A national survey of anaesthetists (NAP5 Baseline) to estimate an annual incidence of accidental awareness during general anaesthesia in the UK†

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Editor’s key points

- This baseline survey of a national project ascertained the number of cases of accidental awareness which became known to UK anaesthetists in 2011.
- All UK NHS hospitals participated in this project, and 82% of anaesthetists responded.
- The estimated incidence of awareness with this methodology of ~1:15,000, is lower than reported previously.
- The survey also identified a low use of depth of anaesthesia monitoring and dearth of hospital policies to manage awareness.

Background. As part of the 5th National Audit Project of the Royal College of Anaesthetists and the Association of Anaesthetists of Great Britain and Ireland concerning accidental awareness during general anaesthesia, we issued a questionnaire to every consultant and staff and associate specialist anaesthetist in the UK.

Methods. The survey was designed to ascertain the number of new cases of accidental awareness that became known to them, for patients under their direct or supervised care, for a calendar year, and also to estimate how many cases they had experienced during their careers. The survey also asked about use of monitoring designed to measure the depth of anaesthesia.

Results. All local co-ordinators responsible for each of 329 hospitals (organised into 265 ‘centres’) in the UK responded, as did 7125 anaesthetists (82%). There were 153 new cases of accidental awareness notified to respondents in 2011, an estimated incidence of 1:15 414, lower than the 1-2:1000 previously reported in prospective clinical trials. Almost half the cases (72, 47%) occurred at or after induction of anaesthesia but before surgery, with 46 (30%) occurring during surgery and 35 (23%) after surgery before full recovery. Awareness during surgery appeared to lead more frequently to pain or distress than at induction and emergence (62% vs 28% and 23%, respectively). Depth of anaesthesia monitors were available in 164 centres (62%), but routinely used by only 132 (1.8%) of anaesthetists.

Conclusion. The disparity between the incidence of awareness as notified to anaesthetists and that reported in trials warrants further examination and explanation.

Keywords: Awareness; explicit recall; accidental awareness; general anaesthesia

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The incidence of accidental awareness during general anaesthesia (AAGA) is reported by several studies to be surprisingly high, in the range of 1-2 per 1000 general anaesthetics administered.1–6

These studies employ a direct patient questionnaire (usually repeated three times over a period of up to 30 days postoperatively) known as the ‘Brice protocol’. It is also reported that a high proportion of patients experiencing AAGA suffer psychological problems including post-traumatic stress disorder.8 There are in fact very few studies reporting an incidence of AAGA much lower than this, an exception being that of Pollard et al., who found an incidence of 1:14 500.6 However, their methods might be criticised as they administered the questionnaire only twice over a 48-h period, which might only detect two thirds of cases. Anecdotally anaesthetists do not perceive the incidence of AAGA to be so high. A small Japanese study found that only 21 of 172 practitioners had known of an incident of AAGA under their care, with an overall incidence of just 1:3500.10 In a larger UK survey of over 2000 consultants, Lau et al. reported that anaesthetists

†This article is accompanied by Editorials I and II.
estimated the incidence to be approximately 1:5000\textsuperscript{11}, similar to the estimated incidence reported previously by 220 Australian anaesthetists of between 1:5000 and 1:10 000\textsuperscript{12}.

Undoubtedly, the problem of AAGA is very important to both patients and anaesthetists. Accidental awareness during general anaesthesia has been described as being the second most important complication that patients (after nausea and vomiting) and anaesthetists (after death) wished to avoid\textsuperscript{13,14}. The 5th National Audit Project (NAP5) is a partnership between the Association of Anaesthetists of Great Britain and Ireland (AAGBI) and the Royal College of Anaesthetists (RCoA). It is the fifth in a series of national audits conducted by the specialty focusing upon important topics in service evaluation (see http://www.nationalauditprojects.org.uk/NAP5_home). We have described the infrastructure elsewhere\textsuperscript{15} but briefly, a team of volunteer local co-ordinators (who are consultant anaesthetists) have been recruited, one in each UK centre (hospital or National Health Service (NHS) trust/board). Through them and the multidisciplinary networks they created with our assistance (encompassing other specialties in the centre and including hospital clinical governance and legal departments), NAP5 will seek prospectively to collect the data for the year 2012-13 anonymised data about salient aspects of anaesthetic care concerning all new reports of AAGA.

