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

Guidelines on autopsy practice

Precautions for high-risk infectious autopsies

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Foreword

The autopsy guidelines published by the Royal College of Pathologists (RCPath) are guidelines that enable pathologists to deal with non-forensic consent and Coroner's/Procurator Fiscal post-mortem examinations in a consistent manner and to a high standard. The guidelines are systematically developed statements to assist the decisions of practitioners and are based on the best available evidence at the time the document was prepared. Given that much autopsy work is single observer and 1-time only in reality, it has to be recognised that there is no reviewable standard that is mandated beyond that of the FRCPath Part 2 exam or the Certificate of Higher Autopsy Training (CHAT). Nevertheless, much of this can be reviewed against ante-mortem imaging and other data. This guideline has been developed to cover most common circumstances. However, we recognise that guidelines cannot anticipate every pathological case type and clinical scenario. Occasional variation from the practice recommended in this guideline may, therefore, be required to report an autopsy in a way that that maximises benefit to the pathologist, Coroner/Procurator Fiscal and the deceased's family.

There is a general requirement from the General Medical Council (GMC) to have continuing professional development (CPD) in all practice areas, which will naturally encompass autopsy practice. Those wishing to develop expertise/specialise in pathology are encouraged to seek appropriate educational opportunities and participate in the relevant external quality assurance (EQA) scheme.

The guidelines themselves constitute the tools for implementation and dissemination of good practice.

The following stakeholders will be consulted for this document:

- the Association of Anatomical Pathology Technology
- the Coroners Society of England and Wales
- the Human Tissue Authority
- the Crown Office Procurator Fiscal Service
- the Coroner's Service for Northern Ireland

The information used to develop this document was derived from current medical literature and a previous draft version of this guideline. Much of the content of the document represents custom and practice and is based on the substantial clinical experience of the

authors. All evidence included in this guideline has been graded using modified SIGN guidance (see Appendix D). The sections of this autopsy guideline that indicate compliance with each of the AGREE II standards are indicated in Appendix E.

No major organisational changes or cost implications have been identified that would hinder the implementation of the guidelines.

A formal revision cycle for all guidelines takes place on a 5-yearly cycle and the full revised version (incorporating the changes) will replace the existing version on the College website.

The guideline has been reviewed by the Professional Guidelines team, Death Investigation Committee, Medical Microbiology Specialty Advisory Committee and Lay Advisory Group. It will be placed on the College website for consultation with the membership from 12 November to 10 December 2024. All comments received from the membership will be addressed by the author to the satisfaction of the Clinical Lead for Guideline Review.

This guideline was developed without external funding to the writing group. The College requires the authors of guidelines to provide a list of potential conflicts of interest; these are monitored by the Professional Guidelines team and are available on request. The authors have declared no conflicts of interest.

1 Introduction

Autopsy work – whether medicolegal or consented/hospital autopsies – frequently involves examination of cadavers with infectious diseases. Most of the infections encountered pose no significant risk to mortuary staff, but some are potentially serious, and a few are so virulent and dangerous that routine autopsy is effectively banned.

'Mortuary staff' means those who are potentially exposed to material including body fluids from cadavers in the mortuary: the anatomical pathology technologists (APTs), pathologists (senior and trainees), visitors and observers – essentially all those who attend an autopsy at the tableside and are in close proximity to a cadaver.

Much of the information and recommendations in this document are the result of practice within a centre of excellence specialising in infectious disease.

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 country to any other within 24 hours and present ill or moribund to a healthcare centre.

There are 4 hazard groups (HG) of infectious biological agents, categorised along 3 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 (managing infection risks when handling the deceased).[2]

1.2 Hazard group definitions

- HG1 – the agent is unlikely to cause human disease.
- HG2 – can cause human disease and may be a hazard to mortuary staff; the agent is unlikely to spread to the community and there is usually effective prophylaxis or treatment available.
- HG3 – can cause severe human disease and may be a serious hazard to mortuary staff; the agent may spread to the community, but there is usually effective prophylaxis or treatment available.
- HG4 – causes severe human disease and is a serious hazard to mortuary staff; the agent is likely to spread to the community and there is usually no effective prophylaxis or treatment available.

The complete list of the relevant pathogens in HGs 2, 3 and 4 is very long.[1] It needs to be considered in conjunction with the guidance from the Control of Substances Hazardous to Health (COSHH) regulations (2002),[3] where risk reduction ('containment') measures are presented. Usefully, it is recognised that 1 size does not fill all and that several nominally hazardous infections can be worked with at less than the minimum containment levels prescribed by COSHH – depending on the actual working activity and the differential risk of infection. For examples, several HG3 infections are not transmitted through airborne spread and, thus, simpler precautions in a mortuary will suffice (see Annex 1 in the HSE/ACDP document).[1] This means that, with sensible universal precautions, the risk of infection with most of the HG3 agents is small during autopsy work.

The list of potential infectious agents considered in this guidance comprise mainly **HG3 agents**, with a few from HG2 also noted. They include virus, bacterial, fungal and parasitic infections, and prions. The main HG3 agents are contained in Table 1.

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

Viruses	Bacteria	Fungi
Rabies and Lyssa MERS (Middle East respiratory syndrome) coronavirus SARS (severe acute respiratory syndrome) coronavirus **SARS-CoV-2** Acute haemorrhagic conjunctivitis (enterovirus 70 & coxsackievirus A24) Poliovirus Lymphocytic chorio-meningitis (LCM) virus Rift Valley fever virus Dengue viruses Japanese encephalitis virus Tick-borne encephalitis virus West Nile virus **Yellow fever and yellow fever inactivated virus vaccine** **Hepatitis viruses B, C, D, E** Mpox Human T-cell lymphotropic viruses (HTLV) 1 and 2 **Human immunodeficiency viruses (HIV) 1 and 2** Chikangunya virus	***Bacillus anthracis*** *Brucella* spp *Burkholderia pseudomallei* (melioidosis) *Chlamidophila psittaci* (psittacosis) *Coxiella burnetii* (Q fever) *Escherichia coli*, verocytotoxigenic strains *Francisella tularensis* (tularaemia) ***Mycobacterium***, including **tuberculosis**, leprae, ulcerans, bovis *Rickettsia* spp *Salmonella paratyphi* *Salmonella typhi* *Shigella dysenteriae* ***Yersinia pestis* (plague)**	*Blastomyces dermatitidis* *Cladosporium* spp *Coccidioides immitis* *Histoplasma capsulatum* and *H.duboisii* *Paracoccidioides brasiliensis* *Penicillium marneffei* *Rhinocladiella* spp
	Parasites	**Prions**
	Echinococcus spp (hydatid disease) – *E.granulosus, E.multilocularis, E.vogeli* *Taenia solium* *Leishmania* spp – *L. braziliensis, L. donovani* *Naegleria fowleri* *Plasmodium falciparum* (malaria) *Trypanosoma brucei* (African trypanosomiasis) *Trypanosome cruzi* (South American trypanosomiasis)	**All transmissible spongiform encephalopathies (TSE)**, including sporadic Creutzfeldt-Jakob disease (CJD) and bovine variant CJD (vCJD).

