group underwent drug therapy for sleep regulation and continuous monitoring of blood pressure.

Results: Among these patients, the blood pressure was higher in the short-term sleep group than that of the normal sleep group, and also more difficult to control (p <0.05). Furthermore, the blood pressure of the patients in the short-term sleep group was more easily controlled after treatment with drugs for sleep regulation and basic antihypertensive drugs (p <0.05).

Conclusion: The blood pressure level in patients with combined SARS-CoV-2 infection and hypertension urgencies was higher in those with a shorter duration of daily sleep, and also more difficult to control in Fangcang shelter hospital. Drug therapy for sleep regulation should be administered early to obtain sufficient blood pressure control effects.

Keywords: hypertension urgencies, shelter hospital, sleep regulation, Fangcang hospital, blood pressure, short-term sleep, SARS-CoV-2, COVID-19

Introduction

Since the outbreak of coronavirus disease 2019 (COVID-19), many countries and regions have established emergency medical systems for classified treatment.[1,2] In China, patients with mild or asymptomatic SARS-CoV-2 infection are sent to designated quarantine facilities with primary medical treatment capabilities, such as the Fangcang shelter hospitals. These facilities have been proven to be an effective strategy for responding to COVID-19 outbreaks in communities.[3,4] Despite having the advantages associated with large hospitals and saving medical resources,[5] Fangcang shelter hospitals also impact the treatment of certain chronic diseases. For example, given the complex arrangement of the facilities and its numerous patients, the light intensity inside these shelter hospitals is usually high; thus, the patient sleep is often affected. According to the definition of sleep duration by the American Heart Association, sleep less than 7 hours per night is defined as short-term sleep (sleep disorder).[6] Previous studies have

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shown that sleep duration can cause fluctuations in blood pressure.[7–9] Given that the environment in Fangcang shelter hospitals cannot be adjusted according to personal preferences, it is necessary to investigate and study the effect of sleep duration on blood pressure in patients with hypertension urgencies combined with SARS-CoV-2 infection. This is because the sleep-related blood pressure effects of living in such Fangcang shelter hospitals (public places) have not been reported in the literature.

Materials and Methods

Study Population

From April 10, 2022 to May 20, 2022, 18,574 patients were successfully treated in Hall 6.2 of the Shanghai National Convention and Exhibition Center Fangcang shelter hospital. From these patients, those who met the diagnostic criteria for hypertension urgencies were included. Hypertension urgencies were defined as acute elevation of blood pressure (usually systolic blood pressure (SBP)>180mmHg and/or diastolic blood pressure (DBP)>110mmHg) without impairment of target organ function.[10] Exclusion criteria included patients with primary renal insufficiency, valvular heart disease, and metabolic diseases. Patients with allergies to the drugs administered in this study were also excluded.

Grouping and Treatment

The patients were divided into the short-term (daily sleep duration: <7 hours) and normal sleep group (with sleep equal to or higher than 7 hours per night) according to the sleep duration. An epidemiological questionnaire was used to obtain the sleep duration and blood pressure of all patients before and after entering the cabin. After entering the square cabin hospital, the patient's previous antihypertensive regimen was continued or adjusted to similar antihypertensive regimens based on the available drugs (amlodipine besylate, clonidine hydrochloride, lisinopril, irbesartan, and bisoprolol). The antihypertensive regimen was adjusted accordingly after the diagnosis of hypertension urgencies. For example, Oral, 1/day the dose was adjusted to 5 mg orally, and ACEI or ARB and/or β-blockers and clonidine hydrochloride were given three times per a day.

To compare changes in blood pressure before and after sleep regulation, a combined administration of drug therapy for sleep promotion was performed in the short-term sleep group after adjusting the antihypertensive regimen. The drug therapy for sleep regulation consisted of oral zolpidem tartrate tablets (10 mg), taken once at night. The blood pressure levels at 12 h and 3 d after hospital admission in both groups and blood pressure level after 1 d of drug-induced sleep regulation in the short-term sleep group were measured. The treatment effects and blood pressure levels before and after treatment were observed in the two groups.

Statistical Methods

All statistical analyses were performed using the IBM SPSS, version 18.0 (IBM Corp., Armonk, NY, USA). Data that conformed to normal distribution were expressed as mean and standard deviation ($x \pm s$), and the comparison between the two groups was performed using the *t*-test. The count data were expressed as the number of cases or the percentage, and the comparison between the groups was performed using the chi-squared ($\chi 2$) test. The difference was considered significant at $p < 0.05$.

