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**Difficult and failed intubation in obstetric anaesthesia: An observational study of airway management and complications associated with general anaesthesia for caesarean section.**

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## **SUMMARY**

**Background:** Recent developments in anaesthesia and patient demographics have potentially changed the practice of obstetric general anaesthesia. There are few contemporary data on Australasian practice of general anaesthesia for caesarean section, especially relating to airway management, anaesthetic techniques and complications.

**Methods:** Using a standardised case record form, a prospective observational study was conducted during 2005-06 in 13 maternity hospitals dealing with approximately 49,500 deliveries per annum. Patient demographics, airway management, anaesthetic techniques and major complications were evaluated.

**Results:** Data were obtained from 1095 women receiving general anaesthesia for caesarean section. 47% of these cases were classified as category 1 and 18% as category 4. Tracheal intubation was planned in all cases with rapid sequence induction used in 97%. A Grade 3 or 4 laryngoscopic view was obtained in 3.6 and 0.6% of cases respectively, with 3.3% of women considered a difficult intubation. There were four failed intubations (0.4%, 95% CI 0.01-0.9%), of which three were subsequently managed using a laryngeal mask airway. Antacid prophylaxis was used in 94% of elective cases and 64% of emergencies. Regurgitation of gastric contents was noted in eight cases (0.7%, 95% CI 0.2-1.2%), with one confirmed case of aspiration (0.1%, 95% CI 0.002-0.5%). There were no cases of serious airway-related morbidity.

**Conclusions:** General anaesthesia is most commonly used in emergency situations. Tracheal intubation after rapid sequence induction remains the predominant approach to airway management in Australasia. The incidence of failed intubation is consistent with previous studies. Aspiration prophylaxis is not routinely performed for emergency surgery.

**Key words:** Anaesthesia, general; anaesthesia, obstetric; Airway management; Intubation, failed

## **INTRODUCTION**

As a result of a number of factors, including the likely influence of recommendations made over 20 years ago in the UK Confidential Enquiries into Maternal Deaths, there has been a widespread shift away from general anaesthesia and toward regional anaesthesia for caesarean section. In many countries general anaesthesia is now only used for a small minority of caesarean sections, predominantly those where surgery is not elective.<sup>1-3</sup> General anaesthesia for caesarean section appears to be associated with higher rates of serious and life-threatening complications than regional anaesthesia<sup>3,4</sup> and most anaesthetic-related maternal deaths are still a consequence of a complication of airway management during general anaesthesia.<sup>5-7</sup>

Nevertheless a number of indications for general anaesthesia remain and the declining use of general anaesthesia in the obstetric population has raised concern that safety standards may be compromised as a result of inadequate exposure to this technique and insufficient training in airway management for the pregnant woman.<sup>8</sup> Furthermore, the demographic of the obstetric population is changing in many countries, with the average age and weight of women giving birth rising and the medical complexity of cases increasing.<sup>9</sup>

The major concerns for the obstetric anaesthetist in providing general anaesthesia for caesarean section relates to potential difficulty with airway management, as well as a potentially higher risk of awareness and concerns about the possible effects of anaesthetic agents on uterine tone and the newborn. This observational study represents the first detailed evaluation of Australasian practice for general anaesthesia for caesarean section in many years and a comprehensive evaluation of associated airway complications. In addition to obtaining contemporary perioperative anaesthetic data, the sample size is sufficient to allow reasonable estimates of the incidence of difficult and failed intubation, aspiration of gastric contents and airway complications such as laryngospasm and bronchospasm in an obstetric population.

## **METHODS**

Between June 2005 and January 2007, with the assistance of the Australian and New Zealand College of Anaesthetists (ANZCA) Trials Group, 13 participating hospitals across Australia and New Zealand prospectively gathered data about patients undergoing general anaesthesia for caesarean section. Each local centre had a designated site investigator responsible for obtaining local institutional ethical approval, for maximising capture of cases and for collating data collection using a standardised data collection form. Ethical approval was received from all sites to perform the data collection with two sites requiring individual

patient consent. Data collection was commenced intraoperatively by the procedural anaesthetist and was then completed postoperatively by the research team. Women were considered eligible if they were aged 18 years and over and underwent CS under general anaesthesia.

