AAGA in obstetric anaesthesia

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HEADLINE

16.1. There were 14 cases of AAGA during obstetric general anaesthesia reported to NAP5. Obstetric cases account for 0.8% of general anaesthetics in the NAP5 Activity Survey but ~10% of reports of AAGA to NAP5, making it the most markedly over-represented of all surgical specialties. Most reports of AAGA occurred after Caesarean section, but a number of cases were reported following obstetric anaesthesia for other procedures. Obstetric general anaesthesia includes most of the risk factors for AAGA, including use of rapid sequence induction with thiopental and neuromuscular blockade during maintenance, in a population with a relatively high incidence of obesity and difficult airway management. The urgency of the situation frequently necessitates surgery beginning within moments of induction.

BACKGROUND

16.2 Scott (1991), writing about awareness during Caesarean section, stated that it '*is due to too little anaesthetic and is the fault (not the bad luck) of the anaesthetist*'. This is not particularly helpful. It is self-evident that 'more anaesthetic' will at a certain dose, make it nearly impossible for the patient to be aware: the problem is knowing how much to give, and how best to monitor it.

16.3 It has long been believed that the incidence of AAGA in obstetrics is higher than in the non-obstetric population. Concerns about deleterious effects of anaesthetic drugs on the fetus, (both directly and via the impact on maternal haemodynamics) and the potential to increase maternal blood loss though decreased uterine tone, have led anaesthetists to minimise anaesthetic dose: that is, to administer 'light' anaesthesia.

16.4 Following the introduction of neuromuscular blockade and tracheal intubation to anaesthetic practice in the UK in the late 1950s, anaesthesia for obstetric procedures was generally induced with thiopental 200–250 mg and maintained with nitrous oxide. With this technique, the incidence of AAGA was reported to be as high as ~4% (Moir 1970; Crawford, 1971). This was reduced to <2% by the practice of adding ~0.5% halothane, although it was turned off after delivery to maintain uterine tone (Moir, 1970).

16.5 Anaesthetists were also taught to use rigid drug-dosing protocols, applying the same regimen for all patients regardless of variation in individual patient characteristics. The pitfalls associated with such an approach are demonstrated by the remarkable case of a woman who experienced AAGA during two separate anaesthetics, even though the anaesthetist on the second occasion knew her history (Lyons & Macdonald, 1991).

16.6 Several epidemiological studies have provided further evidence of increased risk of AAGA in the

obstetric population (Errando et al., 2008; Ghoneim et al., 2009). An important recent study on the topic was by the Australian and New Zealand College of Anaesthetists (ANZCA) trials group in 2005–6, who reported two cases of AAGA in 768 cases (0.26%, 1:384) Paech et al., 2008).

16.7 Regional anaesthesia is now the norm for Caesarean section and in England and Wales in 2013, Hospital Episode Statistics (HES) data reported that general anaesthesia was used for only 8% of all Caesarean sections, most of which were emergency cases (www.hscic.gov.uk/catalogue/PUB12744). The marked reduction in the use of general anaesthesia in obstetric practice, combined with changes in training means individual anaesthetists' experience of general anaesthesia is much more limited than in the past.

16.8 Although thiopental remains the most widely used induction agent in UK obstetric anaesthetic practice, a recent survey of UK anaesthetists found that 55% 'hardly or never' used thiopental outside obstetric practice, with 87% using it less than once per month (Murdoch et al., 2013).

16.9 Past surveys have indicated that isoflurane and sevoflurane are used by >95% of obstetric anaesthetists for maintenance, with sevoflurane the drug of choice. Snaith et al. (2010) reported that 85% of anaesthetists used nitrous oxide in obstetric cases, although only 44% used it outside of obstetrics. Similar practices were reported in the ANZCA trials group study (Paech et al., 2008).

16.10 The optimum dose of thiopental for induction is still disputed. Recommendations range from a maximum of 4 mg/kg (British National Formulary, 2014) to 4–8 mg/kg (Harrad & Howell, 2000). The mean dose in the ANZCA study was 4.9 mg/kg (Paech et al. 2008). When the recommended dose was increased from 3–4 mg/kg to 5–7 mg/kg in one centre, the incidence of AAGA fell from 1.3% to 0.4% (Lyons 1991). Textbooks of obstetric anaesthesia contain the advice that the recommended maximum dose in adults may not be sufficient in the obstetric population (Collis, 2002; Yentis et al., 2004). Overall, current opinion suggests that the induction dose of thiopental for the healthy parturient should be no less than 5 mg/kg.