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

1.3 HG2 infections

HG2 infections of significance in autopsy practice include Group A *Streptococcus pyogenes* and the main agent of community acquired pneumonia, *Streptococcus pneumoniae*. Influenza fatalities are seasonal; the autopsy has a significant role in confirming or excluding the disease as the cause of death (severe influenza has characteristic lung and other organ histopathology). Unusual infections, such as leptospirosis, nocardiosis and legionnaire's disease, are also in HG2.

The fungal infections commonly encountered in immunosuppressed patients – immunocompromised from cancer treatments, transplantation, HIV/AIDS inter alia – are HG2 agents. The HG3 fungal infections in Table 1 are all imported, i.e. not native to the UK; but the lifecycle forms that are present in cadavers are not those which infect prosectors by airborne contamination and, thus, special precautions are not required.

1.4 HG4 infections

HG4 infections, which include haemorrhagic fevers with high mortality, are all viruses. The complete list is presented in Appendix A. Any autopsy work on a cadaver with known or suspected infection in this category should only be performed under special circumstances, which are beyond the scope of this guidance (see also College Ebola guidance).[4]

1.5 Historical perspective on mortuary-acquired infections

From the published literature, the heyday of concern over serious infections acquired in mortuary work was in the 1970s–1990s. Grist and colleagues regularly documented infections acquired in UK laboratories and mortuaries.[5] The risks of acquiring tuberculosis (TB), hepatitis and bacterial sepsis from cadavers declined, presumably reflecting safer working practices. This era coincided with the HIV/AIDS pandemic (first appreciated in 1981). The identification (in 1996) of fatal variant CJD, transmitted from beef meat (bovine spongiform encephalopathy, BSE),[6] contributed further concern.

Numerous guidelines and recommendations on reducing such infections in mortuaries, greater familiarity with the diseases, enhanced personal protection methodology, vaccinations and availability of treatments for acquired infections have all contributed to reducing the risks of infectious disease. Further, hepatitis B and hepatitis C are now treatable (which was not the case 20 years ago) and both infections are potentially curable with antiviral agents. HIV infection is treatable, but not curable.

1.6 Scope of these guidelines

- To advise those who work in mortuaries on the rational approach to significant infections in cadavers and when to know that a particular case should be referred 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 in certain HG3 infections, e.g. evisceration.
- To recommend appropriate vaccination strategies for all mortuary staff.
- To indicate safe personal protective equipment (PPE) against the various likely infections.
- To indicate the optimum evaluation pathways for diagnosing HG3 infections in cadavers.
- To recommend a process of evaluation of a person considered possibly to have died because of a recent vaccination.
- To indicate what to do if a mortuary worker injures or cuts themself while examining a known or suspected HG3 infection case.
- To indicate the public health requirements around notifiable infections.
- To promote more specialist autopsy practice with regard to mortuary development and individual APTs and pathologists.

Section 2 of the guidelines considers the role of these guidelines.

Section 3 indicates general pathology indicators of an infected cadaver. Appendix C details specific considerations of HIV, TB (including multi-drug-resistant TB), rabies, SARS-CoV-2 and vaccination-related fatalities.

Sections 4–6 consider the infection hazards and proportionate measures to take.

Appendices A and B list the HG4 infections and the notifiable HG3 and HG4 infections.

1.7 Target users and health benefits of this guideline

The target primary users of this guideline are pathologists, trainees, 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/Procurators Fiscal.

The outcomes if the recommendations are implemented include:

- more refined appreciation of the infection risks presenting in the case mix of cadavers in all mortuaries
- systematic preparation of protocols to manage known or suspected HG3 infection risks at autopsy
- greater communication and harmonisation between APTs and pathologists on how to manage infections
- encouragement of specialist (here, serious infection) autopsy practice and, thus, producing better informed diagnoses
- improvement of mortuary facilities.

2 The role of the autopsy

The role of the autopsy is to make, confirm and exclude diagnoses, by consideration of all the available information – pre-mortem clinical and laboratory data, as well as autopsy-derived information. Often, there is no pre-mortem clue to the presence of a significant infection.

Thus, it is critical that the pathologist be present when a body is being opened by an APT or trainee, if they are not doing the dissection themselves. Obvious features, such as purulent sepsis and discoloured intestines, are clues to infections (see section 3 below).

The pathologist must depart the mortuary after an autopsy only when all the relevant materials that will enable proper evaluation have been sampled, labelled or preserved as appropriate, or packaged for sending to a laboratory, along with appropriate documentation.

3 Pathology of infectious diseases encountered at autopsy

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

Table 2: Pathological features of some HG3 and HG2 infections.

Skin and subcutis	Ulceration and swelling, with or without pus or underlying osteomyelitis (necrotising fasciitis)
Brain	Swelling and congestion without known hypoxic-ischaemic injury (consider viral and protozoal encephalitis)
Peritoneum	Purulent peritonitis (consider perforation of gut, spread from an adjacent organ or primary bacterial peritonitis)
Chest	Purulent pleurisy and pericarditis; consolidated lung lobes, lung abscess (may be seen in bacterial infections) In the heart, flabby mottled myocardium may be myocarditis, and endocarditis lesions should be sampled for microbiology and histology.
Liver	Cirrhosis (consider viral hepatitis) Submassive necrosis (consider viral hepatitis, yellow fever)
Spleen	Large spleen and lymph nodes (consider HIV infection) Large white pulp follicles in spleen (consider HIV)
Small or large bowel	Distention, discolouration, inflammation and ulceration of small or large bowel (consider salmonellosis or shigellosis; also amoebiasis)
Other	Miliary necrotic nodules in lung, liver, lymph nodes, meninges and spleen (consider TB or fungal infection such as histoplasmosis or aspergillosis) Dark brown liver and swollen dusky brain (consider malaria)
Note: the so-called 'septic spleen' – enlarged soft spleen with semi-liquid pulp dripping out on cut section – is a very non-specific sign; most examples are simply post-mortem autolysis, and a firm spleen is often encountered in systemic sepsis.	

4 Specific health and safety aspects

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

- preparation for the possibility that they may be present in cadavers
- drafting of appropriate and agreed protocols on what to do

- the state of the mortuary and its equipment
- PPE
- prevention prophylaxis through vaccination of staff.

