The Royal College of Pathologists
Pathology: the science behind the cure

Briefing on COVID-19

Autopsy practice relating to possible cases of COVID-19 (2019-nCov, novel coronavirus from China 2019/2020)

This briefing is for mortuary staff who are potentially exposed to material including body fluids from cadavers in the mortuary

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1. Introduction

This brief guidance has been produced by RCPath following the outbreak of the COVID-19 infection in China. It is produced to aid mortuary staff and pathologists in deciding if a post mortem is appropriate on a possible COVID-19 death and to advise them on the possible risks associated with such a case and how to reduce these risks. It also covers diagnosis of COVID-19 at post mortem.

In general, if a death is believed to be due to confirmed COVID-19 infection, there is unlikely to be any need for a post mortem to be conducted and the Medical Certificate of Cause of Death should be issued.

1.1 Categorisation of infectious hazard

The categorisation of infectious hazards across all areas of medicine is regulated by the Health and Safety Executive's (HSE) Advisory Committee on Dangerous Pathogens (ACDP).[1] The schedule is regularly reviewed and updated in the light of global epidemiological trends. All agents encountered across the globe are considered, not just those prevalent in the UK. Since international travel is the norm, people with a potentially lethal infection can now travel from any one country to any other within 24 hours, and present ill or moribund to a healthcare centre.

There are four hazard groups (HG) of infectious biological agents, categorised along three considerations:

- the likelihood that it will cause disease by infection or toxicity in humans
- how likely it is that the infection would spread to the community
- the availability of any prophylaxis or treatment.

This categorisation is primarily aimed at workers in diagnostic microbiology laboratories and infection research laboratories. Mortuary workers are not the main focus, but over recent decades, we have adapted autopsy practice to reflect the seriousness of many infections that could be transmitted from cadavers during dissection, reconstruction, viewing, handling and embalming ('Safe Working' yellow book, 2003).[2]

1.2 HG definition: COVID-19

HG3 agents can cause severe human disease and may be a serious hazard to employees; the agent may spread to the community, but there is usually effective prophylaxis or treatment available.

The main HG3 agents are listed in Box 1. The infections that cause the most concern in the UK, and which are considered specifically hereon, are highlighted in bold.

Box 1: HG3 agents.

Viruses

- **Rabies and Lyssa**
- Middle East respiratory syndrome coronavirus
- Severe acute respiratory syndrome coronavirus
- COVID-19 (from China 2020)
- Acute haemorrhagic conjunctivitis
- Poliovirus
- Lymphocytic chorio-meningitis
- Rift Valley fever
- Dengue viruses
- Japanese encephalitis
- Tick-borne encephalitis
- West Nile fever
- **Yellow fever and yellow fever inactivated virus vaccine**
- **Hepatitis viruses B, C, D and E**
- Monkey pox
- Human T-cell lymphotropic viruses 1 and 2
- **Human immunodeficiency viruses 1 and 2**
- Chikangunya virus

The risks to mortuary staff from most of these HG3 infections are minimal when applying standard universal precautions for prevention of infection, and there is no reason why any of the infections cannot be worked on in a well-appointed mortuary with experienced staff.

1.3 Scope of these guidelines

- To advise those who work in mortuaries on the rational approach to possible COVID-19 cases and when to refer a particular case to a more specialist mortuary.
- To improve the facilities of mortuaries, reducing the likelihood of accidents involving dangerous infections.
- To recommend advance planning for infection contingencies, with preparation of standard operating procedures (SOPs) that cover the main anticipated infections.

- To recommend which levels of staff experience should be mandated for undertaking risky manoeuvres (e.g. evisceration) in certain HG3 infection cases.
- To indicate safe personal protective equipment (PPE) when conducting possible COVID-19 cases.
- To indicate the optimum evaluation pathways for diagnosing COVID-19 infection.

1.4 Target users and health benefits of these guidelines

The target primary users of these guidelines are pathologists, trainees, anatomical pathology technologists (APTs) and onsite managers in the mortuary. The recommendations will also be of value to hospital managers with oversight responsibility of a mortuary, local authority mortuary managers and coroners.

The outcomes, if the recommendations are implemented, include:

- more refined appreciation of the infection risks presenting in possible COVID-19 cases
- systematic preparation of protocols to manage possible COVID-19 cases.

