

Nursing Scheduling Mode and Experience from the Medical Teams in Aiding Hubei Province During the COVID-19 Outbreak: A Systematic Scoping Review of 17 Studies

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Introduction: Due to COVID-19 outbreak, since January 24, 2020, national medical teams from across the country and the armed forces have been dispatched to aid Hubei. The present review was designed to timely summarize the existing frontline information about nursing scheduling mode with special focus on the length of shifts with the aim to contribute to improve the nurses' job satisfaction and the quality of nursing services.

Methods: Articles from Jan 2020 to October 2020 were retrieved from China National Knowledge Infrastructure, Wanfang Data and Weipu Information, with the terms "COVID-19", "designated hospital", "Hubei-assisted", "makeshift hospital", "nursing", "nursing shift", "whole-system takeover" and variations of these, in the title and abstract fields and the Boolean combinations of these words as the retrieval strategy.

Results: Seventeen journal articles have been included in the target field, from the nurses in aiding Hubei Province, four kinds of shift length, 2-hour (h), 3-h, 4-h and 6-h shift have been considered, the main nursing scheduling mode adopted in designated hospitals for COVID-19 patients was dynamic scheduling based on workload, flexible scheduling based on working hours, workload and the number of critically ill patients admitted, humanized scheduling based on the daily reported health status of the nurses, and professional-integrated scheduling according to the professional distribution of nurses on the basis of four-hour shift length, and in makeshift hospitals for mild patients, the scheduling mode was 6-h based correspondingly.

Conclusion: The descriptive results of the present systematic review shed light on the challenges and practical solutions of nursing scheduling mode in the context of cross-regional medical assistance. Additionally, the present systematic review could provide the academic community of nurses, nurse managers and administrators with baseline information and scientific productions from the content's points of view in the target field.

Keywords: nursing scheduling, shift work, nursing management, systematic review

Introduction

Since January 24, 2020, a total of 346 medical teams composed of 42,600 medical workers and 965 public health workers from across China and the armed forces have been dispatched to aid Hubei in fighting COVID-19.¹ Among the medical workers who risked their health and lives to aid Hubei, the nurses accounted for a major part and played a crucial role. With sometimes scarce medical resources and difficult working environment in the early stage of aid to Hubei, these medical

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workers encountered many tremendous challenges in ward division, disinfection, isolation and the deployment of nursing staff, they were at greater risk of experiencing high levels of psychological distress and suffering. That kind of emergency required a quick reorganization of human resources. The timely summarized experience and lessons in the field of patient care and nursing management provided by the medical team are of great importance for improving emergency management strategy.²⁻⁴

In the above-mentioned background, the present systematic review was designed to collect the information about nursing scheduling mode with special focus on the length of shifts. The work organization characteristics have been proved to have a significant impact on the outcome in nursing.⁵⁻⁷ When the nurses in the national medical rescue teams came from different provinces, different hospitals and different specialties, how to arrange shifts reasonably is therefore prudent.^{8,9} When considering the issues of personal safety protection, the nurses' unfamiliarity with the environment, unfamiliarity with the medical equipment and even unfamiliarity with the doctors or patients' local dialects, the length of each shift and the adjustment of the shift length are the important components of the deployment of nursing human resources in this major public health emergency.^{10,11}

In addition to the timely summary of experience and timely submission by the nurse teams in aiding Hubei, Chinese journals in related professional fields have also made corresponding concerted efforts to deal with relevant submissions as soon as possible to disseminate relevant experience for medical staff across the country as the reference. In view of the impressive efforts by the nurses, the description of the organization of nursing shift patterns will help to call the attention to the special considerations during the cross-regional medical assistance process.

