



Measures for preventing nosocomial infection with SARS-CoV-2 in hematology departments

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Received: 5 May 2020 / Accepted: 3 June 2020 / Published online: 29 June 2020
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Introduction

Coronavirus disease 2019 (COVID-19) is caused by the novel coronavirus (SARS-CoV-2) [1]. SARS-CoV-2 infection has spread all over the world and has resulted in 1,436,198 confirmed cases of infection and 85,522 deaths as of 9 April 2020 [2]. This condition poses an urgent public health issue in the world [3]. No specific treatment or vaccine is available against this virus [4]. Hence, a classic but effective method to stop the propagation is by cutting the spread chain by using personal protective equipment and limiting personal contact [5]. The incubation period of COVID-19 is 1–14 days, mostly 3–7 days, and its main manifestations include fever, dry cough, and fatigue. COVID-19 is transmitted person-to-person through respiratory droplets and close contact [6, 7]. Fragile patients such as patients with cancer and elderly persons comprise the frequently infected population with severe symptoms, such as dyspnea and/or hypoxemia, 1 week after the onset of the disease, and the prognosis is very poor [8]. Hence, more attention should be paid in coping with patients having blood diseases. Moreover, these patients usually develop infection other than COVID-19 with manifestation of fever because of immunodeficiency and/or myelosuppression after many cycles of chemotherapy [9]. COVID-19 infection

should be distinguished from other microbiological infections for patients in hematology. Considering the COVID-19 exacerbation, the consequences are extremely serious for these fragile patients. Hence, potentially infected patients with COVID-19 should be identified quickly and isolated early [10]. Furthermore, health personnel should be protected from infection to provide the best possible medical services for patients and evaluate the outbreak risk in hospital [11]. Therefore, the prevention and control strategies for nosocomial infection in the hematology department should be discussed to prevent COVID-19 infection and severe consequences. In the present study, we shared our experience from the past 2 months in the hematological department and suggest preventive actions for the future.

Strategies

Experiences in managing nosocomial infection prevention in the hematology department

Overview of general measures about nosocomial infection prevention in the hematology department

The hematological department of Zhongnan Hospital of Wuhan University constitutes an outpatient clinic and an inpatient department. The latter includes three units, namely, general, intensive care, and laminar air flow wards. Several measures have been implemented to prevent nosocomial infection in the hematology department, and an overview of these measures is shown in Fig. 1.

The inpatient department was reorganized in accordance with the request of nosocomial prevention and control strategies. Intensive care and laminar air flow wards were closed. Temporary isolation wards were planned with three zones and two aisles in case of a suspected or confirmed COVID-19 case [12]. Furthermore, the rules of sanitation and standards of operational procedures were fully implemented in different dimensions, such as health personnel, patient and accompany

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management, local sanitation management including environment disinfection, medical facilities and equipment’s sterilization, and medical and non-medical waste disposal.

A workflow for the outpatient clinic management was also designed to exclude potential risk of these two kinds of patients carrying SARS-CoV-2, namely, infected patients without symptoms and patients in infectious incubation stage [13] (see Fig. 2). All patients were first received at the pre-check office, followed by temperature measurement and short investigation of COVID-19 epidemiology. Then, these patients were guided to fever clinic or specialist clinic for further consultation [14]. Once the patients were excluded for COVID-19, they were allowed to consult with the hematology clinic. Temperature was checked, and careful epidemiological history was inquired again before evaluating hematological problems. For patients who did not require admission for having no or mild symptoms, prescription was provided with a suggestion to continue online follow-up. For patients who needed hospital admission for further treatment, COVID-19 screening tests including chest CT scan, blood routine test, virus PCR, and antibody test were prescribed immediately after admission. Patients with positive findings were transferred to temporary isolation wards attending for expert consultation, and then transferred to the infectious disease department or designated hospital. Only the patients with negative findings could continue specific treatment with close temperature monitoring.

Detailed measures implemented in the hematology department

Standard measures of hygiene for all staff and local environment were implemented according to the international

suggestions and guidelines from the National Health Commission about nosocomial infection prevention and control [15–18]. Moreover, additional measures with intensification were carried out for the management of health personnel and patients.

Health personnel management

Personal health status report with temperature check All staff provided daily report of their temperature and contact history with confirmed or suspected cases with COVID-19. The body temperature of staff on duty was checked before entering the ward.

