



AAGBI SAFETY GUIDELINE

Checking Anaesthetic Equipment 2012

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Guidelines

Checking Anaesthetic Equipment 2012

Association of Anaesthetists of Great Britain and Ireland

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2 Medicines and Healthcare products Regulatory Agency

3 British Association of Anaesthetic and Respiratory Equipment Manufacturers Association

Summary

A pre-use check to ensure the correct functioning of anaesthetic equipment is essential to patient safety. The anaesthetist has a primary responsibility to understand the function of the anaesthetic equipment and to check it before use. Anaesthetists must not use equipment unless they have been trained to use it and are competent to do so. A self-inflating bag must be immediately available in any location where anaesthesia may be given. A two-bag test should be performed after the breathing system, vaporisers and ventilator have been checked individually. A record should be kept with the anaesthetic machine that these checks have been done. The 'first user' check after servicing is especially important and must be recorded.

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This is a consensus document produced by expert members of a Working Party established by the Association of Anaesthetists of Great Britain and Ireland (AAGBI). It has been seen and approved by the AAGBI Council.

This article is accompanied by an Editorial. See page 571 of this issue.

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- *What other guideline statements are available on this topic?*
Guidelines on checking anaesthetic equipment have been published by the Association of Anaesthetists of Great Britain and Ireland (AAGBI), and amongst others, the American Society of Anesthesiologists, the Australian and New Zealand College of Anaesthetists and the World Federation of Societies of Anesthesiologists.
- *Why was this guideline developed?*
The increasing sophistication and diversity of anaesthesia workstations made the AAGBI's existing guideline less universally applicable. Incidents reported to the Medicines and Healthcare products Regulatory Agency (MHRA), National Patient Safety Agency (NPSA) and AAGBI also highlighted priority checks that would avoid harm.
- *How does this statement differ from existing guidelines?*
The checklist specifies outcomes rather than processes and covers all the equipment necessary to conduct safe anaesthesia, not just the anaesthesia workstation. It has been written by Officers and Council members of the AAGBI in conjunction with representatives of the Royal College of Anaesthetists (RCOA), MHRA, NPSA and manufacturers. It was modified after a consultation with the membership of the AAGBI and industry. It has been trialled and modified in simulator settings on different machines. It has been endorsed by the Chief Medical Officers of England, Scotland, Wales and Northern Ireland.
- *Why does this statement differ from existing guidelines?*
The guideline reflects anaesthetic practice and staffing in the UK and Ireland and is applicable to any anaesthetic machine, including those yet to be developed.

The pre-use check to ensure the correct functioning of anaesthetic equipment is essential to patient safety. The importance of this pre-use check is recognised worldwide and the check has been included in the


World Health Organization's Surgical Safety Checklist [1]. The AAGBI published the third edition of *Checking Anaesthetic Equipment* in 2004, and this has gained widespread acceptance in the profession. Changes in anaesthetic equipment and introduction of microprocessor-controlled technology necessitate continued revision of this document.

This new edition of the safety guideline updates the procedures recommended in 2004 and places greater emphasis on checking all of the equipment required. A Working Party was established in 2009 comprising Officers and Council Members of the AAGBI and representatives of the Group of Anaesthetists in Training (GAT), RCoA, MHRA and the British Association of Anaesthetic and Respiratory Equipment Manufacturers Association (BAREMA). The Working Party reviewed the 2004 guideline, together with guidelines published by other organisations, and in addition reviewed incidents reported to the MHRA and the National Reporting and Learning Service (NRLS) of the NPSA [2]. The accompanying *Checklist for Anaesthetic Equipment 2012* has been completely reformatted (Fig. 1). There are two new checklists – the first to be completed at the start of every operating session, the second a short set of checks before each case. The detail of how to perform these checks is given in this safety guideline. The first draft was circulated to the membership of the AAGBI and to manufacturers for comments, and the guideline amended in the light of these. Several versions of the checklist were trialled in simulators using different machines. The final version of the checklist was then submitted for further usability tests in simulators. The guideline and checklists have been endorsed by the Chief Medical Officers of England, Scotland, Wales and Northern Ireland.

The principles set out in previous guidelines have governed amendments in this new edition. It must be emphasised that failure to check the anaesthetic machine and/or the breathing system features as a major contributory factor in many anaesthetic misadventures, including some that have resulted in hypoxic brain damage or death. The RCoA recognises the importance of these safety checks, and knowledge of them may be tested as part of the FRCA examination [3].