Materials and Methods

Study Selection

Articles from Jan 2020 until October 2020 were retrieved from China National Knowledge Infrastructure (CNKI, www.cnki.net), Wanfang Data (www.wanfangdata.com) and Weipu Information (www.cqvip.com), with the terms "COVID-19", "designated hospital", "Hubei-assisted", "makeshift hospital", "nursing", "nursing shift", "whole-system takeover" and variations of these, in the title and abstract fields and the Boolean combinations of these words as the retrieval strategy (Table 1). The type of literature was limited to journal article. The full texts of

Table 1 Search Strategy for Retrieval of Chinese Literature on Nursing Scheduling Mode and Experience from the Medical Team in Aiding Hubei Province During the COVID-19 Outbreak

Search	Query
#1	COVID-19[tiab] OR the novel coronavirus[tiab] OR the coronavirus outbreak[tiab]
#2	Hubei assisted[all fields] OR aid of Hubei[all fields] OR aid of Wuhan[all fields] OR E-assisted[all fields] OR medical teams in assisting Wuhan[all fields]
#3	Nursing[all fields] OR nurses[all fields] OR nursing shift[all fields] OR nursing management[all fields] OR management mode[all fields] OR reorganization system[all fields]
#4	Designated hospital[tiab] OR makeshift hospital[tiab] OR whole system takeover[tiab]
#5	(#1 AND #2 AND #3) OR #4

all related publications were downloaded. Two independent researchers (X.Z. and D.H.) screened the downloaded articles manually according to inclusion and exclusion criteria after reviewing the titles and abstracts and the full text. The references of the downloaded articles were also manually screened for relevant studies. If there were considerable discrepancies, the principal investigator (P. G.) would judge whether an article met the inclusion criteria.

Inclusion and Exclusion Criteria

Observational or self-controlled studies were eligible for the inclusion if they could satisfy the following criteria, (i) they were studies providing nursing scheduling mode and experience from the medical teams in aiding Hubei Province during the COVID-19 outbreak; (ii) they provided the type of the hospital or ward assisted; (iii) they provided the type of aiding mode (whole-system takeover or joint management); (iv) they provided the characteristics of nursing team involved. Regarding the exclusion criteria, case reports and case series, review articles, letters to the editor, the articles that only with ambiguous information of nursing shift and studies providing duplicated information in the same ward and nursing team were excluded.

Information Extraction

After the downloaded full texts were extracted and double-checked, the following eligibility items and information were collected and recorded for each included study: first

author, journal, date of submission, author's identity (nurses aiding epidemic control in Hubei or local nurses in Hubei), date of medical team dispatched to aid Hubei, type of hospital or ward assisted (designated hospital or makeshift hospital) and the mode of aid (whole-system takeover or joint management), characteristics of nursing team involved, nursing shift length, adjustment information, the reasons for the adjustment and the subsequent effects of the adjustment (if available), type of study to measure each work shift (observational study or self-controlled study). In this process, those events that caused nurses to be unable to perform nursing tasks and some work-friendly measures were also extracted. To ensure the reliability, two investigators (X.Z. and D.H.) independently summarized the data before discussing the results together, and all the discrepancies resolved by the principal investigator (P.G.).

Results

Data Acquisition and Characteristics of the Included Studies

Based on the pre-defined search strategy and the inclusion and exclusion criteria, altogether, 17 journal articles have been included in the target field (Table 2). The literature selection process is presented in Figure 1.¹² These 17 articles scattered in 15 kinds of journals, these journals could be grouped into three categories, nursing (eight kinds of journals), clinical medicine, including general medicine, critical care medicine and disaster medicine (five kinds of journals), and hospital management (two kinds of journals). Among the articles, there are 12 articles with all the authors were nurses aiding epidemic control in Hubei, there are four articles published by the nurses aiding epidemic control in Hubei

Table 2 Time of Providing Aid to Hubei, Article Submission Time and Journal Distribution in the Included Studies

