

Self-protection of medical workers in ophthalmology clinic during COVID-19 epidemic

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Abstract. Coronavirus Disease 2019 (COVID-19) is an infectious disease caused by a coronavirus called SARS Coronavirus 2 (SARS-CoV-2). It has been observed that COVID-19 mainly spreads via respiratory tract, contact and digestive tract. Due to the particularity of profession, ophthalmic medical workers need to be in close contact with patients, so they have a higher risk of SARS-CoV-2 infection. In this paper, therefore, the self-protection of medical workers in ophthalmology clinic during COVID-19 epidemic was summarized, so as to improve the occupational protection measures for medical workers in ophthalmology clinic, strengthen the self-protection awareness, and protect the safety of such a special group.

Key Words:

Coronavirus Disease 2019, Ophthalmology, Medical workers, Self-protection.

Introduction

Since December 2019, unexplained pneumonia has been successively found in people with a history of exposure to the Huanan Seafood Market in some hospitals in Wuhan, Hubei Province, China, which has now been confirmed as acute respiratory infectious disease caused by SARS Coronavirus 2 (SARS-CoV-2) infection. On March 27, 2020, the World Health Organization (WHO) Director-General Dr. Tedros Adhanom Ghebreyesus announced that there had been more than 500,000 cases of the novel coronavirus pneumonia around the world. In addition, more than 100,000 cases have been cured worldwide, and it will take at least 12-18 months to develop the vaccine.

Li Wenliang, an ophthalmologist at the Central Hospital of Wuhan, was infected by a glaucoma patient due to no special protection, and died on February 7, 2020.

Due to the particularity of the profession, ophthalmic medical workers need to be in close contact with patients, so they have a higher risk of Coronavirus Disease 2019 (COVID-19). In this paper, the knowledge about the COVID-19 and the self-protection measures for medical workers in ophthalmology clinic were summarized.

Introduction to COVID-19

It was reported prior to 2019 that only 6 kinds of coronaviruses can infect humans and cause respiratory diseases, namely HCoV-229E, HCoV-OC43, HCoV-NL63, HPU1, SARS-CoV and MERS-CoV, in which SARS-CoV and MERS-CoV infection can lead to severe respiratory syndrome in humans¹. COVID-19 is an infectious disease caused by SARS-CoV-2. After genomic sequencing, Chinese scientists and the WHO have jointly announced that SARS-CoV-2 is a kind of novel coronavirus^{2,3}. SARS-CoV-2 is a novel coronavirus belonging to β genus, and it has an envelope and round or oval particles with a diameter of 60-140 nm, mostly in a polymorphic way. Studies have demonstrated that it has a homology of more than 85% with bat SARS-like coronavirus (bat-SL-CoVZC45).

Infectivity and transmission route of SARS-CoV-2 and susceptibility factors for ophthalmic medical workers

In previous studies, coronaviruses were found in tear samples of patients with SARS⁴. During the SARS epidemic, most of the medi-

cal workers who died of infection were in close contact with patients^{5,6}. SARS-CoV-2 causing COVID-19 has a high homology with bat-SL-CoVZC45, and its transmission route is similar to that of SARS. It has been confirmed that COVID-19 mainly spreads *via* respiratory tract, contact and digestive tract (fecal-oral). Previous studies have found that droplets from a sneeze or cough can spread up to 6 meters in an indoor environment⁷. Considering the routine diagnosis and treatment procedures, medical workers in ophthalmology clinic can contact the unscreened people to a large extent. Moreover, in close ophthalmic examinations, such as slit-lamp examination and ophthalmoscopy, especially direct ophthalmoscopy, the doctor must be as close to the patient as possible, facing a higher risk of infection. In addition, aerosols will be produced in the measurement using a non-contact tonometer every time, which also increases the risk of infection for ophthalmic medical workers.