Results

Population Characteristics

A total of 52 patients with combined SARS-CoV-2 infection and hypertension urgencies were selected for this study. Among these 52 patients, 31 were male and 21 were female, with an average age of 58.5 ± 9.2 (range, 39–79 years) years.

Effects of Sleep Duration and Hypertensive Drug Regimen on Blood Pressure

The blood pressure in the short-term sleep group after admission to the Fangcang shelter hospital increased significantly compared to that before admission, especially in those with <4 hours of sleep (Figure 1). The number of patients with hypertension urgencies in the short-term sleep group was significantly higher than that in the normal sleep group

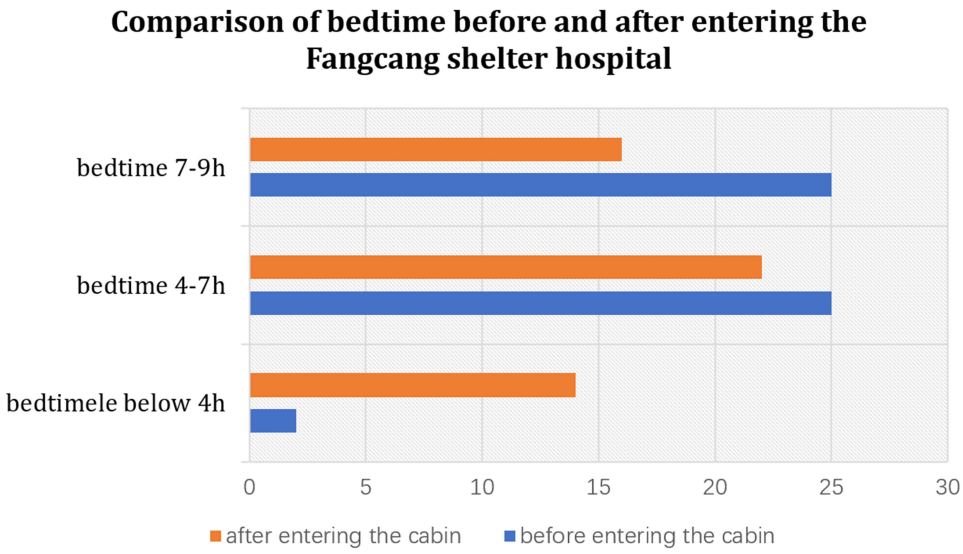

Figure 1 Comparison of the number of patients in different sleep durations before and after admission to Fangcang shelter hospital.

(Table 1). The blood pressure level at admission was also higher in the short-term sleep group than that in the normal sleep group (Table 2). After admission, the blood pressure of the short-term sleep group was still higher than that of the normal sleep group after 12 h and 3 d of treatment with the adjusted antihypertensive regimen (Figure 2).

Table 1 Blood Pressure Fluctuation of Patients Before and After Admission

	Patients (N)	Min	Max	Average	SD	Median
Before hospitalization						
SBP (mmHg)	52	145	200	174.462	13.991	176.5
DBP (mmHg)	52	78	127	113.135	8.158	115.5
After hospitalization						
SBP (mmHg)	52	162	224	189.846	13.522	189
DBP (mmHg)	52	106	138	123.885	4.922	123

Abbreviations: SBP, systolic blood pressure; DBP, diastolic blood pressure.

Table 2 Patients' Characteristics of Short-Term Sleep Group and the Normal Sleep Group

Group	Short Sleep Duration (n=36)	Normal Sleep Duration (n=16)	*p* value
Gender (M/F)	20/16	12/4	0.183
Age (years)	57.5±9.5	60.9±8.4	0.226
Symptoms			
Anorexia	14	2	0.059
Nausea/vomiting	3	0	0.239
Diarrhea	5	0	0.120
Fever	6	0	0.086
Cough/sputum	23	0	<0.001
Headache/pharyngalgia	10	0	0.020
Baseline BP (mmHg)			
SBP	192.2±14.3	184.6±10.2	0.063
DBP	124.0±5.6	123.6±3.2	0.803

Abbreviations: SBP, systolic blood pressure; DBP, diastolic blood pressure.

