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ORIGINAL ARTICLE

Critical incident reports concerning anaesthetic equipment: analysis of the UK National Reporting and Learning System (NRLS) data from 2006–2008*

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Summary

Anaesthetic equipment plays a central role in anaesthetic practice but brings the potential for malfunction or misuse. We aimed to explore the national picture by reviewing patient safety incidents relating to anaesthetic equipment from the National Reporting and Learning System for England and Wales between 2006 and 2008. We searched the database using the system's own classification and by scrutinising the free text of relevant incidents. There were 1029 relevant incidents. Of these, 410 (39.8%) concerned patient monitoring, most commonly screen failure during anaesthesia, failure of one modality or failure to transfer data automatically from anaesthetic room to operating theatre. Problems relating to ventilators made up 185 (17.9%) of the reports. Sudden failures during anaesthesia accounted for 142 (13.8%) of these, with a further 10 cases (0.9%) where malfunction caused a sustained or increasing positive pressure in the patient's airway. Leaks made up 99 (9.6%) of incidents and 53 (5.2%) of incidents arose from the use of infusion pumps. Most (89%) of the incidents caused no patient harm; only 30 (2.9%) were judged to have led to moderate or severe harm. Although equipment was often faulty, user error or unfamiliarity also played a part. A large variety of causes led to a relatively small number of clinical scenarios, that anaesthetists should be ready, both individually and organisationally, to manage even when the cause is not apparent. We make recommendations for enhancing patient safety with respect to equipment.

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Maintaining patient safety has always been a critical element of anaesthetic practice and incident reporting is one key factor in achieving this aim [1]. The UK National Patient Safety Agency (NPSA) set up the National Reporting and Learning System (NRLS) to identify and learn from adverse incidents [2]. Since 2006, which was the first year in which all trusts contributed data, the NPSA began to work more closely with clinicians in an attempt to extract useful lessons that may be then translated into clinical practice [3]. A previous report of over 12 000 NRLS patient safety incidents in anaesthesia identified some general problems with analysing the database, and drew out some themes for further consideration [4]. There have been some detailed analyses of more discrete topics within critical care [5–7] and anaesthesia [8–10], but anaesthetic equipment incidents have not so far been scrutinised. Our aim was to extract and analyse reports of incidents caused by problems with anaesthetic equipment and to identify lessons for improving practice and enhancing patient safety.

Methods

The NPSA provided us with a Microsoft Excel® Microsoft Corporation, Redmond, WA, USA spreadsheet, which contained anonymised incidents arising from anaesthesia and all surgical specialties in the calendar years 2006–2008. 'Incidents' are as defined by the NPSA (Table 1). The inclusion of surgical incidents was stimulated by an earlier methodological inquiry, that highlighted the inclusion of many anaesthetic incidents in the surgical category [11]. Table 2 lists the information included in an incident report to the NPSA. Incident reports are categorised by the NPSA's own classification, which includes the equipment-related categories 'failure of device/equipment' and 'lack/unavailability of equipment'. Our pilot analysis of the 2006 data [12] revealed that most relevant incidents were retrieved by filtering the database to retain these two categories. A keyword search identified a further category, 'inadequate check on equipment/supplies', and so for the 3-year analysis incidents were sought in all three categories.

All incidents in this database were screened by one investigator. Incidents were eligible for inclusion if they involved equipment used to provide general or regional anaesthesia. Events were excluded if they occurred in the Intensive Care Unit. Incidents reporting problems with airway management equipment were excluded from this analysis as they were the subject of a previous study [10]. In each included incident, the free text description of the incident was used to determine which piece of equipment was primarily involved, and also whether the problem related to non-availability, failure or misuse of that equipment. The location of the incident and the degree of patient harm ascribed by the reporter were also noted (Table 3). Two investigators classified the incidents into equipment category.

Table 1 National Patient Safety Agency definitions of incidents.

'Patient safety incident'	Any unintended or unexpected incident which could have or did lead to harm for one or more patients receiving NHS-funded care (this definition incorporates all terms such as adverse incidents, adverse events and near misses)
'Prevented patient safety incident'	Any unexpected or unintended incident which was prevented so no harm occurred
'No harm patient safety incident'	Any unexpected or unintended incident which ran to completion but no harm occurred
'Harm'	Harm is defined as injury, suffering, disability or death

Table 2 Data fields in a National Reporting and Learning System patient safety incident report.

