CHAPTER
14

AAGA in cardiothoracic anaesthesia

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HEADLINE

14.1. NAP5 received four reports of AAGA during cardiac surgical procedures and four during thoracic surgery. Based on the Activity Survey data this gives an incidence of reports of AAGA in cardiac and thoracic surgery of 1 in 10,000 and 1 in 7,000 respectively: both higher than the overall incidence of reports. Most reports in this field involved either brief interruption of drug delivery (caused by human error or technical problems) or use of intentionally low doses of anaesthetic drugs in high-risk patients.

BACKGROUND

14.2 Cardiac surgical patients have traditionally been considered at increased risk of AAGA due to a combination of surgical, anaesthetic and patient factors.

14.3 Surgical myocardial protection strategies in the early years were frequently associated with severely depressed post-bypass myocardial function and so to avoid this, anaesthetic techniques in the pre-propofol era were consequently traditionally largely opioid based and relatively devoid of cardio-depressant inhalational anaesthetic agents or benzodiazepines (Lowenstein et al.,1969). However, this may have increased the risk of AAGA.

14.4 Patients with minimal cardiac reserve and those undergoing emergency cardiac surgery were regarded as particularly vulnerable to AAGA.

14.5 Improvements in myocardial protection and the introduction of more modern anaesthetic techniques over the next two decades, appeared to reduce the incidence of recall of intra-operative events after cardiac surgery from >10% with high dose opiate techniques described above, to 1.1% with a more 'balanced' anaesthetic technique consisting of benzodiazepines, low dose fentanyl and a volatile agent (Phillips et al., 1993).

14.6 Institution of the cardiopulmonary bypass (CPB) phase is an especially vulnerable time. The acute effects of haemodilution and possible sequestration of some drugs into the bypass circuit are potential contributory factors. Although it is possible to administer volatile anaesthetic agents during CPB, there may be delays in achieving therapeutic partial pressures when volatile agents are first administered (Mets, 2000). Many revascularisation operations are now undertaken off-pump. The impact of avoiding bypass on incidence of AAGA is unclear.

14.7 Because cerebral metabolism and anaesthetic requirements decrease by 6–7% for every 1°C fall in temperature below 37°C, the risks of AAGA are reduced during hypothermic CPB (Hogue et al., 2012). Importantly, however, the risk of AAGA is increased during rewarming (Liu et al., 2005).

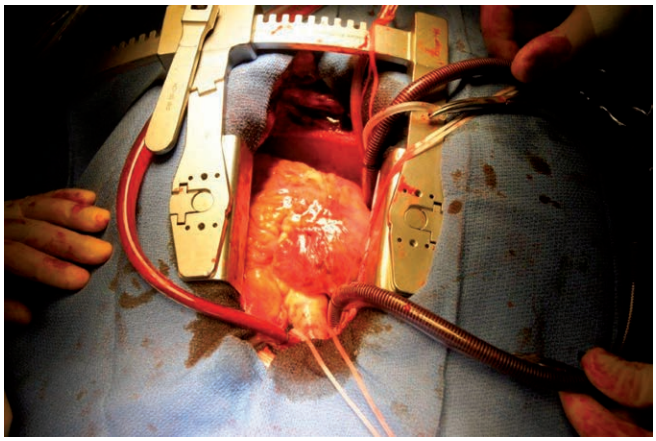
14.8 Dowd et al. (1998) reported a 0.3% incidence of awareness in 617 consecutive low-risk cardiac patients undergoing fast track cardiac surgery. Patients underwent a structured Brice (1970)

interview by a research nurse 18 hours after tracheal extubation. The low incidence of awareness was attributed to the use of a balanced anaesthetic technique involving the continuous administration of volatile (isoflurane) or intravenous (propofol) anaesthetic agents throughout the peri-operative period. However, Dowd et al. had selected a 'low risk' population, and also did not use repeated questioning, which may have contributed to the low reported incidence. Dowd et al.'s paper highlights a change in cardiac anaesthetic practice of relevance to all anaesthetists. In response to hypotension, anaesthesia was traditionally 'lightened'. In contrast, more recent education of cardiac anaesthetists emphasises the need to maintain anaesthesia throughout periods of hypotension and to initiate early treatment of low blood pressure with fluid, vasopressor or inotropic support.

14.9 Ranta et al. (2002) reported on the conscious recollections of >900 patients after cardiac anaesthesia. The incidence of definite awareness with recall was 0.5% and the incidence of possible recall was 2.3%. They found that lower doses of midazolam had been used in those patients with awareness and recall.

14.10 Most studies indicate that factors making for high-risk in cardiac surgical patients (e.g. ejection fraction <30%, cardiac index <2.1 $l.min^{-1}$ $.m^{-2}$, severe aortic stenosis or pulmonary hypertension) also increase risk of AAGA, and are associated with up to a 1% incidence of awareness. Almost half of over 2400 patients in the B-Aware study underwent either high-risk cardiac surgery or cardiothoracic transplantation (Myles et al., 2004). Cardiothoracic surgical patients accounted for a similar proportion (6 of 13) of cases of definite AAGA, with incidences of AAGA of ~ 1:120 and ~1:600 in the routine care and BIS groups respectively. Similarly patients undergoing planned open-heart surgery made up 36% of the 6000 patients recruited to the BAG-RECALL (2011) study, but 52% (14 of 27) definite or possible cases of intra-operative awareness in that study, yielding an overall incidence of ~1:150 (~0.6%) for cardiac anaesthesia.

