



The Royal College of Pathologists

Pathology: the science behind the cure

**Guidelines on autopsy practice:
Autopsy for bodies recovered from water
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For full details on our accreditation visit: www.nice.org.uk/accreditation.

Foreword

The autopsy guidelines published by the Royal College of Pathologists (RCPATH) are benchmark guidelines for pathologists to deal with non-forensic consent and coroner's post-mortem examinations in a consistent manner and to a high standard. They may contain some distressing information and as such are not intended for the lay audience. 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 one-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 examination. Nevertheless, much of this can be reviewed against ante-mortem imaging and/or other data. These guidelines have been developed to cover most common circumstances. However, we recognise that guidelines cannot anticipate every pathological specimen type and clinical scenario. Occasional variation from the practice recommended in this guideline may therefore be required to report a specimen in a way that maximises benefit to 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 the relevant external quality assurance scheme.

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

The stakeholders consulted for this document were the Human Tissue Authority 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.

The information used to develop this document was derived from current medical literature. Much of the content of the document represents custom and practice, and is based on the substantial autopsy experience of the consultant authors. All evidence included in this document has been graded using modified SIGN guidance (see Appendix E). The sections of this document that indicate compliance with each of the AGREE II standards are indicated in Appendix F.

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

A formal revision cycle for all guidelines takes place on a five-year cycle. The College will ask the authors of the guideline to consider whether or not the guideline needs 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 short notice of change will be incorporated into the guideline and the full revised version (incorporating the changes) will replace the existing version on the College website.

These guidelines have been reviewed by the College's Clinical Effectiveness department, Death Investigation Group and Lay Governance Group. It was placed on the College website for consultation with the membership from 9 May to 6 June 2018. All comments received from the membership were addressed by the authors to the satisfaction of the Clinical Director of Clinical Effectiveness.

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 no conflicts of interest.

1 Introduction

While drowning is a common cause of death in bodies recovered from water or other liquid media, appropriate designation of drowning as a cause of death can be challenging owing to problematic interpretation of pathological findings or lack of findings, and consideration of circumstantial information including medical history is always crucial.¹ The removal of a body from water does not indicate death by drowning.² Deaths specifically related to underwater diving are not covered by this guideline and require specialist input at post mortem.

It is important to stress that this document is a guideline and not a protocol. Experience and professional acumen cannot be substituted by guidelines. A low threshold of suspicion of foul play and the consequent early involvement of a forensic pathologist is essential.

1.1 Background

Bodies may be recovered from water in a range of different circumstances, each providing its own challenges. Bodies from the domestic environment, including ponds, swimming pools, baths or buckets, will usually be relatively fresh, as will bodies recovered quickly from open water. By contrast, some bodies recovered from rivers, lakes or the sea will have been in the water for prolonged periods and may demonstrate variable degrees of decomposition; post-mortem predation and mutilation may occur relatively quickly after entry of the body into water, depending on the circumstances.

The recovery of a body from water will raise the possibility of drowning, but other possibilities exist. The victim may have:

- died of a natural cause before entering the water
- died of an unnatural cause before entering the water
- died of a traumatic or natural cause in the water
- died of consequences of immersion other than drowning (e.g. hypothermia, 'dry drowning').

It is essential to consider each of these possibilities, to be confident in differentiating between true, ante-mortem injuries and post-mortem artefacts and to bear in mind that other non-drowning causes of death (e.g. trauma, effects of intoxication, cardiovascular disease, hypothermia) either before or after the body entered the water represent a proportion of autopsies performed on bodies recovered from water.² The interaction between these can be challenging. Victims who have descended into the water from a height may sustain injury in the fall, raising the possibility of death from this impact or unconsciousness contributing to inability to self-rescue/survive.

The pathophysiology of drowning is complex, and readers interested in this topic should refer to the literature, some of which is included in the reference section.^{3,4}

Further information on the epidemiology of drowning is available in Appendix A.

1.2 Target users of these guidelines

The target users of these guidelines are pathologists conducting routine autopsy work on behalf of a coroner.

2 The role of the autopsy

- To identify potentially suspicious issues and thereby diminish or exclude the risk of undetected crime or homicide.

