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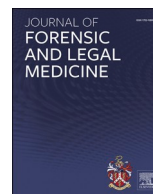
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## Review

## A roadmap to the safe practice of forensic medicine in the COVID-19 pandemic

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## ABSTRACT

The COVID-19 pandemic has forced forensic practitioners to consider how we perform our normal duties, especially when those duties involve humans. The potential for contracting the virus from working in close contact with living sufferers is high, and we have yet to fully determine the risk of infection from the deceased. In an attempt to support the community, the Journal of Forensic & Legal Medicine has drawn together three articles which underline the importance of continued forensic medical practice during the pandemic and highlight some factors to consider in a Roadmap towards safe practice. Our Roadmap has intentionally taken an international perspective and supports other work we have published in the Journal on our collective response to the COVID-19 crisis.

### 1. The importance of clinical forensic medicine at the time of COVID-19

Forensic Medicine can be easily considered as of secondary importance when thousands of people are dying and increasing numbers of infected patients overwhelm health systems in numerous countries. Covid-19 allows us to reconsider the meaning of everyday medical practice. In the surrounding turbulence of restless anxiety and hyperactivity, taking only vital emergencies into account is tempting. Forensic medicine in France has been organized at a national level since 2011 and is based on 48 hospital departments all over the country.<sup>1,2</sup> Would it be appropriate to shut down the departments of forensic medicine until major Covid-19 issues are resolved, making their staff available to redeployment to frontline specialties? Most countries lock down, to curb the spread of the virus and protect their citizens. In France, lockdown started on March 17, 2020 and has been extended until May 11, at least. The French wanting to do some sport can go out for a walk, jog or run

with their children but must go no more than 1 km from their home, be out no more than 1 h and do so only once a day. They are required to carry a signed, dated and timed attestation giving the reason for leaving home to show if stopped by the police. Those found to have repeatedly ignored the regulations can be sent to jail for up to six months. The growing tensions caused by the strict lockdown have been associated with an outbreak of violent clashes with the police in suburban estates.<sup>3,4</sup> This can result in a number of arrestees subject to inappropriate use of force by the police as well as assaulted police. It was also anticipated that the guidelines about self-isolation could leave the victims of domestic violence especially vulnerable and exposed. An increase of violence at home is expected and French and UK domestic abuse help-lines report surge in calls during lockdown.<sup>5,6</sup> Maintaining the activity of a department of forensic medicine in times of crisis allows health issues of law enforcement to be taken into account. Forensic physicians perform medical assessment of victims of interpersonal violence and of arrestees detained in police cells.<sup>7,8</sup> Healthcare interventions among

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arrestees include the forensic assessment of health issues to assist the delivery of justice as well as 'standard' healthcare provision. Medical examination gives access to healthcare to those who have no adequate medical follow-up, such as adolescents and young adults, patients with addictive disorders, and persons in precarious situations.<sup>9</sup>

As long as going out for a walk 1 h a day is allowed, denying someone who complained to the police about an assault the possibility to have a forensic assessment seems unacceptable. The global activity of forensic medicine in our department has decreased (Table 1). We have increased the proportion of medical examinations performed in police cells so that police officers and arrestees avoid hospital, a place with potential higher risk of contamination. We observed an overrepresentation of domestic violence and assaulted police. Arrestees included higher proportions of perpetrators of domestic violence, and of contempt obstruction following police check and their failure to show the requested justification, 17% reported assaults by the police at the time of arrest and 18% presented recent traumatic lesions. Such proportions are in accordance with previous findings.<sup>10</sup> Police and emergency medicine cannot be the only pillars of the health care system in a state of emergency.<sup>11</sup> Administrative measures should not hinder healthcare. We declare no competing interests.

## 2. Systematic autopsies are needed also in the times of pandemics

In most countries, forensic pathologists are requested to perform autopsies in cases of suspected non-natural or sudden, unexpected natural death, such as homicides, mass disasters or sudden cardiac arrests. However, an often overlooked role of forensic pathologists relates to questions of public health and public safety, for example when societies are facing threats from contagious, high-fatality rate infections.<sup>12,13</sup> An autopsy can, when systematically performed and described in detail, generate important information about the characters of an infection, which cannot clinically or otherwise be obtained. Besides the cause of death and pathological characteristics of the disease, key questions in such deaths include the source of transmission.