2. Pathology encountered at autopsy

Although this document is not the place to depict in systematic detail the clinical pathology of all the HG3 infections, it is useful to describe some of the gross pathological features that could signal the presence of HG3 and HG2 infections when not previously known. Post-vaccination fatalities, HIV disease and rabies are also specifically considered.

Table 1: Likely pathological features of COVID-19 infection.

Organ/tissue	Pathological features	Potential HG3/HG2 infection
Chest	Purulent pleurisy, pericarditis and consolidated lung lobes Acute lung injury +/- secondary bacterial pneumonia	Bacterial infections COVID-19 and MERS infections

3. Specific health and safety aspects

The critical issues in managing HG3 infections in the mortuary revolve around:

- preparation for the possible presence of an infection in cadavers
- drafting of appropriate and agreed protocols on what to do
- the state of the mortuary and its equipment
- PPE
- preventive prophylaxis through vaccination of staff.

Secondary issues include:

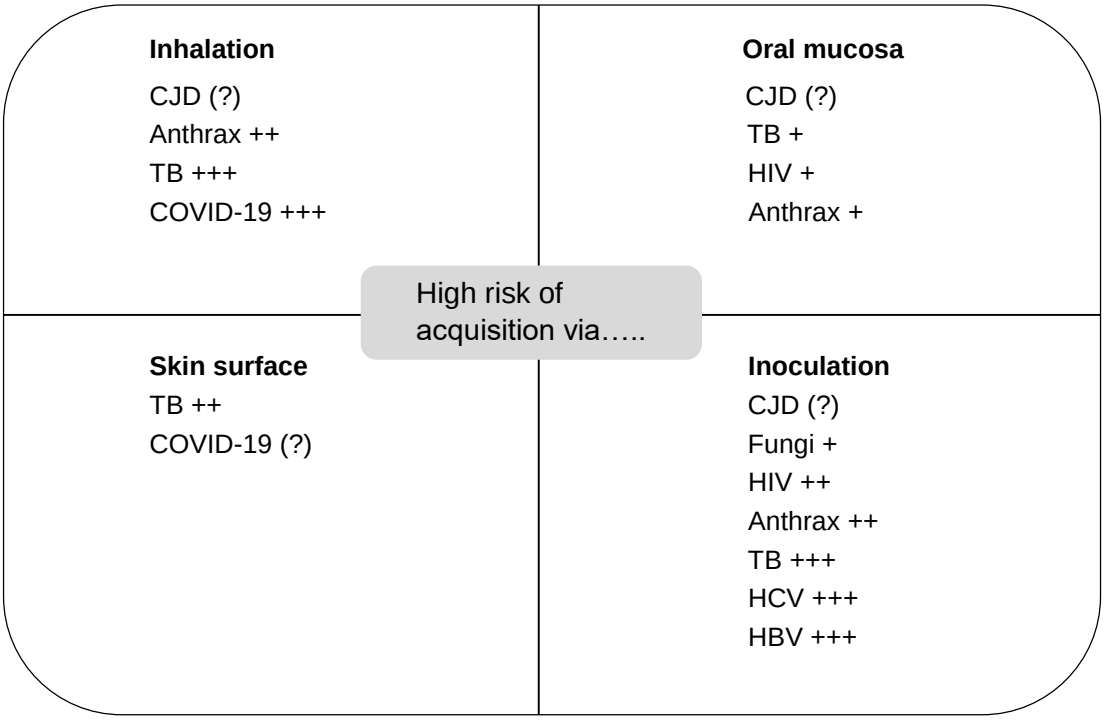
- whether junior staff (trainees) should be involved
- whether pregnant staff are at significant risk
- management of accidents in mortuary when working on infected cadavers
- appreciation that bodies can conceivably be contaminated after death with HG3 and HG4 infections, for example in a bioterrorist attack.

In the mortuary, infections may be acquired via:

- percutaneous inoculation
- skin contamination without inoculation
- ingestion
- inhalation
- contamination of mucosal surfaces (eye, mouth, nose).[3]

The relative risks of acquiring HG3 infections in a mortuary by the routes listed above were evaluated decades ago. This was before treatments for HIV and hepatitis viruses were available, and when the infection loads of these HG3 infections were high in cadavers. Figure 1 lists the routes of infection that are linked to higher risks of acquiring a specific infection after exposure.[3]

Figure 1: Infectious agents with high risk of acquisition via route of infection.