The anaesthetist has a primary responsibility to understand the function of the anaesthetic equipment and to check it before use

Anaesthetists must not use equipment unless they have been trained to use it and are competent to do so [4]. The NHS Clinical Negligence Scheme for Trusts and NHS Quality Improvement Scotland require that hospitals ensure all personnel are trained to use and to check relevant equipment



Checklist for Anaesthetic Equipment 2012

AAGBI Safety Guideline

Checks at the start of every operating session
Do not use this equipment unless you have been trained

Check self-inflating bag available

Perform manufacturer's (automatic) machine check

Power supply	<ul style="list-style-type: none"> Plugged in Switched on Back-up battery charged
Gas supplies and suction	<ul style="list-style-type: none"> Gas and vacuum pipelines – 'tug test' Cylinders filled and turned off Flowmeters working (if applicable) Hyoxic guard working Oxygen flush working Suction clean and working
Breathing system	<ul style="list-style-type: none"> Whole system patent and leak free using 'two-bag' test Vaporisers – fitted correctly, filled, leak free, plugged in (if necessary) Soda lime - colour checked Alternative systems (Bain, T-piece) – checked Correct gas outlet selected
Ventilator	<ul style="list-style-type: none"> Working and configured correctly
Scavenging	<ul style="list-style-type: none"> Working and configured correctly
Monitors	<ul style="list-style-type: none"> Working and configured correctly Alarms limits and volumes set
Airway equipment	<ul style="list-style-type: none"> Full range required, working, with spares

RECORD THIS CHECK IN THE PATIENT RECORD

Don't Forget!

- Self-inflating bag
- Common gas outlet
- Difficult airway equipment
- Resuscitation equipment
- TIVA and/or other infusion equipment

This guideline is not a standard of medical care. The ultimate judgement with regard to a particular clinical procedure or treatment plan must be made by the clinician in the light of the clinical data presented and the diagnostic and treatment options available.
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Figure 1 Checklist for Anaesthetic Equipment 2012.

[5, 6]. This may take place at induction for new staff or at the introduction of new equipment. This responsibility may be devolved to the department of anaesthesia, but where such a department does not exist other

CHECKS BEFORE EACH CASE	
Breathing system	Whole system patent and leak free using 'two-bag' test Vaporisers – fitted correctly, filled, leak free, plugged in (if necessary) Alternative systems (Bain, T-piece) – checked Correct gas outlet selected
Ventilator	Working and configured correctly
Airway equipment	Full range required, working, with spares
Suction	Clean and working

THE TWO-BAG TEST	
A two-bag test should be performed after the breathing system, vaporisers and ventilator have been checked individually	
<ul style="list-style-type: none"> i. Attach the patient end of the breathing system (including angle piece and filter) to a test lung or bag. ii. Set the fresh gas flow to 5 l·min⁻¹ and ventilate manually. Check the whole breathing system is patent and the unidirectional valves are moving. Check the function of the APL valve by squeezing both bags. iii. Turn on the ventilator to ventilate the test lung. Turn off the fresh gas flow, or reduce to a minimum. Open and close each vaporiser in turn. There should be no loss of volume in the system. 	
<p>This checklist is an abbreviated version of the publication by the Association of Anaesthetists of Great Britain and Ireland 'Checking Anaesthesia Equipment 2012'. (Endorsed by the Chief Medical Officers)</p>	

Figure 1 (Continued).

arrangements must be made. A record of training must be kept. The use of routine checks and associated checklists is an important part of training in anaesthesia, and is part of the RCoA's Competency Based Training.

Modern anaesthetic workstations

The AAGBI checklist for anaesthetic equipment is applicable to all anaesthetic workstations and should take only a few minutes to perform. It represents an important part of safe patient care. It is not intended to replace the manufacturer's pre-anaesthetic checks, and should be used in conjunction with them. For example, some modern anaesthetic workstations will enter a self-testing cycle when the machine is switched on, in which case those functions tested by the machine need not be retested by the user. The intention is to strike the right balance so that the AAGBI checklist for anaesthetic equipment is not so superficial that its value is doubtful or so detailed that it is impractical to use. Manufacturers may also produce checklists specific to their device; these should be used in conjunction with the AAGBI checklist for anaesthetic equipment.

The checking procedure described covers all aspects of the anaesthetic delivery system from the gas supply pipelines, the machine and breathing systems, including filters, connectors and airway devices. It includes an outline check for ventilators, suction, monitoring and ancillary equipment.