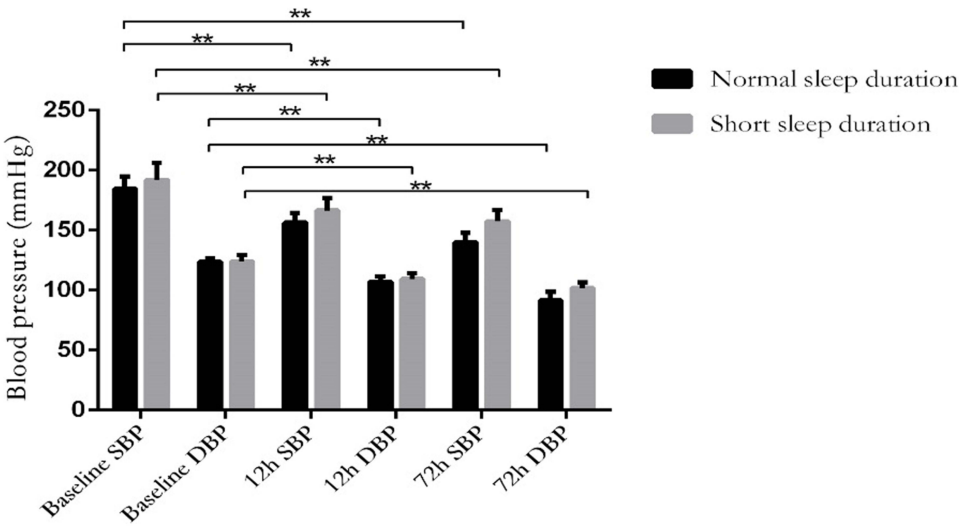

Figure 2 Comparison of blood pressure on 12 h and 3 d of patients after drug sleep regulation in short-term sleep group and the normal sleep group. **p <0.001.

Effect of Drug-Induced Sleep Therapy on Blood Pressure

In the short-term sleep group, the blood pressure after 1 d of drug-induced sleep therapy was lower than before medication administration, and the difference was statistically significant $p < 0.05$. After drug-induced sleep therapy, most patients in short-term sleep group had a more prolonged sleep time, and their blood pressure became closer to the target blood pressure control value than before medication administration (Table 3).

Discussion

In the context of the COVID-19 global pandemic, there have been many reports on the mental and psychological problems of people in isolated or restricted environments.[11–16] Studies have shown that patients with COVID-19 infection are prone to circadian rhythm disorders, including an alerted concept of time in severe cases.[17–19] Furthermore, the resultant increase in physical stress may lead to anxiety, depression, and sleep disorders.[20–22] In the Fangcang shelter hospital, there is continuous bright light intensity even at night. Most patients with SARS-CoV-2 infection already exhibit respiratory symptoms such as cough and fever, and gastrointestinal symptoms such as nausea, anorexia, and diarrhea.[23,24] The abovementioned external environment and these symptoms may affect the sleep duration and quality of patients, especially those with primary hypertension complicated with COVID-19 infection.[25,26] These patients are more likely to have blood pressure fluctuations and even develop hypertension urgencies.

Hypertension urgencies is a group of clinical syndromes caused by an acute increase in blood pressure with or without damage to target organs.[27–29] Hypertension urgencies consists of two categories: hypertensive emergency and hypertensive subemergency.[29] Hypertensive emergency refers to a severe increase in blood pressure within a short period of time [usually systolic blood pressure (SBP)> 180 mmHg and/or diastolic blood pressure (DBP)> 110 mmHg accompanied by progressive target organ damage.[29,30] Hypertension subemergency refers to a significant increase in blood pressure without target organ damage and usually does not require hospitalization. However, oral administration of antihypertensive drugs should be performed immediately to evaluate and monitor possible target organ

Table 3 Comparison of Blood Pressure of Patients in Short Sleep Group Before and After Drug Sleep Regulation

	SBP (mmHg)	DBP (mmHg)	*p* value
Before drug sleep regulation	157.67±9.16	102.08±4.62	<0.001
24h after drug sleep regulation	143.47±6.98	91.41±5.17	<0.001

damage, such as to the heart, brain, and kidney, and also to determine the possible cause of blood pressure increase.[27–30]

A number of previous studies have found that sleep is associated with the occurrence and fluctuation of hypertension. Meng and He showed that a shorter sleep duration and difficulty in falling asleep may increase blood pressure.[31,32] A sleep duration < 6 hours increases the risk of hypertension in the emergency department by 3.5 times.[33] Possible reasons for this association include (1) short-term sleep enhances sympathetic nervous system activity, physical stimulation and psychological stress, resulting in an increase in the 24-hour average blood pressure and heart rate; (2) short-term sleep can disrupt the circadian rhythm and autonomic nerve balance, which can increase blood pressure; and (3) short-term sleep is prone to produce emotions such as, irritability, pessimism, fatigue and stress, thereby increasing the risk of emergencies in hypertension patients.[34–39]

