

# The Effect of Staggered Shift Scheduling Mode on Nurses in the COVID-19 Isolation Ward- A Cross Sectional Study

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## Abstract

In order to explore the rational use of nursing resources in the epidemic situation of COVID-19, we optimized the shift arrangement in COVID-19 isolation area and constructed a reasonable nursing schedule under the condition of limited human resources. Seventy-eight nurses were arranged in COVID-19 isolation area to work for 1 week according to 3 different shifts: 4 + 4h, 6h and 6h (overlapping by 1h). Through the form of questionnaire, the comprehensive job satisfaction of 3 different models were compared, and the nursing quality and the consumption of protective equipment under 3 different modes were analyzed. The results showed that the comprehensive job satisfaction and nursing quality of nurses in 6h (overlapping by 1h) shift mode were better than those in other shift modes, and the consumption of protective equipment was lower.

## Keywords

scheduling modes, COVID-19, isolation ward, work satisfaction, overlapping by 1h

### What do we already know about this topic?

After consulting the relevant literature, we did not find any related research on the difference of nursing staff scheduling and nursing staff's job satisfaction under COVID-19's epidemic situation. We feel that this aspect is worthy of our research and discussion.

### How does your research contribute to the field?

With the exacerbation of the COVID-19 epidemic, compared with the conventional shift system, the 6-h (overlapping by 1h) scheduling mode can improve the comprehensive job satisfaction of nurses in COVID-19 isolation area and ensure the more effective use of manpower and material resources in the isolation area. At the same time, a new and effective way of scheduling for hospital nursing staff management is provided.

### What are your research's implications toward theory, practice, or policy?

Our study is an exploration of the reasonable scheduling of nurses under emergency announcements such as COVID-19 's epidemic, which can provide relevant theoretical reference and relevant reference for hospital managements, and appeal to the public to pay more attention to the front-line nursing staff.

## Introduction

In December 2019, an outbreak of SARS coronavirus type 2 infection caused by COVID-19 occurred in Wuhan, Hubei Province, China.<sup>1-3</sup> On January 20, 2020, the National Health Commission of the people's Republic of China listed COVID-19 as a category B infectious disease stipulated in the Law of the people's Republic of China on the Prevention and treatment of Infectious Diseases and managed it according to. On January 30th, the World Health Organization declared COVID-19 the 6th public health emergency of international concern. The control situation is very serious.

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With the full outbreak of the COVID-19 epidemic in China,<sup>4-6</sup> in the case of an acute shortage of infected specialist personnel, a shortage of protective materials, and a high infection rate of medical and nursing staff, we participated in the management of nurses in the isolation ward of the COVID-19 designated hospital in Guangdong Province.<sup>7-9</sup>

Nursing arrangement is an important part of nursing management.<sup>10</sup> There are too few qualified nurses in the world, especially infectious disease or intensive care nurses.<sup>11</sup> In the treatment work of COVID-19, what is most lacking is well-trained and experienced nurses. Combined with the characteristics of the previous 12-h or 8-h shift system, and according to our previous nursing management experience in the specialist ward, the 3-shift system (8-h system) can well meet the needs of nursing work. However, after the outbreak of COVID-19 in China, there is a serious shortage of professional nursing human resources and protective equipment, and nurses need to carry out all nursing operations under the protection of strict isolation clothing, according to the 3-shift system. After working for 8h, the difficulty of completing nursing work has increased sharply, and some nurses have physical exhaustion (headache, chest tightness/palpitation, malignant/vomiting, fatigue). Some paramedics even try to save isolation clothes by reducing drinking water and wearing disposable adult diapers.

To this end, our nursing department considers whether it is possible to increase the number of nursing staff and reduce the work intensity of nursing staff by reducing continuous working hours, so as to prevent the occurrence of physical overdrift of nursing staff. Combined with the actual situation of the hospital, our nursing department designed and implemented 3 different scheduling methods (4h + 4h, 6h, 6h [overlapping by 1h]), in the form of online questionnaire survey, with all nurses in negative pressure wards participating in order to explore a nurse scheduling method which is more suitable for the epidemic situation of COVID-19. Comparing the feedback of nurses and the use of protective equipment, we concluded that the 6-h (overlapping by 1h) scheduling model can improve the comprehensive job satisfaction of nurses in COVID-19 isolation area, and nurses can complete nursing work energetically. COVID-19 patients can get better and more meticulous nursing treatment to ensure the more effective use of manpower and material resources in the isolation area. It is hoped that it can provide a new scheduling reference for the nursing staff working in the front line of COVID-19,<sup>9,12,13</sup> reduce the nursing workload, and call on the management of various hospitals to pay more attention to the nursing staff.