The anaesthetic equipment must be checked by trained staff on a routine basis using the checklist and according to the manufacturer's instructions, in every environment where an anaesthetic is given. **A record should be kept with the anaesthetic machine that these checks have been done.**

Each hospital must ensure that all machines are fully serviced at the regular intervals designated by the manufacturer and that a service record is maintained. As it is possible for errors to occur when reassembling an anaesthetic machine, it is essential to confirm that the machine is correctly configured for use after each service. **The 'first user' check after servicing is especially important and must be recorded.**

Equipment faults may develop during anaesthesia that were either not present or not apparent on the pre-operative check. This may be caused by pipeline failure, electrical failure, circuit disconnection or incorrect configuration, etc. An immediate and brief check of equipment should be made if there is a critical incident involving a patient, even if the equipment was checked before the start of the case, as the incident may be caused by a primary problem with the equipment.

The checking procedure described in this publication is reproduced in an abbreviated form, as a sheet entitled *Checklist for Anaesthetic Equipment 2012* (Fig. 1). This laminated sheet should be attached to each anaesthetic machine and used to assist in the routine checking of anaesthetic equipment.

Procedures for checking anaesthetic equipment

The following checks should be carried out at the beginning of each operating theatre session. In addition, specific checks should be carried out before each new patient during a session or when there is any alteration or addition to the breathing system, monitoring or ancillary equipment.

It is the responsibility of the anaesthetist to make sure that these checks have been performed, and the anaesthetist must be satisfied that they have been carried out correctly. In the event of a change of anaesthetist during an operating session, the status of the anaesthetic equipment must be confirmed, including that a formal check has been performed.

Before using any anaesthetic equipment, ventilator, breathing system or monitor, it is essential to be fully familiar with it. Modern anaesthetic workstations are complex devices. It is essential that anaesthetists have full training and formal induction for any machines they may use. A quick 'run-through' before the start of an operating session is not acceptable.

Careful note should be taken of any information or labelling on the anaesthetic machine that might refer to its current status.

Alternative means of ventilation

The early use of an alternative means of ventilation (a self-inflating bag that does not rely on a source of oxygen to function) may be life-saving. A self-inflating bag must be immediately available in any location where anaesthesia may be given [7, 8]. An alternative source of oxygen should be readily available.

Perform manufacturer's machine check

Modern anaesthesia workstations may perform many of the following checks automatically during start-up. Users must know which are included and ensure that the automated check has been performed.

Power supply

Check that the anaesthetic workstation and relevant ancillary equipment are connected to the mains electrical supply (where appropriate) and switched on. The anaesthetic workstation should be connected directly to the mains electrical supply, and only correctly rated equipment connected to its electrical outlets. Multisocket extension leads must not be plugged into the anaesthetic machine outlets or used to connect the anaesthetic machine to the mains supply.

Hospitals should have back-up generators, and many operating theatres will have their own back-up system. Anaesthetists should know

what is available where they are working. Back-up batteries for anaesthetic machines and other equipment should be charged.

Switch on the gas supply master switch (if one is fitted).

Check that the system clock (if fitted) is set correctly.

Gas supplies and suction

To check the correct function of the oxygen failure alarm involves disconnecting the oxygen pipeline on some machines, whilst on machines with a gas supply master switch, the alarm may be operated by turning the master switch off. As repeated disconnection of gas hoses may lead to premature failure of the Schrader socket and probe, these guidelines recommend that the regular pre-session check of equipment includes a 'tug test' to confirm correct insertion of each pipeline into the appropriate socket.

It is therefore recommended that, in addition to these checks, the oxygen failure alarm must be checked on a weekly basis by disconnecting the oxygen hose whilst the oxygen flowmeter is turned on, and a written record kept. In addition to sounding an alarm, which must sound for at least 7 s, oxygen failure warning devices are also linked to a gas shut-off device. Anaesthetists must be aware of both the tone of the alarm and also which gases will continue to flow on the particular model of anaesthetic machine in use.

Medical gas supplies

Identify and take note of the gases that are being supplied by pipeline, confirming with a 'tug test' that each pipeline is correctly inserted into the appropriate gas supply terminal. Note that excessive force during a 'tug test' may damage the pipeline and/or gas supply terminal.

- 1 Check that the anaesthetic apparatus is connected to a supply of oxygen and that an adequate reserve supply of oxygen is available from a spare cylinder.
- 2 Check that adequate supplies of any other gases intended for use are available and connected as appropriate. All cylinders should be securely seated and turned off after checking their contents.
- 3 Carbon dioxide cylinders should not be present on the anaesthetic machine. Where a blanking plug is supplied this should be fitted to any empty cylinder yoke.
- 4 Check that all pressure gauges for pipelines connected to the anaesthetic machine indicate 400–500 kPa.