Demographic data included patient age, weight, American Society of Anesthesiologists (ASA) physical status; the presence or absence of labour, a variety of potential risk factors and co-morbidities and the indication for general anaesthesia. The urgency of the caesarean section was classified using the model adopted by the Royal Australian and New Zealand College of Obstetricians and Gynaecologists. A Category 1 caesarean section was defined as one where there was an immediate threat to the life of the mother or fetus, whereas a Category 4 case was an elective procedure.<sup>10</sup> A number of areas of practice were evaluated, including the airway management and difficulty experienced; use of aspiration prophylaxis; operator experience; planned induction technique; laryngoscopic view (Grade 1-4 based on Cormack and Lehane<sup>11</sup>); anaesthetic pharmacology; surgical delivery parameters and postoperative pain management and care plan. Data on critical incidents such as regurgitation, aspiration, bronchospasm, laryngospasm and severe hypoxaemia were recorded.

The definition of a difficult intubation was immediate abandonment of the initial attempt at intubation; more than one attempt at intubation; or classification based on the subjective opinion of the anaesthetist. A failed intubation was defined as the inability to intubate the trachea and the subsequent abandonment of intubation as a means of airway management. Aspiration was classified as possible or confirmed, the latter being defined by typical signs and symptoms, with or without bronchoscopic or x-ray findings and with the exclusion of alternative diagnoses. Severe hypoxaemia was defined as a pulse oximetry recording of less than 85% at any time.

Anonymised data were sent to a central registry for database entry and analysis after study completion. Data were entered into a Microsoft Access 2003 database and subsequently transferred to STATA (Statacorp 2005) for analysis. The comparison of continuous variables was performed using the independent t-test or Wilcoxon rank sum test, as appropriate for parametric and non-parametric data. Discrete variables were analysed using chi squared or Fishers exact test. A p value of less than 0.05 was considered statistically significant. Odds ratio (OR) and 95% confidence intervals (CI) are quoted when required. After closure of the database and analysis, further detail was sought from the local investigator about cases of specific interest, for example the failed intubations.

## RESULTS

A total of 1095 cases were entered into the study during the 18-month study period. The majority of cases (85%) were from seven large tertiary centres each performing between 4000 and 7000 deliveries per year. The remaining 15% were spread across six smaller regional centres (Appendix). The mean age was 30 years (range 18-51) and the median weight was 76 kg (range 34-170). Ninety percent of patients were ASA status 1 or 2, 96 patients (9%) were ASA 3, 10 (1%) were ASA 4 and 1 patient (0.1%) was ASA 5.

Of the 1095 caesarean sections, 47% were classified as category 1, 18% as category 4 and the remaining 35% as category 2 or 3. The most common indications (multiple options possible at the anaesthetist's discretion) for general anaesthesia were immediate delivery of the fetus; obstetrician request; failed regional block, and patient request (Table 1).

Tracheal intubation was the planned airway management method for all patients. A rapid sequence induction using cricoid pressure and suxamethonium was used in 97% of cases, with 22 of 1092 (2%) having a modified rapid sequence induction using rocuronium; 2 (0.2%) a gaseous induction and 1 (0.1%) an elective awake fiberoptic intubation.

Laryngoscopic views are shown in Table 2. Intubation was performed by a consultant anaesthetist in 23% of 1066 cases, an advanced trainee (greater than two years of formal Australasian training) in 49% and a basic trainee (within their first two years of Australasian training) in 23%. The median (IQR) times from induction to intubation; induction to delivery; uterine incision to delivery; induction to completion of surgery end; and induction to extubation were 45 s (30-60); 5 min (3-10); 60 s(30-90); 40 min (34-50); and 49 min (40-60) respectively.