16.11 Several studies in non-obstetric patients suggest that intubation tends to be carried out at higher BIS readings, following induction with thiopental compared with propofol. Beck et al (2006) reported that thiopental induction was associated at intubation with higher BIS values and more

patients with BIS >60. BIS rose a mean of 8 points at intubation. Sie et al. (2004) compared thiopental 4mg/kg or propofol 2mg/kg and reported significantly fewer patients with BIS <60 at 1, 2 or 3 minutes in the thiopental group with up to 50% having BIS>60 at 2 minutes. Heier et al. (2001) reported that when thiopental 5mg/kg and suxamethonium 1mg/kg was administered to volunteers and allowed to wear off: 58% experienced awareness while still paralysed, though none were distressed by the sensation of paralysis. Taken together, these studies highlight the variable effect and short duration of thiopental. There is no reason why this should not also be the case in the obstetric population.

16.12 In a recent study Zand et al. (2014) studied BIS and the isolated forearm technique (IFT) during caesarean section. Anaesthesia was induced with thiopental 4.5mg/kg and maintained with sevoflurane 1.8–2.2% in 50% nitrous oxide before delivery. BIS could not reliably differentiate between positive and negative isolated forearm responses during induction, intubation and skin incision and 46% of patients demonstrated a positive isolated forearm response during airway management. Interestingly no post-operative recall was reported despite use of a Brice questionnaire post-operatively.

16.13 Concerns about using propofol for obstetric anaesthesia include:

(i) slower onset;

(ii) a short distribution half-life;

(iii) the potential for more hypotension at induction with potentially deleterious effects on placental blood flow (Moore et al., 1989) and (iv) the reported complication of profound maternal bradycardia in association with suxamethonium (Baraka, 1988). Despite these concerns, propofol is probably the most commonly used induction agent for general anaesthesia in obstetrics outside the UK (Rucklidge, 2013); reassuringly, case reports of adverse effects are not accumulating.

16.14 An inspired oxygen concentration of >50% has been routinely used before delivery to maintain fetal oxygenation, but has not been demonstrated to improve neonatal outcome when compared with 33%, in the absence of fetal compromise (Lawes et al., 1988).

16.15 An end-tidal MAC of around 0.5 for the halogenated volatile anaesthetics is advocated in order to avoid a tocolytic effect on the uterus. However a higher

MAC has not been associated with increased blood loss (Lyons & Macdonald, 1991).

16.16 Other factors may play a role in the increased incidence of AAGA in the obstetric population:

(a) Obstetric patients do not receive sedative or analgesic premedication.

(b) The majority of general anaesthetics are administered for non-elective Caesarean section and consequently patients' anxiety levels are likely to be high.

(c) The physiological changes of pregnancy (e.g. tachycardia) may mask the clinical signs of inadequate anaesthesia.

(d) Increased cardiac output decreases the duration of action of intravenous anaesthetics, and at the same time prolongs the time to establish effective partial pressure of volatile agents.

(e) A category 1 Caesarean section requires induction of anaesthesia followed by tracheal intubation and then commencement of surgery as rapidly as is compatible with maternal safety. There may be insufficient time for the drugs to take full effect before airway manipulation or surgery.

(f) Rapid sequence induction is almost invariably used in the UK and is coupled with an increased risk of difficult and failed intubation in the obstetric population (Quinn et al., 2013).

(g) A single ampoule of suxamethonium represents an adequate dose for a patient weighing no more than 70 kg. Under-dosing of suxamethonium may worsen intubating conditions and exacerbate the risk of AAGA. Even a dose of 1.5 mg/kg may be inadequate due to the increased volume of distribution in pregnancy; (O'Brien & Conlon, 2013).

(h) The incidence of obesity is increasing in the obstetric population (Helsehurst et al., 2007) and, if regarded as an independent risk factor for AAGA (see Chapter 11, Risk Factors), may be contributory.

(i) The majority of anaesthetics for non-elective Caesarean sections are given by trainees often outside of the main theatre suite and out-of-hours with distant supervision (Hawthorne, 1996). Paech suggested 'trainee stress' may be a contributory factor in obstetric AAGA (Paech et al., 2008).

16.17 To summarise, obstetric patients have hitherto been considered to have a higher risk for AAGA for multiple reasons.

