



## BIOLOGICAL PERSPECTIVES

# Universal Precautions Provide Appropriate Protection during Autopsies of Patients with Infectious Diseases



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The current coronavirus disease 2019 (COVID-19) pandemic has raised concerns about the safety of laboratory personnel who handle tissue samples that harbor pathogens, including those performing autopsies. While pathologists have performed autopsies on infected decedents for centuries, universal precaution protocols for limiting exposure to pathogens were not developed until the 20th century. This article reviews the history and effectiveness of universal precautions, with an emphasis on performing autopsies on COVID-19 decedents. (*Am J Pathol* 2020, 190: 2180–2184; <https://doi.org/10.1016/j.ajpath.2020.08.005>)

### Rationale for Universal Precautions

The AIDS epidemic in the 1980s caused a significant change in the delivery of health care. Specifically, wearing personal protective equipment (PPE) such as gloves and gowns are now worn much more frequently. These changes essentially became the new normal and it is unlikely that a health care worker will examine a patient or handle a biological specimen without wearing gloves. Initially, a clear etiology for AIDS was not determined; therefore, the Centers for Disease Control and Prevention (CDC) published precautions for clinical and laboratory staff in November 1982.<sup>1</sup> Confirmation of the transmission of HIV as the cause of AIDS did not occur until later.<sup>2</sup>

Since the etiology of AIDS was not initially known, the presence of HIV or antibodies to HIV was not tested. Consequently, the concept of universal precautions was developed, in which all biological specimens are considered potentially infectious and thus precautions are recommended and should be followed universally. These precautions include wearing gloves when handling specimens of blood or other body fluids, wearing gowns, and hand washing. After HIV was determined as the cause of AIDS, it was found that the virus could be isolated from several body

fluids, including blood, semen, saliva, and tears, and it is recognized that health care workers are at increased risk for infection when providing care for HIV-positive patients. The initial universal precautions have been updated several times, emphasizing “the need to treat blood and other body fluids from ALL patients as potentially infective.”<sup>3</sup>

While infectious diseases have always been present in pathology samples, the AIDS epidemic increased awareness of the need for robust safety protocols. Universal precautions were widely adopted, including the use of cut-resistant gloves, which significantly decrease the risk for hand injuries.<sup>4</sup> The importance of using universal precautions was highlighted in one small study in which two cases with no known risk factors were found to be positive for HIV at autopsy.<sup>5</sup> The risk for transmission on exposure to non-HIV infectious diseases, such as hepatitis, is even greater than the potential transmission of HIV.<sup>6</sup> This increased risk emphasizes the need for using universal precautions in all autopsies, not just those known to be potentially infectious. The importance of using universal

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precautions during the COVID-19 pandemic needs to be reinforced. The concept of health care workers wearing PPE, even when collecting specimens using nasopharyngeal swabs, has frequently appeared in the lay press during the COVID-19 pandemic.

## Infectious Diseases Potentially Transmissible during Autopsy

Infectious diseases potentially transmissible during autopsy include tuberculosis (TB). Cases of TB obtained during autopsy have been documented since the 18th Century and continue to occur.<sup>7</sup> Compared to the risk in the general population, the occupational risk for TB in laboratory and postmortem room staff is estimated to be 100- to 200-fold greater.<sup>8</sup> While the incidence of TB being present at autopsy has decreased due to the lower worldwide prevalence of the disease, it is still a risk and highlights the need for practicing universal precautions. Other bacterial infections may cause morbidity and mortality in autopsy staff. There have been reports of medical students and physicians acquiring *Streptococcus pyogenes* infection following superficial injuries during autopsy.<sup>9</sup>

Hepatitis B virus (HBV) is highly infectious and primarily transmitted through percutaneous or mucosal exposure to infected blood or other body fluids. Transmission may occur perinatally, sexually, and parenterally. Prior to the availability of an HBV vaccine in 1982, an estimated 200,000 to 300,000 persons were infected with HBV in the United States each year.<sup>10</sup> After the vaccine became available, mandatory screening of pregnant women for the presence of the hepatitis B surface antigen (HBsAg) and universal vaccination of newborn infants were implemented in the 1990s, resulting in a 10-fold reduction in HBV infections. The peak prevalence of reported acute HBV infection in the United States was 11.5 per 100,000 in 1985.<sup>11</sup> Following updates of vaccination and testing protocols, the prevalence has steadily declined, to 0.9 per 100,000 in 2014.<sup>12</sup> It should be noted that even with the decrease in the overall prevalence, the prevalence of HBV infection among health care workers is much higher than in the general population, with pathologists and laboratory technicians being among those at highest risk for infection.<sup>13</sup> In health care workers, the CDC recommends vaccination, followed by HBsAg serologic testing 1 to 2 months after the final vaccine dose. Vaccination should be done in all health care workers lacking documented evidence of a complete HBV vaccine series, and those who lack an up-to-date blood test that shows immunity.<sup>10</sup> Such regimens are required for both medical school attendance and residency training in the United States. Another infectious disease, hepatitis C virus, has been reported in health care workers, with a rate of transmission after percutaneous exposure of 2.5% to 10% (compared to 0.3% in HIV<sup>13</sup>). A diligent search of the literature found no reported cases of hepatitis B being transmitted during autopsy procedures.