- To document injuries present and other relevant findings to permit accurate interpretation, including by others, at a later stage if required.
- To determine the medical cause of death.
- To identify contributory factors, if it is drowning.
- To identify non-drowning causes of death in bodies retrieved from water.
- To assist with identification, particularly in cases of prolonged immersion with decomposition or mutilation.

3 Pathology encountered at autopsy

The pathological findings encountered can be subdivided into those encountered owing to drowning, those identified owing to a body being immersed in water (independent of the underlying cause of death) and other non-immersion, non-drowning findings.

3.1 Findings due to drowning

There are many signs at autopsy that are suggested to be evidence of drowning, none of which should be considered pathognomonic.^{5,6}

Signs that may support a conclusion of drowning include:

- froth (or plume) around the mouth and nostrils (from aspirated liquid mixed with air and pulmonary surfactant), sometimes referred to as a *champignon de mousse*. This may have been washed away and may be transient, but it is seen in other circumstances, such as coma (e.g. from sedative drug intoxication) or severe cardiac failure.
- frothy fluid in airways, which may also contain extrinsic materials such as silt, weeds or sand
- over-distended lungs, sometimes to the extent that they are seen to overlap when the chest is opened. They may be heavy, but a normal lung weight does not exclude drowning.
- emphysema aquosum – alternating segmental over-distention and collapse, with a characteristic ‘doughy’ nature to palpation
- watery fluid and debris in stomach suggests immersion during life but does not confirm drowning.

Other signs previously described (of very limited value and not exclusive to drowning) include.^{2,5,6}

- pleural fluid accumulation (usually in salt water drowning)
- middle ear/mastoid congestion and haemorrhage (asphyxia)
- haemolytic staining of the endothelium of the aorta and carotids (which will also occur with decomposition).

3.2 Deaths due to immersion in water

- Some victims appear to die as a result of reflex cardiac arrest (autonomic conflict) when immersed in water (particularly cold water), when the features of drowning will not be present. Some refer to this specifically as ‘dry drowning’.^{7,8}
- Hypothermia – it should be recognised that hypothermia may be a significant factor in causing death in cold water.

3.3 Possible findings in a body recovered from water (not specifically associated with drowning)

The findings below are influenced by a multitude of factors that include duration of immersion, water temperature and whether water was saltwater or freshwater, still or flowing water or clean or polluted. Immersion modifies most changes observed after death.¹

- Lividity – this should match the known position of the body.
- Variable decomposition – cold water will tend to refrigerate the body, retarding decomposition, but allowing an increased amount of time for post-mortem predation and damage from the environment, including shipping. In extreme circumstances, only skeletal fragments may be recovered.
- Maceration of the skin secondary to immersion of that part of the body in liquid – first identified as whitening, soddening, thickening and wrinkling. With time, the epidermis loses integrity and is lost (so-called ‘washerwoman change’ with slippage).
- Haemorrhages in the soft tissues of the neck – these are occasionally found in victims recovered from water but, when encountered, a forensic pathologist should be consulted as a priority, given the potential significance of the finding in relation to homicidal injury to the neck.⁹

[Level of evidence – D.]

3.4 Injuries and other diseases

Immersion in water commonly leads to post-mortem injuries that include those due to contact with the bed/floor/shoreline, contact with natural or manmade objects, or predation/scavenging by aquatic organisms.¹ Such injuries need to be distinguished from those acquired in the ante-mortem period. Pre-existing natural disease should be recorded, and if there is any question over identity of the victim/subject, identifying features should be recorded in detail (e.g. tattoos).

4 Interaction of natural disease and immersion in water

Physical exertion or struggle while in the water can unmask/expose morbidity or elicit previously undiagnosed conditions. This would be particularly true of cardiac pathology, ranging from the common complications of coronary artery disease to the less common but important genetic causes of sudden cardiac death, including cardiomyopathies and channelopathies. Among others, catecholaminergic polymorphous ventricular tachycardia, a channelopathy, may be triggered by entry into water, especially cold water.¹⁰

Natural disease may have an effect on survival, and it always needs to be considered. It may become particularly relevant to an inquest when other witness, circumstantial and medical evidence becomes known to the pathologist. However, it may be impossible to determine their contribution to death.

