



Perspectives on the death investigation during the COVID-19 pandemic

ABSTRACT

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Forensic science
Death investigation
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The pandemic of COVID-19 caused by 2019-nCoV outbreaks in most of the countries, which has subsequently spread rapidly and become a pandemic worldwide. Due to the strong infectivity of COVID-19 and lack of experience of performing an autopsy to infectious disease-induced death, the pandemic created some challenges for forensic practitioners. In this article, we summarize the experience of how we handle the confirmed or suspected infectious cases, and give some perspectives for the future.

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1. Introduction

A new pneumonia called COVID-19, which is caused by a novel coronavirus (2019-nCoV), has broken out around the world. Due to the characteristics of strong infectivity, long incubation period, over 693,224 cases have been confirmed in the whole world and led to at least 33,106 death by the end of March 2020 [1]. The World Health Organization (WHO) announced that the COVID-19 outbreak can be characterized as a “pandemic” as the virus spreads increasingly worldwide [2]. The Chinese government reacted quickly and took effective measures to deal with the pandemic [3]. During the past three months, this highly contagious pandemic also created some challenges for forensic practitioners in China [4,5]. It is important for forensic practitioners to increase protection awareness and accumulate experience in the medicolegal death investigation of infectious diseases.

2. Potential risks facing by forensic practitioners

2.1. Potential risks during death scene investigations

Because death scenes normally require processing as soon as possible, forensic practitioners may not know the victim's accurate health condition, travel history in a pandemic area or the contact history with possibly infected persons immediately. These uncertainties lead the forensic practitioners and police working at the death scene are faced with severe risks of getting infected. The asymptomatic transmission of 2019-nCoV means that any individual can be infected but not show signs. The use of personal protective equipment by all personnel at a death scene is recommended.

2.2. Potential risks during autopsy

2019-nCoV has strong survivability and resistance to cold environments [6,7]. It indicates that the 2019-nCoV can survive in a corpse for a period of time after the infected person has died. The remains of patients who have died of COVID-19 may have a large

amount of the virus. Cryopreservation may prolong the persistence of the virus in the body [8].

Currently, known routes of transmission of 2019-nCoV are mainly respiratory droplets, aerosols, and contact with viral secretions [9,10]. During an autopsy, forensic practitioners need to perform tissue segmentation, organ extraction, organ incision and other procedures, during which the virus can be passively released and increase the risk of inhaling the virus due to the timeframe of the autopsy and close proximity to the body. Additionally, sharp instrument injury and body fluid spray contact can increase the risk of occupational exposure.

2.3. Potential risks during pathological samples' transfer and storage

Forensic pathology examination of specific organs requires sample extraction, fixation, and section after autopsy. Samples need to transfer to the pathology laboratory and storage in formalin for more than one week; any aerosols have the potential to effuse in air and endanger physicians. Subsequent operations should be performed in a laboratory with a heightened level of protection.

3. Measures we have taken in forensic practice

3.1. Thorough investigation of the history of victims

Thorough investigation before any death scene investigation and body examination is very helpful to determine whether the cause of death has a connection with COVID-19 or not, in order to take proper protections including personal protective equipment. Relevant information such as medical history, travel history in an outbreak area or the contact history with any potentially infected persons and medical records should be obtained from the hospital, family members, witnesses, and morgue personnel.

During the outbreak response, all death investigations should follow the strictest protective measures for dealing with infected cases at the scene and in the morgue. If we are involved in a death

scene with confirmed infected cases, it is better for us to be isolated and under medical observation.

3.2. Protection measures for the death scene and autopsy

Forensic practitioners should wear one-piece protective clothing, N95 mask, protective goggles face shield, protective shoe covers, and at least two layers of medical latex gloves; they should also be aware of the proper order of putting on and taking off protective equipment [11,12]. Autopsies should be performed in a special autopsy laboratory in strict accordance with a process of three areas and two buffer zones, which consist of:

1. Clean area,
2. One first-level buffer zone,
3. Semi-contaminated areas,
4. A second level buffer zone and
5. Contaminated area.

Examiners should wear protective equipment in the clean area before entering the semi-contaminated area and organize autopsy instruments in the semi-contaminated areas before entering the contaminated area for autopsy. After the autopsy, the protective clothing and gloves require disinfecting first in the contaminated area of the autopsy laboratory, and the protective clothing, mask, shoe covers, gloves, and other equipment surfaces require thoroughly disinfecting in the semi-contaminated area a second time before removing. All must be sent for bio-safety disposal immediately.

The contaminated area must maintain a sufficient negative pressure, sufficient filtering conditions for air emission and sewage discharge [11]. Furthermore, the procedure of pathological examination and sample transfer should strictly follow the procedure of sealing after sample extraction. The pathology laboratory should be held to standard negative pressure operating conditions.

4. Future improvement

4.1. Establish a multi-department joint control system

The joint control system should coordinate with multiple departments, such as the Center for Disease Control, Civil Administration Department, Health Commission and Environmental Protection Authorities for death investigation, as soon as possible. All departments should unite together and share information about the pandemic situation.

4.2. Improvement and training of occupational protection for forensic practitioners

Currently, many forensic practitioners lack the occupational protection awareness for infectious disease and lack of experience in death investigation for infectious disease, especially those with asymptomatic transmission. It is necessary to establish rules of occupational protection and risk prevention monitoring systems and integrate these into regular training.

4.3. Improvement of the forensic autopsy laboratory construction

For dealing with infected cases, autopsy laboratories should be constructed in the future to be qualified at certain biological safety levels (P1–P4) [13]. The P3 autopsy laboratory would satisfy the requirements for most of the infectious diseases, with the special requirements in terms of floor layout, maintenance structure, ventilation and air conditioning system, water supply and air

supply system, sewage disposal, and disinfection system. Each functional area of the autopsy laboratory must maintain a certain negative pressure and suction gradient to ensure no leak or reflux of contaminating air [14].

4.4. Forensic radiology requires progress

Clinical diagnostic criteria for COVID-19 are the nucleic acid test and radiology examination by CT scan [15]. Virtual autopsy based on forensic radiology technology could play a significant role in the autopsy of infectious diseases. CT scan of the cadaver before autopsy provides an initial assessment of a possible cause of death and also prevent forensic practitioners from directly contacting an infected but asymptomatic body. Forensic practitioners could make a preliminary judgment on whether the deceased may be infected or not and take appropriate protective measures during subsequent autopsy.

In the past three months, these forensic practices have proven to be effective for the death investigation of confirmed or suspected infectious decedents and also exposed the defects of insufficient response, which also points out the direction for our future development.

Declaration of competing interest

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