Recent discussions throughout the forensic pathology community and allied partners have raised a number of concerns and considerations with regard to the examination of the deceased during the pandemic. Although recommendations or comments about autopsies in suspected COVID-19 related deaths have appeared,<sup>14,15</sup> there is only a limited number of reports from actual autopsy of COVID-19 fatalities.<sup>16,17</sup> Due to the lack of detailed knowledge of the SARS-CoV-2 transmission postmortem, forensic and clinical pathology communities are reluctant to perform post-mortem examinations of suspected SARS-CoV-2 infected corpses in order to protect the mortuary staff. For example, the Royal College of Pathologists (RCP) have advocated the policy of null or limited autopsies for COVID-19 deaths. Their recommendation has a logical basis: if a death is a consequence of a confirmed COVID-19 infection, an autopsy is unlikely to be necessary.<sup>14</sup> Although RCP recommendation state that minimal-invasive procedures could be considered in cases of legal significance, this rather passive standpoint

may also be perceived as a surrender of pathologists' contribution to fight the pandemic. It also diminishes the abovementioned role of forensic pathology community as adjunct experts in public health and public safety. We believe that appropriate risk assessment, use of personal protective equipment, and dedicated autopsy facilities offer opportunities for thorough postmortem examinations, including tissue sampling without posing significant risk for experienced personnel.<sup>18</sup> Moreover, these autopsies allow systematic tissue harvesting of organs that can never be obtained from living people. Such sampling, with adequate ethical permissions, offers a unique material for detailed study of the pathogenesis of COVID-19 using state-of-the-art molecular, immunohistochemical and other advanced laboratory technologies. Thus, knowledge from mortuary practice can be provided for holistic understanding and treatment of COVID-19.

## 3. Autopsy practices in suspected COVID-19 cases: Scenario from India

The coronaviruses are a large family comprises of various viruses, some causing human illness including Middle East Respiratory Syndrome (MERS) and Severe Acute Respiratory Syndrome (SARS) and others that circulate among animals, including camels, cats and bats.<sup>19</sup> A new coronavirus outbreak was initiated in Wuhan, China in 2019 which was then resulted in a pandemic.<sup>20</sup> A novel coronavirus (nCoV) is a new strain that has not been previously identified for causing illness in humans. The WHO designated this disease as COVID-19 (coronavirus disease 2019) and the virus that causes it as SARS-CoV-2 (severe acute respiratory syndrome coronavirus 2).<sup>20,21</sup> The case detection rate is changing daily and can be tracked in almost real time on the website provided by Johns Hopkins University and other forums.<sup>22</sup>

In humans, the transmission of COVID-19 can occur via respiratory droplets directly (inhalation of droplets from coughing or sneezing) or indirectly (through contaminated surfaces).<sup>23</sup> Mostly the disease has a mild course; however, approximately twenty percent develop severe symptoms with high mortality rate especially associated with older age and immunosuppression.<sup>23,24</sup> There will be a possibility of increase in number of suspected COVID-19 related deaths at autopsy.

Few countries till now responded to this concern with the release of guidelines on autopsy practice relating to COVID-19 such as The Royal College of Pathologists (England) and Chinese Medical Association (China).<sup>23,26</sup> India has released various guidelines relating to COVID-19. Autopsy examination in confirmed case of COVID-19 in India has not been reported and published till the end of month of March 2020. The following article is an attempt to summarize and interpret the guidelines released by the government of India those relevant to autopsy practices as well to summarize clinical and investigative features in COVID-19 published across the globe to utilize in early identification of suspected case during autopsy for infection prevention control. This article is written based on the author's current understanding of COVID-19 in the last week of the March 2020 and may change as more information becomes available.

**Table 1**

Medical examinations of victims of interpersonal violence and arrestees detained in police cells in the Department of Forensic Medicine of Seine-Saint-Denis (Paris region), France.