[Level of evidence – GPP.]

5 Specific health and safety aspects

None beyond standard autopsy health and safety considerations.

[Level of evidence – GPP.]

6 Medical and circumstantial information relevant to the autopsy

These pieces of information are essential prior to commencing the autopsy:

- a complete and appropriate history, which is imperative to the investigation and a prerequisite to undertaking the post mortem. The context of a death in water will inform the overall autopsy investigations, particularly whether or not the case should be referred for a forensic autopsy.
- police documentation, to include relevant details regarding the location of the body, its situation relative to tidal water, currents, etc. and the disposition of the clothing, and to confirm that in their opinion the death appears non-suspicious. Even with such documentation, the pathologist remains responsible for determining the presence or absence of suspicious findings.

The following are desirable, but are not essential prior to the autopsy:

- previous medical history, especially history of epilepsy¹¹ and cardiovascular disease
- psychiatric history, including suicidal ideation
- drug and alcohol history
- family history, especially of sudden cardiac death.

[Level of evidence – D.]

7 The autopsy procedure

- Full documentation of the clothing on the body, including its general condition and position where relevant (although its condition must not be over-interpreted).
- Assessment of external injuries before deciding whether to proceed.
- A full autopsy with particular reference to the above issues.
- Sampling should be undertaken as the autopsy progresses. It is wiser to retain blood and urine early in the examination (and return it to the body if it is unnecessary) than to attempt to obtain samples after dissection.

[Level of evidence – GPP.]

8 Specific significant organ systems

- Lungs – emphysema aquosum, pulmonary oedema, pleural haemorrhage, frothy admixture of bronchial secretions with aspirated liquid and foreign material in airways; evidence of pre-existing pulmonary disease.
- Heart – evidence of underlying cardiac pathology, e.g. coronary artery disease, cardiomyopathy.
- Stomach – fluid and debris content.

[Level of evidence D.]

9 Organ retention

None required, although it may be desirable in some circumstances, e.g. brain, heart. This is with the consent of the coroner.

10 Histological examination

The College supports and encourages histological examination of autopsy material.

If applicable, histological samples should be guided by specific details of the case with reference to other College autopsy guidelines.

A refusal by the coroner to sanction the taking of histology should be documented.

[Level of evidence – D.]

11 Toxicology

Toxicology should be performed in all bodies recovered from water unless this is precluded by severe decomposition or refused by the coroner.

Specimens recommended for best practice include the following,¹² although advice should always be sought from the local toxicology provider:

- peripheral blood (femoral vein), unpreserved and preserved in fluoride
- urine, unpreserved and preserved in fluoride
- vitreous humour
- stomach contents.

An alcohol and drug screen should be requested as standard; information regarding specified drugs as indicated from the history should be provided to the toxicologist.

A note of caution should be made as to the interpretation of toxicology in drowning cases as haemodilution in freshwater drowning, post-mortem redistribution and other factors may affect results. There should be a low threshold for discussing cases with a relevant expert.

[Level of evidence – D.]

12 Other samples to consider

Consider measuring carboxyhaemoglobin or methaemoglobin concentration if indicated by the circumstances, e.g. presence of a faulty water heater producing carbon monoxide, or in some confined spaces.

Samples for genetic analyses, e.g. muscle, spleen.

Samples of historical interest are presented in Appendix B and samples that might be of future value in Appendix C.

[Level of evidence – D.]

13 Imaging¹³⁻¹⁵

The role of post-mortem cross-sectional imaging (PMCSI) is expanding as experience and expertise in this field develops. There is clear evidence to support the use of PMCSI in suspected cases of drowning. If the history, scene examination, external examination and laboratory results as well as the PMCSI images support a diagnosis of drowning, there is no reason that such a cause of death cannot be provided without the need for an invasive post mortem. Access to appropriate imaging facilities and expertise to make such a diagnosis varies around the country but where these are available, their use should be supported, in appropriate circumstances, assessed on a case-by-case basis using the criteria used for other prospective PMCSI cases.