Secondary issues include:

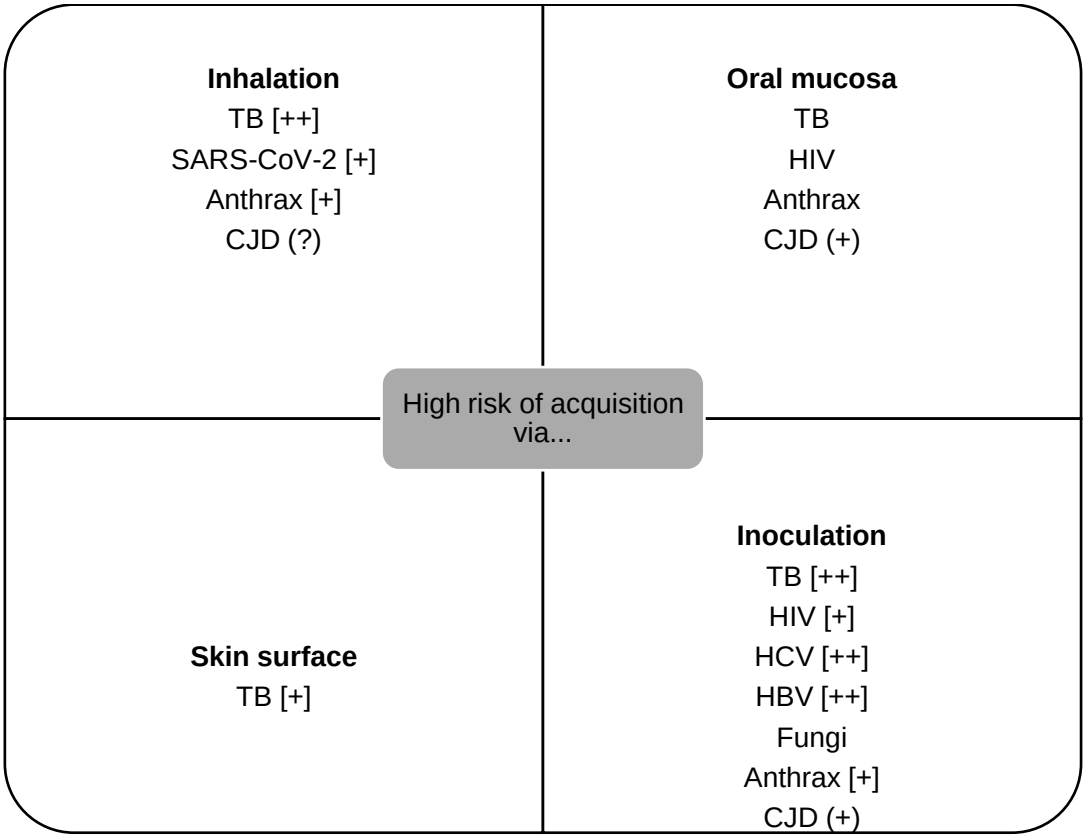
- whether junior staff (trainees) should be involved
- whether pregnant staff are at significant risk
- management of accidents in mortuary when working on infected cadavers
- appreciation that bodies can conceivably be contaminated after death with HG3 and HG4 infections, in a bioterrorist attack.

In the mortuary, infections may be acquired by mortuary staff via:

- percutaneous inoculation
- skin contamination without inoculation
- ingestion
- inhalation
- contamination of mucosal surfaces (eye, mouth, nose).[7]

The following figure lists which routes of infection are linked to higher risks of acquiring a specific infection after exposure.[7]

Figure 1: Infectious agents with high risk of acquisition via route of infection.[8] Insufficient data available is indicated as (?). The higher relative risks of acquisition are indicated as + or ++. But note that for persons treated with modern chemotherapy e.g. HIV and hepatitis C virus (HCV) can be essentially non-infectious.



4.1 Preparation and risk assessment

To perform HG3 autopsies safely and satisfactorily, it is essential to that the following be 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 6.1) effectively protects against most risks and may, in practice, render much 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 (VRE). However, consideration of risks in each case remains important.[7] The

'Managing infection risks when working with the deceased' guidance includes further information on this procedure.[2]

4.2 Risk assessment

Practitioners have a duty under COSSH to carry out risk assessments of each case. This is to prevent actions which may put healthcare workers at risk. Pre-autopsy risk assessment may include:[7]

- the clinical history on a consent form
- the history as provided by a coroner/procurator fiscal
- direct information from the treating clinicians (hospital notes, GP notes)
- 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, e.g. if emaciated and/or unusual skin rash consider HIV; skin injection marks, groin sinuses consider intravenous drug use.

4.3 The autopsy suite and its facilities

The 'Managing infection risks when working with the deceased' document indicates that having a separate high-risk suite is 'ideal', but this is not mandatory to perform HG3 autopsies.[2] 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 also.[7] All electric skull saws now come with vacuum evacuation into a separate chamber.

It is recommended to have all the necessary equipment to hand to avoid the need to leave the area to find additional items.

The NHS Estates regulations on mortuary facilities are published in *Health Building Note 16-01 and Scottish Planning note 16-01.*[9]

In addition, it is essential that all containers for all anticipated samples are to hand. Sterile plastic bottles for fresh tissues and fluid, and blood culture bottles (aerobic and anaerobic) must always be available.

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

The critical decision is whether to proceed with the autopsy examination. The critical issues are as follows:

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

If these conditions are fulfilled, proceed with the case examination.

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

- an autopsy is the once-only opportunity to observe the organs and take optimal samples; if later it is unclear what infection(s) are present and causing disease, it is generally too late to go back and try again
- 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.

4.5 Staff in attendance – and the circulator and trainees

According to the ‘Managing infection risks when handling the deceased’ document,[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.[7]

Can pathology trainees undertake high-risk infection autopsy work? Under supervision by senior staff and when they have demonstrated knowledge of the risks and safe protection practices, they can. One approach is that 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, the trainee can proceed with such autopsies.

Pregnant female trainees may wish to remove themselves from mortuary work. There is no particular infection risk to such persons if they were to follow standard universal precautions.

4.6 What to do in case of potential infection through injury in the mortuary

Most mortuaries will have SOPs that dictate what happens in case of accident. The majority of these will be puncture of the skin through gloves. The wound should be encouraged to bleed and cleaned, after which the potential infection risk can be considered. Advice should be sought from the occupational health (OH) units and the incident logged and reported.[7] Appropriate action should follow for cases which include known infections; for example, healthcare workers exposed to HIV should be offered a 1-month course of multi-drug anti-retroviral therapy, which has been shown to reduce infection risk by 80% in cases of needle-stick injuries.[10]

For HCV, although there is no vaccine or prophylaxis, treatment is very effective if initiated early. Therefore, if the injury is considered to be significant, it is important to check for infection by HCV polymerase chain reaction (PCR) testing at 4 to 6 weeks.

For hepatitis B, it is a mandatory requirement that all exposed staff have been satisfactorily vaccinated against hepatitis B virus (HBV).

If the type of infection in the cadaver is not known but is suspected to be a blood-borne virus, then:

- the healthcare workers who sustained the injury should go straight to an OH unit, where risk assessment, baseline testing, advice and as appropriate, empirical prophylactic treatment can be started.

Hospital mortuaries will all have access to OH units; sometimes accident and emergency (A&E) or emergency departments (EDs) act as the OH unit. For local authority mortuaries, there may be no local such unit to access. Independent pathologists may have no direct access to OH facilities. In this situation they may need to attend A&E/ED for care and advice. It is essential that the mortuary has a protocol that indicates where prompt help and advice can be obtained in the event of an accident (see also information in Appendix B.)