NAP5 CASE REVIEW AND NUMERICAL ANALYSIS

16.18 Data from the Activity Survey confirmed the uniqueness of obstetric anaesthetic practice.

16.19 Almost 2/3 of all anaesthetic activity between 00.01 and 08.00 hrs was obstetric, including 23% of Category 1 lower segment Caesarean section (LSCS). Thiopental was used for <3% and RSI for <8% of anaesthetic inductions, but both were used for >90% of Caesarean sections. An opioid was used in 25%. Nitrous oxide was used for >70% of Caesarean sections but <30% non-obstetric cases.
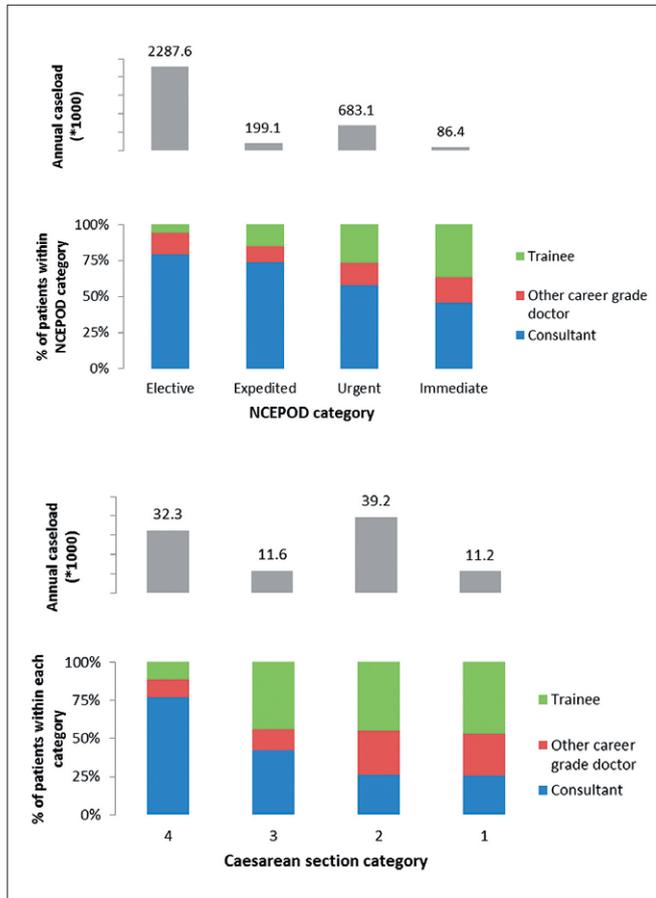
16.20 Anaesthesia for Category 1–2 Caesarean section was less often performed by consultants than other (non-obstetric) emergencies and more often by quite junior trainees (Figure 16.1 and 16.2). This is unsurprising given that, in contrast with emergencies outside obstetrics, urgent delivery may be necessary within a few minutes, such that senior staff may not be able to attend in time. Comparison of management of obstetric and non-obstetric emergencies should be approached with caution, as it should be borne in mind that the NCEPOD classification excludes obstetric cases, and an NCEPOD 'emergency' should not be regarded as synonymous with a 'category 1' Caesarean section (immediate threat to life of the mother or fetus; Lucas et al., 2000).

16.21 There were 14 cases of AAGA in obstetric patients: 13 in Class A (Certain/probable) and one in Class B (Possible). In addition to these 14 cases, there were two cases involving drug errors (Class G) and 12 'Statement Only' cases (which are discussed elsewhere (Chapter 6, Main Results).

16.22 The obstetric cases thus represent 14/141 (~10%) of the total number of Certain/probable and Possible AAGA cases. In the NAP5 Activity Survey obstetric general anaesthetics constituted 0.8% of the total general anaesthesia cases for the UK. Thus, obstetrics is over-represented in AAGA cases by a factor of >10 (see also Chapter 6, Main Results and Chapter 11, Risk Factors).

16.23 All the experiences in obstetric cases concerned awareness at induction or soon after, bearing in mind that incision normally follows very shortly after tracheal intubation. All except one case involved use of neuromuscular blockade; in none of these was the use of a specific depth of anaesthesia monitor recorded (See Table 16.1 for other characteristics).