Incident location
Date and time
Classification of incident (and subcategory) – from list of options
Description of what happened – free text entry
Level of harm sustained
Patient gender, age and ethnicity*
Speciality in which incident occurred
Any planned actions – free text entry*
Perceived causative factors – free text entry*

*Not compulsory entries.

Table 3 National Patient Safety Agency definitions of levels of severity of patient safety incidents.

None	A situation where no harm occurred: either a 'prevented patient safety incident' or a 'no harm patient safety incident'
Low	Any unexpected or unintended incident which required extra observation or minor treatment and caused minimal harm, to one or more persons
Moderate	Any unexpected or unintended incident which resulted in further treatment, possible surgical intervention, cancelling of treatment or transfer to another area and which caused short-term harm, to one or more persons
Severe	Any unexpected or unintended incident which caused permanent or long-term harm, to one or more persons
Death	Any unexpected or unintended incident which caused the death of one or more persons

Results

The number of incidents reported in the 'anaesthetic' and 'surgical specialties' categories provided rose from 30 724 in 2006 to 132 542 in 2008, providing in all a starting database of 195 812 incidents. In the three equipment-related incident categories described above there were 16 128 incidents. A total of 15 099 of these incidents were excluded, leaving us with 1 029 incidents for further analysis, as shown in Fig. 1. Only 385 of these incidents had been correctly classified with anaesthesia as the speciality, with more than 60% recorded under a surgical speciality. Most incidents (87%) were classified as 'failure of device/equipment', with 129 (12.5%) as 'lack of/unavailability of device or equipment' and eight (0.08%) as 'inadequate check on

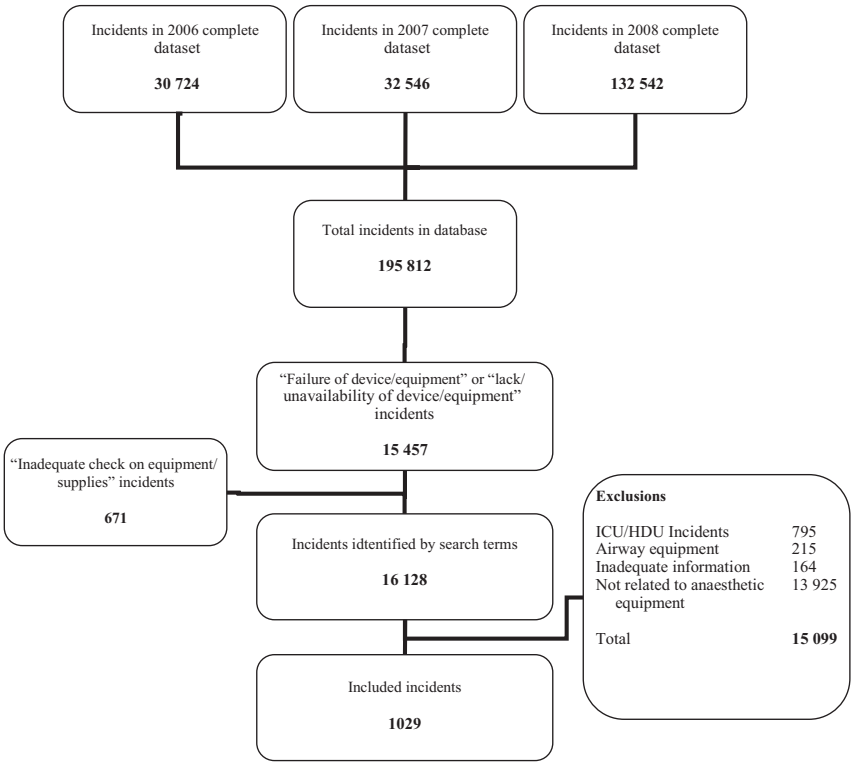

Figure 1 Incident handling. ICU, intensive care unit; HDU, high dependency unit.

equipment or supplies'. The role of 'misuse' or user error is more complex and is considered below. Nine of the included events occured when 'remote site' anaesthetics were delivered, principally in the radiology department.

The breakdown of incidents is shown in Table 4.