	17 Mar – Apr 7, 2020	17 Mar – Apr 7, 2019	P <sup>a</sup> (95 CI)
Victims of interpersonal violence, total	121	444	
Domestic violence (%)	50 (41)	125 (28)	.008 (1.16–2.78)
Assaulted police (%)	30 (25)	34 (8)	<.001 (2.22–7.06)
Sexual assault (%)	13 (11)	46 (10)	.87 (0.50–2.05)
Arrestees, total	334	1015	
Perpetrators of domestic violence (%)	62 (19)	21 (2)	<.001 (6.34–18.94)
Violence towards the police (%)	35 (10)	34 (3)	<.001 (2.00–5.68)
Detention related to lockdown (%)	76 (23)	Not applicable	

<sup>a</sup> Comparisons with last year's examinations were made with Fisher's exact test.

### 3.1. Guidelines released from India

Following guidelines relating to COVID-19 have been released by Directorate General of Health Services, Ministry of Health & Family Welfare (MoHFW), Government of India which are applied to autopsy and related practices:

1. Guidelines on clinical management of COVID-19<sup>27</sup>
2. COVID-19: Guidelines on dead body management<sup>28</sup>
3. Standard Operating Procedure (SOP) for transporting a suspect/confirmed case of COVID-19<sup>29</sup>
4. National guidelines for infection prevention and control in health-care facilities<sup>30</sup>
5. Guidelines on rational use of personal protective equipment<sup>31</sup>
6. Standard Operating Procedure and guidelines for 2019-nCoV specimen collection, packaging and transport<sup>32</sup>
7. Guidelines for handling, treatment and disposal of waste generated during treatment/diagnosis/quarantine of COVID-19 patients. [From Ministry of Environment, Forest & Climate Change].<sup>33</sup>
8. Indian Council of Medical Research guidelines on private laboratories.<sup>34</sup>

### 3.2. Case definitions

Case definitions regarding 'suspect case' and 'confirmed case' considering the epidemiological and clinical criteria are released by the MoHFW.<sup>27</sup> (Box 1).

### 3.3. Risk during autopsy in suspected COVID-19 cases

Autopsy personnel have many fold increased risk of encountering unknown threats while performing autopsies due to exposure to a wide variety of blood-borne and aerosolized pathogens as well as other hazards. There are certain biosafety guidelines established for biomedical and microbiological laboratories by various authorities such as World Health Organization and Department of Health and Human Services (United States).<sup>35,36</sup> These guidelines would be broadly applied to autopsy practices too and it is followed in India as well. SARS-CoV-2 has been categorized as a HG3 (hazard Group 3) organism by the Advisory Committee on Dangerous Pathogens (ACDP) within the Health and Safety Executive.<sup>37</sup> Autopsy on a person with a suspected HG3

organisms seeks prior attention towards risk assessment, understanding of the pathology, universal standard precautions and specific standard operating procedures.<sup>14</sup>

#### 3.3.1. Decision on autopsy

India is currently having travel related cases and cases of local transmission. At this stage, all suspect/confirmed cases are isolated in health care facilities. If the death is considered to be only due to confirmed COVID-19, the requirement of autopsy is unlikely. It shall not be registered as a medico-legal case and medical certificate of cause of death should be issued. The MoHFW (India) strictly suggested to avoid autopsy on COVID-19 dead bodies.<sup>28</sup> However, when the confirmed COVID-19 or a suspected case is registered with medico-legal matter, medical practitioner is abiding by law to inform investigating authority.

The decision on autopsy is carried out under discretion of investigating authority according to the statutory laws considering the general interest of the community. The medico-legal matters in suspected cases seeking the requirement of autopsy may have issue whether the cause of death from COVID-19 or other and it may not always be simple. Autopsy findings, clinical features during course of hospitalization, available investigations and ongoing epidemiology may provide better information on this. Careful observation of clinical examination records before autopsy may be helpful in identification of a suspect case. MoHFW (India) released clinical syndromes associated with COVID-19 infection for purpose of early recognition of suspected cases lead to timely initiation of infection prevention control.<sup>27</sup> (Box 2).