Figure 16.1. a and b: (a) NCEPOD urgency (non-obstetric cases) and most senior anaesthetist present and (b) Caesarean section (general and regional anaesthesia) urgency and most senior anaesthetist present. Top chart shows estimated annual caseload according to NCEPOD or Caesarean section urgency category. Bottom chart shows % of patients, within each category, according to most senior anaesthetist present. Note: category 1,2 and 3 are all forms of emergency Caesarean section. Caesarean and NCEPOD categories are not directly equivalent

Table 16.1. Characteristics of obstetric cases. LSCS, lower segment Caesarean section; Category 4 elective; Categories 3 – 1 increasing degrees of urgency; in hours = weekday 08–18.00; out of hours = outside these times and weekends; obesity = BMI >30. *one patient had bronchospasm; **all cases without monitoring were >10 years old, except one where propofol boluses were used in non-LSCS case

Variable	Number

LSCS
    Category 1
    Category 2
    Category 3–4
	12
	5
	4
	3

Non-LSCS operations	2
In hours: out-of-hours	5:9
Consultant: SAS: trainee: unknown	1:5 : 5:1
Body habitus normal: obese	10:4
Thiopental dose recorded as 'low' or <4 mg/kg	7
Nitrous oxide used yes: no	8:6
Airway difficulty yes: no	9:5*
End-tidal monitoring yes: no	10:4**

16.24 Four of the Caesarean sections (33%) were described as Category 1. In the Activity Survey, the proportions of Categories 1–4 general anaesthesia Caesarean sections were respectively: 39%, 37%, 10% and 14%. Thus Category 1 cases do not appear to be over-represented in patients who reported AAGA to NAP5 (see table 16.1).

16.25 Five cases involved airway or respiratory difficulty. There were two cases of failed intubation (one was managed with a laryngeal mask; one allowed to waken), two other cases of difficulty with intubation and one case of bronchospasm. Of four obese patients, two had airway problems. Difficult airway management and obesity are discussed further in Chapter 8, Induction and Chapter 7, Risk Factors. In two cases, retrograde flow of induction agent into the giving set was considered contributory.

A solo anaesthetist was asked to anaesthetise an obese parturient for a Category 1 Caesarean section, late at night in a unit remote from the main hospital. Following a failed spinal, anaesthesia was induced with thiopental and suxamethonium. The induction agents backtracked up the giving set despite the use of an anti-reflux valve. There was no one available to prepare more induction agent. Intubation was difficult with multiple attempts made. Finally an LMA was inserted and sevoflurane in 50% oxygen and nitrous oxide was used to maintain anaesthesia. On waking the patient was very distressed and reported feeling the attempts at intubation and a feeling of both paralysis and suffocation during bag-mask ventilation. She subsequently developed a new anxiety state following what she considered to be a near-death experience.

A trainee was called to administer general anaesthesia for an urgent forceps delivery and performed a rapid sequence induction with thiopental and suxamethonium. However, the intravenous giving set became occluded during injection. Later, the patient recalled having something "rammed down my throat" but nothing after that – an experience lasting a few seconds. She did not seem perturbed by the experience, understanding the need to deliver her baby as rapidly as possible.

16.26 In four cases, spinal or epidural anaesthesia had failed, necessitating general anaesthesia, and in two cases the anaesthetists at the time considered that neuraxial blockade was contra-indicated. In 4 of 10 Category 2–4 Caesarean sections the Panel could find no reason why general rather than regional anaesthesia was chosen. Indeed in one case the patient had an epidural in situ for labour, one was an elective case, (when there would have been no pressure of time necessitating the use of general anaesthesia) and in one difficult intubation had been anticipated pre-operatively.

A patient with a previous history of neurosurgical intervention was booked for a 'patient choice' elective Caesarean section and general anaesthesia, but presented in labour prematurely during the night. The urgency was classified as category 3 (i.e., needing early delivery but no threat to mother or fetus). Surgery was delayed until the patient was fasted. The trainee anaesthetist did not record an airway assessment, but proceeded with a rapid sequence induction, during which tracheal intubation failed. Ventilation was easy, and after two intubation attempts the patient was woken up and senior help summoned. The patient subsequently underwent awake fibre-optic intubation for the operation. After surgery the patient reported that she had been awake and paralysed during the failed intubation and heard conversation relating to the events. She was terrified. She developed a new anxiety state and was referred for counselling.

16.27 In seven of the 12 Caesarean section cases there was concern expressed by the Panel that the dose of thiopental was low. In one case the thiopental dose was <3 mg/kg given to an obese woman who subsequently also developed bronchospasm. In another, thiopental 300 mg was administered to a patient in whom difficult intubation was anticipated.

16.28 Nitrous oxide was used in 57% of AAGA reports (Table 16.1) compared to >70% of Caesarean sections in the Activity Survey.

16.29 There were several cases of human error. As seen elsewhere (Chapter 8, Induction), in two cases there was a delay in turning on the volatile anaesthetic following induction.