As a prelude to the prospective study, we administered a baseline survey to all consultant and career grade (staff and associate specialist (SAS)) anaesthetists working in NHS hospitals. The focus of our interest was to assess how many cases of AAGA had come to the knowledge of the senior UK anaesthetic community during the preceding calendar year. We do not know of any previous similar large-scale study of anaesthetists’ knowledge of cases of AAGA, as actually reported to them. These data were essential to the design of the prospective phase of NAP5. Additionally, we wished to estimate the historical experience of AAGA cases during respondents’ anaesthetic careers and also to ascertain some demographic data about years of senior practice. Finally, we wished to know about the availability and use of depth of anaesthesia monitors.

**Methods**

The NAP5 project was approved by the National Information Governance Board in England and Wales and Patient Advisory Groups in Scotland and Northern Ireland. The National Research Ethics Service confirmed it to be a service evaluation and waived the requirement for formal ethical approval, and it has the endorsement of all four Chief Medical Officers of the UK.

Each of the 329 identified centres in the UK volunteered a local co-ordinator who distributed a data collection form (Supporting Information: Appendix A. See British Journal of Anaesthesia online) to all consultant and SAS anaesthetists in their institution. Co-ordinators then collated responses and populated a data summary form (Supporting Information: Appendix B. See British Journal of Anaesthesia online), which was returned to the NAP5 team. Local co-ordinators could contact the NAP5 clinical lead (JJP) for further advice (which was also provided via the NAP5 website), and in turn, the clinical lead could contact the local co-ordinator for clarification of data entries. Questions asked included: the total number of consultants and SAS staff and their years of experience as seniors; the number of new cases of AAGA (under their direct or supervised care) of which they were notified during 2011; the availability and use of depth of anaesthesia monitoring; and whether the hospital had policies for the prevention or management of AAGA.

Since there was no hypothesis test, there were no statistical comparisons, but continuous data were described as median (IQR [range]) and categorical data with 95% confidence limits for binomial or Poisson distributions, as appropriate\textsuperscript{16,17}. Where illustrative, the goodness of fit of the data to a Poisson distribution was estimated by the least squares regression of actual vs modelled data.

**Results**

All local co-ordinators (100%) replied on behalf of their centre, and collected data from a total of 7125 (82%) anaesthetists (Table 1). Figure 1 shows the demography of staffing across centres. In 12 of 265 (5%) of centres, the number of SAS doctors was equal to or greater than that of consultant anaesthetists. There was a variety of experience in terms of years worked by respondents (Fig. 2); the crude sum of years’ experience was 81 147 years. A total of 153 new cases of AAGA were reported in the year 2011 to the anaesthetists (Table 1). Figure 1 shows the demography of staffing across centres. In 12 of 265 (5%) of centres, the number of SAS doctors was equal to or greater than that of consultant anaesthetists. There was a variety of experience in terms of years worked by respondents (Fig. 2); the crude sum of years’ experience was 81 147 years. A total of 153 new cases of AAGA were reported in the year 2011 to the anaesthetists who responded to this survey. Most patients experiencing AAGA were young or middle-aged adults (Fig. 3a).

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**Table 1** Response rates from 265 local co-ordinators (responsible for 329 UK hospitals; 100% response rate). All centres had consultant staff so the data for consultants use 265 as denominator; *45 centres had no staff and associate specialist (SAS) anaesthetists, so the denominator used here is 220. Values are median (IQR [range]).

