

Management strategy of novel coronavirus (COVID-19) pneumonia in the radiology department: a Chinese experience

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Since December 2019, the novel coronavirus disease (COVID-19) caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) has been spreading fiercely in Wuhan and has spread to the whole world, causing a health and economic disaster to the people of the world. COVID-19 has been included in class B infectious diseases stipulated in the law of the People's Republic of China on the prevention and control of infectious diseases, but the prevention and control measures for class A infectious diseases have been taken (1, 2). In case of the COVID-19 outbreak, a large number of patients with infection or suspected infection swarm into the hospital, the examination workload of the radiology department increases sharply, the labor intensity of the staff becomes higher, and the manpower becomes tense, because the transmission route of SARS-CoV-2 is through respiratory droplets and close contact transmission. There is also possibility of aerosol transmission when exposed to high concentration aerosol for a long time in a relatively closed environment (3, 4). According to the latest report, the infection rate among people in the hospital is about 41%, of which 29% is hospital staff and 12.3% inpatients (5). The risk of infection is extremely serious. Therefore, it is very important to prevent and control the spread of COVID-19 in the radiology departments, and it is necessary to determine practical, efficient and feasible prevention and control measures (6). In this short communication article, we provide a general overview of the prevention and control of the COVID-19 epidemic in the radiology department based on our own experience in Xiangyang First People's Hospital Affiliated to Hubei University of Medicine. We aim to give a detailed overview including the aspects of CT acquisition process, protection level, equipment management, environmental zoning and disinfection, and psychological counseling measures. It should be noted that the main goal of reasonable control in every link of radiology department is to complete the radiology examination safely and diagnose COVID-19 pneumonia patients with high efficiency and quality.

How to perform safe diagnostic scans

The posts of radiology department for epidemic prevention and control are mainly divided into diagnosis (radiologist, CT reading room) and technology (radiologic technologist, operating CT machines), and the protection for them is mainly divided into four categories: 1) High risk fever outpatient CT technical personnel, 2- High risk emergency CT technician, 3- High risk mobile X-ray technician. CT technologists who are in physical contact with the patient should perform personal protection in strict accordance with the third-level protection standards, and at the same time, do well in wearing and removing protective equipment in accordance with the standards of division of contaminated areas in the department. For example, remove the first layer of protective clothing, protective cap, N95 respirator, face shield, rubber sterile gloves and perform strict surgical hand washing techniques in the contaminated area; remove the work clothes, surgical mask, goggles and wash hands strictly in the intermediate area, and take a shower and wash hair in the clean area. 2) Routine CT technologists at medium risk shall take secondary protection standard to do well in personal protection. 3) Since the diagnostic physician does not need to contact the patient directly, personal protection according to the first or second level protection standards is

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sufficient. 4) The nursing staff shall wear protective equipment according to the tasks performed, such as wearing third-level protective equipment for venipuncture for enhanced CT examination in the contaminated area designated for COVID-19, and wearing second-level protection for guiding others to wear protective clothing in the clean area (Fig. 1, Fig. 2, Table, Supplemental Figs. 1–3). It should be noted that the technologist or the registration clerk should try to avoid contact with the patients; the patients must wear a face mask and engage in minimum conversation, and the distance between the technician and patients must be more than 2 meters (7, 8).

Equipment management and disinfection

Special CT or x-ray equipment shall be set for different risk inspection rooms. An independent control room is set up for special fever (suspected COVID-19 patients) CT examination room, which is isolated from the normal working environment of the radiology department, and a special channel is set up between the CT room, the fever clinic and the isolation area. During the transportation of suspected or confirmed patients,

the upper body and head of the patients need to be covered by plastic bags to prevent the patients from releasing virus by coughing and contaminating the environment (Fig. 3). In order to reduce the spread of virus, a disposable bedspread (one person one change, no reuse) is used to isolate the examination table from the patient. It is recommended to use soft cloth dipped in 2000 mg/L chlorine containing disinfectant or 75% ethanol for disinfection of CT

equipment in the special fever room. When the former is used, the residual chlorine disinfectant on the surface of the equipment shall be carefully cleaned with a soft cloth after disinfection, and then the equipment surface shall be dried naturally or wiped with a dry soft cloth; when 75% alcohol is used, the surface shall be dried naturally. Routine CT machine room equipment can be wiped and disinfected with 1000 mg/L chlorine containing disinfectant, or using

Table. List of items needed at different protection levels

List of protective equipment	Primary protection (low risk)	Secondary protection (medium risk)	Third level protection (high risk)
Protective cap	X	X	X
N95 respirator		X	X
Alcohol-based disinfectant hand sanitizer (75%)	X	X	X
Goggles/face shield	X	X	X
Sterile latex gloves	X	X	X
Isolation gown	X		
Protective clothing		X	X
Shoe covers/ protective boots		X	X
Surgical mask	X		
Adult diaper			X

