Guidelines for post-mortem cross-sectional imaging in adults for non-forensic deaths

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Foreword

This autopsy guideline published jointly by the Royal College of Pathologists (RCPath) and the Royal College of Radiologists (RCR) is a bench-top guideline for pathologists and radiologists to deal with non-suspicious consented and coroner's 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. It may be necessary or even desirable to depart from the guidelines in the interests of specific patients and special circumstances. Occasional variation from the practice recommended in this guideline may therefore be required to investigate a case in a way that maximises benefit to all involved, the coroner and the deceased's family.

There is a general requirement from the General Medical Council to have continuing professional development in all practice areas and this will naturally encompass autopsy practice. Those wishing to develop expertise/specialise in pathology are encouraged to seek appropriate educational opportunities and participate in a relevant external quality assurance scheme, should one become available. The guidelines themselves constitute the tools for implementation and dissemination of good practice.

The following stakeholders will be contacted to consult on this document:

- the Human Tissue Authority (HTA) and its Histopathology Working Group, which includes representatives from the Association of Anatomical Pathology Technology, Institute of Biomedical Science, the Coroners' Society of England and Wales, the Home Office Forensic Science Regulation Unit and Forensic Pathology Unit, and the British Medical Association
- National Post Mortem Radiology Imaging Board
- Society and College of Radiographers
- Chief Coroner.

The information used to develop this document was derived from current medical literature and a previous 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 C).

A formal revision cycle for all guidelines takes place on a five-year cycle. The College will ask the authors of the guidelines to consider whether or not they need to be revised. A full consultation process will be undertaken if major revisions are required. If minor revisions or changes are required, a short note of the proposed changes will be placed on the College website for two weeks for members' attention. If members do not object to the changes, the changes will be incorporated into the guidelines and the full revised version (incorporating the changes) will replace the existing version on the College website.

The guidelines were reviewed by the Clinical Effectiveness department, Death Investigation Group and Lay Governance Group. The guideline will be placed on the College website for consultation with the membership from 2 September to 30 September 2019. All comments received from the membership will be addressed by the authors to the satisfaction of the Clinical Lead for Guideline Review (Cellular Pathology).

These guidelines were 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 Clinical Effectiveness department and are available on request. The authors of this document have declared that there are no conflicts of interest.

1 Introduction

1.01 The system of death registration in England and Wales leads to a higher rate of autopsy than is the case in most other western countries. Of all registered deaths, 43% were reported to coroners in 2017 and 37% of these referrals underwent autopsy.[1]

1.02 There have been calls to find an alternative means for establishing a cause of death other than through an autopsy, in particular from communities who have religious or cultural objections to an invasive autopsy.[2] A shortage of autopsy active pathologists in some areas has also contributed to the expansion of post-mortem imaging services.

1.03 Concerns have also been raised about the quality of coronial autopsy reports in England and Wales with the finding that the cause of death given following autopsy appeared questionable in about 20% of cases following an audit.[3]

1.04 There is a long history of radiographic imaging being used as an adjunct to invasive autopsy, mainly for the depiction of fractures and foreign bodies.[4] It has long been appreciated that the use of post-mortem cross-sectional imaging,[5] including multi-detector computed tomography (CT) and magnetic resonance imaging (MRI), can add significantly to the information available from plain radiography, particularly in the setting of trauma[6] and in disaster victim identification.[7]

1.05 At present in the UK, expertise in post-mortem cross-sectional imaging interpretation resides in a small number of centres.

1.1 Area of practice

These guidelines do not apply to those examinations performed when criminal proceedings are in prospect (forensic examinations).

1.2 Purpose

The document sets out the scope and limitations of post-mortem cross-sectional imaging as an alternative or adjunct to an autopsy, and as a means of reliably establishing a cause of death in adults. It sets out guidelines that should be in place when such a service is being commissioned or an examination is being authorised by a legal authority.

1.3 Target users of these guidelines

The target primary users of these guidelines are those commissioning or authorising post-mortem examinations for medico-legal purposes (e.g. coroners, medical examiners, procurators fiscal and service managers), pathologists who conduct post-mortem examinations on behalf of a legal authority and radiologists who interpret post-mortem cross-sectional imaging studies. The guidelines will also be of value to others interested in the use of imaging as a means of establishing the cause of death and as an alternative or adjunct to an invasive autopsy, for example coroners' officers.