Strict implementation of standard prevention and hand hygiene Standard personal protection with surgical mask, cap, and gloves were applied in dealing with routine activities for all patients. Level 2 protection was implemented with additional isolation gown and protective mask once a patient presented fever and potential risk of COVID-19 exposure. Once the patients were diagnosed as suspected or confirmed with COVID-19, level 3 protection was implemented, especially during high-risk medical activities. Hand hygiene was strictly implemented all the time.

Standardized daily behaviors of medical staff The maximum number of staff in the department was limited, and they were required to have enough rest for enhanced self-immunity. All the staff complied with the confinement of direct pathway between home and hospital to avoid unnecessary contact with persons with unknown conditions. All staff meetings were

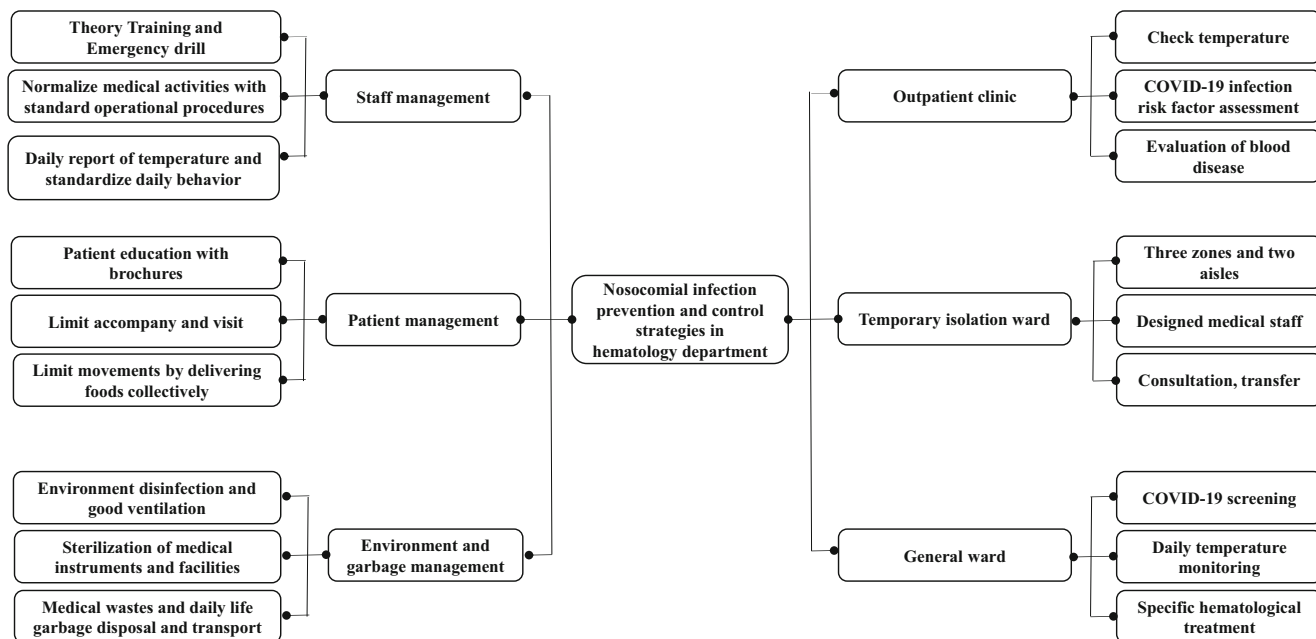
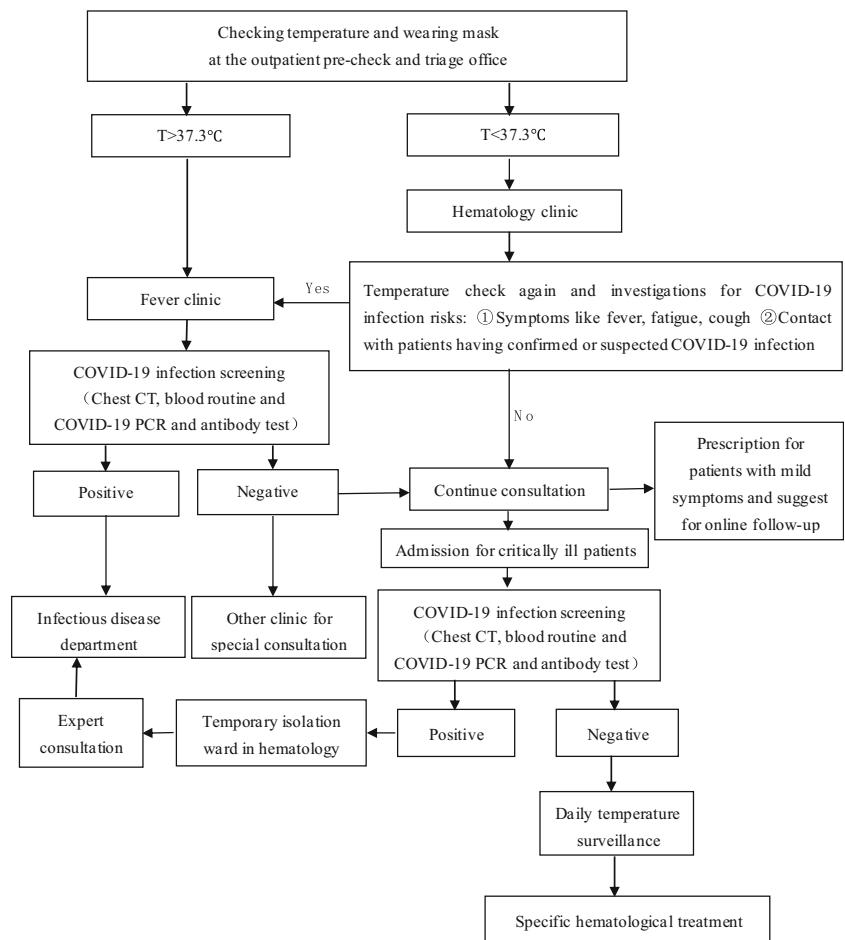