Cardiac surgical patients may be at increased risk of AAGA because anaesthetic dosing is reduced to maintain cardiovascular stability in high-risk patients – here a patient undergoing heart transplant



14.11 Thoracic surgical patients are also at increased risk of awareness compared with the general surgical population. Most operations require administration of neuromuscular blockade to facilitate one-lung ventilation and many of the patients are elderly or frail with multiple co-morbidities. Because many patients undergo bronchoscopy before surgery via a single lumen tube and then need re-intubation with a double lumen tube, there is inevitably a brief period of discontinuity of lung ventilation and volatile anaesthetic delivery, and a potentially increased risk of failure to turn the vaporiser back on if the anaesthetist is distracted.

14.12 Rigid bronchoscopy is associated with a particularly high incidence of haemodynamic disturbance and awareness risk during anaesthesia (Bould et al,. 2007). Anaesthesia for this procedure is challenging due to a 'shared airway' with the surgeon, the need for deep anaesthesia, yet full neuromuscular blockade and rapid recovery. Recent North American and UK guidelines advocate using depth of anaesthesia monitoring for patients receiving TIVA and a muscle relaxant (Mashour et al., 2013; NICE, 2012).

14.13 In summary, patients undergoing both cardiac and thoracic surgery are generally considered to be at an increased risk of AAGA.

Operations such as rigid bronchoscopy require brief anaesthesia, full neuromuscular blockade and TIVA. All are risk factors for AAGA

NAP5 CASE REVIEW AND NUMERICAL ANALYSIS

Cardiac data

14.14 There were four reports of AAGA during cardiac anaesthesia classed as Certain/probable or Possible (Class A and B). One arose in the catheter laboratory and one case was during return to theatre for re-operation for bleeding. Thus there were only two reported AAGA cases during the primary surgical procedure.

14.15 Two cases involved experiences of touch (one of which was distressing to the patient; Michigan 2 and 2D), one of pain (during a line insertion as part of cardiac catheterisation in a child; Michigan 3D) and one of paralysis after induction (Michigan 4D).

14.16 Cardiac cases constituted ~1% of the UK reported caseload during the Activity Survey denominator study (~40,600 cases annually). This yields an overall NAP5 incidence of reports of AAGA of ~1:10,000 (~0.01%). This is perhaps twice as high as the general incidence in NAP5 of such reports of ~1:20,000, but much lower than in previous literature of cases of AAGA of 1:150.

14.17 According to the Society for Cardiothoracic Surgery (SCTS) website (www.scts.org/), 34,174 major cardiac surgical cases (excluding catheter laboratory cases and cases of post-operative bleeding) were undertaken in 2012. Given that estimated 40,600 NAP5 cases also includes GA catheter lab cases and returns to theatres for bleeding, there is good agreement of the NAP5 Activity Survey with confirmed SCTS data.

14.18 Specific EEG-based depth of anaesthesia monitoring was used in 31% of cardiac cases in the Activity Survey and, broadly in proportion with this, BIS was used in one of the four cardiac cases of AAGA in our cohort. The numbers are however too small to draw any meaningful conclusions regarding any preventative effect of DOA monitoring on AAGA in this setting.

A middle aged patient was urgently taken back to surgery for bleeding following a valve repair. During positioning an increased blood pressure and heart rate were noted by the anaesthetist and additional anaesthetic agents administered. The anaesthetist planned to employ intentionally light maintenance levels in view of the clinical situation, so used a BIS monitor whose values were recorded as <60 during induction and throughout surgery. The patient later recalled waking up hearing a specific discussion whilst being positioned on the operating table, and being unable to communicate this. The patient's estimate of the duration was ~30 seconds. The patient was moderately psychologically distressed and concerned about possible awareness during any further general anaesthetics.

An anxious young patient required emergency CABG following a coronary catheter procedure. Anaesthesia in pre-bypass period was a hybrid technique using TCI propofol, medium-dose fentanyl, rocuronium, and 0.6% end-tidal isoflurane. The patient later reported neither pain nor the experience of being paralysed, but was aware of somebody lifting and drawing on the leg and specific conversations. The patient described a sensation of "being alive only in their head with only their brain and ears still working". This was extremely distressing and the patient was frightened and feared death. The patient suffered a psychotic episode afterwards and developed post-traumatic stress disorder.

A patient reported, after a delay of some years, AAGA during elective CABG surgery. Induction was with 5 mg alfentanil, 5mg etomidate and pancuronium. The end-tidal concentrations of (an unspecified) volatile agent were in the range 0.1 – 0.23%. There was no haemodynamic recording until 40 minutes after induction of anaesthesia. The patient remembered being unable to move, breathe or speak and feared death. The patient developed flashbacks brought on by the prospect of further cardiac surgery. The patient was distressed and described this as 'a very effective form of torture', but there was no pain nor recall of the procedure. However, the delay in reporting was to avoid "the anaesthetist getting into trouble".