Section A: Information for those authorising post-mortem examinations

A1 Strengths and limitations in the use of cross-sectional imaging to establish a cause of death

A1.1 In cases of death as a result of major trauma, imaging frequently demonstrates the nature and extent of many injuries better than invasive autopsy.[6,8,9] Post-mortem CT (PMCT) is superior to dissection in the demonstration of pneumothorax and many fractures. It is sensitive for the detection of traumatic internal haemorrhage, but some soft tissue injuries, such as aortic tear, may not be visible without angiography.

A1.2 In combination with the clinical history, circumstances of the death and external examination, the causes of natural death that can be diagnosed using cross-sectional imaging without angiography include:

- haemorrhagic events such as intracerebral haemorrhage, haemopericardium secondary to ruptured myocardial infarct and ruptured aortic aneurysm
- coronary heart disease in the presence of severe coronary calcification
- disseminated malignancy, although it might not be possible to identify tumour deposits within a solid organ such as the liver using unenhanced imaging.
- pneumonia
- certain intra-abdominal events such as intestinal obstruction and perforation, although identification of the cause of obstruction or site of perforation is often not possible on imaging. Therefore, limited invasive examination of the abdomen, directed by the imaging findings, might be required.

A1.3 Causes of natural death that cannot be reliably diagnosed using unenhanced cross-sectional imaging alone include:

- sepsis (without abscess), including meningitis
- toxic and metabolic conditions
- primary inflammatory diseases
- pulmonary thromboembolism
- intestinal ischaemia.

Imaging might still be useful in such cases to exclude injuries and other pathologies, and to plan further investigation. PMCT can usually allow the scope of a subsequent invasive procedure to be restricted or confined to certain areas of the body through limited or targeted autopsy.[10]

A1.4 Imaging can be supplemented by minimally invasive procedures to determine the nature of a radiological abnormality and refine the cause of death. For example, imaging-guided needle sampling can be performed to provide histological, toxicological and microbiological diagnosis.[11–16]

A1.5 The use of PMCT angiography, a minimally invasive adjunct to a standard CT examination, improves the accuracy of diagnosis. There are two approaches to angiography that have been shown to increase accuracy of diagnosis for PMCT: whole body angiography and angiography targeted to the coronary arteries.[17–19] The addition of targeted coronary angiography to PMCT increases the proportion of sudden adult deaths that can be diagnosed with imaging alone to 70–92%, depending on case mix.[20,21]

A1.6 Post-mortem imaging can be combined with rapid turnaround toxicology in the investigation of suspected drug-related deaths. This reduces the requirement for invasive autopsy, although the body should not be released until the cause of death has been established.[22]

A1.7 The decision as to whether or not an invasive autopsy is necessary can only be made after the post-mortem imaging has been analysed and an external examination performed.

[Level of evidence – B.]

A2 Imaging modality

A2.1 Most peer-reviewed literature about post-mortem cross-sectional imaging has described the use of CT rather than MRI. This is mainly because CT provides greater overall diagnostic accuracy, and is also more widely available, cheaper and faster.[23]

A2.2 CT is the modality of choice for adult post-mortem cross-sectional imaging.

A2.3 MRI has potential advantages for certain specific pathologies.[24,25]

[Level of evidence – C.]

Section B: Guidelines for service delivery of post-mortem cross-sectional imaging

B1 Case selection

B.1 There should be a defined process, agreed with the relevant legal authority, which specifies how to proceed in the eventuality that an invasive autopsy or further tests are required.

B1.2 Those commissioning or authorising post-mortem cross-sectional imaging should be aware that it cannot replace all invasive autopsies and should seek expert advice when any issue is raised over the suitability of CT or MRI in any diagnostic context. When cross-sectional imaging is being used to establish a cause of death, a formal process should be in place, including providing written material to coroners or, where appropriate, next of kin and/or other interested parties, which clearly explains the strengths and limitations of post-mortem cross-sectional imaging and the processes involved. It should be made clear that in some cases an invasive autopsy may be required.

