British Journal of Anaesthesia **110** (1): 74–80 (2013)
Advance Access publication 17 September 2012 · doi:10.1093/bja/aes320

BJA

OBSTETRICS

Failed tracheal intubation in obstetric anaesthesia: 2 yr national case–control study in the UK

A. C. Quinn[1]*, D. Milne[2], M. Columb[3], H. Gorton[1] and M. Knight[4]

[1] The General Infirmary at Leeds, Great George Street, Leeds LS13EX, UK
[2] Pinderfields General Hospital, Aberford Road, Wakefield WF1 4DG, UK
[3] Department of Anaesthesia and Intensive Care Medicine, University Hospital of South Manchester, Wythenshawe, Manchester M23 9LT, UK
[4] National Perinatal Epidemiology Unit (NPEU), University of Oxford, Old Road Campus, Oxford OX3 7LF, UK

* Corresponding author. E-mail: a.c.quinn@leeds.ac.uk

Editor's key points

- This survey confirms the expected incidence of failed tracheal intubation in obstetrics at one in 224.
- The incidence of failed intubations did not decrease in the last 20 yr, despite advances in airway techniques.
- Age, BMI, and a recorded Mallampati score were significant independent predictors of failed tracheal intubation.

Background. There are few national figures on the incidence of failed tracheal intubation during general anaesthesia in obstetrics. Recent small studies have quoted a rate of one in 250 general anaesthetics (GAs). The aim of this UK national study was to estimate this rate and identify factors that may be predictors.

Methods. Using the UK Obstetric Surveillance System (UKOSS) of data collection, a survey was conducted between April 2008 and March 2010. Incidence and associated risk factors were recorded in consultant-led UK delivery suites. Units reported the details of any failed intubation (index case) and the two preceding GA cases (controls). Predictors were evaluated using multivariable logistic regression, significance $P<0.05$ (two-sided).

Results. We received 57 completed reports (100% response). The incidence using a unit-based estimation approach was one in 224 (95% confidence interval 179–281). Univariate analyses showed the index cases to be significantly older, heavier, with higher BMI, with Mallampati score recorded and score >1. Multivariate analyses showed that age, BMI, and a recorded Mallampati score were significant independent predictors of failed tracheal intubation. The classical laryngeal mask airway was the most commonly used rescue airway (39/57 cases). There was one emergency surgical airway but no deaths or hypoxic brain injuries. Gastric aspiration occurred in four (8%) index cases. Index cases were more likely to have maternal morbidities ($P=0.026$) and many babies in both groups were admitted to the neonatal intensive care unit: 21 (37%) *vs* 29 (27%) (NS). Three babies died—all in the control group.

Keywords: airway complications; failed tracheal intubation; anaesthesia obstetrics; incidence; laryngeal masks; UK Obstetric Surveillance System, UKOSS

Accepted for publication: 18 July 2012

The incidence of failed intubation among the pregnant population is estimated to be up to eight times that of the non-pregnant population. In previous studies, this has varied between one per 238 and one per 750 general anaesthetics (GAs)[1–5] with 1:250 being most widely quoted ratio. Reports from the Confidential Enquiries into Maternal Deaths have shown a decrease in the number of anaesthetic-related deaths over recent years.[6] In 1967–9, there were 35 deaths directly attributed to anaesthesia; the last three reports had six to seven cases, and in each report, two of these were associated with difficult tracheal intubation. It can be difficult to predict difficult intubation in the obstetric population[7] and management of the failed obstetric airway is often extremely problematic with two lives at stake. Previous work in this area has largely relied on longitudinal retrospective data from one region or over long periods of time, for example, 20 yr and in smaller groups of patients.[1–5] The Royal College of Anaesthetists' Fourth National Anaesthesia Project (NAP4) audit of serious airway events occurring in the UK in 2008–9[8] reported four obstetric cases with major complications in airway management.