The increasing relative risks of acquisition are indicated by +, ++ or +++. It should be noted that HIV and HCV are essentially non-infectious in people undergoing effective chemotherapy, since the body fluid viral loads are undetectable.

3.1 Preparation and risk assessment

To perform HG3 autopsies safely and satisfactorily, it is essential that the following are in place:

- universal standard precautions
- routine risk assessment
- knowledge of the diseases one may encounter
- SOPs for managing specific high-risk infectious autopsies.

The use of universal precautions (see section 5.2) effectively protects against most risks and may, in practice, render much of the pre-autopsy risk assessment unnecessary. Similarly, universal precautions protect against a number of other diseases in the post-mortem setting, including staphylococcal infection, salmonellosis and vancomycin-resistant enterococci. However, consideration of the risks in each case remains important.[3] The safe working guidance[2] includes further information on this procedure.

3.2 Risk assessment

Practitioners have a duty under COSSH to carry out risk assessments of each case. This is to prevent actions that may put healthcare workers at risk. Pre-autopsy risk assessment may include:[3]

- the clinical history on a consent form
- the history as provided by a coroner
- direct information from the treating clinicians
- pathological information from a laboratory database, e.g. positive infection serologies, etc.
- information from hospital infection control
- information on an infection notice proforma that should accompany each cadaver to the mortuary
- external examination of the body. An emaciated cadaver or the presence of unusual skin rash may indicate HIV infection; the presence of injection marks on the skin could be the result of intravenous drug use, which is associated with an increased risk of infections.

In general, if a death is believed to be due to confirmed COVID-19 infection there is unlikely to be any need for a post mortem to be conducted and the Medical Certificate of Cause of Death should be issued.

3.3 The autopsy suite and its facilities

The safe working guidance[2] indicates that having a separate high-risk suite is ideal but not mandatory for HG3 autopsies. Good ventilation is required in the working areas (autopsy table and dissection bench), as well as adequate space away from other activities.

Whole room ventilation with the draught passing from ceiling height down and across the tables, exiting at floor level, is suitable. Alternatively, down-draft tables work well.[3] Electric skull saws all now come with vacuum evacuation into a separate chamber.

It is essential to have all the necessary equipment to hand to avoid the need to leave the area to find additional items. For example, containers for all anticipated samples must be available, including sterile plastic bottles for fresh tissues and fluid, and blood culture bottles (aerobic and anaerobic).

The NHS Estates regulations on mortuary facilities are published in *HBN 20. Facilities for mortuary and post-mortem room services (3rd edition, 2005)*.[4]

3.4 Critical decision on undertaking a potential or known HG3 infection autopsy

The critical decision is whether or not to proceed with the autopsy examination. The following conditions must be fulfilled to proceed with the autopsy:

- the mortuary is sufficiently well-equipped, safe and accredited
- the APTs are comfortable with continuing the examination
- the pathologist has knowledge of what they might encounter in the organs and how to proceed with sample selection and then interpretation of the histopathology.

If these conditions are not fulfilled, then either a more experienced pathologist may be invited to perform the autopsy in the same mortuary, or the case may be referred to another mortuary that is appropriately equipped and staffed.

The issues are:

- an autopsy is the only opportunity to observe the organs and take optimal samples. It is usually too late to take additional samples after the initial autopsy if the original samples were inadequate to identify what infections are presence and causing disease.
- inexperience and lack of upfront protective practices are risk factors for accidentally acquiring potentially severe infections.

SOPs should be generated by mortuaries to cover all the common and uncommon autopsy scenarios.

3.5 Staff in attendance

According to the safe working guidance,[2] the team undertaking a high-risk infectious autopsy should ideally include a circulator assistant in addition to the pathologist and APT (although this is not mandatory). The circulator assistant carries out auxiliary tasks such as sample labelling.[3] Nowadays, circulators are rarely available.

Pathology trainees can undertake high-risk infection autopsy work under supervision by senior staff and when they have demonstrated knowledge of the risks and safe protection practices. In the authors' unit, junior trainees do not eviscerate HG3 cases, but can dissect the organs after removal. Essentially, if the senior staff have confidence in the trainee's experience and knowledge, they can proceed with such autopsies.