An obese parturient underwent a Category 1 section in the early hours. General anaesthesia was chosen as there was a history of spinal injury. Induction employed what was described as 'a small hypnotic component'. There was a delay of a few minutes before the sevoflurane vaporiser was turned on and from the start a total gas flow of <1 L/min was used in a circle system, with 50% oxygen in air and opioids given only after delivery. At the routine anaesthetic follow-up the next day, the patient recalled a painless sensation of being cut and being unable to communicate or move that lasted a few minutes. There appeared to be no adverse sequelae at the time of reporting.

16.30 There were two cases involving syringe swaps, (both emergency procedures), which are also discussed elsewhere (Chapter 13, Drug Errors). In one a large dose of intravenous lidocaine was given instead of an antibiotic during surgery complicated by massive haemorrhage. In another antibiotics were given instead of thiopental.

An unwell patient with pre-eclampsia considered severe enough to preclude neuraxial blockade was anaesthetised by a consultant for a category 2 Caesarean section out of hours. The anaesthetist had spent several hours pre-operatively stabilising the blood pressure with anti-hypertensives. The unit's protocol had recently changed to recommend antibiotic therapy before skin incision, so cefuroxime was drawn up ready for administration. For induction, the anaesthetist administered magnesium, fentanyl, rocuronium and in error, cefuroxime, instead of thiopental. After the cords were sprayed with lidocaine before intubation, the lack of hypnosis was noted. Thiopental 375mg was then given. The anaesthetist questioned the patient in recovery who recalled that she had been aware of the laryngoscope being inserted and wondered 'if she should have been asleep for this bit'. She was not worried by the experience as she trusted the clinicians who had been looking after her for several hours.

16.31 The duration of AAGA was brief. In all but one case the episode lasted <5 minutes and in ten cases a few seconds only.

16.32 In three (21%) cases, new significant psychological morbidity was reported: in ten cases there were apparently no sequelae. In one case the patient had indicated a decision to litigate at the time of the report, which may indicate an adverse psychological impact.

Data limitations

16.33 The denominator for obstetric and Caesarean section cases is less robust than for other sections of the NAP5 project. This section explains this is some detail – for clarity. However as Figure 16.2 below indicates the possible under-estimation of the denominator has little major impact on estimates of incidence.

16.34 A problem with the Activity Survey specifically for obstetric data, was the number of uninterpretable forms (Figure 16.2). Of the estimated 352,300 obstetric cases annually, there were 17,000 general anaesthetics. However on 34% of the forms collected, further details were absent; a marked increase compared with other specialties. This leads to concerns about the accuracy of the denominator (and in turn the estimated incidences we calculate). To try to address this we compared our denominator for obstetric activity with HES data. Because the HES data covers only England, whereas the Activity Survey included the whole UK, we used a multiplier (based on populations of the various countries) of 1.2 to estimate UK-wide 'modified HES' activity.

Figure 16.2. Flowchart of cases from the Activity Survey of obstetric activity. CS = Caesarean section; GA = general anaesthesia; NMB = neuromuscular blocking drug
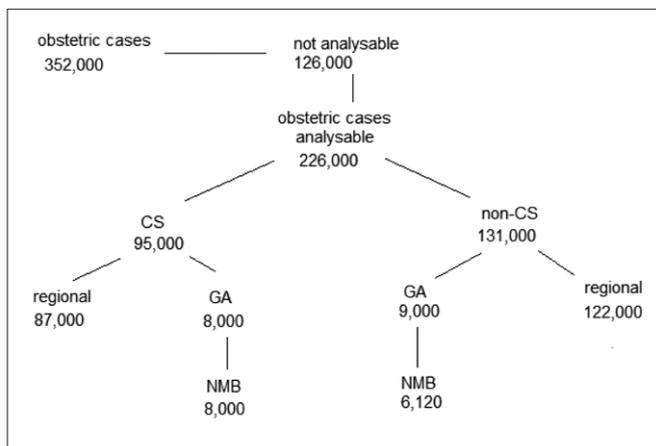
16.35 In the Activity Survey data non-Caesarean section regional anaesthesia cases were likely to have been mainly neuraxial blocks for labour analgesia. The type of non-Caesarean section procedures carried out under GA is uncertain but may have been for examination under anaesthesia, manual removal of placenta, control of haemorrhage or just wrongly coded.

16.36 To complicate matters further, the authors of the HES data have also raised concerns about their accuracy: specifically, regarding the data on general

anaesthesia for obstetric procedures that are not Caesarean sections it is noted that the data '… should be treated with caution as these represent unlikely events' (www.hscic.gov.uk/catalogue/PUB12744).