Fig. 1 Overview of strategies in the prevention and control of nosocomial infection in the hematology department during the COVID-19 outbreak

Fig. 2 Workflow for outpatient consultation. Pre-check and triage were done first, and only patients without risk of COVID-19 could proceed with hematology consultation after double checking of temperature



scheduled through Internet as E-meeting. The use of personal protection equipment should comply with hygienic regulations, and it should be replaced after use for each suspected patient. Eating and drinking were only allowed in the clean area. Furthermore, staff was allowed to rest in staggered time intervals. In case of unexpected meeting with each other, a distance of at least 1 m was observed. Hand hygiene was observed before examining patients and doing tests. After contact with patients, providing treatment, and touching any sample from patients, hand hygiene was strictly observed. All staff was required to wear a mask even during breaks.

Sustained training by taking theory courses and doing drill practice First, training courses about COVID-19 knowledge, including clinical manifestation, diagnosis, and treatments; nosocomial infection prevention and control strategies, including personal and environmental hygiene maintenance; and wearing and removing personal protective equipment correctly, were provided to all the staff by online courses and video. An assessment quiz was conducted after training courses to make sure that all members know how to protect themselves. Second, an emergency drill was designed and practiced with small groups, as shown in Fig. 3. A particular case was examined, and the medical team

dealt with this situation as an actual emergency. By doing this drill, potential problems about personal protection and the implementation of a chart about dealing with a local COVID-19 outbreak were examined, and improvements and adjustments were realized according to the results of drill. Finally, all the staff were well trained before this epidemic.

Patient and their family management

Training courses and brochures about COVID-19 and nosocomial infection prevention and control strategies were provided at the first day of admission. Local management rules were explained clearly with signature of confirmation. New patients admitted could have COVID-19 screening tests. No companions or visitors were permitted, except for extremely old and disabled patients with an absolute demand of assistance, and COVID-19 screening tests were required for companions before entering the department. Furthermore, once the patient developed fever or other suspected symptoms, COVID-19 screening tests were conducted again to make ensure that he or she was not infected or a potential infection source. Temperature was checked twice a day. The patients were asked to stay in their own wards with group meals

Fig. 3 Chart for the emergency drill of local COVID-19 outbreak in the hematology department



delivered to their door to reduce unnecessary contact. Patients and their companions were asked to respect personal hygiene instructions, such as wearing masks, 1 m of distance in contact, eating or drinking in staggered time, hand hygiene, and taking showers frequently.

Suggestions and perspectives for future work in preventing nosocomial infection

With the measures described above, including the workflow implemented in the outpatient clinic and inpatient department, and management of staff and patients, zero nosocomial

infection of COVID-19 was recorded in the hematology department. More measures could be explored in preventing nosocomial infection not only in hematology but also in other departments, even in worldwide medical institutions.