Although there is no particular infection risk to pregnant trainees if standard universal precautions are followed, they may wish to remove themselves from mortuary work. The deanery may need to be informed of this decision.

4. Clinical information relevant to the autopsy

Information about the circumstances of a death that requires an autopsy is key. In addition to standard clinical information and location of death, knowledge of past international travel, laboratory data and microbiology data (positive and negative) are critical. It is important not to assume that the information provided is accurate. There have been many cases in which an unanticipated HG3 became manifest at autopsy. Likewise, there have been many cases where a confident clinical statement that the patient had (for example) active TB, or even HIV, turned out to be untrue.

5. The autopsy procedure and PPE

For most HG3 infections (known or suspected), a standard systematic external and internal organ examination procedure is appropriate. In cases of blood-borne infections, the presence of multiple hands within the cadaver should be avoided to prevent accident.

5.1 Behaviour and technique

Knowledge of the potential hazards that may be encountered determines the approach to a HG3 autopsy. It is essential that training is provided and safe practice is demonstrated. Some mortuaries forbid trainees to operate on any HG3 infection cadavers, yet on appointment to consultant status, they will find themselves rapidly involved in such cases. Trainee APTs usually undergo a more structured introduction to this work, in line with their curriculum and the Royal Society for Public Health (RSPH) diploma. It is recommended that pathology trainees are inducted in similar fashion, with regular instruction on safe practice.

The following are part of universal precautions in autopsy dissection practice:[3]

- round-ended scissors should be used
- PM40 blades with blunted points reduce prick injuries
- sharps in the working area should be kept to a minimum and their whereabouts known at all times
- practitioners should operate within the body cavity one 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
- an oscillator saw with suction extraction of the bone aerosol into a removable chamber should be used for sawing the skull; alternatively, a hand saw with a chain-mail glove may be used
- needles should not be re-sheathed after fluid sampling – needle and syringe should be placed in a sharps bucket.

5.2 Universal precautions and PPE

All employers have to protect the health and safety of their employees under the Health and Safety at Work Act 1974. PPE is essential. It is standard for all autopsies that pathologists and APTs wear the following:[3]

- surgical scrub suit
- hat to protect hair
- clear visor to protect the face, eyes and mouth
- respiratory protection, either as a standard surgical mask or a FFP3 mask, which more effectively excludes small particles of infective material
- a waterproof gown that covers the entire body, including the forearms
- a plastic apron over a waterproof gown
- rubber boots with metal-protected toecaps and dorsal reinforcement
- latex or other equivalent material gloves
- under latex gloves, protective gloves made of kevlar or neoprene, which are cut-resistant in case of potential blood-borne infection. This is increasingly standard practice in UK mortuaries.

PPE gives as much protection as reasonably possible against the majority of HG3 infections, including blood-borne viral agents. Only infective aerosols (e.g. TB) are not 100% protected against.[3]

5.3 Additional personal protection

Surgical masks do not provide adequate protection against air-borne infections entering the respiratory tract. FFP3 masks are designed to be over 95% effective. FFP3 masks are appropriate for suspected COVID-19 infection cases. Full body suits that include a powered air-purifying respirator with high-efficiency particulate air filters essentially provide 100% protection.[3] However, this is unnecessary and logistically unrealistic. In the authors' unit, this equipment is used mainly for examining chemical toxic deaths such as cyanide poisoning.

5.4 Limited autopsies

There has been much research on the utility of limited autopsies (i.e. needle sampling or single opening organ sampling) in the context of autopsy practice in resource-poor countries with limited mortuary facilities and staff. Such minimally invasive autopsies (MIA) are undoubtedly useful in cases of systemic infection by viruses and bacteria, where sampling blood, liver and spleen will reliably provide diagnostic samples.[5] However, when infections are focal, the use of MIA as a blind technique is limited.