Another group of infectious diseases potentially transmitted during autopsy are the transmissible spongiform encephalopathies, such as Creutzfeldt-Jakob disease. These encephalopathies are particularly relevant since a postmortem examination remains essential for confirming the clinical diagnosis. However, caution must be used since the pathogens that cause Creutzfeldt-Jakob disease are highly resistant to disinfection, and even tissue from paraffin-embedded blocks can cause disease. The current guideline from the World Health Organization advocates the proper use of PPE as well as the limitation of aerosol production. The use of electric saws is discouraged unless appropriate protocols are followed.<sup>14</sup> Limiting bone sawing has been suggested since both human and veterinary autopsy procedures generate aerosols.<sup>15,16</sup> Despite these concerns, appropriate protocols, such as the use of purified air-powered respirators and placing the head in a transparent plastic bag, provide protection of personnel in the autopsy suite. After the outbreak of bovine spongiform encephalopathy (mad cow disease) in England, several countries initiated surveillance programs by performing brain autopsies in suspected cases. The reports from these programs have not mentioned any transmission to autopsy personnel.<sup>17,18</sup> A study from France also showed no transfusion-associated cases, suggesting that the transmissibility is low.<sup>19</sup>

## Transmission of Respiratory Pathogens, including SARS-CoV2

Of course, the current severe acute respiratory syndrome coronavirus (SARS-CoV)-2 is predominantly a respiratory pathogen so comparisons should be made with related pulmonary pathogens, that is, the original SARS-CoV and the Middle East respiratory syndrome (MERS)-CoV. The published data has assured that the risk of transmission to pathologists is low. One report showed no cases of the original SARS transmission to health care workers in the United States, even though SARS patients were cared for in this country.<sup>20</sup> An epidemiology report examined the transmission of SARS-CoV and MERS-CoV to health care personnel and documented that as of August 2015, worldwide there were 8096 cases of SARS-CoV and 1382 cases of MERS-CoV. Despite the number of patients, there did not appear to be any cases of coronavirus transmission to laboratory personnel.<sup>21</sup>

The original SARS-CoV virus has been found in multiple tissues at autopsy, although the highest concentrations were in the lungs and small bowel.<sup>22</sup> Formalin-fixed tissue, or samples that have been processed for histologic examination \ cytology \ electron microscopy, may be handled using biosafety level (BSL)-2 precautions.<sup>23</sup> The most significant issue will be to reduce the production of aerosols, especially when doing frozen sections. With the current COVID-19 disease, environmental contamination has been documented.<sup>24</sup>

## Effectiveness of Universal Precautions

One study examined the effectiveness of universal precautions by spiking patient samples with a nonpathogenic microbe and having technicians prepare the sample for routine laboratory testing. This simulation showed a 1% contamination rate in the laboratory personnel who handled the specimens, demonstrating that universal precautions provide a high level of effectiveness.<sup>25</sup> The risk for transmission while performing autopsies on AIDS patients is virtually nonexistent, with one reported case of autopsy transmission of HIV to a pathologist.<sup>26</sup>

An important, and disturbing, feature of COVID-19 is the presence of the virus in asymptomatic or presymptomatic individuals.<sup>27</sup> It is possible that a patient who has died from other causes, such as atherosclerotic cardiovascular disease, could harbor the virus. Rather than test for potential infectious diseases at every autopsy, it is more practical to adopt universal precautions for all autopsies. A recent response to a listserv of pathologists performing autopsies demonstrated that the risk for transmission was very low, that is, 1 in 675 person-exposures. However, the office performing that particular autopsy (the 1 out of 675) stated that the exposure more likely occurred in the community rather than during the autopsy.<sup>28</sup>

## Current Recommendations for Performing COVID-19 Patient Autopsies

Universal precautions outlined by the CDC cover autopsy practice, as well as the fields of surgical pathology and clinical pathology.<sup>29</sup> The CDC website should be consulted since the guideline may evolve as more is learned about the virus (<https://www.cdc.gov/coronavirus/2019-ncov/hcp/guidance-postmortem-specimens.html>, last accessed August 6, 2020). The guideline includes the recommended BSL for performing autopsies, and the use of PPE as well as instruments during procedures. Regarding the appropriate BSL, the guideline recommends that all autopsies would be safest if performed at BSL-3. If a BSL-3 facility is not available, autopsies can be performed using the barrier precautions of BSL-2 plus negative airflow and the respiratory precautions of BSL-3. During autopsy procedures, one should wear a fluid-resistant (surgical) jumpsuit or shirt and pants that cover from neck to feet and arms, waterproof apron and waterproof sleeves, closed-toed shoes covered with fluid-proof shoe covers or booties, and a surgical cap or hood bonnet that entirely covers the head. Double-gloving is recommended, with cut-resistant gloves of fine-woven steel covered by rubber gloves. In addition, one should wear a respirator that is at least a disposable N-95 approved by the National Institute for Occupational Safety and Health. Those who cannot wear an N-95 must wear a purified air-powered respirator. For removal of the brain, aerosol generation should be minimized by avoiding