#### 3.4. Removal of the body from isolation area

Training in infection prevention and control practices shall be imparted to all the staff identified to handle dead bodies of confirmed or suspected case in the isolation area, mortuary, ambulance and all the susceptible areas of contact. While removing of the body from the isolation room the attending health care personnel should follow standard precautions as well hand hygiene, proper use of personal protection equipment (PPE), removal of all tubes, drains and catheters on the body, dressing of puncture holes or wounds with use of 1% sodium hypochlorite and plugging of all orifices of body. Body should be placed in leak-proof plastic body bag. External surface of the bag can be decontaminated with 1% hypochlorite. Appropriate authority should be

#### Box 1

Case Definitions released by MoHFW (Government of India) as on 31<sup>st</sup> March 2020.<sup>27</sup>

#### Suspected Case\*:

- All symptomatic individuals who have undertaken international travel in the last 14 days *or*
- All symptomatic contacts of laboratory confirmed cases *or*
- All symptomatic healthcare personnel (HCP) *or*
- All hospitalized patients with severe acute respiratory illness (SARI) (fever AND cough and/or shortness of breath) *or*
- Asymptomatic direct and high risk contacts of a confirmed case (should be tested once between day 5 and day 14 after contact)

Symptomatic refers to fever/cough/shortness of breath.

Direct and high-risk contacts include those who live in the same household with a confirmed case and HCP who examined a confirmed case.

#### Confirmed Case\*:

A person with laboratory confirmation of COVID-19 infection, irrespective of clinical signs and symptoms

\*This may be updated regularly. Please review this link when considering any potential cases of SARS-CoV-2 infection at autopsy. <https://www.mohfw.gov.in/>

**Box 2**

Clinical syndromes associated with COVID-19 released by MoHFW (Government of India) as on 31<sup>st</sup> March 2020.<sup>27</sup>

## Uncomplicated illness

Patients with uncomplicated upper respiratory tract viral infection, may have non-specific symptoms such as fever, cough, sore throat, nasal congestion, malaise, headache. The elderly and immunosuppressed may present with atypical symptoms.

## Mild pneumonia

Patient with pneumonia and no signs of severe pneumonia.

Child with non-severe pneumonia has cough or difficulty in breathing/fast breathing: (fast breathing - in breaths/min): <2 months,  $\geq 60$ ; 2–11 months,  $\geq 50$ ; 1–5 years,  $\geq 40$  and no signs of severe pneumonia

## Severe pneumonia

Adolescent or adult: fever or suspected respiratory infection, plus one of the following; respiratory rate  $> 30$  breaths/min, severe respiratory distress,  $SpO_2 < 90\%$  on room air

Child with cough or difficulty in breathing, plus at least one of the following: central cyanosis or  $SpO_2 < 90\%$ ; severe respiratory distress (e.g. grunting, chest in-drawing); signs of pneumonia with any of the following danger signs: inability to breastfeed or drink, lethargy or unconsciousness, or convulsions. Other signs of pneumonia may be present: chest in-drawing, fast breathing (in breaths/min): <2 months  $\geq 60$ ; 2–11 months  $\geq 50$ ; 1–5 years  $\geq 40$ . The diagnosis is clinical; chest imaging can exclude complications.

Acute  
Respiratory  
Distress  
Syndrome

Onset: new or worsening respiratory symptoms within one week of known clinical insult.

Chest imaging (radiograph, CT scan, or lung ultrasound): bilateral opacities, not fully explained by effusions, lobar or lung collapse, or nodules.

Origin of oedema: respiratory failure not fully explained by cardiac failure or fluid overload. Need objective assessment (e.g. echocardiography) to exclude hydrostatic cause of oedema if no risk factor present.

Oxygenation (adults):

Mild ARDS:  $200 \text{ mmHg} < PaO_2/FiO_2 \leq 300 \text{ mmHg}$  (with PEEP or CPAP  $\geq 5 \text{ cm H}_2\text{O}$ , or non-ventilated)

Moderate ARDS:  $100 \text{ mmHg} < PaO_2/FiO_2 \leq 200 \text{ mmHg}$  with PEEP  $\geq 5 \text{ cm H}_2\text{O}$ , or non-ventilated)

Severe ARDS:  $PaO_2/FiO_2 \leq 100 \text{ mmHg}$  with PEEP  $\geq 5 \text{ cm H}_2\text{O}$ , or non-ventilated)