6. Diagnosis of COVID-19 infection *(REF AAAA)*

Samples for diagnosing cases of COVID-19 at post mortem are identical to those used to make the diagnosis in life and consist of upper respiratory tract swabs (viral nose swab, viral throat swab), lower respiratory tract (sputum, BAL) and a plain tube of blood for serology. Full guidance on samples suitable for making a diagnosis of COVID-19 can be found at: https://www.gov.uk/government/publications/wuhan-novel-coronavirus-guidance-for-clinical-diagnostic-laboratories

The guidance includes all the necessary specific information on organising such testing including how to package samples, where to send them and how to contact the laboratory involved with testing by email with the relevant proforma, etc. There is a specific E28 request form that should be used; there is a box to tick for post-mortem samples. The form can be found at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/862474/PHE_VRD_laboratory_testing_request_form_E28_for_2019-nCoV.pdf

Specific post-mortem guidance obtained from Public Health England states that 'it would be helpful if you were able to swab the upper respiratory tract with one swab, and conduct a swabbing of the internal lungs on another swab. Lung tissue could be taken at the time of swabbing, but if the swabs are negative then the tissue would not be tested. Please note that each sample requires its own E28 form.'

Further information can be obtained at WNCoV.virology@phe.gov.uk or the following address:

Respiratory virus unit (RVU)
Public Health England
61 Colindale Avenue
London
NW9 5EQ
Tel: 020 8327 6017
Fax: 020 8205 8195

In addition to the specific samples taken for COVID-19 testing, we recommend standard samples, including swabs and tissue samples from the respiratory tract, be sent locally for microbiology/virology to assess for other infectious agents. Furthermore, we recommend a full set of tissue samples are taken for histology together with other samples for other investigations taken as appropriate and defined on the merits of the case.

6.1 How to take these samples

Urine, blood and cerebrospinal fluid (CSF) need to be taken as cleanly as possible, and before opening any cavity of the body, to reduce contamination of skin. The skin sample site can be cleaned with alcohol-containing swabs.

Blood for bacterial culture must be taken from above the umbilicus to reduce faecal contamination. Thus, take it from subclavian or jugular veins, or from the heart left ventricle through the sternum.

Pre-prepared sample sticks can be used for nasal swabs and submitted immediately for PCR influenza virus identification.

7. Clinicopathological summary and notification of infection

If infection was the main cause of death, it needs to be stated in the bottom line of part 1 of the cause of death sequence; specific organ lesions may or may not need to be stated, depending on the case. If infection contributed to the death, but is not the main cause, then placing it in part 2 is appropriate.

Public Health England should be notified of any confirmed case of COVID-19; however, this will be done by the laboratory making the diagnosis.

7.1 Other useful contacts

Wales

Public Health Wales,

2 Capital Quarter

Tyndall Street

Cardiff

CF10 4BZ

Telephone: 029 2022 7744

Email: general.enquiries@wales.nhs.uk

Northern Ireland:

Public Health Agency

Linenhall Street Unit

12-22 Linenhall Street

Belfast, BT2 8BS

Tel: 0300 555 0114

Scotland:

Gyle Square

1 South Gyle Crescent

Edinburgh

EH12 9EB

&

Meridian Court

5 Cadogan Street

Glasgow

G2 6QE. Tel: 0141 414 2888

8. Recommendations

1. Knowledge, experience and preparation are the key aspects in managing any possible COVID-19 post mortem.

2. COVID-19 is an HG3 infection.

3. All the staff – pathologists and APTs – must be aware and in agreement with protocols to manage such cases.

4. Preparation of appropriate protocols for safe and effective practice are essential.

5. Suitable PPE should be worn.

6. Mortuaries must have appropriate blood, CSF and tissue sampling technical systems and access to appropriate microbiology and virology laboratory facilities.

7. Nasal swabs are the preferred method for confirming COVID-19 infection. These can be supported by assessment blood and tissue samples.

8. If an unexpected infection becomes apparent during an investigation that is beyond the experience of the pathologist, they must seek advice and assistance from the UK network of experts.

8.1 Summary

See Figure 1 for infection risk data. Table 2 summarises the PPE that should be worn.

Table 2: Recommended PPE for COVID-19.

Infection	Facial protection	Hand protection
COVID-19	FFP3 mask and eye protection	Neoprene cut-resistant glove under rubber gloves

9. References

REF AAA: https://www.eurosurveillance.org/content/10.2807/1560-7917.ES.2020.25.3.2000045

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5. Castillo P, Martinez MJ, Ussene E, Jordao D, Lovane L, Ismail MR *et al.* Validity of a Minimally Invasive Autopsy for Cause of Death Determination in Adults in Mozambique: An Observational Study. *PLoS Med* 2016;13:e1002171.