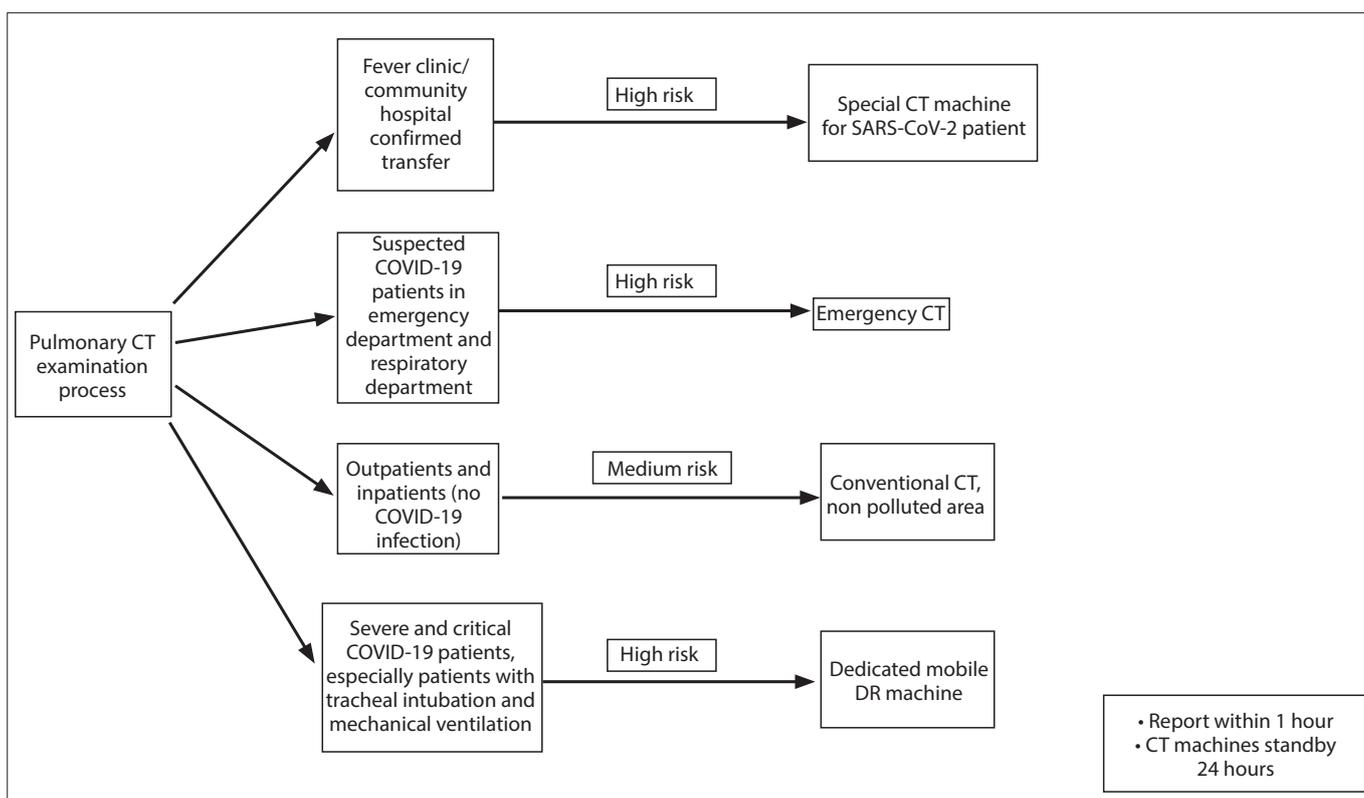


Figure 1. CT examination room: patient triage process.



Figure 2. Disposable bed sheet, CT technologist wearing full personal protective equipment.



Figure 3. The upper body and head of the patients are covered in plastic bags to prevent COVID-19 spread through patients coughing, releasing virus, and causing pollution.

disposable disinfectant wipes containing 75% ethanol, at least 3 times a day. According to the contaminant treatment regulations, the used cleaning wipes and other materials shall be uniformly incinerated. It is forbidden to disinfect the medical equipment room with spray, because this may cause the disinfectant vapor to penetrate

into the equipment, causing short circuit or corrosion (9, 10).

The flat detector of special mobile x-ray equipment is wrapped with disposable bed sheet. After the completion of imaging, the equipment is disinfected (wiped with 75% alcohol solution). After that, the equipment shall be stored in the designated location,

and it can only be put out for reuse after being thoroughly disinfected by ultraviolet light.

Disinfection in imaging suites

The special environment for “fever CT” which is designated for suspected COVID-19 patients, is divided into six areas and two channels strictly according to the requirements, i.e., contamination area, intermediate area, clean area, and two channels for CT personnel and patient (Fig. 4). Each area should be marked clearly, and the professional infection management personnel or nurses should provide the wearing guidance, and special attention should be paid to the importance of hand hygiene in each step during the wearing and removing of personal protective equipment. The floor of the computer room for CT examination of fever patients should be wiped and disinfected with 2000 mg/L chlorine-containing disinfectant at least 4 times a day. Negative pressure air circulation disinfection equipment has to be installed and the imaging suite of suspected or confirmed COVID-19 patients has to be disinfected strictly every day; if not possible, the circulating air disinfection machine needs to be used to continue disinfection. The average time interval between scans was 15–20 minutes during the peak period of the outbreak in our hospital and the longest interval was up to 3 hours.