Included Studies	Author's Identity	Date of Medical Team Dispatched to Aid Hubei	Article Submission Date	Type of Journal
Chen Q 2020 ¹⁴	Nurses aiding epidemic control in Hubei	14 February, 2020	03 March 2020	Nursing professional journal
Gao S 2020 ¹⁵	Nurses aiding epidemic control in Hubei	09 February 2020	20 March 2020	Nursing professional journal
Guo Q 2020 ¹⁶	Hubei local nurses in host hospital	Not mentioned	02 April 2020	Nursing professional journal
Kong R 2020 ¹⁷	Nurses aiding epidemic control in Hubei	13 February 2020	25 March 2020	Medical professional journal
Liu Y 2020 ¹⁸	Nurses aiding epidemic control in Hubei	25 January 2020	15 May 2020	Nursing professional journal
Lu J 2020 ¹⁹	Nurses aiding epidemic control in Hubei & Hubei local nurses	14 February 2020	02 March 2020	Medical professional journal
Luo C 2020 ²⁰	Nurses aiding epidemic control in Hubei & Hubei local nurses	13 February 2020	22 April 2020	Nursing professional journal
Nie J 2020 ²¹	Nurses aiding epidemic control in Hubei	24 January 2020	05 June 2020	Nursing professional journal
Peng X 2020 ¹³	Nurses aiding epidemic control in Hubei	26 January 2020	10 February 2020	Nursing professional journal
Shen P 2020 ²²	Nurses aiding epidemic control in Hubei	February 2020	14 March 2020	Medical professional journal
Wu Y 2020 ²³	Nurses aiding epidemic control in Hubei	Not mentioned	15 March 2020	Nursing professional journal
Xiao Y 2020 ²⁴	Nurses aiding epidemic control in Hubei & Hubei local nurses	Not mentioned	26 February 2020	Hospital management related journal
Ye L 2020 ²⁵	Nurses aiding epidemic control in Hubei & Hubei local nurses	Not mentioned	10 March 2020	Nursing professional journal
Zhang L 2020 ²⁶	Nurses aiding epidemic control in Hubei	Not mentioned	11 March 2020	Nursing professional journal
Zhang Y 2020 ²⁷	Nurses aiding epidemic control in Hubei	28 January 2020	27 February 2020	Medical professional journal
Zheng J 2020 ²⁸	Nurses aiding epidemic control in Hubei	Not mentioned	Between 25 March 2020 and 20 April	Hospital management related journal
Zheng X 2020 ²⁹	Nurses aiding epidemic control in Hubei	24 January 2020	20 February 2020	Medical professional journal