- 5 Check the operation of flowmeters, where these are present, ensuring that each control valve operates smoothly and that the bobbin moves freely throughout its range without sticking. If nitrous oxide is to be used, the anti-hypoxia device should be tested by first turning on the nitrous oxide flow and ensuring that at least 25% oxygen also flows. Then turn the oxygen flow off and check that the nitrous oxide flow also stops. Turn on the oxygen flow and check that the oxygen analyser display approaches 100%. Turn off all flow control valves. (Machines fitted with a gas supply master switch will continue to deliver a basal flow of oxygen).
- 6 Operate the emergency oxygen bypass control and ensure that flow occurs from the gas outlet without significant decrease in the pipeline supply pressure. Ensure that the emergency oxygen bypass control ceases to operate when released.

Suction

Check that the suction apparatus is functioning and all connections are secure; test for the rapid development of an adequate negative pressure.

Breathing system and vaporisers

Whole breathing system

Check all breathing systems that are to be used and perform a 'two-bag test' before use, as described below [9]. Breathing systems should be inspected visually and inspected for correct configuration and assembly. Check that all connections within the system and to the anaesthetic machine are secured by 'push and twist'. Ensure that there are no leaks or obstructions in the reservoir bags or breathing system and that they are not obstructed by foreign material. Perform a pressure leak test (between 20 and 60 cmH₂O on the breathing system by occluding the patient-end and compressing the reservoir bag.

Vaporisers

Manual leak testing of vaporisers was previously recommended routinely. It should only be performed on basic 'Boyle's' machines and it may be harmful to many modern anaesthetic workstations. **Refer to the manufacturer's recommendation before performing a manual test.**

Check that the vaporiser(s) for the required volatile agent(s) are fitted correctly to the anaesthetic machine, that any locking mechanism is fully engaged and that the control knobs rotate fully through the full range(s). Ensure that the vaporiser is not tilted. Turn off the vaporisers.

Check that the vaporiser(s) are adequately filled but not overfilled, and that the filling port is tightly closed.

Manual leak test of vaporiser

- 1 Set a flow of oxygen of 5 l.min^{-1} and with the vaporiser turned off, temporarily occlude the common gas outlet. There should be no leak from any part of the vaporiser and the flowmeter bobbin (if present) should dip.
- 2 Where more than one vaporiser is present, turn each vaporiser on in turn and repeat this test. After this test, ensure that the vaporisers and flowmeters are turned off.

Changing and filling vaporisers during use. It may be necessary to change a vaporiser during use. Where possible, repeat the leak test; failure to do so is a common cause of critical incidents [10]. Some anaesthetic workstations will automatically test vaporiser integrity.

It is only necessary to remove a vaporiser from a machine to refill it if the manufacturer recommends this. Vaporisers must always be kept upright. Tilting a vaporiser can result in delivery of dangerously high concentrations of vapour [11].

Carbon dioxide absorber

Inspect the contents and connections and ensure there is adequate supply of carbon dioxide absorbent. Check the colour of the absorbent.

Alternative breathing systems

For Bain-type and circle co-axial systems, perform an occlusion test on the inner tube and check that the adjustable pressure limiting (APL) valve, where fitted, can be fully opened and closed.

Correct gas outlet

Particular care must be exercised in machines with an auxiliary common gas outlet (ACGO). Incidents of patient harm have resulted from misconnection of a breathing system to an ACGO or misselection of the ACGO [12].

Whenever a breathing system is changed, either during a case or a list, its integrity and correct configuration must be confirmed. This is particularly important for paediatric lists when breathing systems may be changed frequently during a list.

Ventilator

Check that the ventilator is configured correctly for its intended use. Ensure that the ventilator tubing is securely attached. Set the controls for use and ensure that adequate pressure is generated during the inspiratory phase.

Check that alarms are working and correctly configured.

Check that the pressure relief valve functions correctly at the set pressure.

Two-bag test

A two-bag test should be performed after the breathing system, vaporisers and ventilator have been checked individually [9].

- 1 Attach the patient-end of the breathing system (including angle piece and filter) to a test lung or bag.
- 2 Set the fresh gas flow to 5 l.min^{-1} and ventilate manually. Check the whole breathing system is patent and the unidirectional valves are moving (if present).
- 3 Check the function of the APL valve by squeezing both bags.
- 4 Turn on the ventilator to ventilate the test lung. Turn off the fresh gas flow or reduce to a minimum. Open and close each vaporiser in turn. There should be no loss of volume in the system.

Breathing systems should be protected with a test lung or bag when not in use to prevent intrusion of foreign bodies.

Scavenging

Check that the anaesthetic gas scavenging system is switched on and functioning. Ensure that the tubing is attached to the appropriate exhaust port of the breathing system, ventilator or anaesthetic workstation [13].