4.7 Vaccination of mortuary staff and pathologists

All healthcare workers are required to be vaccinated with Bacillus Calmette-Guerin (BCG) (for some protection against TB) and hepatitis B. Several mortuaries further protect staff with hepatitis A vaccine and top-up vaccinations against diphtheria, polio and tetanus. Meningococcal and typhoid vaccination are also possible. SARS-CoV-2 and influenza seasonal vaccines are recommended for all healthcare workers. As new infections and vaccinations emerge mortuary staff should adhere to vaccination advice for healthcare workers. Beyond this level it is arbitrary; additional vaccines depend on the known and expected case mix. If a mortuary receives international travellers (e.g. near an airport or serving a tropical medicine hospital), then yellow fever and rabies vaccination should be considered.

While it is generally possible to control and effect vaccination programmes for APTs, it may not be so for pathologists, who may work normally onsite or be occasional visitors to the mortuary. The mortuary manager is responsible for enforcing the appropriate vaccination of pathologists who undertake autopsies there; the GMC's Good Medical Practice includes vaccination for doctors.[11,12]

Bioterrorism has raised the prospect of cadavers containing anthrax or smallpox.[13] Vaccines against these agents are available upon request from the Department of Health.

5 Clinical information relevant to the autopsy

Information about the circumstances of a death which requires an autopsy is key. As well as 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 where an unanticipated HG3 became manifest at autopsy; likewise, the many cases where a confident clinical statement that the patient had (for example) active TB, or even HIV, turned out to be untrue. Similarly, treated HCV infection and a subsequent negative test may not be accurate at the time of autopsy if high risk behaviours continue and repeated infection occurs.

6 The autopsy procedure and personal protective equipment

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 avoidance of many hands within the cadaver is important to avoid accident.

6.1 Behaviour and technique

Knowing the hazards determines how to undertake a HG3 autopsy, in conjunction with colleagues. 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 level 4 diploma. It is recommended that pathology trainees are inducted in like fashion, with regular instruction on safe practice.

The following are part of universal precautions in autopsy dissection practice:[7]

- 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 1 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
- for sawing the skull, use an oscillator saw with suction extraction of the bone aerosol into a removable chamber; alternatively, a hand saw with a chain-mail glove may be used
- needles should not be resheathed after fluid sampling – needles and syringes should be placed in a sharps bucket.

6.2 Universal precautions and personal protective equipment

All employers have a duty 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:[7]

- 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 the gown
- rubber boots with metal-protected toecaps and dorsal reinforcement
- latex or other equivalent material gloves
- under these gloves, protective gloves made of Kevlar or neoprene that 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. It is only infective aerosols (e.g. TB) that are not 100% protected against.[7]

6.3 Additional personal protection

TB has always been a risk to mortuary staff.[14] Surgical masks do not provide adequate protection against airborne infections entering the respiratory tract. FFP3 masks are designed to be >95% effective. Full body suits that include a powered air-purifying respirator with high-efficiency particulate air (HEPA) filters essentially provide 100% protection,[7] but this is usually unnecessary. (See Appendix C4 for TB.)

For additional hand protection when sawing bones and opening the skull, a metal fine mesh glove can be used in place of an under-glove; however, this may hinder manipulation.[7,15]

For suspected TSE/CJD autopsies, it has been recommended that a modified brain removal exercise is safer than the usual open-air skull removal process.[16] In this, the head, with the operator's hands and the skull saw, is encased in a transparent plastic bag. Further information on minimising transmission risk of CJD and vCJD in healthcare

settings is available from Advisory Committee on Dangerous Pathogens' Transmissible Spongiform Encephalopathy (ACDP TSE) subgroup of the Department of Health and Social Care.[17] The National CJD Research and Surveillance Unit can provide guidance and a free diagnostic service funded by the Department of Health (www.cjd.ed.ac.uk/neuropathology).

6.4 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.[18] But, where infections are focal, then MIA used as a blind technique has limited utility.

See also section 12 on Imaging in infectious disease post mortems.

7 Specific organ systems to be considered

The organ systems to be sampled depend on the known or suspected infection, and whether the infection is local (e.g. only a brain abscess) or systemic, or somewhere in between. If the disease is systemic, then, as well as obvious local lesions, a standard set of tissue samples is most helpful in evaluating the body's systemic response (SIRS – the systemic inflammatory response syndrome).[19]

This SIRS tissue set comprises the lungs, heart, spleen, liver, the largest lymph node, bone marrow (lumbo-sacral) and kidneys. Adrenal, gut, brain, skin, bladder and genital tract may also be taken.

In suspected encephalitis, it is recommended to take cortex samples for virology directly from the in-situ brain, after cutting the dura, but before brain removal. These are sent fresh to the laboratory, while fixed samples can be later trimmed for histology.

8 Organ retention

There is nothing specific to infectious disease diagnostics that requires retention of any particular whole organ. The general principle of sampling an evident lesion plus the background more normal tissue applies. In cases of meningo-encephalitis, while it is ideal

that the whole brain (+/- spinal cord) be fixed before cutting and blocking, it is not essential in practice.

9 Histological examination

Histopathology is the bedrock of infection diagnosis at autopsy, supplemented by microbiological and molecular diagnostic methods. Fixation in formalin is generally considered to neutralise all infectious agents; thus, when it is critical, fresh material needs to be given to microbiology departments. An increasing range of infectious agents can now be evaluated via molecular diagnostics in formalin-fixed paraffin-embedded (FFPE) material.

Histopathology laboratories will usually allow samples to fix in formalin for 48 hours if there is a known high-risk infection. Sample pots should be identified as high risk using appropriate labels.

Exceptions to efficacy of formalin include prions in the TSEs and large lesions of TB. For TSE, formalin fixation followed by treatment with 96% formic acid prior to processing is optimal. There are further COSHH recommendations for the laboratory technical aspects of TSE diagnosis.[16]

10 Toxicology

Toxicology samples and tests will be determined by the scenario of the death and the possibility of a toxic agent being part of the cause of death. It is the practice in some mortuaries for known or suspected blood-borne HG3 infected cadavers, who are strongly suspected of dying from toxic agents (e.g. morphine in HCV-infected persons), to have blood drawn for toxicology and only if the results are negative or non-contributory to proceed with autopsy.

If the toxicology laboratory can indeed turn round the tests in 1 to 2 days, this might be satisfactory in some scenarios; but further delay degrades the cadaver tissues and so reduces the likelihood that an autopsy will produce a confident diagnosis. In addition, toxicology results need to be interpreted in the overall context of the autopsy, including the circumstances of death and internal examination – the presence of a drug in the blood does not necessarily imply it is the cause of death. (See also RCPath Guidelines on autopsy practice: Autopsy when drugs or poisoning may be involved.)[20]

11 Other relevant samples

Many samples in addition to solid tissues are appropriate for making infectious disease diagnoses at autopsy.