There were 61 women (6%) in whom intubation was predicted as likely to be difficult and 3 (0.3%) in whom it was known that intubation was difficult. One hundred and seventy eight patients (17%) were assessed as obese by the procedural anaesthetist (definition at their discretion). Intubation was classified as difficult in 36 of 1095 patients (1 in 30) (3.3%, CI 2.3-4.5%) and failed intubation occurred in 4 patients (1 in 274) (0.4%, CI 0.01-0.9%). Of the 36 difficult intubations, the laryngoscopic view was grade 3 in 39% and grade 4 in 14% (Table 2). The likelihood of encountering a difficult intubation was not related to the age ( $p = 0.09$ ), weight ( $p = 0.59$ ), urgency ( $p = 0.85$ ) or ASA status ( $p = 0.31$ ) but was predicted by the experience of the anaesthetist, with a specialist anaesthetist being more likely to be involved with a difficult intubation (OR 2.6, CI 1.3-5.3,  $p = 0.009$ ). Two of the cases of failed

intubation had a grade 3 and two a grade 4 view. Two of the failed intubations had been classed as a “predicted difficult intubation”.

The women who proved difficult to intubate had a weight range of 50 to 140 kg (median 80 kg) while those in whom intubation failed ranged from 50 to 73 kg (median 57 kg). Overall, 14% of women included in the study weighed 100 kg or more compared with 25% of those who were a difficult intubation. Using logistic regression analysis a weight of 100 kg or more was not an independent predictor of a difficult intubation (OR 1.74, CI 0.796-3.78,  $p = 0.166$ ).

The laryngeal mask airway was used in all 4 failed intubations. One failed intubation occurred at an elective caesarean section and in this case the intubating laryngeal mask (ILMA™) enabled effective ventilation, although the patient was not able to be intubated through the ILMA device and was woken up. A regional anaesthetic was subsequently performed. The other 3 failed intubations all arose in Category 1 caesarean sections. In each case the surgery was allowed to proceed by an advanced trainee after successful insertion and airway control with a ProSeal™ laryngeal mask ( $n = 2$ ) or a Classic™ laryngeal mask ( $n = 1$ ).

Regurgitation of gastric contents was seen in 8 of 1095 patients (0.7%, CI 0.2-1.2%) with four episodes occurring at induction of anaesthesia and five at extubation (one at both intubation and extubation). Two cases of regurgitation were at elective caesarean section. There were four possible cases and one (0.1%, CI 0.002-0.5%) confirmed case of pulmonary aspiration. Severe hypoxaemia occurred in 24 patients (2%, CI 1.4-3.2%); bronchospasm in 13 (1%, CI 0.6-2.0%) and laryngospasm in three (0.3%, CI 0.06-0.8%).

The use of medications for the prophylaxis against aspiration varied depending on the urgency of the caesarean section (Figure 1). Of the Category 1 cases, 64% received some form of pharmacological prophylaxis, while 94% of elective cases received prophylaxis, most commonly sodium citrate, ranitidine or both.

## **DISCUSSION**

This survey provides information on the demographic of the Australasian obstetric population as well as contemporary perioperative anaesthetic data, particularly in relation to airway management. The incidence of failed intubation (1 in 274, 0.36%) is comparable to the two most recent reports from the United Kingdom<sup>12, 13</sup> and from the USA.<sup>14</sup> We found consensus regarding airway management in these patients, with rapid sequence induction of anaesthesia including cricoid pressure and tracheal intubation being planned in almost all patients.

Previous studies have demonstrated a relationship between the incidence of failed intubation

and the urgency of the case, the time of day it is performed and the experience of the anaesthetist, with up to 80% of failed intubations in the hands of junior trainees.<sup>12, 13, 15</sup> Of the four failed intubations in this series, three occurred in the hands of trainees. We found a difficult intubation was more likely reported at caesarean sections attended by a specialist anaesthetist. We assume that this may have been because of planned involvement with patients with a predicted difficult airway or because they were called to help with difficult cases.

When considering the limitations of the data obtained in this study it should be noted that the demographic data on the incidence of general anaesthesia for caesarean section between units were absent or limited. This study was spread across 13 units in Australia and New Zealand with the majority (85%) of cases coming from centres with a large obstetric workload. It is possible variations in patient complexity and obstetric anaesthesia experience across centres were relevant to outcomes. The study could have been enhanced by including information on the preoperative airway assessment, as well as including information on the number of attempts at intubation, the supervision status of the trainees, the trainee experience with obstetric general anaesthesia and the time of day that the anaesthetic was administered.