## Method

### Basic Information of Isolation Area

SARS-CoV-2 infected patients were admitted to the isolated infection building of our hospital. the isolation area is divided strictly according to the layout of “3 districts and 2

passageways,” which continued the requirements of the ward for SARS patients admitted to our hospital in 2003. There are 5 floors in this building, the 1st floor is the negative pressure ward, the 2nd floor is the original infection ward, and the 3rd-5th floor is the general isolation ward. At first, the patients were mainly treated as suspected patients, whose condition was relatively mild. Six mild patients in the isolation area were assigned a nurse, and then daily dispatching was carried out through mobile nurses according to the increase or decrease in the number of patients. Two team leaders were set up in each shift in the whole building, mainly by experienced nurses from infection department, respiratory department, and ICU. Another observer will be assigned to supervise and undertake all the work of office nurses in cleaning area of each ward, and they work shifts according to APN mode.

### Scheduling Modes

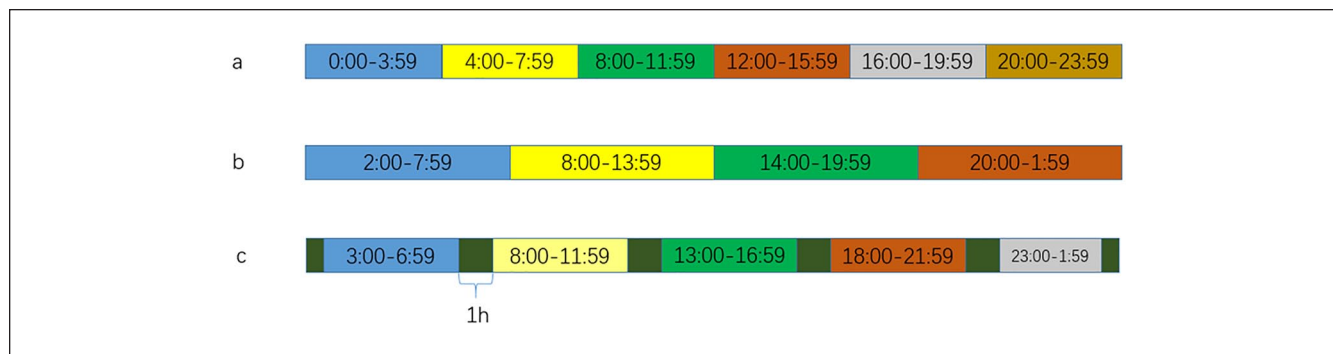
COVID-19 patients were officially admitted to the isolation area on January 24, 2020. In the initial stage, nurses need to adjust their shifts once every 2 days due to many uncertain factors with a 4-h mode. With the increase of the number of patients and the limitation of nursing human resources, 3 scheduling modes had been tried out for 1 week each since January 27th, that is, a.4+4h shift (0-4+12-16/4-8+16-20/8-12+20-24 6 shifts/day), b.6h (2-8-14-20 4 shifts/day). c.6h include 1h interlace (2-8/7-13/12-18/17-23/22-3 5 shifts/day), nurses work for 24h under each mode, and the rest of the time is off.

### Object

On February 20, 2020, Nurses, mainly from infection department, critical medicine department, emergency department, and respiratory department, all signed a volunteer to participate in the negative pressure isolation ward, informed and agreed to this investigation. A Wechat questionnaire was distributed to 78 nurses who participated in 3 shifts at the same time in the isolation area, and 78 valid questionnaires were received, with an effective recovery rate of 100%. All the respondents were women. Age 21 to 42 years old, average ( $28 \pm 5.78$  years); working years 1-20 years, average ( $3 \pm 0.89$ ) years, of which 59 (75.65%) worked clinically for more than 3 years; marital status: 46 unmarried, 32 married; education: technical secondary school 0, junior college 34, undergraduate 44; professional title: 61 nurses/senior nurses, 16 nurses in charge, 1 deputy chief nurse; job post: 1 deputy head nurse; There were 23 nursing leaders and 54 nursing members.