There are as yet no UK national data on the incidence of failed tracheal intubation in obstetrics. The aims of this study were to use the UK Obstetric Surveillance System (UKOSS)[9] to calculate the national incidence of failed intubation in obstetric GA, to quantify the risk factors for failed intubation, and to describe how failed intubation is currently managed in the UK.

Methods

After ethics committee approval by the London research ethics committee in 2007 reference 08/H0781/1, the UKOSS collected data on cases and controls for all consultant-led UK delivery suites between April 2008 and March 2010. We recorded the potential risk factors; age, BMI, gestation, parity, multiple pregnancy, maternal disease, smoking status, ethnic group, time of day, history of anaesthetic difficulties, grade of anaesthetist, grade of laryngoscopic view, drug dosing, urgency of case, and preoperative airway assessment, including Mallampati score,[10] inter-incisor gap, sternomental, thyromental distances, and cervical spine abnormality.

A case of failed intubation was defined as failure to achieve tracheal intubation during a rapid sequence induction for obstetric anaesthesia, thereby initiating a failed intubation drill. This implied either that the neuromuscular blocking agent effect had worn off or that the patient's oxygen saturations had decreased to the point that manual ventilation by the mask or other airway devices had become necessary. Cases included any GA administered to a parturient of over 20 weeks gestation (whether on delivery suite or another hospital department). The cases of failed intubation were identified through the monthly mailing of the UKOSS; the data collection methods have been described in detail elsewhere.[9] The controls were obtained from the same hospitals as the cases. We requested information on the two pregnant women to whom GA was administered before the case of failed intubation, and in which intubation was successful. The same data were collected from both the cases and the controls, with the exception of the management of the failed intubation.

Statistical analysis

Data are presented as mean (SD), median (inter-quartiles), or count as appropriate. For each unit, a denominator representing the number of obstetric GA cases in a 2 yr period was estimated using the time intervals between controls and index cases using the formula: denominator=$2(365a/1.5b)$, where a is the number of cases in the interval and b the interval in days. Continuous data were examined for Gaussian distributions using normal probability plots and the D'Agostino omnibus test. Incidence rates that were positively skewed underwent $\log_e$ transformation. Unit-specific approaches were used to estimate incidence rates with 95% confidence intervals (CIs), estimated using the exact Clopper–Pearson method and from back-transformed $\log_e$ data, respectively.

The Fisher exact test was used to compare categorical variables. Univariable conditional logistic regression was used to compare matched cases and controls with respect to predictor variables. Variables which were significantly associated on univariate analysis were included in a full stratified multivariate model to identify significant independent predictors of failed intubation. Significance was defined at $P<0.05$ (two-sided). Data were analysed using Excel 2010 (Microsoft Inc., Redmond, VA, USA) Number Cruncher Statistical Systems 2007 (NCSS Inc., Kaysville, UT, USA) and LogXact 8 (Cytel Inc., Cambridge, MA, USA).

Results

Incidence

Seventy-nine cases of failed intubation were reported to UKOSS, but data were not received for 10 of these (13%). Of the 69 remaining cases, all returned completed forms. Eight were notified as not meeting the case definition and four were duplicates. We therefore identified 57 cases fitting the entry criteria. There were 107 matched controls as described above. The overall estimated denominator number of GAs was 6400 per year, giving an estimated incidence of failed intubation using a unit-based estimation approach of one in 224 GAs (95% CI 179–281). Reasons for GA were: fetal distress (83), failed instrumentation or inadequate regional (29), previous Caesarean section(s) (24), antepartum haemorrhage, or abnormal placenta (17), and a small number in a miscellaneous group, for example, maternal request and other pre-eclampsia reasons.