The most common indication for delivery under GA was the perceived need to deliver the fetus immediately and frequently the obstetrician applied pressure for general anaesthesia to be used. Observational evidence indicates that converting epidural analgesia to anaesthesia allows expedient delivery almost within the same time as administering general anaesthesia,<sup>16</sup> so it should be left to the anaesthetist, on a case-by-case basis, to choose the safest and most expedient anaesthetic technique. This stance can be further supported when local audit and clinical governance provides evidence of rapid and safe anaesthetic service provision.

A conventional rapid sequence induction using suxamethonium was the most commonly used technique to induce anaesthesia in this study, with a modified approach using rocuronium employed in only 2% of patients. This most likely reflects the lack of a suitable alternative to suxamethonium in the Australasian market, but the impending introduction of sugammadex, which appears to be able to rapidly reverse the neuromuscular blockade of rocuronium,<sup>17</sup> has the potential to change practice in this respect.

The incidence of difficult intubation in this study was 1 in 30 (3.3%) which is similar to previous studies in obstetric patients.<sup>11, 14, 18-21</sup> Most obstetric airway studies have focused on failed intubation as the primary outcome measure and only a limited number of studies, often with a small sample size, have reported a difficult intubation rate. Comparing studies is also problematic because the outcome definition has varied – for example, a number of airway

studies used a Grade 3 or 4 laryngoscopic view as the criterion for difficult intubation. Our results indicate that not all anaesthetists consider intubation difficult with a Grade 3 view, but that others, despite having a Grade 1 or 2 view, describe intubation as difficult. The latter may be a result of reporting the best laryngoscopic view from multiple attempts, with the likelihood that a more senior anaesthetist was called to attend and obtained an improved view compared with the original. Again, it would have been interesting to know the number of attempts required to achieve the reported view.

The laryngeal mask airway proved useful in all four failed intubations in this study, enabling surgery to proceed in the three urgent cases. This airway device is popular in anaesthesia for a wide variety of procedures but our findings confirm that it is still rarely used in obstetric anaesthesia, despite emerging evidence of potential safety.<sup>22,23</sup> It is possible that our survey findings reflect selection bias, auditing a relatively small number of elective cases and being restricted to 13 centres. We are aware that there is some use of the laryngeal mask for elective airway management of well-selected patients undergoing general anaesthesia for caesarean section in Australasia.

Obesity has been previously reported as a risk factor for difficult intubation in both the obstetric and non-obstetric settings<sup>21</sup> and requires the expenditure of more time and resources prior to induction, including to ensure that the patient is optimally positioned for intubation. We were unable to find a statistically significant relationship between the weight of the patient and the likelihood of encountering a difficult intubation. This is likely to be due to the small sample size in the difficult intubation group and also a limitation of the data in that only weight was recorded and not body mass index (BMI). As part of our overall management of the obese parturient in our centre we encourage the early placement of an epidural catheter during labour because this allows for a rapid and safe method of anaesthesia in the event of an emergency caesarean section being required.

Pregnant women are considered at higher risk of aspiration while undergoing general anaesthesia, because of the physiological changes that occur in the gastro-intestinal tract, particularly when non-elective caesarean section is required.<sup>24</sup> We found only one confirmed case of aspiration in this study, and other reports also indicate that this is a rare event.<sup>25</sup> Nevertheless, episodes of regurgitation occurred in eight patients, with five at extubation. This reinforces the need for safe emergence from anaesthesia, as well as induction of anaesthesia.