- Urine.
  - In cases of systemic or renal tract infection, bacterial culture is helpful.
  - Several antigens of bacterial agents emerge in urine and can be identified in microbiology departments. Currently, pneumococcal and legionella antigen identification are standard procedures and will assist in confirming or negating suspected diagnoses.
- Blood: The commonest use of autopsy blood, apart from toxicological analysis, is for bacterial culture. Ideally, both anaerobic and aerobic culture bottles should be filled, but if blood is limited, place it in the aerobic bottle.
  - Serology for infections including HIV, fungi and parasites can be performed. For serology, the blood should be spun down as soon as possible and the serum (with or without some haemolysis) presented to the laboratory.
  - Although not as accurate as with in-life samples, HIV viral load estimations can be performed in autopsy blood.
  - Confirmation of sickle cell status can be done on autopsy blood by chromatography. This is useful in identifying a previously undocumented sickle status as a risk factor for virulent bacterial infections.
- Cerebrospinal fluid (CSF): CSF can be cultured for bacteria and fungi, tested for antibodies to infectious agents, and virologically analysed for numerous meningo-encephalopathic viruses. PCR is the main method used.
- Nasal swabs: In adult and non-infant autopsy work, these are primarily for identifying influenza virus or SARS-CoV-2.
- Dab cytology of lesions: Dab imprints of autopsy tissues may be prepared (alcohol-spray fixed for Papanicolou stain, and air-dried for Giemsa, Gram, Ziehl-Neelsen and immunohistochemical stains). These can give rapid diagnoses for bacterial and fungal infections. Their specificity depends on the infection genus and the experience of the pathologist.

- Brain smears: A smear of brain, air-dried and stained with Giemsa, is a rapid means of diagnosing or excluding cerebral falciparum malaria.

11.1 How to take these samples

Urine, blood and 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.

For CSF, the largest volumes are obtained from the cisterna magna, via under the occipital bone, or alternatively, the L4-L5 space, as per CSF sampling in live patients.

Nasal swabs utilise the pre-prepared sample sticks that can be submitted straight for PCR influenza virus identification.

11.2 Rare and Imported Pathogens Laboratory

The UK Health Security Agency (UKHSA) provides expert laboratory analysis for the whole of the UK in cases of suspected rare and imported pathogens. They can provide clinical advice prior on samples to take or testing to be performed. Samples are usually sent to your local microbiology laboratory to be forwarded on to the Rare and Imported Pathogens Laboratory.

Their request form can be found online: https://www.gov.uk/government/publications/rare-and-imported-pathogens-testing-form-to-submit-sample

12 Imaging

Imaging based post-mortem examination should never be undertaken without an expert external examination of the body having first been performed by an appropriately trained and experienced individual.

In the realm of infectious diseases, primary diagnostic cadaveric imaging has no role to play. Pre-death imaging often provides clues to undiagnosed significant infections. But there is no infection scenario where a post mortem computed tomography or magnetic resonance imaging (MRI) scan can indicate or exclude a particular infection.

13 Clinicopathological summary and notification of infection

If the 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 the infection contributed to the death, but is not the main cause, then placing it in part 2 is appropriate.

13.1 Notifiable infectious diseases

Notifiable infectious diseases (NOIDs) are diseases notifiable to local authority proper officers under legislation and associated regulations and guidance[21] (see Appendix B for the listing).

Registered medical practitioners in England, Wales, Scotland and Northern Ireland have a statutory duty to notify their local authority, local Health Protection Team, Director of Public Health (in Northern Ireland) or the local Consultant in Communicable Disease Control of suspected cases of certain infectious diseases. Laboratories in England performing a primary diagnostic role must notify the UKHSA when they confirm a notifiable organism. Laboratories in Wales should notify Public Health Wales. Laboratories in Scotland should notify Public Health Scotland. Laboratories in Northern Ireland should notify the Public Health Agency.

This duty should be taken to include mortuaries and cellular pathology laboratories where morphological diagnoses of infectious diseases are made. Not all infections are diagnosed primarily in microbiology departments and so pathologists have a duty to inform the public health authorities of any listed NOIDs that they identify at autopsy when it is certain or likely that any microbiology department does not know about the case. The Coroner/Procurator Fiscal will not so notify, nor will the Office of National Statistics. There are standard forms available from the NOIDs website, but in practice one can approach a colleague in microbiology to perform the notification.

HIV infection is not listed for notification under NOIDs. Although virtually all such autopsy HIV diagnoses will be known to virology departments who will have notified the authorities, the occasional autopsy-only derived identification of HIV will need to be notified by the pathologist.

14 Examples of cause of death opinions/statements

1a. Rabies encephalitis

1a. Cryptococcal meningo-encephalitis

1b. HIV disease

NB. While, in general, the use of abbreviations is not acceptable on a death certificate, the use of HIV or AIDS is acceptable, although ‘AIDS’ is less commonly used now in clinical practice (the term ‘advanced HIV disease’ is preferable).

1a. Pulmonary abscess and aspergillosis

1b. Old treated cavitary pulmonary tuberculosis

1a. Disseminated nocardiosis

1b. End stage renal disease (on dialysis)

1a. Gastrointestinal haemorrhage

1b. Liver cirrhosis

1c. Hepatitis B virus and hepatitis C virus co-infection

1a. Creutzfeldt-Jakob disease

1b. Contaminated corneal transplant graft

1a. JC virus encephalitis

1b. Chemotherapy with immunomodulatory drug XYZ

1c. Ulcerative colitis

1a. Disseminated strongyloidiasis and T-cell lymphoma

1b. Human T-lymphotropic virus 1 (HTLV-1) infection

1a. COVID-19 (NB. This is an acceptable abbreviation.)

Note: Uniquely, putting ‘HIV/AIDS/HIV disease’ on a cause of death sequence can be deeply upsetting if the family were not aware of that infection in the deceased relative. If the HIV infection is not relevant to the death – either directly, via complications of treatment, or through psychological issues – then omit it from parts 1 and 2; the infection is notified to the public health body anyway and will later be matched with the Office for National Statistics/National Records of Scotland/Northern Ireland Statistics and Research Agency cause of death data. If HIV is relevant to cause of death, then it should be put in part 1 or part 2 of the sequence.

15 Summary and recommendations

Infections have often (mainly historically) been acquired in mortuary practice by pathologists and their technical assistants. The modes of infection include direct cuts or pricks through skin, inhalation and oral contamination.

More stringent and effective PPE has reduced the infection rates of late. Administration of relevant prophylactic vaccines for mortuary staff are another safeguard (the maximal set could include BCG, HBV, influenza, SARS-CoV-2, Hepatitis A virus (HAV), meningococcal, rabies, yellow fever and typhoid).

Regarding the important high-risk HG3 infections in the UK, the major concerns are TB, HIV, HCV, TSEs, mycoses, anthrax, rickettsioses and dengue. Although SARS-CoV-2 was a major concern during its initial pandemic in 2020, the effects of vaccination and the mutation of the virus over time has reduced the risk; transmission in the mortuary setting is virtually unreported.

The critical decisions regarding an autopsy on a known or suspected high-risk infectious case are:

- are the mortuary facilities sufficient for that infection?
- are the staff sufficiently experienced to undertake the case and pursue the necessary post-dissection analyses? If they are not, then the case should be referred to a more specialist mortuary.

More attention to autopsy practice for high-risk infections and to the subsequent necessary investigations (histological and microbiological) should drive up standards of reporting these cases, as well as encouraging safer working for the relevant health care staff.