Risk factors

Univariate stratified logistic regression analysis of risk factors revealed some significant differences (Table 1): cases were older, heavier, had higher BMI, had a Mallampati score recorded on the anaesthetic chart, and a score >1. However in 40% and 65% of cases and controls, respectively, there was no Mallampati score recorded and the recording of a Mallampati score itself was significantly associated with failed intubation. There were no significant effects of ethnicity, gestation, parity, multiple births, previous GA, or airway problems with previously difficult airway or smoking status. There was no difference in the groups with regard to urgency of GA (60% *vs* 65% case *vs* control for urgent (category 1) GA.[14] Table 1 shows the BMI and differences between cases and controls. Multivariate stratified logistic regression analysis showed that age, BMI, and recording of Mallampati score remained independently significant as predictors (Table 2).

Timing and staffing

Cases most commonly occurred out of hours in both groups (between 18:00 and 00:00 h), and there was usually more than one anaesthetist involved (consultant as first anaesthetist 40% of the time in both case and control groups). An anaesthetic registrar with >2 yr experiences was usually first at the scene with senior support at a later stage in all cases. Only a small number of first or second year trainees were involved with a failed intubation. Using stratified logistic regression for the most senior anaesthetist present at induction, the odds ratio (95% CI) for the risk of failed intubation was significantly greater at 2.42 (1.06–5.52, $P=0.036$) for junior trainee compared with when a consultant was present.

Table 1 Univariable predictors for failed tracheal intubation. Data are presented as mean (SD) and count as appropriate. Effect sizes are presented as odds ratios with 95% CIs. *P*-values are estimated using matched logistic regression with categories pooled for presentation

Variable	Cases (n=57)	Controls (n=106)	Odds ratio (95% CI)	*P*-value
Age (yr)	32.8 (6.2)	30.1 (6.7)	1.07 (1.02–1.14)	0.01
Gestation (weeks)	38.4 (2.4)	38.2 (3.7)	1.02 (0.90–1.17)	0.71
Height (cm)	163.1 (7.2)	162.6 (6.0)	1.04 (0.97–1.12)	0.30
Weight (kg)	79.3 (21.0)	71.3 (16.9)	1.02 (1.01–1.04)	0.013
BMI (kg m^{-2})	29.9 (7.6)	27.1 (6.4)	1.06 (1.01–1.12)	0.02
Ethnicity (Asian/Black/Mixed/White)	8/8/1/38	13/11/4/74	Not presented	0.60
Smoking (never/smoked during pregnancy)	40/15	69/31	2.34 (0.18–31.3)	0.64
Previous pregnancies ≥24 weeks (0/1 or more)	32/25	44/61	1.27 (0.94–1.72)	0.11
Previous pregnancy problems (yes/no)	9/48	20/85	0.76 (0.27–2.14)	0.60
Previous GA for CS (no/yes)	49/8	95/10	1.26 (0.53–2.97)	0.38
Previous medical problems (yes/no)	21/36	24/81	2.02 (0.93–4.54)	0.08
Mallampati recorded (yes/no)	34/23	40/65	2.70 (1.19–6.56)	0.014
Mallampati score (1/>1)	3/31	17/23	7.64 (2.00–29.2)	<0.0001
In labour (yes/no)	40/17	75/30	0.84 (0.34–2.07)	0.70
Urgency grade (1/>1)	29/27	60/42	1.12 (0.74–1.71)	0.59

Table 2 Independent predictors of failed tracheal intubation. Effect sizes are presented as odds ratios with 95% CIs. *P*-values are estimated using multivariate matched logistic regression

Variable	Odds ratio (95% CI)	*P*-value
Age (yr)	1.07 (1.01–1.14)	0.029
Body mass index (kg m^{-2})	1.06 (1.00–1.13)	0.035
Mallampati score recorded	3.06 (1.18–7.88)	0.021

Table 3 Rescue procedures for failed tracheal intubation

Rescue	Number of cases (n=57)
Classical LMA	39
Intubating LMA	4
PROSEAL	3
IGEL	3
Bag and mask	2
Smaller tracheal tube	1
Re-intubation attempt	3
Second-dose succinylcholine and TT	1
Tracheostomy	1
Patients woken up	4
Sedation+LA	1 (urgency grade1)
Intrathecal block	3 (urgency grade 1, 2, 4)