Strengthening the training of medical and paramedical staff about nosocomial infection

Once the staff fully understands the importance of nosocomial infection prevention and control, measures will be taken correctly in place. Adequate personal protection equipment is used in response to the risk level after infection risk evaluation [19, 20]. Standardized operation procedures and suggestions

about regulated daily activities and personal daily activities, such as eating and drinking, were specified in documents, and are implemented strictly for everyone. Inspection and supervision were reinforced by the nosocomial infection control office [21]. E-meetings or discussions about residual problems were scheduled to sustain improvement and adjustments. Furthermore, emergency drills were carried out regularly in cases of sudden outbreak in local service or in hospital.

Generalization of the knowledge about COVID-19 and personal hygiene for all the population by distributing brochures

One of the crucial methods to stop the propagation of COVID-19 epidemic is cutting the spread chain, particularly by controlling the infection source. Notably, some people infected with SARS-CoV-2 do not exhibit symptoms [22]. Hence, the general population should be educated about this epidemic and its corresponding solutions to protect themselves from COVID-19 [23].

Local reorganization in accordance with the epidemic infectious disease prevention and control norms

The outpatient clinic and hematological inpatient department were localized in different buildings separately. Local layout was planned according to three zones and two passageways. Transit wards were constructed for patients during the 3–5 days of waiting for screening results before transferring to the hematology department. A temporary isolation ward was also prepared for patients who presented symptoms after availing hematology service. Different zones including the clean, buffer, and polluted area were organized clearly [16].

Disinfection and hygiene maintenance of local environment

Sanitation workers were trained systematically in respecting all the procedures of nosocomial infection prevention and control. They understand how to use adequate disinfection methods for cleaning different materials, such as ground, wall, object surface, and medical facilities. They fully know how to deal with the different wastes generated in the service, such as medical wastes and normal domestic garbage. Good natural ventilation or air-sterilizing machines should be used [18]. Once the patients were discharged, complete terminal disinfection was done in their ward. Furthermore, a tracing system should be implemented with execution form recording the disinfection time with signature. All these activities should be supervised by nurses or doctors assigned to the nosocomial infection prevention and control team.

Using network information technology for teleconsultation with patients

All patients were recommended to consult with an online clinic first for a preliminary consultation with doctors. Then, doctors could evaluate whether they need to come to the hospital, or they just need to stay at home with prescription and regular follow-ups by teleconsultation. For patients who really need to come to the hospital for further examination or treatment, they could make an appointment with doctors at a fixed time point to avoid close contact with other patients. The registration could be done online, and the results can be seen in their mobile phone. The following admission appointment could be sent to the patients through messages or calls, thus avoiding prolonged stays in the outpatient clinic to wait for results or coming again to the hospital for obtaining the results.

Exploring the application of artificial intelligence technologies

A robot could be installed in the outpatient clinic. It could perform pre-check and triage by checking the patient temperature and taking the rough investigation of their chief complaints and associated symptoms. Then, it could guide the patients to the specified clinic or site of examination according to the appointment made. It could assist hospitalized patients, especially patients in temporary isolation ward. It can deliver food and oral drugs to patients, take basic vital parameters, and help in integrating useful information in the patient document. The video surveillance system and intercom system allowed the close monitoring of patients and prompted communication with patients without close contact. These applications could be useful and accommodating, especially during this epidemic period [24].

Conclusions

In conclusion, considering all the measures described above, such as rational local organization, training courses and emergency drilling, standardized operation procedures or documents for medical activities, local disinfection and hygiene maintenance, and patient education brochures, the hematology department has maintained zero infection among the medical staff and no cross-infection among patients and their family members. Moreover, the absence of nosocomial infection could be maintained by observing all the suggestions related to sanitation security. Even after the epidemic, the regulations about nosocomial infection prevention and control should be observed. Moreover, the basic strategies of nosocomial infection prevention should be understood and practiced in daily medical activities to prevent nosocomial infection.

Acknowledgments The authors would like to thank the staff of Zhongnan Hospital of Wuhan University for their support.

Funding information This work was supported by the Key Project for Anti-2019 novel Coronavirus Pneumonia from the Ministry of Science and Technology, China (grant number 2020YFC0845500).

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Compliance with ethics guidelines This manuscript is a review article and does not involve a research protocol requiring approval of relevant institutional review board or ethics committee.

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