Only 10% of the incidents were felt by the reporter to have resulted in any harm to the patient, as shown in Figure 2. The incidents deemed to have resulted in more than a low level of harm are highlighted in Table 5. Of the five incidents rated as 'severe harm', the description did not support this. However, two incidents listed as 'moderate harm' may be considered to have led to severe harm. Figure 3 shows the description of the incident, which was suggested as the main cause of the issue. Most reports suggested equipment malfunction, with only 4% of incidents being clearly or most likely the result of user error. In some of these cases, the reporter identified this in the report, but in several incidents later information based on an investigation highlighted that the user was at fault.

Some general points can be made before individual items of equipment are considered. Some reports stated that equipment checklists available in their departments

Table 4 Principal categories of equipment involved in incidents. Values are number (proportion).

Monitoring*	272 (26.4)
Screen failure during anaesthesia	94 (9.1)
Failure of one monitoring modality	59 (5.7)
Some modalities missing	39 (4.0)
Failure to transfer data	28 (2.7)
Monitoring unavailable or substandard	27 (2.7)
Ventilator problems*	185 (17.9)
Sudden failure during anaesthesia	142 (13.8)
Sustained or increasing positive pressure	10 (0.9)
Gas monitoring*	138 (13.4)
Sudden failure	57 (5.5)
Malfunctioning	49 (3.8)
Not available or parts missing	14 (1.7)
Leak in circuit	99 (9.6)
Anaesthetic machine failing 'cockpit check' or condition of machine/ equipment unacceptable	54 (5.2)
Intravenous infusion pumps	53 (5.2)
Vaporiser problems	52 (5.1)
Bed/trolley problems	26 (2.5)
Patient warmer	20 (1.9)
Gas supply to machine	20 (1.9)
Alarm failure	14 (1.4)
Other	96 (9.3)
Total	1029 (99.8†)

*The subcategories in these rows comprise the most numerous types of incident; not all incidents are classified.
†Percentage total does not exactly equal 100% because of rounding.

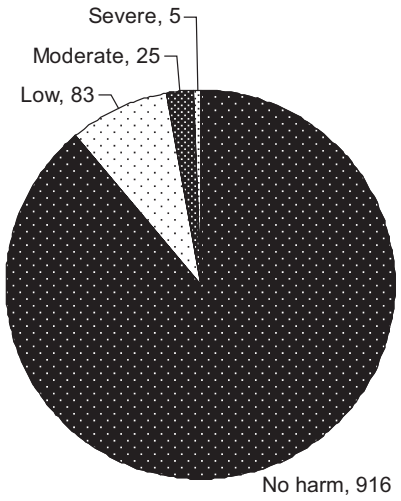

Figure 2 Reported level of harm.

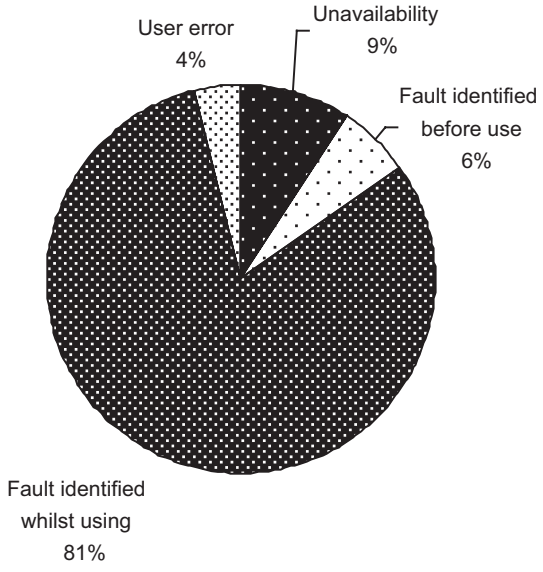

Figure 3 Reported cause of incident.

had not been followed, and had they been, the incident would not have occurred. Other recurrent issues included staff unfamiliarity with equipment (more common where equipment was not standardised and where departments relied more on locum and agency staff) and difficulties in finding a satisfactory substitute or 'spare' when a piece of equipment was suddenly found to be unserviceable.