<table>
<thead>
<tr>
<th></th>
<th>Consultants</th>
<th>SAS*</th>
<th>Total senior staff</th>
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<tbody>
<tr>
<td></td>
<td>Total (n=7140)</td>
<td>Responding (n=5951; 83%)</td>
<td>Total (n=1532)</td>
</tr>
<tr>
<td>Staff response/centre; n</td>
<td>22 (15-33 [2-131])</td>
<td>19 (13-28 [2-101])</td>
<td>5 (1-9 [0-22])</td>
</tr>
<tr>
<td>Response rate/centre; %</td>
<td>94 (78-100 [18-100])</td>
<td>91 (60-100 [0-100])</td>
<td>92 (76-100 [17-100])</td>
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</table>
the details of more than twice as many cases were volun-
teeed to anaesthetists by patients (114, 75%), compared
with those established by direct questioning (39, 25%;
Fig. 3b). Most cases related to experiences of AAGA at or
soon after induction of anaesthesia but before surgery com-
menced (72, 47%; Fig. 3c), followed by experiences of AAGA
during surgery (46, 30%) and lastly, by reports of awareness
during induction and emergence (35; 23%). Indeed, the combined total for experiences during induction and emergence (i.e. the ‘dynamic phases’ of an-
aesthesia) was twice as high (107, 70% of cases) as for
experiences during surgery (the ‘static phase’; 46, 30%).
A minority (58, 38%) of cases of AAGA suffered pain or dis-
tress as part of their experience, and even smaller propor-
tions went on formally to complain (29, 19%) or begin
legal proceedings (6, 4%; Fig. 3d).
Proportions of patients volunteering their experience com-
pared with those responding to direct questioning were
broadly similar across the age groups (Fig. 4a). The distribution
of awareness experienced by phase of anaesthesia/surgery
was also similar across the age groups (Fig. 4b), and there
were no striking age-dependent influences upon the degree
of pain or distress, or likelihood of formal complaint (Fig. 4c).
However, AAGA experienced during surgery appeared more
likely to result in pain or distress than did that experienced
in the dynamic phases (induction and emergence) of anae-
thesia (Fig. 5).

Using a denominator for the number of general anae-
thetics administered in the UK (obtained from the 4th
National Audit Project18) and adjusting this figure by the
number of respondents, we estimated the incidence of
AAGA, known to anaesthetists in the year 2011, to be ap-
proximately one case for every 15 414 general anaesthetics
(Table 2). As the denominator value may have changed
since NAP4 (which we consider to be unlikely given the rela-
tively short time interval involved), the calculated incidence
may vary depending on the actual denominator (Fig. 6).
The effect of relatively large changes in the denominator
(± one million) can be seen to be relatively small, leading
to a range of 1:12 500 to 1:20 000.

These data imply that just one senior anaesthetist out of
around 47 will know of a new case of AAGA each year
(Table 3). The median (IQR [range]) number of new cases
per centre was 0 (0-1 [0-4]) (Fig. 7). Over the course of an an-
aesthetic career, we estimate that a senior anaesthetist will
have personal experience of one case of AAGA for every
36 years of practice (Table 3). The vast majority of anaesthe-
tists reported never having had direct experience of a case of
AAGA (Fig. 8).

Approximately two thirds of centres reported the immedi-
ate availability of depth of anaesthesia monitors (Table 4),
with their routine use practised by 132 (1.8%) respondents.
Twelve centres (4.5%) reported the existence of a policy to
prevent or manage awareness. Two of these used their
general critical incident policy, with no specific reference to
AAGA. The policies ranged from very general, brief or mini-
reviews of AAGA to somewhat more comprehensive sugges-
tions (Supporting Information: Appendix C. See British
Journal of Anaesthesia online).

Discussion
The striking finding of this survey is that the incidence of new
cases of AAGA as notified to anaesthetists in the year 2011 of
approximately 1:15 000 is much lower than the incidence
previously published, that was ascertained through direct
patient questioning, of approximately 1-2:1000. If both sets
of data are valid, then it means that for approximately
every 15 000 general anaesthetics administered, the anaes-
thetist may learn of just one case of AAGA, while up to
around 30 other patients will experience AAGA but not
report it. Interestingly, the incidences in Table 2 are very
similar to those described by Pollard et al., who reported
(also by direct questioning) an incidence of 1:14 5009.
Indeed, our figure of 1:15 000 is even lower than the inci-
dence anaesthetists believe it might be, as ascertained
from smaller-scale surveys of the profession. We believe that our baseline information on more than 150 cases of AAGA in the UK exceeds that of any previous publication in this area, and may represent the most complete survey of medical practitioner experience of any disease or complication, across an entire nation.