the use of oscillating saws if possible, moistening the bone before cutting, and using vacuum attachments if an oscillating saw it to be used. There are also additional recommendations specifically for microbiological and biomedical laboratories.<sup>30</sup> In the face of the new COVID-19 pandemic, the CDC has published an interim guideline that highlights the importance of following proper standards as well as biosafety precautions for autopsies.<sup>31</sup> This guideline specifies that all autopsies on decedents known or suspected to be COVID-19 cases should be conducted in a negative-pressure room, with a minimum of 6 air changes per hour for existing structures and 12 air changes per hour for renovated or new structures.<sup>32</sup>

Other countries have published guidelines regarding the handling of bodies and the performance of autopsies on COVID-positive decedents. A group from Germany recommends that when a body is being moved either to or from a morgue, the mouth and face should be covered by surgical masks. Before and after autopsy procedures, all wound openings should be cleaned, disinfected, and covered with a waterproof bandage. In addition, the body orifices (mouth, nose, and anus) should be plugged with cotton or gauze soaked in 3000 to 5000 mg/L chlorine containing disinfectant or 0.5% peroxyacetic acid. The body should then be washed, sprayed with a 1/10 disinfectant-water solution, and placed in a corpse bag that is closed and sprayed with a washing solution of 1/10 disinfectant-water.<sup>33</sup> China and India have similar guidelines for the cleaning and disinfecting of bodies, and the United States also requires the use of body bags for transporting bodies to and from a morgue.<sup>34</sup> Per the current CDC guideline, the exterior surface of these body bag should be disinfected with a disinfectant approved by the US Environmental Protection Agency and that meets the criteria for use against SARS-CoV2. The guideline also discusses the possibility of using minimally invasive autopsies, which can be performed for obtaining the necessary samples in decedents with widespread signs of infection, but should be supported with postmortem imaging. These safety considerations were also discussed in an article published in 2020.<sup>23</sup>

## Value of Performing COVID-19 Patient Autopsies

Given the potential infectious nature of any autopsy, some may question the value of conducting these studies. Several recent examples show the substantial public health benefits of performing autopsies during this time. A 2019 commentary in the *New England Journal of Medicine* outlined the value of the autopsy.<sup>35</sup> During the 1918 Spanish flu pandemic, bacterial pneumonia caused the majority of deaths, information that would not have been documented without autopsies.<sup>36</sup> Autopsies in decedents with HIV have revealed a striking prevalence of TB, a finding that affects recommendations for treatment.<sup>37</sup>

Multiple groups have been requesting autopsy specimens to examine the pathogenesis of the disease and are actively generating biobanks that will allow for the sharing of resources (Biogen, [https://www.biogen.com/en\\_us/covid-19-updates/biobank.html](https://www.biogen.com/en_us/covid-19-updates/biobank.html), last accessed August 4, 2020; Columbia University Irving Medical Center, <https://www.cuimc.columbia.edu/news/new-covid-19-biobank-columbia-opens-researchers>, last accessed August 4, 2020).

Several recent reports of autopsy findings in COVID-19 decedents have helped to define the pathogenesis of the SARS-CoV2 infection. A complete autopsy examines multiple organs and tissues, including the brain. Such detailed studies are not possible when a patient is alive since it would involve numerous biopsies in critically ill patients. One autopsy series detailed cardiovascular findings in COVID-19 decedents.<sup>38</sup> A report of 10 cases in New Orleans, Louisiana, found thrombotic changes in the lungs.<sup>39</sup> A review of data from 80 autopsies of COVID-19 decedents in Germany detailed the comorbidities and found that 40% of cases had evidence of deep venous thrombi.<sup>40</sup> Given the need for understanding the host response, there has been a call to action to describe the extent of organ involvement when performing autopsies.<sup>41</sup> Autopsies may provide biospecimens that are useful for the study of the disease. To determine whether biospecimens from COVID-19 patients were being collected during the current pandemic, a survey was sent to the Association of Pathology Chairs listserve, and 59 institutions responded. Of the 50 respondents who maintained biobanks, 45 were collecting specimens from COVID-19 patients. According to one comment, one institution had distributed over 10,000 aliquots of specimens to investigators.

## Conclusion

Autopsies may provide important public health information during the COVID-19 pandemic. With appropriate precautions, there is limited risk to autopsy personnel. All autopsies should use a universal protocol for protecting pathology personnel, regardless of the known presence of infectious disease.

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