It was also clear that on occasion, there were reports where problems had been identified with equipment, without action being taken immediately, e.g. one anaesthetic machine was described as having been 'temperamental a few days beforehand' before the incident that had triggered a report. It was also clear that machines had returned from service, either routinely or after a fault had been identified, with a variety of problems, most noticeably altered default settings. Finally, although few reports specifically alluded to user error, we noted a number of situations where we thought human error might have contributed to the development of the incident (Table 6).

With regard to monitoring, the most common problem reported was transient, usually very brief loss of monitoring on the anaesthetic machine; monitoring failed during anaesthesia in 94 cases. Typically, the monitoring screen went completely blank and this led to an interruption of patient monitoring ranging between 2 s and 15 min (usually between 30 s and 2 min). Monitors often rebooted themselves and if not, it was usually possible to reboot them to initiate the start-up procedure. Monitoring of the patient remains impossible during this period.

In 59 cases, one monitoring modality failed or malfunctioned. In two cases, patients were harmed when non-invasive blood pressure cuffs remained continuously inflated. In one, the sustained pressure led to a swollen and blistered arm, whereas the other required a fasciotomy. Complete monitoring failure was often preceded by failure of, or interference in, one or more single modalities. In 39 cases, one monitoring modality was missing from the machine supplied for use. In 28 instances, data were not transferred from the anaesthetic room to theatre monitor. Loss of data is inconvenient at best but, as in the case of an emergency repair of an abdominal aortic aneurysm described, may mean that there is no contemporaneous record of patient data if the anaesthetist is fully occupied with patient care. In 27 reports, either one or more monitoring modalities were not available or were considered to be substandard.

Ventilators

There were 142 instances of sudden failure of ventilators that had previously passed machine checks, either in the anaesthetic room or during surgery. Moreover, in a number of cases, complete failure of the ventilator was preceded by readings of increased ventilation pressures, gradual failure of power to monitoring screen then ventilator bellows, and misleading alarms such as low airway pressure or high drive gas pressure. In 10 cases, a problem with the expiratory or PEEP valve led to a progressive increase in airway pressure,

Table 5 Incidents initially reported as causing 'severe' or 'moderate' patient harm, with corrected classification according to definitions in Table 3.

	Reported harm	Description	Actual patient harm	NPSA classification
1	Severe	Non-invasive blood pressure monitor failure for prolonged period, patient hypotensive when fixed	Nil described	No/low
2	Severe	Non-invasive blood pressure cuff left inflated throughout long procedure after invasive arterial line inserted	Swelling and skin break to arm, but no surgical intervention needed	Moderate
3	Severe	Transient ventilator failure, self-corrected within 1 min	Short period of manual ventilation	No/low
4	Severe	Anaesthetic machine failure	Nil described	No (based on very little data provided)
5	Severe	No warming device for an elderly patient undergoing prolonged surgery	Patient became hypothermic (nil further described)	Low/moderate
6,7	Moderate	Pumps delivering total intravenous anaesthesia stopped infusing without alarm	Movement during procedure in one report. Awareness reported by patient in other	Moderate/severe
8,9	Moderate	Loss of monitoring during procedure	None described	No/low
10	Moderate	Blood pressure cuff inflated throughout prolonged procedure after invasive arterial line inserted	Fasciotomy required	Severe
11–15	Moderate	Failure of ventilator during procedure	One report stated no harm suffered. Others not specified	No/low
16	Moderate	Loss of agent analysis, quickly recovered	Nil stated	No/low
17–19	Moderate	Machine failure during procedure	In two cases stated no harm suffered. Other nil stated	No/low
20,21	Moderate	Infusions pumps needed for procedure not available	Nil stated	No
22–26	Moderate	Wrong rate delivered by infusion pumps – in four cases under-delivered and one over-delivered	Two reported period of 'lightness' and one very prolonged recovery period	No/low
27–29	Moderate	No warmer available for patient undergoing procedure	Nil stated	No/low
30	Moderate	No ultrasound aid available to place a central venous line	Nil stated	No

NPSA, National Patient Safety Agency.

that fortunately was recognised before it harmed any patient. In five cases, there was malfunction of pressure or spirometry alarms, triggering the anaesthetist to take action inappropriate for the patient's true condition. In one case, the pattern shown by the end-tidal CO_2 trace suggested that the patient was making respiratory efforts during laparoscopy, leading the anaesthetist to administer a further dose of atracurium; this led to a delay at the end of surgery before the neuromuscular blockade could be reversed. Controls became unresponsive in three cases, preventing the anaesthetist from altering ventilator settings. Lastly, in one case, a partially used bag of intravenous fluid was placed on top of the anaesthetic machine and leaked into the machine causing ventilator failure and a smell of burning.