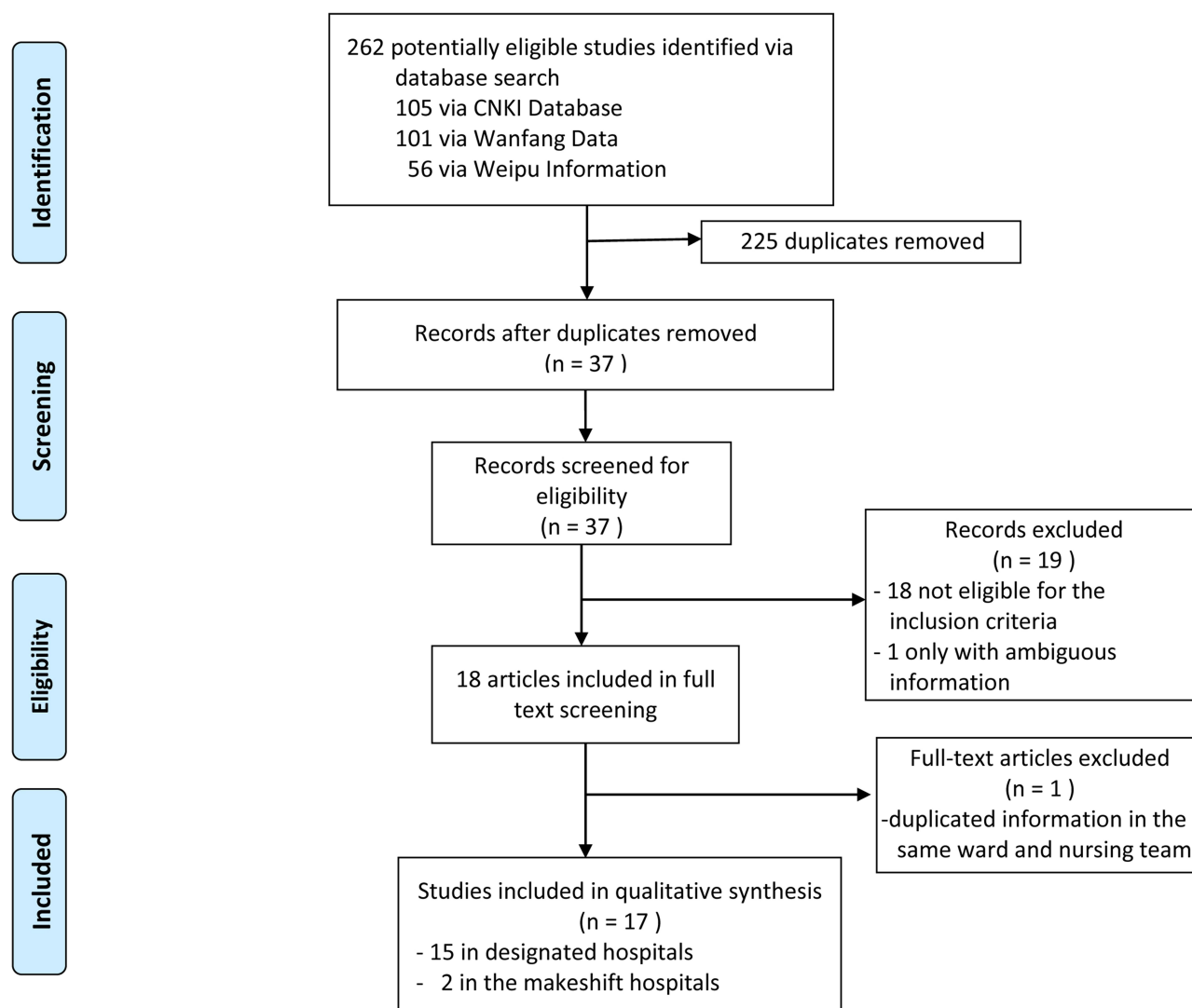


Figure 1 The preferred reporting items for systematic reviews and meta-analyses flow diagram. Adapted from Moher D, Liberati A, Tetzlaff J, Altman DG; PRISMA Group. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *PLoS Med.* 2009;6(7):e1000097.¹²

and the nurses in Hubei local hospitals, there is one article written by Hubei local nurses. According to the available information regarding the dispatch date of aiding Hubei and the date of article submission, the fastest article was summarized and submitted within 15 days after aiding Hubei,¹³ this article was also the earliest submission (Table 2).

Nursing Shift Length and Adjustment in the Included Studies

Among the included 17 studies, 15 medical teams provided medical assistance in designated hospitals and the other two medical teams worked in the makeshift hospitals (Table 3); among these 17 studies, 16 medical teams worked in Wuhan City, the capital city in Hubei

Province, and one medical team worked in a county-level designated hospital in Huanggang City.¹⁷ Regarding the distribution of management mode, two studies indicated joint nursing management,^{16,24} and the rest 15 studies presented the whole-system takeover mode (Table 3).

Among the included 17 studies, six studies indicated clear adjustment of nursing schedule mode and subsequent effect of the adjustment (Table 3).^{13,17,21,22,28,29} Most medical teams worked in a three-zone environment (contaminated area, ie red zone; potentially contaminated area, ie yellow zone; clean area, ie green zone), and one medical team²⁰ had to work in a two-zone environment (contaminated area, ie red zone; relatively clean area, ie green zone) under the limitations of the original layout of the hospital building.

Table 3 Nursing Shift Length and Adjustment Provided by the Medical Teams in Aiding Hubei Province During the COVID-19 Outbreak