Hand hygiene of medical workers

The implementation rate of hand hygiene is low in medical workers, and there are many reasons, such as overestimating their own consciousness, inconvenient location of hand sink, insufficient number of medical workers or busy work, skin irritation and insufficient attention to guiding principles⁸. In a study on a Ugandan eye clinic, it was found that about 80% of medical workers do not adhere to the hygiene standards, because they think that only symptomatic patients are at risk of disease transmission, so they can wash hands arbitrarily⁹. According to a study on bacteria on the hands of ophthalmologists, although their hands are considered “relatively clean”, some pathogens are still found on them after contacting the patient, including methicillin-resistant *Staphylococcus aureus*¹⁰. During diagnosis and treatment in the Department of Ophthalmology, medical workers often need to touch the patient’s eye or even mucosa with their hands. There are disposable medical gloves in the ward and clinic, but it does not guarantee that the doctors use disposable gloves every time they contact with the patients, especially in Ophthalmology Clinic. When changing gloves frequently, medical workers may be exposed to pollutants, or wash hands incorrectly or not promptly, making contaminated hands an infection medium¹¹.

Prevention and control of patients

Screening of patients

In a recent article of a research group of Academician Zhong Nanshan about clinical analysis involving nearly 1,100 COVID-19 patients in 552 hospitals in 31 provincial-level administrative regions, it was pointed out that only 43.1% of patients have fever on admission, but fever occurs in more patients during hospitalization¹². In epidemic prevention and control, checking suspected cases only by body temperature measurement may “miss a large number of patients without fever”^{13,14}. Therefore, in addition to body temperature measurement for all patients, it is also necessary to inquire the epidemiological history for those with normal temperature, including the history of contact with suspected/confirmed cases, history of travel to epidemic areas, and history of exposure to suspected epidemic places of disease.

Full implementation of appointment registration for treatment

To avoid the gathering of people for on-site registration and control the number of patients, the patients should be registered online for treatment.

Secondary pre-examination in ophthalmology clinic

Secondary pre-examination is required at the entrance of Ophthalmology Clinic. The patients should measure the body temperature and fill in relevant questionnaires, so as to screen out suspected cases as far as possible.

Air sterilization

COVID-19 can now be transmitted through the respiratory tract, so air sterilization in the clinic is extremely important. Air sterilization has been long considered as an important measure to purify indoor air and prevent nosocomial infection. Physical sterilization and chemical sterilization are two commonly-used methods of air sterilization. Physical sterilization includes ultraviolet air sterilization and ozone sterilization, and air sterilization tools are electrostatic adsorption air sterilizers, plasma air sterilizers and photocatalyst air sterilizer. Chemical sterilization includes air disinfectant tablets and peroxyacetic acid sterilization. During clinical reception, air sterilization can be implemented in various ways in Ophthalmology Clinic according to the actual conditions. After daily reception, ultraviolet sterilization can be adopted in the Clinic for 60 min. In the case of difficulty, aerosol sprays of 0.2% peroxyacetic acid

solution or 500 mg/L chlorine dioxide solution can be used for sterilization in an unattended and closed environment with doors and windows closed. After 60 min, the windows should be opened for ventilation.

Central air-conditioning

Microbial aerosols refer to the particulate matters in size of 1-100 μm , containing bacteria, archaea, fungal spores, pollen, viruses, organic substances secreted by active organisms, and plant or animal fragments and debris, which are a colloidal system formed by suspended microorganisms in the air. The air-conditioning ventilation system is a potential source of pollution, which increases the microorganisms in the midstream-downstream air, thereby raising the concentration of microorganisms in the indoor environment. According to previous studies on the air-conditioned wards, the particle size distribution of bacterial aerosols is related to the season, grade 3-5 in summer and grade 1-3 in winter. At the same time, the median diameter of planktonic bacteria is also affected by the season, smaller in summer than that in winter¹⁵. For the air-conditioning system with built-in purification function in the hospital, it is appropriate to clean the coarse filter gauze of fresh air unit every 2 days, replace the coarse filter every 1-2 months, check the mid-effect filter every week and replace it every 3 months, and replace the sub-high-effect filter every year. The air-conditioning system without built-in purification function can be sterilized through ultraviolet circulating air, electrostatic adsorption and spray-type air sterilization. The working principle of ultraviolet circulating air sterilization is to suck polluted indoor air through multipath return air inlets under the sterilizer. Then, the clean air flows from the top to the ceiling of room after internal filtration and high-intensity ultraviolet light radiation, so that it spreads along the wall and forms a 360° large circulation field, ensuring the maximum range of air circulation and eliminating dead space. The working principle of electrostatic adsorption air sterilization is to filter and adsorb the dust with bacteria in the air and also adsorb the microorganisms through the voltage high-efficiency electrostatic dust collection room or combined electrostatic device and filtering system. Besides, the working principle of spray-type air sterilization is to intermittently atomize the disinfectant into floating particles through the ultrafine nozzles in line with the principle of high-pressure delayed spray gasification. Then, the particles vaporize in the air fans and ducts, and spread within rooms along the vent pipes, realizing disinfection and air sterilization. Based on the suggestions in previous research on