### Survey Tool

In this study, according to the actual nursing human resources of the hospital and the existing scheduling methods,



**Figure 1.** Three ways of scheduling: (a) 4 + 4 h shift (0-4 + 12-16/4-8 + 16-20/8-12 + 20-24 6 shifts/day), (b) 6 h (2-8-14-20 4 shifts/day) and (c) 6 h include 1 h interlace (2-8/7-13/12-18/17-23/22-3 5 shifts/day).

**Table 1.** Comparison of the Frequency of Physical Overdraft Among Nurses Under Different Scheduling Modes (Person-to-Person/Percentage).

Items/(person/percentage)	4 + 4 h	6 h	6 h (including 1 h staggered)	$\chi^2$	P
Headache	20/210 (10%)	28/140 (20%)	15/155 (10%)	10.046	.007
Chest tightness/palpitations	26/210 (12%)	36/140 (26%)	28/155 (18%)	10.462	.005
Nausea/vomiting	16/210 (8%)	25/140 (18%)	18/155 (12%)	8.534	.014
Weakness	10/210 (5%)	18/140 (13%)	10/155 (6%)	8.281	.016
Dyspnea	17/210 (8%)	26/140 (19%)	19/155 (12%)	8.56	.014
Pharyngeal discomfort	6/210 (3%)	15/140 (11%)	10/155 (6%)	9.038	.011
Hold back urine	6/210 (3%)	14/140 (10%)	10/155 (6%)	7.774	.021

The frequency of physical overdraft of nurses in 6 h scheduling mode was slightly higher than that of the other 2 scheduling modes, such as headache, chest tightness/palpitation, malignant/vomiting and fatigue. There was no significant difference in physical overdraft between the 6 h (overlapping by 1 h) model and the 4 + 4 h model.

combined with the relevant opinions put forward by the front-line nurses (such as long duty time, large physical exertion, etc.), so the nursing department revised the scheduling mode. The following 3 scheduling methods are designed (4+4h, 6h, and 6h [overlapping by 1h]) (shown in Figure 1), 1 week after the implementation of various shifts, self-designed network questionnaires were adopted, through Wechat app, nurses can fill out the questionnaires within 24 h to evaluate nurses' comprehensive satisfaction degree under different shifts, including personal basic data and scheduling comprehensive satisfaction scale. The personal basic situation scale mainly collects basic personal information, mental and physical sources of stress faced by front-line nurses, as well as views on shift scheduling and tolerable working hours, with a total of 30 questions. The schedule comprehensive satisfaction scale was used for further evaluation of 3 scheduling modes (4h, 6h, 6h [overlap 1h]), including direct preference and physical discomfort of front-line nurses under various scheduling methods, with a total of 15 questions (the survey scale can be found in the attachment to this article).

### Statistical Method

The original data was analyzed by SPSS20.0 software package. The percentage is used to describe the data. The

counting data were analyzed by Kruskal-Wallis rank sum test. A *P* value <.05 was considered statistically significant.

## Result

### Comparison of the Frequency of Physical Overdraft among Nurses Under 3 Scheduling Modes

The frequency of physical overdraft of nurses in 6-h scheduling mode was slightly higher than that of the other 2 scheduling modes, such as headache, chest tightness/palpitation, malignant/vomiting, and fatigue. There was no significant difference in physical overdraft between the 6-h (overlapping by 1 h) model and the 4 + 4-h model (shown in Tables 1–4).

### Comparison of Nurses' Comprehensive Satisfaction under 3 Scheduling Modes

The comprehensive satisfaction of nurses in 6-h (overlapping by 1 h) shift mode was significantly higher than that in 4 + 4-h and 6-h mode, mainly in the aspects of work intensity, work status, degree of cooperation, procrastination, and so on (shown in Table 2).

### *Comparison of Protective Clothing Consumption under 3 Scheduling Modes*

There are 6 shifts per day in 4-h shifts, the consumption of protective clothing is the largest, and vice versa, and 6 h (overlapping by 1 h) is between the 2 (shown in Table 3).

### *Comparison of Nursing Quality under 3 Scheduling Modes*

The nursing quality of the 6-h (overlapping by 1 h) model was significantly higher than that of the 4-h model and the 6-h model, which was mainly manifested in the implementation of basic nursing, the degree of disease awareness and the writing of nursing documents.