When  $PaO_2$  is not available,  $SpO_2/FiO_2 \leq 315$  suggests ARDS (including in non-ventilated patients)

Oxygenation (children; note OI = Oxygenation Index and OSI = Oxygenation Index using  $SpO_2$ )

Bi-level NIV or CPAP  $\geq 5 \text{ cm H}_2\text{O}$  via full face

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Sepsis	<p>mask: <math>\text{PaO}_2/\text{FiO}_2 \leq 300</math> mmHg or <math>\text{SpO}_2/\text{FiO}_2 \leq 264</math></p> <p>Mild ARDS (invasively ventilated): <math>4 \leq \text{OI} &lt; 8</math> or <math>5 \leq \text{OSI} &lt; 7.5</math></p> <p>Moderate ARDS (invasively ventilated): <math>8 \leq \text{OI} &lt; 16</math> or <math>7.5 \leq \text{OSI} &lt; 12.3</math></p> <p>Severe ARDS (invasively ventilated): <math>\text{OI} \geq 16</math> or <math>\text{OSI} \geq 12.3</math></p> <p>Adults: life-threatening organ dysfunction caused by a dysregulated host response to suspected or proven infection, with organ dysfunction.</p> <p>Signs of organ dysfunction include: altered mental status, difficult or fast breathing, low oxygen saturation, reduced urine output, fast heart rate, weak pulse, cold extremities or low blood pressure, skin mottling, or laboratory evidence of coagulopathy, thrombocytopenia, acidosis, high lactate or hyperbilirubinemia.</p> <p>Children: suspected or proven infection and <math>\geq 2</math> SIRS criteria, of which one must be abnormal temperature or white blood cell count</p>
Septic Shock	<p>Adults: persisting hypotension despite volume resuscitation, requiring vasopressors to maintain MAP <math>\geq 65</math> mmHg and serum lactate level <math>&lt; 2</math> mmol/L</p> <p>Children: any hypotension (SBP <math>&lt; 5</math>th centile or <math>&gt; 2</math> SD below normal for age) or 2–3 of the following: altered mental state; bradycardia or tachycardia (HR <math>&lt; 90</math> bpm or <math>&gt; 160</math> bpm in infants and HR <math>&lt; 70</math> bpm or <math>&gt; 150</math> bpm in children); prolonged capillary refill (<math>&gt; 2</math> s) or warm vasodilation with bounding pulses; tachypnea; mottled skin or petechial or purpuric rash; increased lactate; oliguria; hyperthermia or hypothermia</p>

informed and body should be handed over to them or to mortuary. All surfaces of the isolation area should be wiped with 1% sodium hypochlorite solution; allow a contact time of 30 min, and then allowed to air dry.<sup>29–31</sup>

### 3.5. Safe autopsy practices

#### 3.5.1. Handling of body in mortuary

Mortuary area is categorized as 'high risk' for the risk of exposure (Box 3).<sup>31</sup> Embalming of the body should not be allowed. Mortuary staff handling suspected or confirmed COVID-19 dead body should observe standard precautions. Body should be stored in cold chambers maintained at approximately 4 °C. Environmental surfaces, instruments and transport trolleys should be properly disinfected with 1% Hypochlorite solution. After removing the body, the chamber door, handles and floor should be cleaned with 1% sodium hypochlorite.<sup>28</sup>

#### 3.5.2. Precautions during autopsy

If autopsy is to be performed for special reasons, infection control practices are released to follow.<sup>28</sup> The number of forensic experts should be limited in mortuary. Whole team should use full complement of personal protective equipments (PPE) (Box 3).<sup>31</sup> Areas should be defined

separately for donning and doffing procedures. For the minimum exposure to prick injuries, PM40 or any other heavy duty blades with blunted points and round ended scissors should be used. Only one body cavity should be dissected at a time. Unfixed organs must be held firm on the table and sliced with a sponge – care should be taken to protect the hand. Negative pressure to be maintained in mortuary. An oscillator saw with suction extraction of the bone aerosol into a removable chamber should be used for sawing skull, otherwise a hand saw with a chain-mail glove may be used. Disposal of needles should be done only in sharp container and not be re-sheathed. While handling lung tissue, appropriate technique should be utilized to reduce aerosol generation. After the procedure, body should be disinfected with 1% sodium hypochlorite and placed in a body bag, the exterior of which will again be decontaminated with 1% sodium hypochlorite solution. Autopsy table to be disinfected as per standard protocol.<sup>28</sup>