air sterilization in an air-conditioned environment during the SARS period, it is recommended to stop using central air-conditioning for caution's sake.

Ophthalmology clinic management

Ventilation of consulting room

It is recommended to strengthen the ventilation of consulting room in Ophthalmology Clinic, including natural ventilation and mechanical ventilation, so as to keep indoor air circulation. One patient should be treated by one doctor in one room, so as to avoid cross infection among patients.

Diagnosis and treatment recommendations

The patients need to wear masks, rather than masks with a breather valve, throughout the consultation. During consultation, the doctor and the patient should keep a safe distance (more than 1 m) and avoid unnecessary conversation. The electronic medical records should be used, rather than paper medical records. The air damper can be installed to the inspection instrument by the manufacturer. In the case of condition restrictions, the air damper can be replaced with X-ray films. It is recommended to adopt indirect ophthalmoscopy and fundus photography instead of direct ophthalmoscopy, and adopt anterior segment optical coherence tomography (OCT) instead of gonioscopy and ultrasound biomicroscopy.

Patient channel

The patients in the clinic are usually sitting in the public area (such as waiting area) for a long time, but the patients with infectious respiratory diseases cannot be identified immediately. Therefore, it is very dangerous for the nurses responsible for separate diagnosis and the doctors responsible for diagnosis and treatment. It is necessary for patients to enter through a one-way entrance, and then leave from a designated channel. After the patient leaves, the surface of any objects touched by him, such as the seat and door handle, needs to be disinfected promptly. It can be wiped and disinfected with 1000 mg/L chlorine-containing disinfectant at least twice a day, and disinfected at any time in the case of evident pollution.

Medical waste in the clinic

The medical waste in the clinic must be cleared promptly. All medical waste must be placed in a covered trash can. The inside and outside surfaces of the trash can must be disinfected with 1000 mg/L chlorine-containing disinfectant every day.

Handling of protective articles

The recyclable and non-recyclable protective articles should be strictly classified and separately handled. Recyclable articles include one-piece protective clothing, isolation gowns, work clothes and goggles. Protective clothing should be placed in a special sealed plastic bag, disinfected with ethylene oxide and cleaned. Goggles should be immersed in chlorine-containing disinfectant (1000-2000 ppm) for more than 1 hour. Non-recyclable articles include outer masks, caps, gloves and shoe covers, and they should be packed in a sealed plastic bag and placed in a designated covered waste pail for centralized processing.

Protection of medical workers in ophthalmology clinic

Protection based on different risk levels

Different levels of protective measures should be taken based on different risks of operation. Guidance, indirect contact with patients and inquiry are low-risk operations, so it is recommended to wear work clothes or isolation gowns, medical surgical masks and work caps, and pay attention to hand hygiene. Slit-lamp examination, gonioscopy, ophthalmoscopy, ultrasound biomicroscopy, eye B-ultrasound, fluorescein fundus angiography, injection, puncture, anterior segment laser and fundus laser are medium-risk operations, so it is recommended to wear work clothes, isolation gowns, medical surgical masks/protective masks, work caps, face shields/protective glasses and gloves. Eye operations in contact with blood, body fluids and aerosols and collection of eye specimens are high-risk operations, so it is needed to wear (disposable) medical protective clothing or isolation gowns, N95 masks or higher-grade ones, face shields/protective glasses and double gloves.