## **Discuss**

### *The 6-h (Overlapping by 1 h) Scheduling Model Improved Nurses' Work Satisfaction*

Nurses' work satisfaction refers to nurses' general attitude toward their own work or the degree of satisfaction obtained from their work, which directly or indirectly affects the quality of nursing provided to patient.<sup>8,14</sup> Nurses' work satisfaction is one of the most important reference indicators to evaluate the effectiveness of nurses' scheduling. Many studies have found that shift mode has a significant impact on nurses' satisfaction.<sup>15</sup> The results of this survey showed that the comprehensive work satisfaction of nurses in 6-h (overlapping by 1 h) shift mode was significantly higher than that in 4 + 4-h and 6-h mode, mainly in the aspects of work intensity, work status, degree of cooperation, procrastination, and so on.<sup>16</sup> As COVID-19 is highly infectious, nurses not only complete the treatment and nursing of patients, but also need to do a lot of non-nursing work such as cleaning, disinfection and more. The staggered hour is shared by 2 people from the non-nursing work that was completed by 1 person, and they usually use this time to carry out operations that are not convenient for 1 person, such as bed sheets, child puncture, and so on.<sup>17</sup> Eighty-nine percent of the nurses in the survey believe that cooperation can improve work efficiency and reduce the workload per unit of time, and the shift also avoids sacrificing personal rest time due to procrastination. Although the 4 + 4-h mode has an advantage in the length of each shift, it makes nurses work twice a day, which is equivalent to a 12-h shift. Most nurses reported that their biological clock has not been adjusted, they have to start work again and wear protective clothing twice a day. According to the past experience in fighting against SARS, Ebola virus and MERS, standardizing the use of protective clothing is the main protective measure to reduce the risk of infection among health care workers.<sup>18</sup> Nurses entering the contaminated area must wear 3 layers of protective equipment according to the strict work flow.<sup>18,19</sup> It takes 20 or 30 minutes to wear the protective equipment at a

time, and about 30~40min to remove the protective equipment. At least 2 h were consumed to wear protective clothing every day, and most nurses feel burdened.<sup>20,21</sup>

### *The 6-h (Overlapping by 1 h) Scheduling Mode can Reasonably Reduce the Consumption of Protective Clothing*

In the face of the unpredictability of sudden epidemic, the uncertainty of a large number of patients and outbreak duration, the management of protective materials is a very important work for emergency managers.<sup>22-24</sup> The reasonable arrangement of manpower and working hours in the isolation area is a link in the effective management of protective materials. Patients with suspected cases of new coronary pneumonia are isolated in a single room in accordance with the diagnostic and treatment standards. However, the author's hospital can only receive a maximum of 9 patients in each temporary isolation ward, patients are generally in a mild condition, and 1 nurse is arranged for each class. During the peak period of the epidemic, the hospital opened 7 temporary isolation wards, and mobile nurses are assigned to dispatch at any time.<sup>25</sup> According to the 4 + 4-h shift mode, the daily consumption of protective clothing was  $6 \times 7 = 42$  sets, the 6-h shift mode consumed  $4 \times 7 = 28$  sets per day, and the 6-h (overlapping by 1 h) shift mode consumed  $5 \times 7 = 35$  sets per day. In a week, 294 sets of protective clothing, 168 sets of 6-h mode and 245 sets of 6-h (overlapping by 1 h) were consumed in 4 + 4-h mode, although the consumption of protective clothing in 6-h shift mode was the least among the 3 scheduling modes. However, in the questionnaire, the frequency of physical overdraft in this mode was slightly higher than that of the other 2 modes, such as headache, chest tightness/palpitation, malignant/vomiting and fatigue.<sup>26</sup> There were even 5 cases of early withdrawal from the isolation ward because of physical discomfort. There was no significant difference in physical overdraft between the 6-h (overlapping by 1 h) mode and the 4 + 4-h mode. Therefore, we thought that the 6-h (overlapping by 1 h) scheduling mode is more reasonable, which can not only reasonably save the consumption of protective clothing, but also reduce the discomfort of nurses.<sup>27</sup>

To sum up, in a special period and under specific conditions, providing nurses with flexible 1-h buffer time, not only can staggered shifts reduce their work intensity and physical exertion per unit time, but also save materials reasonably and improve nurses' work satisfaction, so that the human resources and protective materials in the isolation ward can be used more reasonably and effectively.<sup>28,29</sup>