16.37 The Activity Survey included 2,880 obstetric cases that apparently received general anaesthesia without neuromuscular blockade. These are hard to explain as intubating the trachea without muscle relaxation in the obstetric population would be considered negligent by the majority of UK anaesthetists.

Table 16.2. Incidence of AAGA based on Activity data denominators. CS = Caesarean section; GA = general anaesthesia

	Estimated annual	AAGA	
	Number of cases	Number	Incidence
All obstetric GAs	17,000	14	1:1,200 (0.08%)
CS under GA	8,000	12	1:670 (0.15%)
GA for other procedures	9,000	2	1:4,500 (0.02%)

16.38 There are concerns about both the Activity Survey obstetric data and the HES obstetric data (see above). We therefore present the obstetric data in two ways: firstly using the assessable Activity Survey data as a denominator and secondly using the 'modified HES data' (i.e. corrected for UK population) see Table 16.3. This leads to two sets of incidences with that based on NAP5 being higher than that based on HES data. We hope that in the future more precise data on national obstetric general anaesthesia activity will clarify this.

Table 16.3. Comparison of Hospital Episode Statistics (HES) data with Activity Survey data for obstetric activity. GA = general anaesthesia; LSCS = lower segment Caesarean section; regional = neuraxial block; *** = specified by HES as instrumental and spontaneous delivery

	Activity Survey estimate	HES data estimate*	Ratio HES Activity Survey:	Modified HES: Activity Survey ratio**
Total GAs	17,000	19,100	1.12	1.35
GAs for LSCS	8,000	9,194	1.15	1.38
GAs for non-LSCS***	9,000	9,538	1.06	1.27

*HES data for England only.
**Each ratio is multiplied by 1.2 (based on population of UK vs England) to provide a comparator ratio of assessable data captured by the Activity Survey compared to modified HES data (i.e. extrapolated to UK population)

16.39 Based on Activity Survey data, the estimated incidence of reports of AAGA during all obstetric general anaesthesia is 1:1,200 (0.08%) which is more than 12 times greater than the overall incidence in NAP5 of ~1:15,000. Incidence based on modified HES data is presented in Table 16.4.

16.40 Using the Activity Survey estimate of 8,000 general anaesthetic Caesarean sections per annum yields an incidence of AAGA in Caesarean section of ~1:670 (0.13%) (Table 16.4). This estimate is about half the incidence estimated by Paech et al. (2008), of ~1:384, using the Brice survey in obstetric practice. The incidence based on modified HES data is presented in Table 16.4.

Table 16.4. Comparison of incidence of AAGA for all obstetric cases and for Caesarean section using Activity Survey data and Modified HES data (i.e. corrected for UK population)

	Activity Survey denominator	Modified HES denominator
Incidence of AAGA – all obstetric cases	1 in 1,200	1 in 1,640
Incidence of AAGA – Caesarean sections	1 in 670	1 in 920

16.41 Using Poisson distribution confidence intervals Figure 16.3 shows the effect an underestimate or overestimate of the denominator would have on estimates of incidence of AAGA during Caesarean section. As can be seen, increasing the true denominator (i.e. our estimate being an underestimate) has a rather modest impact on the estimate of incidence of AAGA.

Figure 16.3. Plot of Poisson distribution confidence intervals to indicate how varying denominator (true number of Caesarean sections per year) impacts on the estimate of incidence of AAGA during Caesarean section. The dashed lines indicate the 95% confidence limits for incidence of AAGA assuming the numerator remains stable and the denominator varies. The vertical line indicates the NAP5 estimate of number of Caesarean sections based on the Activity Survey. As can be seen increasing the true denominator (i.e. the NAP5 estimate being an underestimate) has a rather modest impact on the estimate of incidence of AAGA
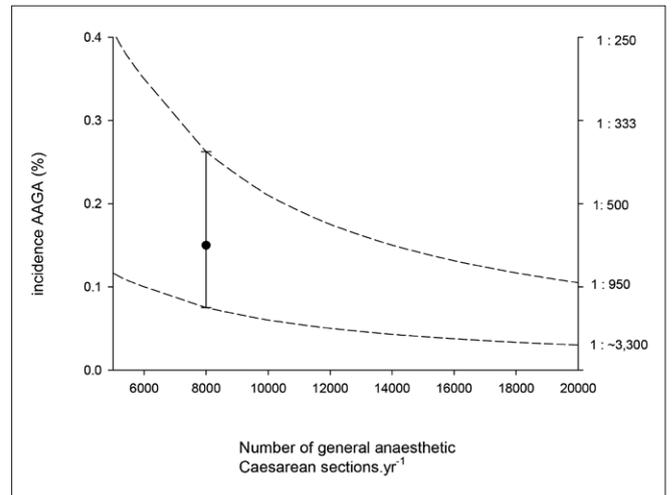
DISCUSSION