Although no cause was reported for many ventilator failures (indeed, frequently no more detail than 'ventilator failure' was given), a variety of causes was described, including:

- Disconnected expiratory pressure monitoring line.
- Breathing filter and circle absorber found to be full of water.
- Expiratory valve full of condensation and stuck shut.
- Adjustable pressure-limiting valve caught on capnograph tubing, lifting it up and causing a large internal leak not detected by leak test.
- Faulty expiratory limb connection.
- Faulty 'toggle' switch resetting itself to manual instead of automatic ventilation.
- External power failure (machine not plugged in to uninterruptible power supply).

Table 6 Situations described in incident reports in which human error is contributory.

- Damage to machine occurring between sessions
- Default settings on machines altered (including language in one case)
- Communication failure (trainee and supervisor each turning on a different vaporiser so two volatile agents used)
- Pumps being incorrectly set up
- Staff unfamiliar with machines (particularly when spare machine differed from those usually used or in case of locum staff)
- Failure to follow checking protocols
- Machines not checked after servicing before being used
- Equipment not serviced at appropriate intervals
- Expired consumables used
- Single-use equipment being reused
- Known unsafe equipment in ongoing use
- Failure to report faults so they recur
- Not acting on error warnings
- Equipment left unusable at the end of sessions
- Changes made to circuits as training aids but not corrected
- Failure to leak test when vaporisers changed

Gas monitoring

One hundred and thirty-eight (13.4%) incidents concerned gas monitoring. The frequency of the most common problems is shown in Table 4. The most potentially serious problem is perhaps the failure of CO_2 monitoring around the time of tracheal intubation. A number of malfunctions was observed, including:

- Slow response of CO_2 analyser.
- Underestimation of volatile agent concentration.
- Exhaust tubing of gas analyser module trapped under wheel of anaesthetic machine causing misreading.
- Sampling port of gas analyser broken and entraining air, giving loss of trace and low end-tidal CO_2.
- Continuous detection of halothane despite gas not being in use.

Leaks

There were 99 reports of leaks from the anaesthetic machine and breathing system (9.6% of the total). Causes included:

- Capnograph tubing detached from breathing system.
- Oxygen sensor disconnected – fully or partially.
- Scavenging tubing occluded by wheel of anaesthetic machine (broken bracket created large redundant loop of tubing that fell to floor).
- Tear in breathing system from tube holder.
- Breathing bag ripped by patient trolley.
- Ventilator bellows/soda lime canister.
- Fracture in tubing connecting gas outlet of machine to breathing system.
- No 'O' ring under vaporiser seating on machine back bar.

Intravenous infusion pumps

A mixture of mechanical and electronic problems was reported with infusion pumps (53 incidents, 5.3% of total), which together accounted for some of the most serious events in this series. Problems of both under- and over-delivery of drugs were reported. Incidents included the delivery of 8 ml remifentanil in under a minute leading to apnoea (no obvious malfunction was found), and propofol infusions failing, leading to unintentional awareness, on four occasions. In one case, a software error allowed continuous infusion of a drug regardless of the programmed settings. Mechanical problems included one instance where drug was not delivered because the syringe plunger was not correctly located on the seating unit of the drive and another where the arm that assesses syringe diameter was broken, misreading the size of the syringe.

Other equipment

There were 52 reports of vaporiser problems (5.1%). The most common problem arose from a misfit of vaporisers onto the back bar of the anaesthetic machine. Often, leak tests were not performed after replacing a vaporiser. One case was described of a non-functioning interlock mechanism and in one case the vaporiser appeared to turn itself off whilst in use. Beds and trolleys (26 reports, 2.5%) caused safety concerns, as many beds could not be tilted head-down or conversely would not allow the patient to be raised into a sitting position. In particular, electrically controlled beds were noted to be brought to theatre with a depleted battery, meaning that the position of the bed could not be altered. Other equipment issues related mostly to the lack of availability of ultrasound machines and peripheral nerve stimulators for assessing the degree of neuromuscular blockade (reported in more detail elsewhere [8]).