Included Studies	Type of Hospital or Ward Assisted and the Mode of Aid	Characteristics of Nursing Team Involved	Type of Study, Shift Length, Adjustment and Effects
Chen Q 2020 ¹⁴	Designated hospital, whole-system takeover	91 nurses from 39 hospitals in Fujian Province	Observational study. 4-hour (h) shift, work-rest balanced mode, flexible scheduling according to nursing workload (in the afternoon and evening shifts during peak hours for admission of patients, 1–3 additional standby nurses; during the peak discharge period, reduce the number of standby nurses according to the real-time workload)
Gao S 2020 ¹⁵	Designated hospital, whole-system takeover	100 nurses from Shandong Province	Observational study. Dynamic scheduling based on workload, flexible scheduling based on working hours, workload and the number of critically ill patients admitted, humanized scheduling based on the daily reported health status of the nurses, and professional-integrated scheduling according to the professional distribution of nurses on the basis of four-hour shift length
Guo Q 2020 ¹⁶	Intensive Care Unit in designated hospital, joint management	100 nurses from other provinces, 25 local nurses	Observational study. 4-h shift for responsible nurses aiding Hubei, 6-h shift for local nurses from host hospital assisting in communication and handling of medical advice and other administrative matters
Kong R 2020 ¹⁷	County-level designated hospital, whole-system takeover	35 nurses from 7 hospitals in Shandong Province	Self-controlled study. Humanized scheduling, at the beginning, special considerations for ensuring sufficient nursing manpower and protection safety; In the later stage, stepwise progressive scheduling mode with considerations for senior-junior cooperation and group-fixed arrangement Effects: no complaints about nursing service, no accidents in nursing quality, and no infection among nursing staff.
Liu Y 2020 ¹⁸	Designated hospital, whole-system takeover	93 nurses from Zhejiang Province	Observational study. 4-h shift from 8 a.m. to 8 a.m. the next day, 5 nurses/group per shift during daytime, 3 nurses/group per shift at night
Lu J 2020 ¹⁹	Intensive Care Unit in designated hospital, whole-system takeover	99 nurses from Zhejiang Province	Observational study. 4-h shift, nurse-patient ratio: 1:5 ~ 1:8 for moderate COVID-19 patients; 1:3 ~ 1:5 for severe patients; 1:1 ~ 1:3 for critically ill patients, 1–2 standby nurses for each shift
Luo C 2020 ²⁰	Designated hospital, whole-system takeover	50 nurses from the military medical team	Observational study. 4-h shift, within 2 to 3 hours for the first time working in the contaminated area; fixed arrangement of 6 nurses/group
Nie J 2020 ²¹	Designated hospital, whole-system takeover	80 nurses from the armed force	Self-controlled study. Preliminary schedule: 4-h shift from 9 a.m. to 9 a.m. the next day, 8 responsible nursing groups rotating in turn. After adjustment: 4-h shift, fixed work shift sequence, 8 days as a rotation cycle thus one day off after the 3rd shift and the 7th shift Effect: The three fixed shifts of each nursing group in each rotation cycle improved the proficiency and work efficiency of nursing work, and reduced the psychological burden of nursing staff; between two shifts in each group, 4 hours of rest time was added, and thus the effective rest time could reach 18 to 20 hours.
Peng X 2020 ¹³	Designated hospital, whole-system takeover	48 nurses from the military medical team	Self-controlled study. Preliminary schedule: 2-h shift, special considerations for personnel adaptation, environmental adaptation, collaboration; After adjustment: 3-h shift, special considerations for morning/evening shift and the rescue period Effect: the scheduling design and adjustment improved the overall scheduling satisfaction of nurses and thus provided a good foundation for human resources protection.

(Continued)

Table 3 (Continued).