**Discrepancy between our calculated incidence and other estimates**

There are a number of possible reasons for the discrepancy between the incidence of AAGA as established by this survey, and that reported in other research studies; these are summarised in Table 5. The issue of trainees’ experiences of AAGA is worth discussing: we did not ask trainees to complete a questionnaire, assuming that any complaint received would be handled also by a consultant supervisor. Although our survey included cases reported to senior staff by trainees they were supervising, it is possible that we missed a number of cases generated by trainees administering anaesthesia unsupervised, who did not subsequently forward a complaint to their senior. Our questionnaire did specifically ask about instances of AAGA related to ‘unsupervised’ trainees (e.g. trainee working alone out of hours), but only 3 of 153 cases fell into this category. We received some feedback from centres expressing surprise even to be asked this question, as the feeling was that trainees were never really ‘unsupervised’. In addition, we cannot exclude the possibility that some cases were reported twice, if more than one anaesthetist was involved in caring for the particular patient. Some consultants may also have erroneously reported cases from the private sector, although our guidance stressed that this survey concerned only NHS hospitals. For the purposes of this survey, AAGA was defined as ‘reported awareness during intended general anaesthesia for surgery’. We do not know how many respondents also included cases of dissatisfaction (perhaps described in terms of ‘awareness’) in patients for whom sedation was planned, be it in the operating theatre, the intensive care unit, or whilst undergoing medical procedures in interventional radiology or medical suites.

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**Figure 3** a) Distribution of accidental awareness during general anaesthesia (AAGA) reports by age. b) Proportions where reports were volunteered by the patient vs established by direct questioning. c) Distribution of reported experiences by phases during anaesthesia and surgery. d) Patients’ experiences that included pain or distress, resulting in a formal complaint or in legal proceedings (as a proportion of total cases of AAGA).
Less likely explanations for the discrepancies in incidence are that our survey represents a UK population that might be more susceptible to the hypnotic effects of anaesthetic agents, or resilient in their psychological response to an experience of AAGA. For example, it has been suggested that the Chinese population may have a higher incidence of AAGA than other groups²⁶ ²⁷, and the reverse may be theoretically (albeit unlikely) true for the UK. None of the recent trials has used a UK population, but one study that is more than 20 years old reported an incidence of 2:1000 when the Brice questionnaire was used²⁸.

Consequences of AAGA, and implications of the phases of anaesthesia in which AAGA occurs

As well as the reported incidence of AAGA being very low in this survey, so also are the apparent adverse consequences for the patients who experienced the complication. In two thirds of the AAGA cases reported, patients felt no pain or distress, and only a fraction resorted to complaint or legal action. These last two need to be interpreted with caution, since there can be considerable delay between an incident and legal proceedings (see http://www.justice.gov.uk/courts/procedure-rules/civil/protocol/prot_rcd) and our survey may not therefore have captured all such events.

Table 2  Number and incidence of reported accidental awareness during general anaesthesia (AAGA) in 2011 by various descriptors. The binomial and Poisson estimates for 95% CI are almost identical; the binomial are presented. The denominator used in the calculations is taken from the data of NAP4 of 2 872 600 general anaesthetics per year [18], adjusted for the fact that the response rate was 82% (Table 1).

<table>
<thead>
<tr>
<th>Descriptor</th>
<th>Incidence</th>
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<tbody>
<tr>
<td>Cases of AAGA</td>
<td>153 (131 – 180)</td>
</tr>
<tr>
<td>Incidence per general anaesthetic</td>
<td>0.0065% (0.0055 – 0.0076%)</td>
</tr>
<tr>
<td>Cases : anaesthetic</td>
<td>1 : 15 414 (1:13 158 – 1:18 181)</td>
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<tr>
<td>Cases per senior per year</td>
<td>1: 47 (1:40 – 1:55)</td>
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Figure 5  Influence of when during anaesthesia/surgery accidental awareness during general anaesthesia was experienced on whether pain or distress resulted, or if a complaint or legal proceedings were issued.