Monitoring equipment

Check that all monitoring devices, especially those referred to in the AAGBI's *Standards of Monitoring during Anaesthesia and Recovery* guidelines [14], are functioning and that appropriate parameters and alarms have been set before using the anaesthetic machine. This includes the cycling times, or frequency of recordings, of automatic non-invasive blood pressure monitors. Check that gas sampling lines are properly attached and free from obstruction or kinks. In particular, check that the oxygen analyser, pulse oximeter and capnograph are functioning correctly and that appropriate alarm limits for all monitors are set. Be aware of the 'default' alarm settings if using these.

Gas monitoring lines are often the cause of a significant leak; check that they are properly attached and any sampling ports not in use have been blanked off. To eliminate the need to change the sampling line repeatedly, the gas monitoring line should be assembled as an integral part of the breathing circuit by attaching it proximal to the patient breathing filter.

Airway equipment

These include bacterial filters, catheter mounts, connectors and tracheal tubes, laryngeal mask airways, etc.; check that these are all available in the appropriate sizes, at the point of use, and that they have been checked for patency.

A new, single-use bacterial filter and angle piece/catheter mount must be used for each patient. It is important that these are checked for patency and flow, both visually and by ensuring gas flow through the whole assembly when connected to the breathing system, as described below.

Check that the appropriate laryngoscopes are available and function reliably. Equipment for the management of the anticipated or unexpected difficult airway must be available and checked regularly in accordance with departmental policies [15]. A named consultant anaesthetist must be responsible for difficult airway equipment and the location of this equipment should be known.

Total intravenous anaesthesia (TIVA)

When TIVA is used there must be a continuous intravenous infusion of anaesthetic agent or agents; interruption from whatever cause may result in awareness. A thorough equipment check is therefore the most important step in reducing the incidence of awareness. Anaesthetists using TIVA must be familiar with the drugs, the technique and all equipment and disposables being used.

The Safe Anaesthesia Liaison Group (SALG) has produced safety guidance on guaranteeing drug delivery during TIVA [16]; SALG made the following recommendations:

- 1 An anti-reflux/non-return valve should always be used on the intravenous fluid infusion line when administering TIVA.
- 2 Sites of intravenous infusions should be visible so that they may be monitored for disconnection, leaks or infusions into subcutaneous tissues.
- 3 Clinical staff should know how to use, and to check, the equipment before use.

4 Organisations should give preference to purchasing intravenous connectors and valves that are clearly labelled.

Ancillary and resuscitation equipment

Check that the patient's trolley, bed or operating table can be tilted head-down rapidly. A resuscitation trolley and defibrillator must be available in all locations where anaesthesia is given and checked regularly in accordance with local policies.

Equipment and drugs for rarely encountered emergencies, such as malignant hyperthermia and local anaesthetic toxicity must be available and checked regularly in accordance with local policies. The location of these must be clearly signed [17, 18].

Single-use devices

Any part of the breathing system, ancillary equipment or other apparatus that is designated 'single-use' must be used for one patient only, and not reused. Packaging should not be removed until the point of use, for infection control, identification and safety. (For details of decontamination of reusable equipment, see the AAGBI safety guideline *Infection Control in Anaesthesia* [19].)

Machine failure

In the event of failure, some modern anaesthetic workstations may default to little or no flow, or oxygen only with no vapour. Users must know the default setting for the machine in use. Alternative means of oxygenation, ventilation and anaesthesia must be available.

'Shared responsibility' equipment

As a member of the theatre team, the anaesthetist will share responsibility for the use of other equipment, e.g. diathermy, intermittent compression stockings, warming devices, cell salvage and tourniquets, but should have received appropriate training. Involvement with this equipment, especially 'trouble shooting' problems that arise intra-operatively, must not be allowed to distract anaesthetists from their primary role.

Recording and audit

A clear note must be made in the patient's anaesthetic record that the anaesthetic machine check has been performed, that appropriate monitoring is in place and functional, and that the integrity, patency and safety of the whole breathing system has been assured. A logbook

should also be kept with each anaesthetic machine to record the daily pre-session check and weekly check of the oxygen failure alarm. Modern anaesthesia workstations may record electronic self tests internally. Such records should be retained for an appropriate time. Documentation of the routine checking and regular servicing of anaesthetic machines and patient breathing systems should be sufficient to permit audit on a regular basis.

Recovery

There must be clear departmental procedures for the daily and other checks of equipment that is used in recovery. This may also include pre-use checks of patient-controlled analgesia and epidural pumps, etc. [20].

Disclaimer

The AAGBI cannot be held responsible for failure of any anaesthetic equipment as a result of a defect not revealed by these procedures.

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