Introduction to protective devices and solutions to possible problems and selection and anti-fog treatment of eye protective devices

What needs to be emphasized is that ordinary frame glasses and contact lenses are beyond the scope of "eye protection"⁹. Safety glasses are needed in the case of contact with body fluid¹⁶, and protective glasses or face shield is needed when the non-contact tonometer is used². To avoid the fog, the soap-based detergent can be applied on the eye protective device, and then rinsed clean with running water. The hand sanitizer can be applied on

the eye protective device and then rinsed clean with running water. Moreover, 0.45-0.55% iodophor can effectively prevent fog, and 5% iodophor can avoid fog for the longest time, in either case the surface of glasses remains clear. Anti-fog cream can also be applied and then wiped clean. In addition, windshield washer fluid and anti-fog liquid for swimming goggles can also be used for anti-fog treatment.

Gloves and protective clothing

To prevent spraying of droplets and body fluids, gloves and waterproof surgical gowns can be worn¹⁷. Surgical gowns should cover the arms and trunk, gloves should be tightened and cover the cuffs of surgical gowns. Isolation gowns should be worn in the same way as surgical gowns. If there is a lack of waterproof surgical gowns and isolation gowns, the disposable bedsheet can be tailored into 45 cm-long and 90 cm-wide clothes, with the collar depth and width of 10 cm and 20 cm, respectively. Two straps with a width of 3 cm and an appropriate length are made along the shoulder.

Masks

According to the mask filtration curve released by the National Institute for Occupational Safety and Health in 2003, the filtration rate of N95 masks is the highest, followed by that of FFP2 masks, FFP1 masks, activated carbon medical masks, medical masks and gauze masks. In a study on the resistance of 21 models of N95 masks in 2015, it was found that the resistance is 21.33-5.33 Pa under 85 L/min, with an average of 47.5 Pa, and the average inhalation resistance of all masks rises with the increase of flow. N95 masks are relatively lacking, and it is not suitable to wear for a long time due to the higher respiratory resistance compared to medical surgical masks. Therefore, it is recommended that medical workers in Ophthalmology Clinic choose masks of N95 or higher grades only in the case of high-risk operations.

Hand washing and disinfection

It has been proved that learning the knowledge related to hand hygiene is beneficial for the implementation of hand hygiene. A study in Taiwan of China showed that installing washbasin in the emergency room is the only effective infection control measure, which is closely related to the prevention of SARS among medical workers¹⁸. It also confirms the protective effect of hand hygiene on medical workers¹⁸. Besides, hand disinfection is a key factor in controlling infection, especially

without disposable gloves. It is needed to disinfect the hands touching patients. Although it is more acceptable to wash hands with soapy water and running water, alcohol-containing sanitizing gels have a stronger disinfection efficacy¹⁹. Therefore, the WHO recommends the use of alcohol-containing sanitizing gels characterized by extensive antibacterial activity, superior compliance and convenience in the clinic. When seriously contaminated, the hands need washing with soap/hand sanitizer and running water²⁰. According to Specification of Hand Hygiene for Healthcare Workers (WS/T 313-2019) of China, medical workers in Ophthalmology Clinic need to wash their hands and/or use hand antiseptic agents for antiseptic hand rubbing in the following cases: 1) before/after contacting with the patient, 2) before cleaning, sterile and invasive operation, 3) after exposure to the patient's body fluids, including contacting with the mucosa, damaged skin or wound, blood, body fluids, secretions and wound dressings, and 4) after contacting with the surrounding environment of patient, including the surface of medical apparatus and instruments around the patient. Medical workers in Ophthalmology Clinic need to wash their hands when the hands are contaminated by visible blood or other body fluids, or they can use hand antiseptic agents for antiseptic hand rubbing. In the following cases, medical workers in Ophthalmology Clinic need to first wash their hands before antiseptic hand rubbing: 1) after contacting with the blood, body fluids and secretions of patients with infectious diseases and objects contaminated with infectious pathogenic microorganisms, and 2) after direct examination, treatment and nursing for patients with infectious diseases or handling of waste. In the hospital, the picture posters about hand hygiene and seven-step hand washing can be put up to strengthen the medical workers' awareness of hand hygiene. The hand washing environment should be improved, with waterless antiseptic agent in a fixed position, as well as dry paper, hand drier, hot-water system and hand cream, so as to offer support to hand hygiene of medical workers in Ophthalmology Clinic.