B1.3 The HTA has confirmed that non-invasive post-mortem examination (including angiography) does not have to be carried out on HTA-licensed premises. However, if any tissues or organs are removed, post-mortem biopsies taken or aspiration of body fluids for laboratory analysis performed, this exception does not apply and the premises must be HTA licensed.

[Level of evidence – GPP.]

B2 Interpretation of the results of imaging

B2.1 Information about post-mortem cross-sectional imaging should be available to non-specialists.

B2.2 In any authorised examination, a pathologist should retain a central coordinating role in establishing the cause of death, working closely with practitioners who perform and interpret post-mortem imaging studies. If another qualified medical practitioner is to take the central role, this should be under the express instruction of the relevant senior coroner and they should be suitably experienced as defined below.

B2.3 Full clinical information should be available to those interpreting post-mortem imaging studies.

B2.4 Imaging-based post-mortem examination should never be undertaken without an external examination of the body having first been performed by an appropriately trained and experienced individual, either a pathologist or another practitioner, of a description designated by the Chief Coroner, working under the governance of a nominated lead pathologist.

B2.5 The findings of the external examination should be available to the individual providing the cause of death.

B2.6 The final post-mortem report should include a clinicopathological/radiological correlation and when necessary an explanation of the cause of death.

[Level of evidence – GPP.]

B3 Ancillary tests

B3.1 A cause of death based on post-mortem imaging should be delivered in the context of all aspects of the investigation.

B3.2 The use of contrast media in a non-targeted fashion (e.g. whole body perfusion angiography) can compromise the results of toxicology. Samples for toxicology must therefore be taken before the administration of these media.[26]

B3.3 If blood-based samples are required for diagnostic purposes, consideration must be given to when these samples should be taken.

B3.4 There is currently no evidence that targeted coronary or cerebral angiography affects toxicology performed on blood taken from peripheral sites or vitreous humour.[27,28]

B3.5 There is currently no evidence that targeted coronary angiography affects microbiology and DNA analysis performed on peripheral blood.[29]

B3.6 On occasions when toxicology of other internal tissues (such as gastric contents, bile, liver and brain tissue) is indicated, an invasive procedure might be required.

[Level of evidence – C.]

B4 Training and qualifications

B4.1 Those commissioning or authorising post-mortem cross-sectional imaging should ensure that those providing the service are appropriately qualified and trained.

B4.2 Interpretation of whole-body cross-sectional imaging should be performed by a medical practitioner holding a CCT or equivalent in radiology, or a practitioner with equivalent competencies in cross-sectional imaging working under the governance of a nominated lead radiologist (holding CCT or equivalent).

B4.3 The radiological skills required to interpret PMCT and MRI are broadly the same as those required to interpret cross-sectional imaging in the living. However, training is required, particularly on the range of normal appearances after death, including the effects of decomposition and mechanisms of death, and on the limitations of the scanning techniques in imaging the dead.

B4.4 Knowledge of the process and language of death investigation is essential.

[Level of evidence – GPP.]

B5 Audit of post-mortem imaging services

B5.1 Good practice suggests that a post-mortem cross-sectional imaging service should be subject to audit. Suggested criteria are included in Appendix B.

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Journals with regular PMCT Imaging content

- *Journal of Forensic Radiology and Imaging* (http://www.jofri.net)
- *International Journal of Legal Medicine* (http://link.springer.com/journal/414)
- *Legal Medicine* (http://www.journals.elsevier.com/legal-medicine)
- *Forensic Science International* (http://www.journals.elsevier.com/forensic-science-international)
- *Forensic Science, Medicine and Pathology* (http://www.springer.com/medicine/pathology/journal/12024)

The international society for the field of practice is the International Society for Forensic Radiology and Imaging (www.isfri.org).

Appendix A Example information sheet for families on minimally invasive autopsy (only for use when minimally invasive autopsy is not the default method of death investigation)

When a death is reported to a coroner, a post-mortem examination (also known as an autopsy) may be necessary to determine the cause of death and provide information to assist with the coroner's inquiries. The traditional or invasive autopsy involves the body cavities being examined internally to enable the removal and careful examination of the major organs. In a full autopsy, the chest, abdomen and head are examined internally. The organs are subsequently returned to the body. You may find the thought of your loved one's body being examined internally in this way distressing, or you may have an objection to invasive autopsy based on your religious beliefs.