Air disinfection, object surface disinfection, and floor disinfection should be carried out according to the daily operation specifications and quality control standards. During the epidemic period, we increased the frequency of disinfection of office articles and environment with 75% alcohol to 3 times a day (in the morning, midday, and evening), with particular care in disinfecting the surface of objects that are frequently touched, such as desktops, telephones, computer keyboards, and door handles. Good ventilation in the clean work area needs to be ensured at all times to prevent air and contact transmission. In addition, all waste material of patients should be regarded as infectious medical waste and immediately removed. The protective articles of the staff who have examined the suspected or confirmed patients shall be directly discarded in the medical waste bin with double garbage bags after the examination, and shall be clearly marked and transported in a sealed manner.

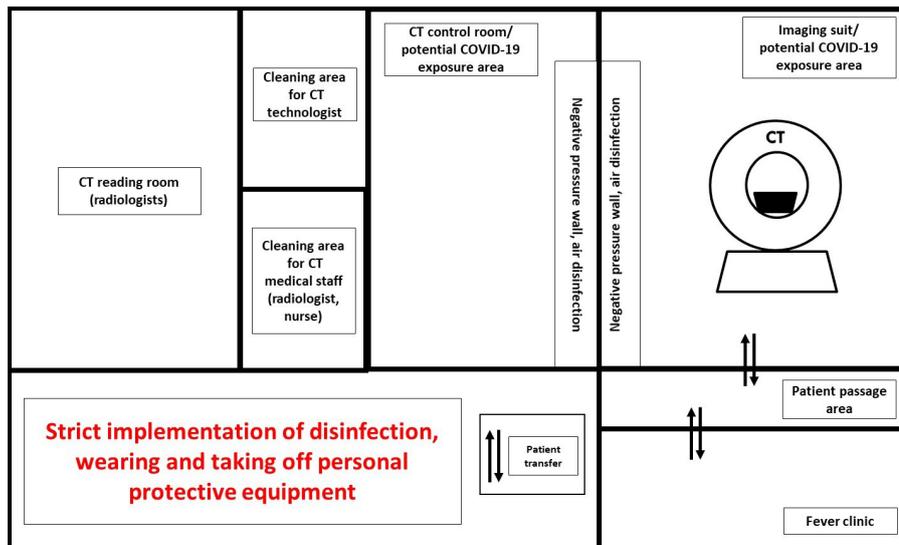


Figure 4. CT area design for fever clinic.

Psychological counseling measures for staff members

Since the emergence of the outbreak, all the staff of the radiology department have been arranged to live in a hotel near the hospital and are not allowed to go home. The virus and its outbreak is devastating, but more terrible than that were rumors and panic related to the COVID-19. The medical staff of radiology department was faced with the problems of high work intensity and high psychological pressure in the front line of the battle, so they needed psychological intervention and guidance. Some important measures taken were as follows: teach decompression techniques to help relieve bad emotions; remind the combination of diligent work and enough rest to ensure adequate diet, sleep and rest; encourage to seek social support, more video communication and talk with family members, friends and colleagues; require those finding themselves in abnormal emotional state to seek the help of a professional psychologist. The professional knowledge, careful prevention, and mental well-being of every radiology staff will protect themselves and have a positive impact on the patients in the fight against COVID-19 (11, 12).

Basic indications for computed tomography

Depending on the severity phase of the outbreak, the indications can change. In

our experience, in principle, in the peak period of the outbreak, adults who had fever symptoms, contact history in the center of epidemic (Wuhan travel history or contact history of Wuhan personnel) or positive nucleic acid test had to receive CT examination, since we found that many patients tried to conceal their illness, causing spread of COVID-19 to medical staff or other personnel. However, imaging of pregnant women and children were decided by the expert group after discussion.

As the epidemic subsided, the patients with contact history in the center of epidemic still needed to receive CT examination, while the patients with ordinary fever without contact history were triaged to receive chest X-ray examination and medical observation in the isolation ward. Additionally, there was a special group of patients who self-treated fever symptoms with over-the-counter antipyretics before the admission, but presented with abnormal findings in routine blood examination; this group of patients were observed in the isolation ward and the need for CT examination was decided upon after the discussion of the expert group.

Conclusion

In conclusion, COVID-19 pandemic is affecting most countries in the world and healthcare workers are in the frontline in the fight against this pandemic. Imaging, especially CT and x-ray, plays a critical role in the diagnosis of COVID-19 pneumonia and triage of patients for appropriate man-

agement. It is critical to make sure that suspected or confirmed COVID-19 patients are scanned and diagnosed safely. In doing so, available guidelines have to be applied strictly.

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Conflict of interest disclosure

The authors declared no conflicts of interest.

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Supplemental Figure 1. CT room triage table, the protection of guide nurses.



Supplemental Figure 2. Protection of CT physicians, CT reading room.



Supplemental Figure 3. Protection of technicians in the emergency CT room.