15.1 Recommendations

- Knowledge, experience and preparation are the key aspects in managing infectious autopsies in a mortuary.
- All the staff – pathologists and APTs – must all be aware and in agreement with protocols to manage infections.
- Vaccinations of selected staff are important, particularly for more unusual infections such as rabies and yellow fever.
- Preparation of appropriate protocols of safe and effective practice are essential and need updating periodically.
- Mortuaries must have appropriate blood, CSF and tissue sampling technical systems and access to appropriate microbiology laboratory facilities.
- If an unexpected infection becomes apparent during an investigation which is beyond the experience of the pathologist, they must seek advice and assistance from the UK network of experts.
- Pathology trainees must be introduced to safe practice on cadavers with HG3 infection.

15.2 Summary

See also Figure 1 for infection risk data.

Table 3: Recommended PPE for seven common HG3 and HG2 infections.

Infection	Facial protection	Hand protection
SARS-CoV-2	FFP3 mask and eye protection	Neoprene cut-resistant glove under clinical examination gloves
TB	FFP3 mask and eye protection	
Hepatitis C	Full face visor or usual surgical mask and eye protection	
HIV	Full face visor or usual surgical mask and eye protection	
HG2 Mycoses – Aspergillus, Candida	Full face visor or usual surgical mask and eye protection	
HG3 Mycosis – Histoplasma	FFP3 mask and eye protection	
Group A Strep pyogenes (HG2)	Full face visor or usual surgical mask and eye protection	

16 Criteria for audit

The following standards are suggested criteria that might be used in periodic reviews to ensure a post-mortem report for coronial autopsies conducted at an institution comply with the national recommendations provided by the 2006 NCEPOD study:

- supporting documentations:
  - standards: 95% of supporting documentation was available at the time of the autopsy
  - standards: 95% of autopsy reports documented are satisfactory, good or excellent.
- reporting internal examination:
  - standards: 100% of the autopsy report must explain the description of internal appearance
  - standards: 100% of autopsy reports documented are satisfactory, good or excellent.
- reporting external examination:

- standards: 100% of the autopsy report must explain the description of external appearance
- standards:100% of autopsy reports documented are satisfactory, good or excellent.

A template for coronial autopsy audit can be found on The Royal College of Pathologists' website.[22]

17 References

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2. Health and Safety Executive. *Managing infection risks when handling the deceased: Guidance for the mortuary, post-mortem room and funeral premises, and during exhumation.* Available at: http://www.hse.gov.uk/pUbns/priced/mortuary-infection.pdf.

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Appendix A Hazard Group 4 viral infections

List of Hazard Group 4 viral infections

- Some simian herpes viruses.
- Nipah virus.
- Hendra virus.
- Lujo virus.
- Machupo virus.
- Junin virus.
- Sabia virus.
- Congo–Crimea haemorrhagic fever virus.
- Far eastern tick-borne encephalitis virus.
- Kyasanur Forest virus.
- Omsk haemorrhagic fever virus.
- Russia spring–summer virus.
- Chapare virus.
- Lassa virus.
- Ebola viruses.
- Smallpox (variola major).

Appendix B Notifiable infections and notifiable diseases

The most up-to-date lists of notifiable diseases and causative organisms can be found online. There are some minor differences in the 4 UK nations and the lists are periodically updated, so the pathologist is advised to check the latest information online:

- England: UK Health Security Agency. *Notifiable diseases and how to report them*. Available at: https://www.gov.uk/guidance/notifiable-diseases-and-causative-organisms-how-to-report#list-of-notifiable-diseases
- Scotland: UK Government. *Public Health etc. (Scotland) Act 2008*. Available at: https://www.legislation.gov.uk/asp/2008/5/schedule/1#commentary-key-87bf8043151276484c43b2c5a29e3288
- Wales: Welsh Assembly Government. *Health Protection Legislation (Wales) Guidance 2010*. Available at: https://www.gov.wales/sites/default/files/publications/2019-04/health-protection-guidance-2010.pdf
- Northern Ireland: UK Government. *Public Health Act (Northern Ireland) 1967*. Available at: https://www.legislation.gov.uk/apni/1967/36/schedule/1

Current lists of notifiable diseases and causative agents (England), as of July 2024, are copied below.

List of notifiable diseases

- Acute encephalitis.
- Acute infectious hepatitis.
- Acute meningitis.
- Acute poliomyelitis.
- Anthrax.
- Botulism.
- Brucellosis.
- Cholera.
- COVID-19.
- Diphtheria.
- Enteric fever (typhoid or paratyphoid fever).
- Food poisoning.
- Haemolytic uraemic syndrome (HUS).
- Infectious bloody diarrhoea.
- Invasive group A streptococcal disease.
- Legionnaires' disease.
- Leprosy.
- Malaria.
- Measles.
- Meningococcal septicaemia.
- Monkeypox.
- Mumps.

- Plague.
- Rabies.
- Rubella.
- Severe acute respiratory syndrome (SARS).
- Scarlet fever.
- Smallpox.
- Tetanus.
- Tuberculosis.
- Typhus.
- Viral haemorrhagic fever (VHF).
- Whooping cough.
- Yellow fever.

Report other diseases that may present significant risk to human health under the category ‘other significant disease’.

List of notifiable organisms (causative agents)

Causative agents notifiable to UKHSA under the *Health Protection (Notification) Regulations 2010*.

- *Bacillus anthracis*.
- *Bacillus cereus* (only if associated with food poisoning).
- *Bordetella pertussis.*
- *Borrelia* spp.
- *Brucella* spp.
- *Burkholderia mallei*.
- *Burkholderia pseudomallei*.
- *Campylobacter* spp.
- Carbapenemase-producing Gram-negative bacteria.
- Chikungunya virus.
- *Chlamydophila psittaci.*
- *Clostridium botulinum*.
- *Clostridium perfringens* (only if associated with food poisoning).
- *Clostridium tetani*.
- *Corynebacterium diphtheriae.*
- *Corynebacterium ulcerans*.
- *Coxiella burnetiid*.
- Crimean-Congo haemorrhagic fever virus.
- *Cryptosporidium* spp.
- Dengue virus.
- Ebola virus.
- *Entamoeba histolytica*.
- *Francisella tularensis*.
- *Giardia lamblia*.
- Guanarito virus.
- Haemophilus influenzae (invasive).
- Hanta virus.
- Hepatitis A, B, C, delta and E viruses.
- Influenza virus.
- Junin virus.
- Kyasanur Forest disease virus.
- Lassa virus.
- *Legionella* spp.
- *Leptospira interrogans*.
- *Listeria monocytogenes*.
- Machupo virus.
- Marburg virus.

- Measles virus.
- Monkeypox virus.
- Mumps virus.
- Mycobacterium tuberculosis complex.
- *Neisseria meningitidis*.
- Omsk haemorrhagic fever virus.
- Plasmodium falciparum, vivax, ovale, malariae, knowlesi.
- Polio virus (wild or vaccine types).
- Rabies virus (classical rabies and rabies-related lyssaviruses).
- *Rickettsia* spp.
- Rift Valley fever virus.
- Rubella virus.
- Sabia virus.
- *Salmonella* spp.
- SARS-CoV-2.
- *Shigella* spp.
- *Streptococcus pneumoniae* (invasive).
- *Streptococcus pyogenes* (invasive).
- Varicella zoster virus.
- Variola virus.
- Verocytotoxigenic *Escherichia coli* (including *E. coli* O157).
- *Vibrio cholerae*.
- West Nile virus.
- Yellow fever virus.
- Yersinia pest.