The specific mechanism of the effect of short-term sleep on the blood pressure of hypertensive subemergency patients may be that when the human body is continuously in lack of sleep, mental stress and sympathetic nerve excitement occurs, and the central and peripheral RAAS can be activated. This leads to angiotensin increased secretion and release of angiotensin II (Ang II).[39–45] Ang II is the main effector of the RAAS. It can cause contraction of arteriole smooth muscle and stimulate the adrenal cortex globular zone to secrete aldosterone, which increases the secretion of norepinephrine through the positive feedback of the presynaptic membrane of the sympathetic nerve endings, resulting in an increase in blood pressure.[43–48] In addition, Ang II, as a stress hormone, can also directly act on the central nervous system, thus increasing sympathetic nerve impulse, and participating in and regulating the activation of the hypothalamic–pituitary–adrenal cortex axis. It can also increase blood pressure.[49,50] These mechanisms often have a synergistic effect and are involved in the pathogenesis of hypertension and maintain blood pressure at a high level.[40–50]

In the past, self-regulation was a recommended treatment module for hypertension urgencies caused by short-term sleep. Self-regulation practices include maintaining a quiet environment, adjusting mood and a reasonable diet, and adjusting work intensity and time.[30–32] However, many infection patients coexist in the Fangcang shelter hospital, with noisy voices and bright lights, and it is difficult to ensure privacy. Therefore, the patients are more likely to have sleep disorders. In addition, patients with COVID-19 infection may have respiratory symptoms, such as nighttime cough and fever, which also exerts certain effects on sleep. More importantly, anxiety and depression are prone to appear in the isolation environment or due to the fear of the disease itself, which also has many impacts on sleep. Therefore, the sleep duration of patients is often difficult to achieve through self-regulation in such clinical settings.

In view of the abovementioned clinical scenarios, we adopted a drug-induced sleep regulation therapy. Most patients had a more prolonged sleep time and improved blood pressure levels after undergoing the sleep regulation therapy, and compared to taking blood pressure medications alone, these patients had blood pressure levels closer to the target value of the blood pressure control. Drug-induced sleep regulation therapy showed significant effects on blood pressure control in patients with SARS-CoV-2 infection and hypertension urgencies in Fangcang shelter hospital. Therefore, for patients with hypertension who are treated in Fangcang shelter hospital, the indications for the use of drugs for sleep regulation should be relaxed, and the blood pressure of the patients should be controlled in a relatively shorter duration with antihypertensive drugs to avoid the development of hypertension urgencies.

This study also had some limitations. Firstly, the sample size of a single center is limited, hence the study results need to be verified in future studies with a larger population size. Secondly, due to the limited follow-up time, there was a lack of data on the influence of patients' underlying diseases, follow-up and objective interview data, which may lead to deviations in the research results. Third, the monitoring time of patients' blood pressure was short, hence the follow-up effect of blood pressure lowering drugs cannot be completely eliminated. Fourth, COVID-19 causes severe acute respiratory syndrome by binding to epithelial lung cells through angiotensin-converting enzyme 2 in the human body, the limited sample size dimension cannot permit us to draw definitive conclusions about the drugs of ACEI or ARB effects in patients with hypertension who also have COVID-19. However, this does not affect the conclusion of this study on sleep regulation drugs to control blood pressure.

Conclusions

In summary, in the isolation environment of Fangcang shelter hospital, most hypertension patients have short-term sleep (sleep disorders). Short-term sleep may be related to the increase and fluctuation of blood pressure in patients. In combination with adjusting the antihypertensive drug regimen, the application of sleep regulation drug for short-term sleep patients can achieve better blood pressure control effects. Therefore, this combined theory has clinical application and promotion value for hypertensive populations under public places such Fangcang shelter hospitals.

Ethics Statement

The Ethics Review Committee of General Hospital of Central Theater Command of the Chinese People's Liberation Army approved this study. The patients provided their verbal informed consent to participate from every patient we could contact by phone in this study. This is a medical assistance during a major emergency of infectious disease in China, and this paper is a public health management experience report, and the centers for disease control and prevention of General Hospital of Central Theater Command of the Chinese People's Liberation Army does not allow paper materials with infectious diseases to be taken out of infected areas; thus, written informed consent for participation was not required for this study in accordance with the hospital legislation and the institutional requirements. This retrospective data study complies with the guidelines for human studies and is in accordance with the Declaration of Helsinki. We have withheld patient identification information in this paper and have not shared patient information with any third parties.

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Disclosure

The authors report no conflict of interest in this work.

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