Figure 4  a) Distribution of volunteered reports vs those established by questioning by age. b) Lack of influence of age on when accidental awareness during general anaesthesia (AAGA) was experienced during anaesthesia/surgery. c) Lack of influence of age on pain or distress, or issuing a complaint or legal proceedings.
a tracheal tube or other airway device. This has at least two implications. First, the duration of the AAGA episode must have been necessarily brief (seconds, or at most a few minutes) because these dynamic periods by definition do not last very long. Second, detecting awareness during this period with depth of anaesthesia monitoring may not be easy because of the dynamic nature of the processes. The putative monitor would have to possess very rapid response times to detect brief awareness, and also rapid output times to communicate to the anaesthetist that awareness has become a (transient) possibility. The incidence of AAGA during surgery itself was relatively low in our study, but associated with higher levels of pain, distress and likelihood of early complaint.

Strengths and limitations of the survey
The limitations (and strengths) of this survey are relevant, the former related to the general problems associated with all surveys. Brevity of questions helped achieve a high response rate, but at the cost of some loss of detail. The response rate was very high indeed for a survey of this size, and gives us some confidence as to the accuracy of the data. We have been careful to estimate rates of AAGA assuming an equivalent incidence in non-responders as in responders. The demographic data are very consistent with the RCoA’s 2010 census (see http://www.rcoa.ac.uk/careers-training/workforce-and-manpower-planning/census)\(^3\). Our numbers for consultants (7140) and SAS doctors (1532) agree well with those of 6849 and 1843, respectively, as estimated by the RCoA.

Implications of survey results on use of depth of anaesthesia monitoring
With regards to the use of depth of anaesthesia monitoring, we found that almost three quarters of senior anaesthetists...
never use a monitor, despite two thirds of centres possessing such equipment. Even in those centres with equipment available to them, only a minority of practitioners employ it, even for selected cases. We did not ask how many monitors were available in each centre, so it is possible that there is not enough equipment to service each operating theatre or, that consumable costs are constraints. However, some comments written on survey returns suggest otherwise (e.g. “the monitor is locked in a cupboard and nobody uses it” or “we have a monitor, but it has stopped working and nobody has serviced it”). In this respect, our survey results differ from those of Lau et al.11, who found that 85% of anaesthetists would use a depth of anaesthesia monitor if it were available (21% would use it routinely). Because it was a much smaller study with a lower response rate, the respondents to Lau et al.’s study may have been enthusiasts of depth of anaesthesia monitoring or may have been those more likely to have experienced a case of AAGA. This last is certainly possible, as they reported that 33% of anaesthetists had experienced a case of AAGA; our data suggests only 21% have ever

<table>
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<th>Table 4</th>
<th>Access to and use of depth of anaesthesia monitoring (DOA) for the 7125 senior staff who responded. Values are number (proportion).</th>
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<tbody>
<tr>
<td>Centres with DOA</td>
<td>Anaesthetists using DOA in selected cases only</td>
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<tr>
<td>-----------</td>
<td>----------------------------------------------------------</td>
</tr>
<tr>
<td>163/263 (62%)</td>
<td>1772 (25%)</td>
</tr>
<tr>
<td>332 (17%)</td>
<td>90 (4.7%)</td>
</tr>
</tbody>
</table>

BIS, bispectral index; EP, evoked potential monitoring; IFT, isolated forearm technique; ‘Other’ included mention of the Vigeleo flotrac as a haemodynamic monitor of awareness, the cerebral function analysing monitor, a targeted end-tidal volatile agent algorithm, or was not specified.