Included Studies	Type of Hospital or Ward Assisted and the Mode of Aid	Characteristics of Nursing Team Involved	Type of Study, Shift Length, Adjustment and Effects
Shen P 2020 ²²	Designated hospital, whole-system takeover	102 nurses from the military medical team	Self-controlled study. Preliminary schedule: 4-h shift in progressive scheduling mode. After adjustment: 4-h shift in rolling scheduling mode. Effect: the nurse staff could get a timely rest, the damage to sleep was minimized, and thus the body's tolerance and resistance were improved.
Wu Y 2020 ²³	Makeshift hospital, whole-system takeover	100 nurses from Xinjiang Uygur Autonomous Region	Observational study. 6-h shift from 8 a.m. to 8 a.m. the next day
Xiao Y 2020 ²⁴	Designated hospital, joint management	93 nurses from national medical team, 15 nurses from host hospital	Observational study. 4-h shift, 6 nurses/group per shift during daytime, 4–5 nurses/group per shift at night
Ye L 2020 ²⁵	Makeshift hospital, whole-system takeover	200 nurses from Anhui Province	Observational study. 6-h shift from 8 a.m. to 8 a.m. the next day
Zhang L 2020 ²⁶	Intensive Care Unit in designated hospital, whole-system takeover	120 nurses from 7 hospitals in Tianjin City	Observational study. 4-h shift with senior nurses take care of severe and critically ill patients
Zhang Y 2020 ²⁷	Designated hospital, whole-system takeover	19 nurses from Gansu Province	Observational study. 6-h shift from 8 a.m. to 8 a.m. the next day, with 7, 5, 5 and 3 nurses per shift
Zheng J 2020 ²⁸	Intensive Care Unit in designated hospital, whole-system takeover	100 nurses from Beijing City	Self-controlled study. Preliminary schedule: 6-h shift. After adjustment: 4-h shift Effect: the nurses' job satisfaction was increased
Zheng X 2020 ²⁹	Designated hospital, whole-system takeover	82 nurses from 9 hospitals in Guangdong Province	Self-controlled study. Preliminary schedule: 4-h shift, the quota of nurses was allocated to the assisted medical teams from each hospital (9 hospitals in total). After adjustment: 4-h shift, group-fixed arrangement (nurses in one group from at most 1 or 2 hospitals) Effect: nursing work more smoothly and cooperate more tacitly.

Note: Designated hospital for COVID-19 patients.

In the makeshift hospitals that mainly treated mild COVID-19 patients, six-hour (h) shift was adopted; while in the designated hospitals, four kinds of shift length, 2-h,¹³ 3-h,¹³ 4-h and 6-h^{23,25,27,28} shift have been considered (Table 3). For the shift rotation mode, it has been indicated that the mode of rotating in turn was adopted first and then was modified to fixed work shift sequence to provide the nurses an extra four hours' rest between two work shifts. Flexible scheduling and humanized scheduling were indicated in all the included 17 studies. Nine articles recommended the relatively fixed-grouping of nurses in the nursing management.^{13,14,17,19–22,26,29}

Events with Impact on Nurses' Work and Some Work-Friendly Measures

In the 17 included studies, the events that have been reported to have an impact on the nurses' work and life mainly include the psychological stress,^{15–17,20,23,24} facial pressure injuries from wearing personal protective equipment,^{13,20} female menstrual period¹⁸ and the symptoms of chest tightness, dizziness, nausea under the three-level protective measures.^{15,19,20} The specific solutions mentioned include the clarification of job responsibilities as detailed as possible,^{15,20,24} the deployment of

psychologist in the medical team,¹⁶ timely statistics of nurses' extra shift and extra working hours and timely arrangement of compensatory time off,¹⁷ preparing obvious labels or identifications for various items and medicines,^{21,26} the optimization of the placement and location of items, especially the placement of the items in the upper cabinet which can reduce the number of squatting and standing posture conversions,²¹ those solutions have been proved to save working time and reduce the nursing workload. In the composition of each nursing team, the following composition has been considered and put into practice, each nursing team was equipped with one to two nurses with intensive care or respiratory care experience,^{19,28} in the intensive care unit, at least one nurse in each nursing shift could operate the ventilator proficiently,²⁶ at least one to two male nurses in each nursing shift.²⁰ Additionally, in each nursing team, the composition of senior and junior nurses was also considered.^{15,16,23,27–29} In terms of emotional motivation, the organization of activities during the time of traditional festivals and medical team members' birthdays has also been proved helpful to improve the quality of work life in the fast-paced working environment of cross-regional medical assistance.^{17,28}

Discussion

In the context of COVID-19 outbreak and epidemic status, the nurses from across the country to aid Hubei have encountered the vast challenges. Their roles were not only the nurses, but also the care workers, cleaners and porters, they needed to undertake the extra tasks of disinfection, isolation and item handling.^{30–32} Thus, in this situation, timely summarizing the existing frontline experience in managing the human resources and the scheduling mode can contribute to improve the nurses' job satisfaction and the quality of nursing services.³³ The scheduling mode in designated hospital that presented in the included studies could be summarized as

Dynamic scheduling based on workload, flexible scheduling based on working hours, workload and the number of critically ill patients admitted, humanized scheduling based on the daily reported health status of the nurses, and professional-integrated scheduling according to the professional distribution of nurses on the basis of four-hour shift length. (abbreviated as 4-h shift based DFHPI scheduling strategy).