An example of a decision-making algorithm for diagnosis of drowning using PMCSI is available in Appendix D.¹⁴

[Level of evidence – C and D.]

14 Clinicopathological summary

14.1 Factual summary

- Summarise all relevant background, autopsy and additional findings.

14.2 Interpretation of findings

- Decide whether death was non-drowning related or if there is sufficient supporting evidence that drowning has occurred.
- If drowning has occurred, are there any significant contributory factors that have been identified?
- In cases with negative pathological findings (without evidence of water aspiration) certification as 'unascertained' may be appropriate. However, depending on the history and supporting evidence provided, certification as 'immersion in water' may still be justified on the balance of probability. This is in acknowledgment of the well-documented lack of physical and laboratory findings available for definitive confirmation of drowning as the cause of death.

[Level of evidence – GPP.]

15 Examples of cause of death statements

1a. Drowning

or

1a. Drowning

2. Idiopathic primary generalised epilepsy

or

1a. Immersion in water

16 Criteria for audit

The following standards are suggested criteria that might be used in periodic reviews to ensure that post-mortem examination reports for coronial autopsies conducted at an institution comply with the national recommendations provided by the 2006 National Confidential Enquiry into Patient Outcome and Death (known as NCEPOD) study (www.ncepod.org.uk/2006Report/Downloads/Coronial%20Autopsy%20Report%202006.pdf):

- supporting documentation:
 - 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 autopsy reports must explain the description of internal appearance
 - standards: 100% of autopsy reports documented are satisfactory, good or excellent.
- reporting external examination:
 - standards: 100% of autopsy reports 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 (www.rcpath.org/profession/quality-improvement/conducting-a-clinical-audit/clinical-audit-templates.html).

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Appendix A Epidemiological information

The National Water Safety Forum (NWSF) report from 2014 provides an accurate picture of water-related deaths in the UK.¹⁶ There was a total of 381 drowning and water-related deaths from accidents or natural causes across the UK in 2013. More than half of these deaths were in inland waters, such as rivers, lakes and reservoirs, while fatalities at sea, on the beach or shoreline accounted for nearly a third. An additional 22 deaths occurred in harbours, docks, marinas and inland or coastal ports. Eight deaths occurred in the bath and six in swimming pools. Three deaths happened in areas that are not normally watercourses, such as marsh and flooded land.

The NWSF's Water Incident Database (WAID) is a valuable resource for understanding the related activities, age and location of drowning or water-related deaths. It reveals that in 2013 the demographic group with the highest number of fatalities was males aged 20–24. Meanwhile 0–19 year olds accounted for 12% of deaths, of which more than half were teenagers aged 15–19. In the youngest age bracket of 4 years old and under, ten children drowned. The peak summer months of July and August witnessed the most deaths, with 106 during this period.

The leading activities were: people walking alongside water and falling in, swimming (predominantly in open water) and jumping into open water.