Disinfection of office supplies

Office supplies in the hospital are one of the most neglected sources of nosocomial infection. Most of these supplies are contacted by many medical workers, but not every worker will carefully wash hands before using office supplies, and most of them rarely or even do not wash hands. In addition, medical workers will not carefully clean

and disinfect office supplies like medical instruments according to regulations. As a result, office supplies become a potential source of infection. According to a study on the disinfection effects of different disinfectants on computer keyboard and mouse²¹, 0.025% effervescent disinfectant tablets have the best disinfection effect, followed by 75% alcohol. There are studies showing that the coronavirus can be easily inactivated by about 4 log₁₀ or more by 78-95% ethanol, 70-100% 2-propanol, mixture of 45% 2-propanol and 30% 1-propanol, 0.5-2.5% glutaraldehyde, 0.7-1% formaldehyde and 0.23-7.5% povidone iodine. Moreover, sodium hypochlorite is effective at a minimum concentration of at least 0.21%, and hydrogen peroxide is effective at a concentration of 0.5% after contacting for 1 minute²². To sum up, it is recommended that medical workers in Ophthalmology Clinic improve the disinfection of office supplies, especially the keyboard and mouse, using appropriate disinfectants and methods.

Disinfection of examination instruments and equipment

The examination instruments and equipment in Ophthalmology Clinic need to be properly cleaned and disinfected, because many bacteria and viruses can survive on the surface of these instruments and equipment for several days. Studies have demonstrated that human coronavirus can remain infectious for 9 days on the inanimate surface at room temperature, while animal coronavirus can do so for up to 28 days. Therefore, the surface of frequently-contacted objects in medical institutions is contaminated, becoming a potential source of viral transmission. Ophthalmic medical equipment should be kept clean before use, and disinfected every time after use. 75% ethanol, double-chain quaternary ammonium salt disinfectants and disinfectant wet wipes can be used for daily disinfection of ophthalmic medical equipment, and 75% ethanol gauze or disinfectant wet wipes for concurrent disinfection. Before and after use, slit lamp, OCT, visual field machine, corneal endothelial machine and corneal topography should be wiped with 75% ethanol at the contact position. It is recommended to strictly disinfect the examination instruments during a special period as if they are used by "suspected infectious disease patients". All washable examination instruments should be treated in the order of disinfection, cleaning, and re-disinfection/sterilization. According to the recommendations for disinfection of ophthalmic examination in-

struments by the Chinese Ophthalmological Society in 2003, Goldmann applanation tonometer, gonioscope and three-mirror contact should be washed first, and then carefully wiped with 75% ethanol or 3% hydrogen peroxide cotton ball before use. Moreover, the pressure measuring head of Goldmann applanation tonometer, gonioscope or three-mirror contact can be immersed in 10% sodium hypochlorite (domestic bleaching powder), 3% hydrogen peroxide or 70% isopropyl alcohol for 5 minutes before use. Aerosols will form easily during the examination using non-contact tonometer, so the pressure measuring head should be wiped carefully with 75% ethanol or 3% hydrogen peroxide cotton ball before use, and disinfected with alcohol sprays after use. In addition, the patients should be examined at a certain time interval. To avoid fire caused by excessive alcohol concentration in the air, the examination room should be regularly ventilated. The disinfecting paper on the slit lamp holder must be replaced timely every time after use. The covering plate should be disinfected every time after use, and the glass frame and ophthalmoscope should be wiped and disinfected with 75% ethanol cotton ball after use.

In addition, medical workers should alternate work with rest, avoid fatigue, and take a bath, drop eyes and gargle after work.

Conclusions

Medical workers in Ophthalmology Clinic must be aware of the risk of infectious diseases during such a special period, and they should not only protect themselves, but also protect patients from the spread of infection. It is necessary to strengthen hand hygiene, use individual protective equipment, use eye drops correctly (use individually-packaged eye drops as much as possible, and discard the eye drops if the bottle mouth is in contact with the patient or his secretions), and improve the disinfection of ophthalmic examination instruments and equipment²³, and medical workers in ophthalmology clinic should pay attention to self-protection, so as to inhibit the spread of virus, and contribute to winning the battle against epidemics.

Conflict of Interests

The authors declare that they have no conflict of interests.

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