<table>
<thead>
<tr>
<th>Table 5</th>
<th>Possible reasons for disparity between, or accuracy of, our reported incidence and any hypothetical ‘true’ incidence of accidental awareness during general anaesthesia (AAGA).</th>
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<tbody>
<tr>
<td>Under-reporting</td>
<td>Anaesthetists forgot the number of cases of AAGA with which they were involved. Unlike surgeons, anaesthetists generally do not routinely see postoperative patients at an interval after surgery in a clinic. As some patients only become aware of their experience of AAGA after a time interval, they have no direct opportunity to communicate this to their anaesthetist. Governance and reporting systems in hospitals may not be conducive to patients’ reporting their complications; patients may be reporting their experience to surgeons (or other medical staff) but this is then not passed on to the anaesthetic department staff. The majority of patients consider their experience to be too trivial to report and are not harmed or affected by it. However, this interpretation is at odds with some findings that, in fact, a high proportion of patients in prospective studies experience psychological symptoms, including post-traumatic stress, after AAGA. Patients suffering AAGA may exhibit anxiety-fuelled avoidance and frank phobic reactions to hospitals and doctors, arising as a direct result of the AAGA trauma. The most adversely affected patients are less likely to volunteer their experiences, which would bias the reported cases towards those of lesser psychological impact. Since patients may delay reporting AAGA for some time after their surgery, and as we conducted this survey in March-April 2012 (asking about knowledge of reports made in 2011), we may have missed a large cohort of cases. Balanced against this is the likelihood that some cases first presenting to anaesthetists in 2011 underwent anaesthesia before 2011, including in some cases many years previously. Trainees did not complete a questionnaire (see text for fuller discussion).</td>
</tr>
<tr>
<td>Over-reporting</td>
<td>Some previous suggestions of a high incidence may themselves be flawed: study consent processes may make it more likely that patients respond affirmatively to a direct question. While most studies employing the Brice protocol seek to confirm that a report of AAGA is verifiable against the medical case notes, this is not universal. The UK population might be more susceptible to the hypnotic effects of anaesthetic agents, or resilient in their psychological response to an experience of AAGA (see text for fuller discussion). UK clinical practice differs to an extent that makes AAGA less common, e.g. greater use of supraglottic airways with avoidance of neuromuscular blockade; or, UK anaesthesia is a purely medical specialty and further, in recent years has been an increasingly consultant-delivered service.</td>
</tr>
<tr>
<td>Why our reported incidence may not accurately reflect a ‘true incidence’</td>
<td>If false memories or dreaming by patients were erroneously classified as AAGA by doctors, or if cases were reported twice or from the private sector (see text for fuller discussion), or if cases arising from sedation were also reported.</td>
</tr>
</tbody>
</table>
done so. Or, as Lau et al.'s study was conducted in 2005, perhaps the passage of time has since made anaesthetists more (rather than less) sceptical of the benefits of existing depth of anaesthesia monitors.

The National Institute for Health and Clinical Excellence (NICE) has recently issued guidance under its Diagnostics and Technology programme on depth of anaesthesia monitors (specifically Bispectral Index (BIS), Entropy and Narcotrend; see http://guidance.nice.org.uk/DT/7). Its Technology Assessment Report (see http://www.nice.org.uk/nicemedia/live/13504/59370/59370.pdf) concluded that there is only modest evidence that depth of anaesthesia monitors reduce total anaesthetic consumption and shorten recovery times. For BIS, which has the largest evidence base, the report concluded that its use was not associated with a statistically significant reduction in intra-operative awareness, even in patients classified as at higher risk. These sentiments appear consistent with the behaviour of the majority of senior UK anaesthetists with respect to such monitors. Although the NICE guidance recommends the consideration of depth of anaesthesia monitoring in certain situations, this would seem to require a considerable change in the normal practice of the UK anaesthetic community.

Hospital protocols for prevention or management of AAGA

Our finding that so few centres have developed any protocols for either the specific prevention or the management of AAGA is notable. Anaesthetists might consider AAGA so rare (or of so little importance) that such policies are not needed, although this seems unlikely. More plausibly, this behaviour reflects the lack of robust evidence to support the use of any specific technique, including depth of anaesthesia monitoring, in the reliable prevention of AAGA. More fundamental questions about the anaesthetic community's understanding of the neuroscience of consciousness, especially the lack of a relevant model of consciousness, might also contribute to the absence of preventative strategies.

Notwithstanding this scientific gap, AAGA remains an important complication to avoid, for both patients and anaesthetists, and we hope the prospective phase of NAP5, by studying in detail the causes and effects of a large number of cases of AAGA, may be able to make a contribution to practical guidance on this topic.

Supplementary material

Supplementary material is available at British Journal of Anaesthesia online.

Acknowledgements and competing interests

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