Discussion

Our analysis reveals a number of reports relating to anaesthetic equipment in the NRLS. Most of these concern the anaesthetic machine or its associated monitoring, although problems have arisen from a wide range of apparatus. This is the first report of such incidents from the NRLS and although a national system offers great potential for learning and sharing safety lessons, a number of points must be made.

Firstly, the incidents reported are likely to represent a small proportion of those that actually occurred. Under-reporting of incidents is usual for a number of reasons [13, 14] and so it is not possible to derive accurate incidence figures for equipment problems. However, Fasting and Gisvold estimated that equipment problems arise in 0.23% of general anaesthetics and 0.05% of regional anaesthetics [15]. A Thai study suggested an even lower figure of 0.04% or one in 2252 anaesthetics [16]. Whether the distribution of types of equipment in submitted reports is representative of the spread of equipment in unreported incidents is unknown, although it seems likely. Secondly, there is evidence of misclassification both of clinical specialty and of degree of patient harm. It was possible to retrieve anaesthetic incidents mislabelled as 'surgical' but this was time-consuming. With regard to degree of harm, the NPSA definitions listed in Table 3 are available to reporters within the reporting system, but may not always have been consulted. Some reporters appear to have used their own subjective interpretation and it is possible that harm has been graded according to their perception of potential, rather than actual, harm. Conversely, two incidents which led to unintentional awareness were classified as 'no harm', whereas this complication can lead to long-term problems for the patient [17]. This underlines another problem inherent in all reporting systems, as reports submitted soon after the event may not capture outcomes occurring later. It is not easy to annotate or track a previously submitted report within the national system, although this may be possible within individual hospitals. Notwithstanding these classifications, 89% of incidents led to no harm for the patient, reflecting the rarity of harm arising from equipment problems in the two studies cited above [15, 16]. Thirdly, data quality was a problem in that there was often insufficient detail to establish quite what had happened in a particular incident. Furthermore, reports can be submitted to the NRLS by anyone and it is possible that many of the brief reports were written by people with a limited understanding of what actually occurred. The most detailed and useful reports were written in the first person, presumably by the clinician involved. We commend these individuals on the high quality of such reports. Some included not only a detailed explanation of events but also identified potential issues for future follow-up, and even reported how this was achieved. More free text offers the best opportunity to gain maximum learning benefit from these incidents. Finally, problems with equipment may have been reported not to the NRLS but to the Medicines and Healthcare Products Regulatory Agency (MRHA), which runs its own reporting scheme for such incidents.

The breakdown of incident categories in our study is somewhat different from previous surveys. Chopra et al. found that monitoring problems made up 18.4% of technical issues, ventilator problems 8.8% and leaks and disconnections 11.6% [18]. A report from the Australian Incident Monitoring Study in 1993 focusing specifically on 'pure' equipment failure found that 60% of incidents involved anaesthetic equipment (mostly valves and ventilators) and 24% involved monitors [19]. In the later study of Fasting and Gisvold, 31% of equipment problems involved the anaesthetic machine, 17.2% the monitoring and 10.2% the gas analyser [15]. Disconnections of the breathing system were not mentioned specifically in this later study, although problems with the gas analyser were highlighted. Although appropriate comparison is hampered by the different methodological approaches used by the different studies, it is clear that the pattern of reports has changed over the years as technology has advanced in anaesthesia.

One aspect of equipment problems that seems to be under-represented relates to human error. Partially this is methodological, in that the NRLS is not primarily designed to elicit causes, unlike single-department anaesthetic studies of human factors [20, 21], including those cited above, which implicated human error in 25% [15] and 75% [18], respectively. A closed claims analysis of problems with gas delivery equipment also attributed 75% of incidents to misuse of equipment [22]. Nevertheless, what might be termed 'user failure' (usually accidental) is suggested in many of our reports. For example, engineers were sometimes noted to be unable to find faults with allegedly malfunctioning equipment. Some reports were clearer: although one was logged initially as failure of the anaesthetic machine during a procedure, the locum anaesthetist performing the list later admitted to being unfamiliar with the machine being used and this had been the cause of the problem. It is probable that other incidents attributed to equipment failure might be due, at least in part, to error by the user. This has been noted previously [23] and is borne out by more recent data from the MRHA, where in 50% of adverse incidents reported, there is no readily identifiable equipment fault [24]. We suggest that it may be easier for a clinician to blame equipment than admit a misunderstanding or mistake.