16.42 The data from the Activity Survey yield a denominator for much of NAP5. In the obstetric population however, the assessable denominator data appear to be an under-estimate and incidences of AAGA based on this may be over-estimates by about one third.

16.43 As previously noted many Activity Survey forms for obstetrics were incomplete or un-analysable. This did not apply to any other subset of patients or subspecialty we examined, where attrition rates were <5% at most. Irrespective of this, using denominator data either from the Activity Survey or from HES, indicates that reports of AAGA in obstetrics are markedly more common than in other areas of practice. This is especially the case for Caesarean section.

16.44 For obstetric patients, the gap between reports of AAGA and incidence of AAGA from a Brice questionnaire appear less marked than in other areas of practice. Why this is so is uncertain but one possibility is that post-operative anaesthetic follow-up of patients after Caesarean section is very rigorous, and that perhaps the visit more readily facilitates reporting of AAGA. In this regard, although the delay in reporting had a wide range (up to 22 years), in the majority of cases the patient reported the episode either on the same or the next day. Three reports

were made to the anaesthetist involved in patient care, whilst five cases were reported during the routine postnatal anaesthetic round the following day.

16.45 In other chapters (Chapter 8, Induction and Chapter 7, Risk Factors) rapid sequence induction, especially with thiopental, neuromuscular blockade and difficult airway management is identified as a risk factor for AAGA. This is likely to contribute to the increased incidence of AAGA seen in obstetric anaesthesia. In the obstetric population RSI with thiopental followed by neuromuscular block is routine practice, and the incidence of failed intubation is reported to be ~1 in 224 (Quinn et al., 2013).

Rapid sequence induction is a risk factor for AAGA in obstetric anaesthesia, as it is in other specialties

16.46 A recurring theme in the Induction section of this Report is the need to 'mind the gap' (Chapter 8, Induction). In emergency Caesarean section during general anaesthesia, an anaesthetic room is rarely used, and the 'obstetric gap' refers to the very short period between induction of anaesthesia (by RSI) and the start of surgery. This is a period when rapid redistribution of the intravenous induction agent and slowly increasing partial pressure of the volatile anaesthetic may lead to a gap in effective anaesthetic depth. Delays in starting the volatile agent (difficult airway management, delay in turning on the agent or a slow 'wash-in' due to low flow techniques) will exacerbate this effect and increase the risk of AAGA.

16.47 Syringe swaps accounted for 14% of obstetric AAGA cases and both cases involved antibiotics. In one, a recent change of policy led the anaesthetist to change practice and draw up the antibiotic before delivery, making the possibility of syringe swap more likely. In the other case, the urgency of the case was a distracting factor.

16.48 There is good evidence that general anaesthesia for emergency obstetric procedures is associated with greater maternal mortality than central neuraxial blockade (Ginosar et al., 2005). Yet, in a proportion of cases there appeared to be no apparent indication for choosing general anaesthesia and indeed, sometimes good reason to avoid it. The relative risks and benefits of regional versus general anaesthesia always need to be considered, with the risk of AAGA amongst the latter. A failed regional anaesthesia followed by difficult general anaesthesia includes the risks of both and such circumstances were also not infrequent in reports to NAP4 (Cook et al., 2011). Such a situation might usefully be highlighted as a time of increased risk for both airway and AAGA complications and one in which senior staff should be involved rather than automatically proceeding to general anaesthesia.

16.49 The Activity Survey shows that 2–3% of Category 3 Caesarean sections are undertaken by trainees out of hours. There is rarely any indication to undertake elective high risk cases (including those at increased risk of AAGA), out of hours by single-handed trainees. The timing of such cases should be decided by discussion between consultant obstetric and consultant anaesthetic staff, and in most instances with care delivered by consultants.

16.50 In some cases, the need to care for their new-born seemed to ameliorate the adverse impact of AAGA on the patient. A trusting relationship between clinician and parturient prior to the episode of AGAA exerted an apparently highly protective effect. Some of the comments reported in Statement Only cases (see Chapter 6, Main Results) may still be relevant today. One woman did not report the event for nearly 50 years because she did not want to '*get the anaesthetist into trouble*'. Another '*did not want to make a fuss*', '*I thought being awake was inevitable*'.