While the family cannot prevent a coroner's autopsy taking place, if you do have an objection to traditional autopsy, it is possible to request a less invasive post-mortem examination. A minimally invasive autopsy (MIA) service is now offered. Instead of the body being examined internally, a CT scan (a form of x-ray examination) is performed. In some cases, a procedure known as an angiography is also necessary, whereby a type of fluid that can be detected by x-rays is injected into the patient. This allows the blood vessels to be visualised and can show arterial disease that could have, for example, caused a heart attack.

Commonly asked questions

Can all autopsies be replaced by MIA? MIA is not always appropriate as some conditions cannot be detected by a scan. However, most cases of sudden unexpected deaths in adults can be investigated in this way. If you request a MIA, the coroner's office will contact the pathologist who will review the clinical history and decide whether or not MIA is appropriate.

Does MIA always identify the cause of death? MIA will identify a definite cause in approximately three-quarters of sudden adult deaths. In the other quarter of cases, some form of invasive procedure will be required, although this is usually limited according to the imaging findings. It is very unusual for a full invasive autopsy to be required following MIA.

Will MIA delay the funeral? No. MIA takes place on the same day as invasive autopsy would normally be performed (either the same day or next day following instruction from the coroner). If an invasive examination is required this will be performed immediately following MIA in the mortuary.

Is there a cost associated with MIA? Yes, the cost of the scanning procedures is £xxx. This will normally be paid by the family through their funeral director or burial society. The funeral director may also issue a fee for transferring the deceased for MIA.

Please contact the coroner's office if you have any further questions.

Appendix B Suggested criteria for audit

An audit could measure the following.

1. Radiologist report:
   (i) completeness of information in radiologists' reports compared with a standard reporting proforma
   (ii) appropriateness of conclusion drawn (cause of death possible to deduce or not)
   (iii) correlation with pathologist's report.
2. Percentage of cases triaged to post-mortem computed tomography.
3. Percentage of cases requiring targeted angiography.
4. Percentage of cases requiring an invasive procedure following imaging, analysed according to the variables that might influence this figure. These include:
   (i) circumstances of death (unwitnessed death, witnessed death in the community, in-hospital death, intra- or post-operative death)
   (ii) unit (reflecting differences in coronial case mix, pathologist and radiologist experience)
   (iii) radiologist
   (iv) pathologist (to determine whether the reporting and decision-making of individual pathologists are consistent with their peers).
5. NCEPOD-style central review of a proportion of final autopsy reports, including evaluation of appropriateness of decision-making and cause of death.
6. A proportion of post-mortem scans and reports are randomly selected for audit. The report is assessed according to the following criteria:
   i) major finding: score
      1. Complete agreement
      2. Minor disagreement
      3. Major disagreement
   ii) cause of death. (Scores and categories as above.)
7. Timelines of the stages from referral to body release.

   The auditors should have access to the same clinical information (e.g. GP records, GEN 19, etc) as the original reporters and pathologists.
8. Any trauma or untoward incident to a body, or a member of staff.

Appendix C 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 one 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 population.
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 D AGREE II compliance monitoring sheet

The 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 below.

AGREE II standard	Section of guideline
Scope and purpose	
1 The overall objective(s) of the guideline is (are) specifically described	Foreword
2 The health question(s) covered by the guideline is (are) specifically described	Foreword, 1
3 The population (patients, public, etc.) to whom the guideline is meant to apply is specifically described	Foreword, 1
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	1
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	n/a
12 There is an explicit link between the recommendations and the supporting evidence	A1–B4
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	A1–B4
16 The different options for management of the condition or health issue are clearly presented	Foreword
17 Key recommendations are easily identifiable	A1–B4
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	Appendix A
20 The potential resource implications of applying the recommendations have been considered	Foreword
21 The guideline presents monitoring and/or auditing criteria	Appendix B
Editorial independence	
22 The views of the funding body have not influenced the content of the guideline	Foreword
23 Competing interests of guideline development group members have been recorded and addressed	Foreword