Although readers may have personally encountered some of the problems described in these reports, it is likely that to others, these problems may be entirely new. Our aim in reporting problems in detail is to publicise those that anaesthetists may not have come across. Over and above the specifics of any report is the fact that many problems can be prevented in some way and many can be effectively managed with the appropriate knowledge and back-up equipment. For instance, despite the complexity of modern anaesthetic machines and monitoring equipment, many equipment faults are mechanical or due to simple power failure due to blown fuses, or during generator tests when backup power is not available. Furthermore, the pure capriciousness of chance means that new problems will always evolve and so strategies for dealing with the 'final common pathways' of failure patterns will be our (and our patients') protection. Some recommendations for preventing equipment failure and safeguarding against the consequences are given in Table 7. Some of these recommendations echo advice already given by professional organisations [24, 25] and regulatory agencies [26, 27]. A key action is to ensure that malfunctioning equipment is taken out of use immediately; a complete set of backup equipment should be available so that the service is not disrupted [24]. It is surely indefensible to continue to use equipment when its safe functioning is not guaranteed. User training is also vital, and the new guidelines on checking anaesthetic equipment from the Association of Anaesthetists of Great Britain and Ireland now include a requirement that all users should be familiar with the equipment to be used [28]. Periodic checks of the machine log are also important, especially if there is frequent rotation of staff between different operating theatres and departments. Likewise, the calibration records should also be reviewed periodically, although not necessarily before every theatre list. If information from monitors does not seem correct, it should be cross-checked against other monitors and the clinical state of the patient [29].

In terms of reporting, as incidents are also noted locally before submission to the national database, root cause analysis or other risk assessment exercises based on incident data [30] may be performed. However, currently there is no mechanism for sharing the results of such analyses more widely through the NRLS. There has also been little direct feedback to the trusts and individuals who made the report, although continued feedback is vital to maintain the momentum of reporting [31]. To encourage the specialty of anaesthesia to feel that it has greater control over its reporting system [32], there is now a national specialty-specific reporting scheme for anaesthesia [33, 34] and this should improve the engagement of anaesthetists in incident reporting [35]. This should avoid some of the difficulties we have encountered in sifting out incidents relevant to anaesthesia from a generic database. Furthermore, the procedures established nationally for analysis will allow anaesthetists to see, comment on and spread relevant lessons learned from reported incidents within the specialty. We would encourage anaesthetists to report incidents, in as much detail as possible, referring to the NPSA definitions of harm.

Table 7 Examples of existing safeguards noted in reports and recommendations for improving practice.

- There should be a planned replacement programme for anaesthetic equipment
- A complete set of backup equipment should be available. 'Spares' should be as well maintained and up to date as the equipment in frequent use or the initial problem can be compounded
- Theatres/departments of anaesthesia should have a plan to deal with monitoring and/or ventilator failure
- Users must satisfy themselves that they are competent to use the equipment
- Individual machine service logs should be maintained and checked; with staff changes and rotations, such written documents supplement information passed on at spoken handovers
- Anaesthetic machines should be plugged into an uninterruptible power supply (UPS) and batteries, where present, should be kept charged
- Problems (including intermittent faults) should not be ignored; equipment should be taken out of service immediately and sent for examination or repair
- A self-inflating bag for ventilating the patient's lungs should be available wherever and whenever patients are anaesthetised
- Unusual alarms or machine malfunctions should not be ignored as they may immediately precede total failure of monitor or ventilator
- Anaesthetists should balance clinical information about the patient against electronic monitoring
- Generator tests should be communicated to all relevant staff. Equipment problems may arise not only from power failure during the test if backup power is not available; machines may need to be rebooted after the test to restore proper function
- The settings of infusion pumps should be double-checked before infusions are commenced; manual checks of volume delivered as well as displays on the pump should be noted. Devices and lines should not be obscured by surgical drapes

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