16.51 In most of the more contemporaneous reports, end-tidal concentrations of anaesthetic agent were monitored, both during induction and maintenance. Nitrous oxide was used in a smaller proportion of obstetric AAGA cases than in the Activity Survey.

16.52 The use of specific DOA monitoring during obstetric general anaesthesia appears very sparse (in the Activity Survey, the only use of a DOA monitor in obstetric practice was a single use an E-entropy monitor in just one non-Caesarean section case). This may reflect lack of confidence that such monitors provide clinically useful information (Pandit & Cook, 2013), or the perceived

impracticality (because of slow response time) of using such monitors in obstetric practice. However, in the cases studied by the ANZCA group, one-third of patients received DOA monitoring, none of whom experienced AAGA (Paech et al., 2008), suggesting practices vary internationally.

16.53 In summary, obstetric anaesthetic practice differs in several ways from other areas of practice, and anaesthetists providing obstetric anaesthesia must manage a unique combination of challenges. Factors, some of which are unavoidable, contributing to an increased risk of AAGA include:

(a) Rapid sequence induction.

(b) Use of thiopental (in inappropriately low doses in some cases).

(c) Use of neuromuscular blockade.

(d) Increased risk of difficult airway management.

(e) Increased incidence of obesity.

(f) A short period between anaesthetic induction and start of surgery.

(g) A high rate of category 1 and 2 Caesarean section and surgery performed out of hours resulting in high rates of non-consultant care.

16.54 This combination of risk factors is particular if not unique, to current obstetric anaesthetic practice. Obstetric anaesthesia should continue to be regarded as a high risk sub-specialty for AAGA.

The roles of thiopental vs propofol for induction in obstetric anaesthesia could usefully be examined

IMPLICATIONS FOR RESEARCH

Research Implication 16.1
Studies are required to further establish the optimal dose of thiopental for obstetric induction.

Research Implication 16.2
Further studies are required to assess the effect of propofol as an anaesthetic induction agent in the compromised mother and fetus.

Research Implication 16.3
The safe minimum inspired oxygen fraction during general anaesthesia for Caesarean section, especially in the presence of suspected fetal compromise, needs to be established to guide the maximum recommended fraction of nitrous oxide.

Research Implication 16.4
Further research is needed on the effect of syntocinon infusions to maintain uterine tone when high concentrations of volatile agent are used.

Research Implication 16.5
Further research is needed to clarify the optimum timing and dosing of opiates during anaesthesia for Caesarean section.

Research Implication 16.6
Further research is needed more clearly to define the incidence of AAGA as identified by the Brice questionnaire in the obstetric population.

Research Implication 16.7
Further research is needed to explore whether factors make obstetric patients more likely to report episodes of AAGA than the non-obstetric population; perhaps to improve self-reporting rates in the latter.

RECOMMENDATIONS

RECOMMENDATION 16.1
Anaesthetists should regard obstetric patients, particularly those undergoing Caesarean Section, as being at increased risk for AAGA. This risk should be communicated appropriately to patients as part of the consent process.

RECOMMENDATION 16.2
Consideration should be given to reducing the risk of AAGA in healthy parturients by (a) the use of increased doses of induction agents (b) rapidly attaining adequate end-tidal volatile levels after induction without delay (c) use of nitrous oxide in adequate concentrations (d) appropriate use of opoids (e) maintaining uterine tone with uterotonic agents to allow adequate concentrations of volatile agents to be used.

RECOMMENDATION 16.3
Before induction, the anaesthetist should have decided what steps to take if airway management proves difficult, with maternal wellbeing being the paramount consideration, notwithstanding the presence of fetal compromise. An additional syringe of intravenous hypnotic agent should be immediately available to maintain anaesthesia in the event of airway difficulties, when it is in the mother's interest to continue with delivery rather than allow return of consciousness.

RECOMMENDATION 16.4
Anaesthetists should regard failed regional technique leading to the need for general anaesthesia for obstetric surgery to be an additional risk for AAGA (and for other complications).

RECOMMENDATION 16.5
Anaesthetists should regard the presence of antibiotic syringes during obstetric induction as a latent risk for drug error leading to AAGA. The risk can be mitigated by physical separation, labelling or administration of antibiotics by non-anaesthetists. Using propofol for induction mitigates the risk of this drug error.

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