### *Limitations*

Limitations of this investigation are recognized. Firstly, there may be selective bias. In this study, 3 models were implemented for 1 week each, but with the severity of the epidemic situation, the number of patients entering the isolation ward



at different time gradually increased, and the workload and work intensity of nurses may be different. Another limitation is that the sample from only 1 hospital in China, so the results can only be used for reference. The sample is from only 1 hospital in China, so the results can only be used for reference. COVID-19 outbreak suddenly, the whole questionnaire factors cannot be effectively verified, however, in our subsequent shift, the 6-h system (overlapping by 1 h) has achieved good results. Moreover, as far as we know, there are few articles to explore the correlation of nurses' shifts on nursing quality, physical overdraft and protective equipment consumption. therefore, this study can still provide valuable information for future research and clinical practice.

## Conclusions

In the face of the sudden outbreak of public events such as COVID-19, this research shows that 6-h (overlapping by 1 h) scheduling mode provide nurses with flexibility for 1 h through staggered shifts, which can not only reduce nurses' work intensity and physical exertion per unit of time, but also save materials reasonably and improve nurses' job satisfaction. Therefore, this article to provide 6-h (overlapping by 1 h) scheduling experience for hospital nursing staff management around the world, so that the human resources and protective materials in the isolation ward can be used more reasonably and effectively.

**Table 2.** Comparison of Nurses' Comprehensive Satisfaction under 3 Scheduling Modes (Percentage).

Items	4 + 4h	6h	6h (including 1h staggered)	P
Working time	71.46%	68.05%	79.76%	.014
Working intensity	74.39%	64.15%	79.27%	.01
Working state	75.85%	66.1%	81.22%	.06
Cooperation	71.95%	70%	86.66%	.001
Procrastination	75.71%	65.58%	79.73%	.015
Biological clock	63.66%	76.1%	77.8%	.048
Continuous rest time	67.07%	74.39%	81.22%	.04
Terminal disinfection	66.58%	67.07%	80.24%	.02
Take off protective clothing	70.98%	68.05%	80.73%	.016

The comprehensive satisfaction of nurses in 6h (overlapping by 1h) shift mode was significantly higher than that in 4 + 4h and 6h mode, mainly in the aspects of work intensity, work status, degree of cooperation, procrastination and so on.

**Table 3.** Comparison of Protective Clothing Consumption under 3 Shifts (1 Nurse per Class in 7 Wards).

Time	4 + 4h	6h	6h (including 1h staggered)
1 Day	42	24	35
1 Week	294	168	245

There are 6 shifts per day in 4h shifts, the consumption of protective clothing is the largest, and vice versa, and 6h (overlapping by 1h) is between the two.

**Table 4.** Comparison of the Frequency of Physical Overdraft Among Nurses under 2 Scheduling Modes (Person-to-Person/Percentage).

Items/(person/percentage)	4 + 4h	6h (including 1h staggered)	$\chi^2$	P
Headache	20/210 (10%)	15/155 (10%)	0.2	.961
Chest tightness/palpitations	26/210 (12%)	28/155 (18%)	2.285	.131
Nausea/vomiting	16/210 (8%)	18/155 (12%)	1.684	.194
Weakness	10/210 (5%)	10/155 (6%)	0.492	.483
dyspnea	17/210 (8%)	19/155 (12%)	1.738	.187
Pharyngeal discomfort	6/210 (3%)	10/155 (6%)	2.749	.097
Hold back urine	6/210 (3%)	10/155 (6%)	2.749	.097

There was no significant difference in physical overdraft between the 6h (overlapping by 1h) model and the 4 + 4h model (there was no significant difference between the 2 scheduling modes  $P > .05$ ).

## Authors' Note

All experimental protocols were approved by the Committee of Guangdong Second Provincial General Hospital, Guangzhou, China.

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## Authors' Contributions

Lishan Huang, the first author, served as head nurse in the isolation ward and assisted in drafting the manuscript. Li Tang and Lingna Yu contributed to the setup of the shift schedule. Yuelin Wu and Zixiang Huang analyzed the data. Xiaobo Tian designed the study and was a major contributor in writing the manuscript. All authors read and approved the final manuscript.

## Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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## Statement

We have provided the English version of the questionnaire and related experimental data. If you still need to obtain the basic materials of this research, you can contact me directly by email.

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## Supplemental Material

Supplemental material for this article is available online.

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