And in makeshift hospital, the corresponding scheduling mode was "6-h shift based DFHPI scheduling".

The efficient work of nurses after arriving in Hubei contributed a lot to shorten the long waiting list of COVID-19 patients and deal with the short-term crisis in Hubei province. Some medical teams first chose the 6-h shift mode from the perspective of treating more patients as soon as possible, and some other medical teams first chose the 2-h¹³ or 3-h¹³ shift mode from the perspective of improving the adaptability of nurses. Subsequently, they all adjusted the shift length according to the severity of the condition of the admitted COVID-19 patients, the adaptation of the nurses and the peak number of admitted patients or discharged patients. Professional integrated scheduling indicated that the nurse leaders had to conduct the baseline survey of the nurses' professional background, age, education level and work experience before grouping. All the shift length-related adjustment decisions required the nurse leaders to have a good knowledge of not only the distribution of disease severity among the admitted patients, but also to understand the professional background and dynamic personal physical condition and emotional stress of the responsible nurses.³⁴ In the era of COVID-19, it has been reported that the recognition of the leadership style, organizational culture and model of successful implementation are inextricable is the first step to guarantee sustainable interventions to support healthcare workers' well-being will follow.³⁵

In terms of working hours in each shift, from February to March, 2020, one questionnaire-based cross-sectional survey has been conducted among 109 nurses who have worked in 10 designated hospitals providing treatments to patients with COVID-19 in China.³⁶ In the survey, 60.55% (66/109) of the nurses regarded four hours as the preferred number of work hours per shift and it has been identified that the circumstances, personal preventable equipment, the nurses' physical and emotional needs of nurse, and the nurses' safety needs and work intensity are the main influencing factors associated with gap between the actual work hours and the nurses preferred work hours.³⁶

The topic discussed in the present study is the cross-regional medical assistance in the same country in the face of major public health emergencies, in the early days of the COVID-19 outbreak and epidemic.³⁷ The authors clearly understand that in the real world, it is difficult to provide recommendations or solutions that could fit all medical institutions, owing to the major differences between them in terms of the total number of beds including ICU capacity,

the availability of hospital resources and the severity of admitted COVID-19 patients in each country or region. It can be inferred that if in the context of cross-border medical assistance, the jet lag, different standards of medical devices, labeling issues on various kinds of drugs and the language issues between the medical teams from different countries and local people will pose considerable challenges. In the future, there are more things that can be done to improve the nursing management.^{38,39} Continuous scientific arrangement of nursing shifts, simpler checklist, better interpretation of the nursing management plan, smarter equipment for monitoring and evaluating the nursing workload or physical conditions of nurses would be helpful to improve the nurses' job satisfaction and the quality of nursing, reduce the work intensity and work stress of the nurses.⁴⁰⁻⁴²

This present systematic review has several potential limitations which may encourage further research efforts. First, 16 of the 17 included studies introduced the work in Wuhan city, and only one article reported the status in Huanggang city. The reports on the nursing management situation in other cities in Hubei Province will be further collected. Second, the generalizability of the protocols or nursing scheduling modes provided in the included studies could not be judged or evaluated. Third, due to time constraints or other reasons, only a small part of nurses that have provided assistance to Hubei summarized their nursing scheduling experience in the format of journal article. The experience that might nest in the newspaper and video interview will be further explored and collected.

Conclusion

The descriptive results of the present systematic review shed light on the challenges and practical solutions of nursing scheduling mode in the context of cross-regional medical assistance. Additionally, the present systematic review could provide the academic community of nurses, nurse managers and administrators with baseline information and scientific productions from the content's points of view in the target field.

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Disclosure

The authors declare no conflicts of interest in this work.

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