Under the Reporting of Injuries, Diseases and Dangerous Occurrences Regulations 1995 (RIDDOR), the Incident Contact Centre (ICC) is to be notified if a healthcare worker, through work:[1]

- is infected with a pathogen on the list (mainly Hazard Group 3 and Hazard Group 4 agents), or
- suffers a ‘dangerous occurrence’ such that the incident could have resulted in such infection.

It is unclear how diligent this reporting by mortuaries is, but it is essential to have standard protocols available on what to do if injury occurs.

Reference

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Appendix C Specific considerations

1 Post-vaccination fatality

Vaccinations are not free from risk; morbidity and some deaths do occur. To maintain public confidence in immunisation programmes, such fatalities must be rigorously investigated in order to determine to what extent the vaccination contributed to death.

If a vaccine is considered to have caused an adverse reaction, this should be reported via the yellow card reporting tools online: https://yellowcard.mhra.gov.uk/ or https://www.yccscotland.scot.nhs.uk/.

Hazard Group 3 vaccine-related infections of concern are tuberculosis, SARS-CoV-2, rabies and yellow fever; smallpox (Hazard Group 4 infection) vaccination is still given to certain sections of the community, such as the Army and some laboratory workers. But there may also be deaths following vaccination against numerous Hazard Group 2 agents, such as mumps, rubella, influenza and pertussis.

Bacillus Calmette-Guerin vaccine for tuberculosis causes disseminated infection in immunocompromised subjects (such as HIV infection or congenital immunodeficiency).

Rabies vaccine has no apparent association with post-vaccine mortality.

Uptake of yellow fever vaccine (YFV) has become more common in countries outside the standard tropical endemic zones. It is necessary to consider potential complications of the vaccine, as it can cause yellow fever hepatitis and a haemophagocytic syndrome and death. Risk factors for morbidity and mortality are age >60 years, thymectomy or thymus disease and previous chemotherapy for cancer.

The following factors should be considered as part of the protocol for such autopsies:

- factors suggesting death is associated with vaccine-related complication
- clinical pathology produced by the vaccine
- time period since vaccination
- clinical scenario
- possible and actual comorbidities
- other potential causes of death.

Protocols for performing autopsies in these cases depend on the vaccine and target organs involved. Post mortems should be approached as per autopsies involving the relevant infective agent. Full organ sampling is vital. Retention of frozen tissue samples and frozen spun blood is critical if later investigations are to be carried out. In the case of a suspected YFV fatality, a frozen sample of liver must be retained.

1.1 Recommended autopsy procedure

Obtain maximum clinical information around the death scenario and the type of vaccine administered, with accurate chronology.

There is no common time frame for adverse events; acute anaphylaxis is rapid, while other consequences can take a week or more. Careful clinicopathological correlation of the scenario of the death is essential.

Perform a full external examination and internal evisceration autopsy. If a vaccine-related adverse event is likely, PM-CT is not appropriate as a sole method of examination.

If there is a clear cause of death (non-vaccine-related, e.g. ischaemic heart disease, intracerebral haemorrhage in a hypertensive), consideration should be given to retaining a relevant tissue sample to confirm this. Otherwise, follow your normal, HTA-regulated procedures.

If the autopsy is ‘negative’ or indicates disease that could be an adverse reaction, then:

- take samples for fixed tissue histology from all critical organs:
  - brain, heart, lungs, liver, spleen, kidney, bone marrow, any skin lesions
- remove and fix the spinal cord and roots if Guillain-Barre syndrome or paralytic poliomyelitis is clinically possible.

If the vaccine was ‘live − attenuated or inactivated, viral or bacterial’, i.e. capable of producing infection, additionally:

- retain samples of organ(s) most affected pathologically, e.g. brain, liver, in a freezer; this is for later microbiology analysis
- retain the blood and CSF samples in a freezer for later analysis (plasma is better than raw blood for later virology).

If the fatal collapse happened within an hour of vaccination, send blood for mast cell tryptase straight away. For more information on acute anaphylaxis, see the RCPath guideline on acute anaphylaxis (G170).[1]

In a negative autopsy, samples for toxicology should also be taken.

Examine the histology samples carefully and consult with specialists in infectious disease if in doubt over lesions.

1.2 General points

Any autopsies will be medico-legal. The Coroner/Procurator Fiscal will be obtaining data on the vaccine used and its reference/batch number and any history of previous reactions to a vaccine.

Do not disseminate information prematurely to persons not directly involved in the autopsy commissioning or performance. The Coroner/Procurator Fiscal must be the first person receiving the final conclusions.

2 HIV infection and autopsy pathology

HIV disease occupies a special place in autopsy pathology, since it is a relatively recent phenomenon and, in the early days, autopsy was a major source of clinicopathological information about what HIV can do to people. HIV has had a profound impact on autopsy practice in areas with significant infection prevalence through the perceptions of the risks involved.[2] Moreover, with the advent of effective combination antiretroviral therapy (cART) (after 1996), the pathology encountered at autopsy has changed significantly.

Previously, most deaths in people with HIV involved opportunistic infections and tumours. They could be highly infectious, with millions of viral particles per millilitre of blood, and thus highly infectious. Pathologists have been known to cut themselves and become infected.[3] Now, those on cART are mostly ‘well-controlled’, with undetectable viral loads in body fluids, i.e. they are effectively non-infectious. Simultaneously, the range of observed pathologies has become both easier to evaluate at autopsy and more difficult.

The majority of those with HIV infection now die from non-HIV related disease: cardiovascular atheroma and stroke, adenocarcinoma of lung and liver, lymphoma, chronic obstructive pulmonary disease (COPD), accidents, suicide and drug overdose. A minority are complicated, involving cART toxicity to organs, IRIS (the immune reconstitution inflammatory syndrome), direct HIV damage to organs and encephalopathy, such as CD8 encephalitis. We recommend that such HIV deaths are referred directly to specialist pathologists, or at least are sampled extensively for later review by experts.

If a cadaver at autopsy is suspected to have HIV infection and there is no known in-life diagnosis, there are 2 complementary means of confirming the infection: serology and

immunohistochemistry (IHC) on tissue samples. Autopsy blood can be tested for HIV antibodies; the results are specific and sensitive, providing the delay time from death to autopsy is not prolonged. Whole blood is sent to a virology laboratory. For all autopsies, such investigation does not require patient or relative consent, since it is part of the diagnostic process, like histopathology.[4]

Should tissue histopathology suggest HIV infection in a case and no blood is available for testing – either from the autopsy or retained from life in a laboratory – application of IHC with anti-HIV p24 antibodies is effective and specific, as long as the viral load in the tissues is high.[5] Both solid tissue and dab imprints can be so immunostained.[6]

3 Rabies

Suspected rabies fatalities happen in the UK once every 5 to 10 years. These usually require autopsy to confirm the diagnosis. Any APT and pathologist performing the autopsy, and reconstructing the body, must have received prior rabies vaccination (with interval top ups as necessary). The critical organs are the heart and the brain. The heart is sampled in the standard manner and formalin-fixed blocks taken. The brain should be fixed whole, but only after small fresh samples of cerebellum and temporal cortex have been taken for rapid immunodiagnosis; the rabies reference centres, related to the public health laboratories, will collect these tissues and perform the tests.