A number of previous surveys have looked at individual and departmental practices in regards to aspiration prophylaxis.<sup>26-32</sup> Aspiration prophylaxis for caesarean section is



commonly recommended and the combination of sodium citrate, ranitidine and metoclopramide has been suggested.<sup>24</sup> Results from a New Zealand postal survey in 1998 show that 95% of departments would recommend sodium citrate prior to emergency obstetric surgery, with 72% also including a histamine type-2 receptor antagonist.<sup>30</sup> This approach is consistent with reports from the UK between 1984 and 1993.<sup>26, 27, 29</sup>

We found high use of ranitidine and sodium citrate in the elective situation but only 64% of the Category 1 caesarean section patients (arguably at highest risk of aspiration) received some form of prophylaxis. Possible explanations include the considerable time pressure of these cases, inadequate training and familiarity with general anaesthesia for caesarean section and the recognition that aspiration is a rare event. Analysis of the results from individual centres showed little variation in practice across the centres in both the elective and acute situations, highlighting that the problem is not confined to centres performing relatively smaller numbers of caesarean sections. We feel that the utilisation of aspiration prophylaxis for emergency cases should be much higher than 64%, given that sodium citrate is a simple and quick intervention pre-induction and that intravenous ranitidine and metoclopramide can be administered either pre- or post-induction. Currently in Australasia there are no guidelines as to a minimum standard of care, so individual departments establish and audit their own local standard.

In conclusion, this study demonstrates that emergency situations remain the most common indication for general anaesthesia for caesarean section. Traditional rapid sequence induction of anaesthesia is the predominant approach to airway management in the Australasian obstetric population. The incidence of difficult and failed intubation is similar to that reported from other countries and from previous decades. The laryngeal mask airway proved valuable in all four failed intubations encountered, but was not chosen for elective airway management. There was only one confirmed episode of aspiration, but the use of pharmacological prophylaxis against aspiration was substantially lower among emergency cases than elective cases.

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## Appendix

### Demographics of participating hospitals

| Hospital                                        | Deliveries in 2006 (n) | Caesarean section rate (%) | Cases (n) |
|-------------------------------------------------|------------------------|----------------------------|-----------|
| Royal Melbourne Hospital (Melbourne, Australia) | 5967                   | 30.3                       | 219       |
| Middlemore (Auckland, NZ)                       | 6000                   | 22.4                       | 170       |
| King Edward Memorial (Perth, Australia)         | 5512                   | 29.7                       | 169       |
| National Women's (Auckland, NZ)                 | 7212                   | 33.1                       | 156       |
| Wellington (Wellington, NZ)                     | 4051                   | 32.9                       | 87        |
| Women's and Children's (Adelaide, Australia)    | 4475                   | 30.5                       | 85        |
| Royal Prince Alfred (Sydney, Australia)         | 4926                   | 28.5                       | 50        |
| Rockhampton (Rockhampton, Australia)            | 1204                   | 24.3                       | 36        |
| Nambour (Nambour, Australia)                    | 2120                   | 22.5                       | 35        |
| Gold Coast (Southport, Australia)               | 2893                   | 29.6                       | 30        |
| Toowoomba (Toowoomba, Australia)                | 1700                   | 23.6                       | 22        |
| Frankston (Frankston, Australia)                | 2043                   | 29.9                       | 20        |
| The Northern (Epping, Australia)                | 1710                   | 27.0                       | 16        |

Table 1 Indication for general anaesthesia

| n=1095                                          | N   | %   |
|-------------------------------------------------|-----|-----|
| Immediate delivery mandated                     | 471 | 43  |
| Obstetrician request                            | 321 | 29  |
| Failed regional block                           | 272 | 25  |
| Maternal request                                | 260 | 24  |
| Actual or potential<br>haemodynamic disturbance | 231 | 21  |
| Coagulopathy / bleeding risk                    | 58  | 5.3 |
| Sepsis                                          | 44  | 4.0 |
| Other                                           | 169 | 15  |

Table 2 Cormack and Lehane laryngoscopic view obtained (n=1086)

| View    |           | Difficult intubation<br>n=36 | Failed intubation<br>n=4 |
|---------|-----------|------------------------------|--------------------------|
| Grade 1 | 882 (81%) | 6 (17%)                      | 0 (0%)                   |
| Grade 2 | 159 (15%) | 11 (31%)                     | 0 (0%)                   |
| Grade 3 | 39 (3.6%) | 14 (39%)                     | 2 (50%)                  |
| Grade 4 | 6 (0.6%)  | 5 (14%)                      | 2 (50%)                  |

Values are n (%)

Figure 1 Aspiration prophylaxis by caesarean section category