### 3.6. Consideration of findings during autopsy in suspected cases

A staged postmortem<sup>23</sup> or minimally invasive postmortem<sup>38</sup> is recommended in highly infective environment. However, in India staged postmortem is not followed usually. Autopsy examination in confirmed case of COVID-19 in India has not been reported and published till the end of March 2020. In suspected cases, it may be difficult to identify the infections at an early stage. Although pathological findings during

**Box 3**

Rational use of personal protective equipment (PPE) in suspected COVID-19 cases Released by MoHFW<sup>31</sup>

**High Risk Areas (for risk of exposure):**

- Mortuary- while performing autopsy
- Dead body packing
- Sample collection/sample testing for COVID-19

**List of minimum PPE:**

- N-95 Mask
- Gloves
- Gown/Coverall
- Goggles/Face shield
- Head cover
- Shoe cover

autopsy and radiological findings may improve the chances of identification. Recent studies in COVID-19 patients may impart light on it.

**3.6.1. Pathological findings in COVID-19**

MoHFW defined 'suspected case' considering epidemiological and clinical criteria (Box 1).<sup>27</sup> These criteria are the same when the patient is deceased considering the timeliness which shall refer to the time prior death. Sample collection techniques shall be the same when the patient is deceased.

As avoidance of autopsy in confirmed case of COVID-19 is suggested by all of the leading associations such as Royal College of Pathologists,<sup>23</sup> International Committee of the Red Cross,<sup>39</sup> European Centre for Disease Prevention and Control,<sup>40</sup> etc.; the number of autopsies in confirmed cases of COVID-19 are limited. Suddenness of the outbreak, large volume of patient inflow in hospital, shortage of healthcare personnel and high rate of transmission may be the reasons which makes invasive diagnostic procedures less of a clinical priority.<sup>16</sup> So, pathological findings in COVID-19 have been imparted very limited, although few case reports have been published recently.<sup>16,23-26,41-46</sup>

Likely pathological features were noted by Royal College of Pathologists include purulent pleurisy, pericarditis, consolidated lung lobes, pulmonary oedema, acute lung injury with or without secondary bacterial pneumonia.<sup>23</sup>

Histo-pathology examination of biopsy samples from lungs in confirmed COVID-19 case of a fifty years old male featured bilateral diffuse alveolar damage with cellular fibromyxoid exudates, desquamation of pneumocytes and hyaline membrane formation indicating acute respiratory distress syndrome in both lungs, lymphocytic inflammatory infiltrates, multinucleated syncytial cells with atypical enlarged pneumocytes. Liver biopsy revealed moderate microvesicular steatosis and mild lobular and portal activity may be resulted either from infection itself or drug-induced injury. Myocardial tissue biopsy was not conclusive.<sup>41</sup> However, acute cardiac injury was reported in 12% cases of confirmed diagnosis in Wuhan.<sup>24</sup> Apart from these, few more features were also reported in another study showing prominent inspissated spherical secretions, focal fibrin clusters mixed with inflammatory cells, severe pneumocytes hyperplasia and interstitial thickening. Suspected viral inclusions were noted in some cells.<sup>16</sup> These features were also reported in pathological examinations of three confirmed cases by minimally invasive autopsies.<sup>42</sup> They reported coronavirus particles in bronchial mucosal epithelia and type II alveolar epithelia observed under electron microscope.<sup>42</sup>

Flow cytometric analysis from peripheral blood sample of confirmed COVID-19 case showed reduction in CD4 and CD8 T cells with

hyperactivated status in the form of high proportion of HLA-DR and CD38 double positive fractions. Moreover, increase of Th17 and high cytotoxicity of CD8 T cells conclusive of the severe immune injury.<sup>41</sup> A study from Wuhan, China revealed investigation of several cytokines in serum in total 41 patients with confirmed diagnosis of COVID-19, that resulted higher level of IL2 (Interleukin), IL7, IL10, TNF $\alpha$  (Tumor Necrosis Factor) which suggested that the cytokine storm was associated with disease severity. Moreover, the infection also initiated increase secretion of T-helper-2 (Th2) cytokines that suppress inflammation.<sup>24</sup>