Thoracic data

14.19 There were four reports of AAGA during thoracic anaesthesia. One report occurred at induction due to failure to turn on the vaporiser after inserting a double lumen tracheal tube. One was a case of inadequate reversal of neuromuscular blockade, with recall of extubation that arose in recovery. There were only two reported cases of awareness during the primary surgical procedure: one of these arose due to a failure to recommence vapour on moving to the operating room; the other arose because of a tissued intravenous cannula.

14.20 Thoracic cases made up ~0.7% of UK reported caseload during the Activity Survey (~28,000 cases). This yields a NAP5 incidence of reports of AAGA of ~1:7,000, similar to the estimated incidence for cardiac cases, and notably higher than the incidence of ~1:20,000 overall.

14.21 Specific depth of anaesthesia monitoring was used in ~24% of thoracic cases in the Activity Survey, but none was used in any of the four thoracic AAGA reports.

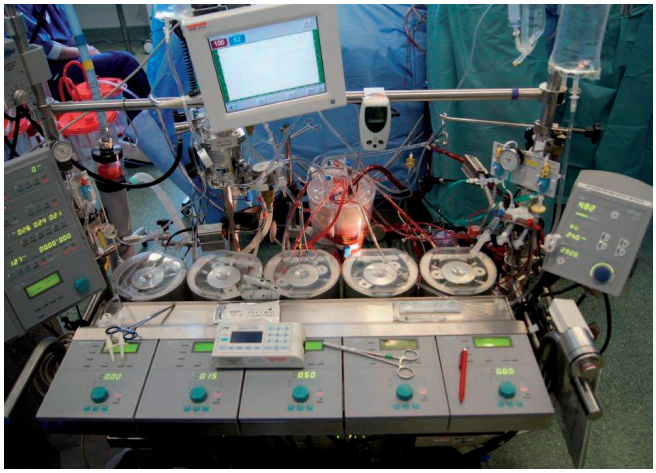
A young patient with airway obstruction underwent elective surgical rigid bronchoscopy. The intended anaesthesia was a target controlled infusion of propofol, with midazolam and fentanyl, suxamethonium and mivacurium. Surgery involved jet insufflations, rigid bronchoscopy and tube exchange. However the patient was aware and reported being curious and surprised hearing the surgeon talking to the nurse after induction. The patient signalled this by blinking the eyes, all lasting several minutes. The anaesthetist recognised a failure of the cannula.

DISCUSSION

14.22 There are too few cardiothoracic cases of AAGA reported to NAP5 to make robust recommendations. Combining the cardiac and thoracic data results in a total of eight Certain/probable or Possible reports, with a combined denominator estimated by the Activity Survey of 68,600. This yields an estimated incidence of reports of AAGA of ~1:8,600 (~0.01%).

14.23 This is very much lower than previous estimates of cases of AAGA of up to ~1:150, but those have employed repeated Brice questioning. The differences in methodology of NAP5 versus other studies using Brice have been discussed elsewhere (Chapter 5, Methods), and additional factors may be relevant for cardiothoracic anaesthesia that explain the disparity.

Cardiothoracic anaesthesia is traditionally considered a high risk specialty for AAGA and NAP5 confirmed this



14.24 Perhaps elderly cardiothoracic patients are more tolerant and less liable to mention an AAGA episode. Age-related attitudes to AAGA could be a contributory factor to the difference in incidence. Indeed, it is notable that there were no reported cases of AAGA in patients aged >50 during their primary surgical procedure.

14.25 Cardiothoracic patients are invariably warned pre-operatively that they will likely be awake in intensive care or high dependency units, with tracheal tube and invasive monitoring in place; therefore, the experience of awakening whilst the lungs are ventilated with limited ability to move, etc, is not entirely unexpected.

14.26 Another interpretation is that the NAP5 estimate of incidence reflects factors including changed anaesthetic practice with more attention to maintaining anaesthesia during periods of haemodynamic instability or bypass, etc.

14.27 Cardiothoracic anaesthesia would seem to lend itself well to research questions relating to whether EEG-based monitoring helps achieve the optimum balance between too light and too deep levels of anaesthesia.

IMPLICATIONS FOR RESEARCH

Research Implication 14.1

There is scope to combine aspects of the NAP5 methodology with previously published methods using the Brice questionnaire in cardiothoracic surgery. The incidence of AAGA needs to be ascertained, with an emphasis on the phase of anaesthesia/surgery in which the AAGA arises, and the degree to which the 'awareness' was anticipated by patients in this surgical group.

Research Implication 14.2

If in cardiothoracic surgery the incidence of AAGA found using the Brice questionnaire is as high as 1:150, and if mortality/morbidity are high, then this surgery type presents an important focus to test the hypothesis that specific depth of anaesthesia monitoring helps achieve the optimum balance between too little and too much anaesthesia.

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