Appendix B Samples of historical interest

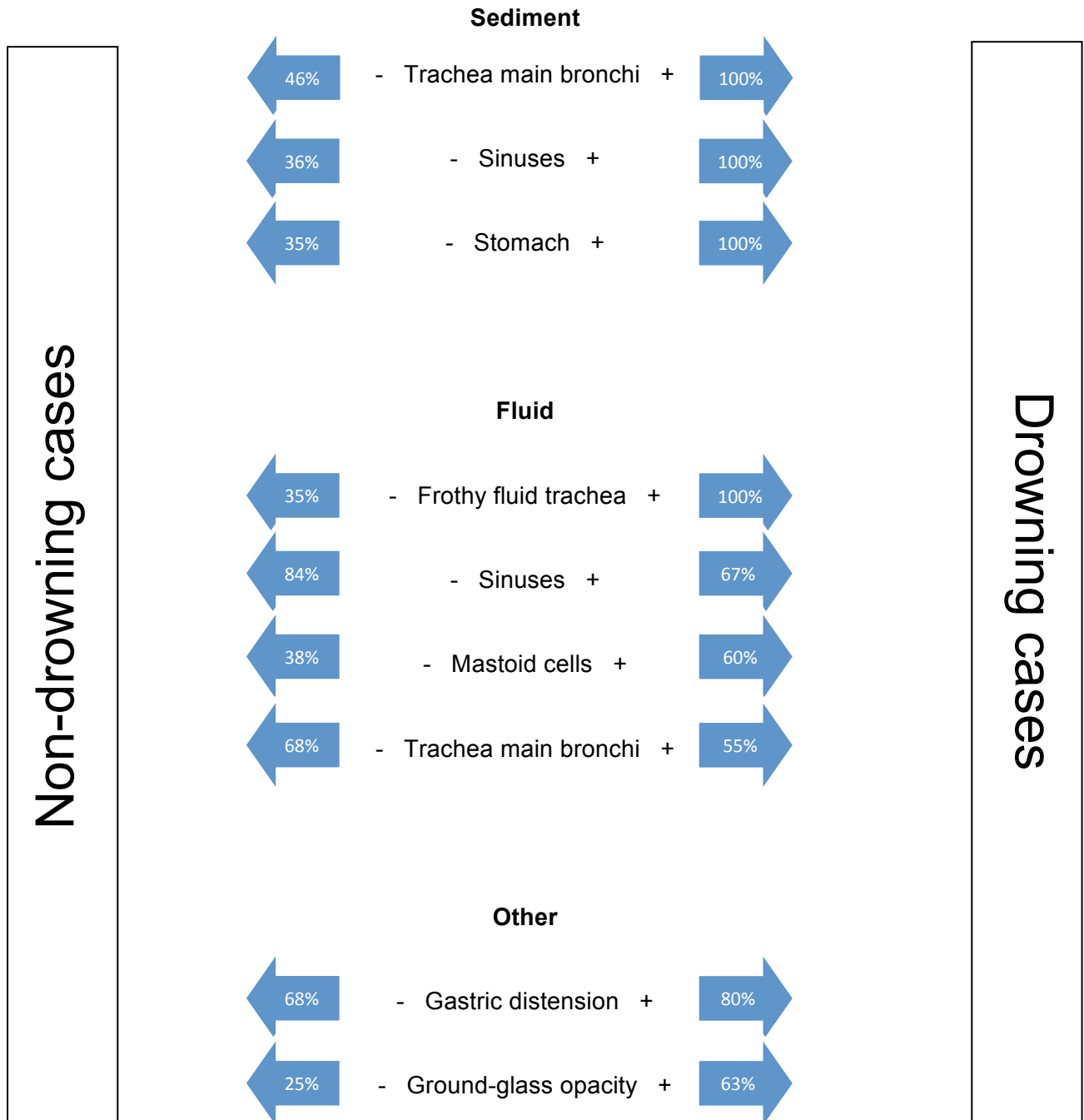
- 1 Diatom testing of major organs (e.g. kidney, liver and brain) may be undertaken, although the validity of the diatom test for the diagnosis of drowning remains controversial. The finding of diatoms in lungs and other organs from bodies of non-drowned human beings and the existence of false negatives makes interpretation in the drowned individual precarious, with studies to date having yielded conflicting results.^{2,6,17}
- 2 Difference in blood chloride content/specific gravity in the left and right ventricles is considered to be of no practical utility for the diagnosis of drowning.⁶
- 3 A difference in blood strontium or other elemental concentration between the left and right ventricle of >75 mg Sr/l may support a diagnosis of drowning in seawater, but is not diagnostic.⁵

Appendix C Samples of potential future value

Detection of bacterioplankton using polymerase chain reaction probes has recently been described as a potential supportive test for the diagnosis of freshwater, brackish and saltwater drowning.¹⁸ However, this test is yet to be used in routine practice, and it is unlikely to be available in most centres.

Appendix D Decision-making algorithm for the diagnosis of drowning

See in conjunction with: Raux C, Saval F, Rouge D, Telmon N, Dedouit F. Diagnosis of drowning using post-mortem computed tomography – state of the art. *Arch Med Sadowej Kryminol* 2014;64:59–75.¹⁴



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Appendix E 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 F 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 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	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	Foreword
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 B–D
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