Rapid progression of pneumonia was evident in chest X-ray.<sup>41</sup> Bilateral multiple ground-glass opacities (GGO) were most common and consistent manifestations noted in an enhanced chest CT scan.<sup>16,43-45</sup> About two third of the cases CT images showed consolidation and vascular enlargement in the lesion.<sup>44</sup> Traction bronchiectasis was noted in almost 50% cases.<sup>44</sup> The lesions were more likely to have peripheral distribution and bilateral involvement and be lower lung predominant and multifocal.<sup>44,45</sup>

**3.7. Sample collection procedures and laboratory diagnosis of COVID-19**

Specimen type for the diagnosis of COVID-19 in autopsy are same to the one used in suspected cases for patients. Indian Council of Medical Research (ICMR) and National Institute of Virology (NIV) jointly issued guidelines for specimen collection, packaging and transport for novel coronavirus.<sup>32</sup> The guidelines were adapted from the WHO guidelines on 2019-nCoV.<sup>32</sup> Type of specimen includes nasopharyngeal and oropharyngeal swab (both should be placed in same tube to increase viral load), bronchoalveolar lavage, tracheal aspirate, sputum from lower respiratory tract, tissue biopsy from lung and serum - acute and convalescent samples (5 ml blood). Use of viral transport medium (VMT) for transport of samples and maintenance of temperature at 4 °C is suggested. The test to be conducted by a laboratory which has NABL (National Accreditation Board for Testing and Calibration Laboratories) accreditation for Real-time PCR (polymerase chain reaction) assay for RNA (Ribonucleic Acid) virus.<sup>34</sup> Commercial kits for real time PCR based diagnosis of COVID-19 should be US FDA (United States Food and Drug Administration) approved or European CE (European Conformity) Certified.<sup>34</sup> Nucleic acid extraction kits and other reagents should be of standard quality. The sample should be opened only in Biosafety Cabinet Class II A2.<sup>34</sup> The VMT with swabs should be discarded in a biohazard bag containing 2% Lyzol or 5% freshly prepared hypochlorite solution.



### 3.8. Transportation of body

The body, secured in a body bag, exterior of which is decontaminated poses no additional risk to the staff transporting the dead body. The personnel handling the body may follow standard precautions (surgical mask, gloves). The vehicle, after the transfer of the body to cremation/burial staff, will be decontaminated with 1% Sodium Hypochlorite.<sup>28</sup>

### 3.9. Biomedical waste disposal in suspected cases

Central Pollution Control Board guidelines<sup>33</sup> suggests arrangement of separate color coded bins/bags, proper segregation of waste as per Bio-Medical Waste Management Rules, use of double layered leak proof bags for collection of waste and labelling the bin as 'COVID-19 Waste' prior to handing over to authorized staff.

### 3.10. Conclusion

This article outlined the guidelines released by competent authorities in India for COVID-19 pandemic situation including case definitions, risk reduction during autopsy in suspected cases, associated clinical syndromes and pathological features reflected globally based on current knowledge to build approach to the autopsy in suspected cases for the betterment of infection prevention control of mortuary workers and so on society at large. India, a country with a very large population, many autopsies are performed daily. The pathological, radiological and cytology features of the COVID-19 cases shall be very useful if considered during routine autopsy practices for early detection of suspected cases as well in medical certificate of cause of death process.

### Declaration of competing interest

The authors declare that they have no affiliations with or involvement in any organization or entity with any financial interest (such as honoraria; educational grants; participation in speakers' bureaus; membership, employment, consultancies, stock ownership, or other equity interest; and expert testimony or patent-licensing arrangements), or non-financial interest (such as personal or professional relationships, affiliations, knowledge or beliefs) in the subject matter or materials discussed in this manuscript that could inappropriately influence (bias) their work.

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