4 Tuberculosis

The population incidence of tuberculosis (TB) within the UK varies tenfold, with London areas having the highest rates; this relates to immigration from low-income countries, HIV infection, illicit drug usage, poverty and homelessness. Anyone can acquire tuberculosis and the risk of serious disease is highest in the first 2 to 3 years post-infection. In the elderly and those with diseases that affect immune competence, old inactive TB lesions can reactivate and cause local or miliary disease with high mortality.

The number of persons dying with and/or of TB in the UK is not clearly known; death certificates and public health TB registers produce inconsistent data. Many cadavers coming to autopsy with a ‘history of TB’ turn out not to have – nor even have had – active TB; cadavers coming to autopsy with non-specific symptoms or ‘probable cancer’ may actually have miliary TB. A high index of suspicion on the part of pathologists is necessary. Multi-organ miliary white lesions, lung cavitation, solid white-yellow necrotic nodules and basal meningeal thick white exudate are some versions of TB.

Formal diagnosis of TB requires fixed histology with Ziehl-Neelsen stains and – if the infection was not previously cultured in life – microbiological culture and PCR identification. Apart from confirmation, this is frequently necessary to try to trace where and from whom the deceased acquired the infection and, thus, potentially limit further spread of TB in the community.

For rapid diagnosis, dab cytology can be used (see Section 11, bullet point 5).

For fixation, normal formalin is used, but it may require longer than a day or 2 for the bacilli to be killed. Culture of formalin-fixed samples of tuberculous lung lesions has demonstrated that they may still contain viable TB bacilli.[7]

Instances of pathologists and APTs acquiring TB from a cadaver can always occur, despite risk reduction through PPE. Thus, persistent symptoms in pathologists (e.g. cough, weakness, night sweats) need to be taken seriously and investigated. Inoculation of TB material through sharp injury at autopsy has also occurred, producing a chronic nodular skin lesion.

4.1 Multi-drug-resistant TB

Multi-drug-resistant TB is still uncommon in the UK and is often associated with HIV disease. The risk of infection is no greater than with usual *M. tuberculosis* and the same safety precautions apply.

5 SARS-CoV-2

When SARS-CoV-2 emerged at the end of 2019 and beginning of 2020, the virus was classified as a HG3 organism. It remains in this category.

Autopsy protocols[8–10] were rapidly devised to protect those dealing with the deceased during the pandemic. At the time, they were based on quite limited information but were informed by experience and the first principles of dealing with a respiratory virus in HG3. For the most part, these recommendations are still valid. Respiratory protection remains the key.

Widespread vaccination against SARS-CoV-2 has changed the likelihood of serious infection, both in the community and in the healthcare setting, including in the mortuary. Regular booster vaccination is available to all healthcare workers, including mortuary staff.

While principally a respiratory infection, with the propensity to cause viral pneumonitis and associated diffuse alveolar damage with consequent respiratory failure, it is now well

known that COVID-19 can have other physiological effects, the most significant being thrombosis; thus, deaths related to thrombosis or thromboembolism may have a direct link to SARS-CoV-2 infection.

On terminology – SARS-CoV-2 is the causative organism and COVID-19 (coronavirus disease-19) is the name of the disease. ‘COVID-19 disease’ is a misnomer, much like ‘HIV virus’.

COVID-19 is an acceptable abbreviation on a death certificate.

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Appendix D Summary table – explanation of grades of evidence

(modified from Palmer K *et al. BMJ* 2008; 337:1832)

Grade (level) of evidence	Nature of evidence
Grade A	At least 1 high-quality meta-analysis, systematic review of randomised controlled trials or a randomised controlled trial with a very low risk of bias and directly attributable to the target population or A body of evidence demonstrating consistency of results and comprising mainly well-conducted meta-analyses, systematic reviews of randomised controlled trials or randomised controlled trials with a low risk of bias, directly applicable to the target cancer type.
Grade B	A body of evidence demonstrating consistency of results and comprising mainly high-quality systematic reviews of case-control or cohort studies and high-quality case-control or cohort studies with a very low risk of confounding or bias and a high probability that the relation is causal and which are directly applicable to the target population or Extrapolation evidence from studies described in A.
Grade C	A body of evidence demonstrating consistency of results and including well-conducted case-control or cohort studies and high-quality case-control or cohort studies with a low risk of confounding or bias and a moderate probability that the relation is causal and which are directly applicable to the target population or Extrapolation evidence from studies described in B.
Grade D	Non-analytic studies such as case reports, case series or expert opinion or Extrapolation evidence from studies described in C.
Good practice point (GPP)	Recommended best practice based on the clinical experience of the authors of the writing group.

Appendix E AGREE II guideline monitoring sheet

The autopsy guidelines of The Royal College of Pathologists comply with the AGREE II standards for good quality clinical guidelines. The sections of this autopsy guideline that indicate compliance with each of the AGREE II standards are indicated in the table.

AGREE standard	Section of guideline
Scope and purpose	
1 The overall objective(s) of the guideline is (are) specifically described	Introduction
2 The health question(s) covered by the guideline is (are) specifically described	Introduction
3 The population (patients, public, etc.) to whom the guideline is meant to apply is specifically described	Foreword
Stakeholder involvement	
4 The guideline development group includes individuals from all the relevant professional groups	Foreword
5 The views and preferences of the target population (patients, public, etc.) have been sought	Foreword
6 The target users of the guideline are clearly defined	Introduction
Rigour of development	
7 Systematic methods were used to search for evidence	Foreword
8 The criteria for selecting the evidence are clearly described	Foreword
9 The strengths and limitations of the body of evidence are clearly described	Foreword
10 The methods for formulating the recommendations are clearly described	Foreword
11 The health benefits, side effects and risks have been considered in formulating the recommendations	Foreword and Introduction
12 There is an explicit link between the recommendations and the supporting evidence	2–15
13 The guideline has been externally reviewed by experts prior to its publication	Foreword
14 A procedure for updating the guideline is provided	Foreword
Clarity of presentation	
15 The recommendations are specific and unambiguous	2–15
16 The different options for management of the condition or health issue are clearly presented	2–15
17 Key recommendations are easily identifiable	2–15

Applicability	
18 The guideline describes facilitators and barriers to its application	Foreword
19 The guideline provides advice and/or tools on how the recommendations can be put into practice	Appendices
20 The potential resource implications of applying the recommendations have been considered	Foreword
21 The guideline presents monitoring and/or auditing criteria	16
Editorial independence	
22 The views of the funding body have not influenced the content of the guideline	Foreword
23 Competing interest of guideline development group members have been recorded and addressed	Foreword