Airway management

Table 3 shows the airway 'rescue' techniques and alternative anaesthesia techniques used after failed intubation. The classical LMA^{TM} (cLMA) was the rescue technique in 39 of the 57 cases. A small number of second generation devices were used; four intubating LMAs, three proseals^{TM}, and three iGels^{TM}. Four patients were woken up (despite two patients of urgency grade 1) and three of these had subsequent intrathecal anaesthesia. Eight anaesthetists continued GA with a cLMA instead of waking the patient up, even though they were non-urgent (urgency grade 3 or 4). No case used a fibrescope to aid intubation of the trachea. One emergency tracheostomy was performed in a woman with a stable airway using a cLMA^{TM} who required prolonged ventilation in the intensive care unit (ICU). Only 122 of the 164 patients were reported to have received an antacid, but a higher rate of prophylaxis occurred in the failed intubation group (46 out of 57). Twenty-seven out of 46 were given sodium citrate and 34 out of 46 were given an H_2 blocker.

Morbidity and mortality

Table 4 shows the rates of hypoxaemia and aspiration. Failed intubation was associated with a significantly higher incidence (71% *vs* 2%, $P<0.0001$) of hypoxaemia (Sp_{O_2} <90%) and the lowest recorded Sp_{O_2} was 40% in the cases and 84% in controls. We also found a suggestion of a higher aspiration rate (8% *vs* 1%, $P=0.051$). There were no maternal deaths but significantly more maternal co-morbidities in the case group (14% *vs* 4%, $P=0.026$) for reasons usually independent of the failed intubation, for example, pre-existing medical problems. No case was admitted to ICU purely for airway management. Similar percentages from both groups were admitted to ICU (12% *vs* 14%). This reflects the fact that GA is most commonly used in the emergency situation, for example, massive haemorrhage and fetal distress. Although three babies in the control group died from prematurity, more babies of women with failed intubation were admitted to neonatal ICU (NICU), case *vs* control (37% *vs* 27%) (Table 5).

Table 4 Hypoxia aspiration and antacid prophylaxis. Data are presented as value or count (%). Fisher's exact test was used to estimate *P*-values

	Case (n=57)	Control (n=106)	Odds ratio (95% CI)	*P*-value
Sp_{O_2} < 90%	36 (71%)	2 (2%)	89.1 (19.9–399)	<0.0001
Lowest Sp_{O_2} (%)	40	84		
Gastric aspiration	4 (8%)	1 (1%)	7.93 (0.86–72.2)	0.051
Antacid given	46 (81%)	76 (72%)	1.65 (0.76–3.61)	0.25

Table 5 Maternal and neonatal morbidity and mortality

	Case (n=57)	Control (n=106)	Odds ratio (95% CI)	*P*-value
Maternal morbidity	8 (14%)	4 (4%)	4.16 (1.20–14.5)	0.026
Maternal ICU	7 (12%)	15 (14%)	0.85 (0.32–2.22)	0.81
Neonatal ICU	21 (37%)	29 (27%)	1.55 (0.78–3.08)	0.22
Neonatal deaths	0 (0%)	3 (3%)	0.26 (0.013–5.07)	0.55

Discussion

This prospective survey has revealed the rate of failed tracheal intubation after obstetric GA in the UK as one in 224. In the 2 yr of the study, there were ~720 000 deliveries, each year giving an approximate failed tracheal intubation rate of one per 25 000 deliveries. The rate per GA is dependent on the accurate estimate of national GA rates for the denominator and this was difficult to determine. As was reported in NAP4,[11] there are few robust national statistics on the GA rates in the general population and the obstetric population is no exception.

Conclusions

At the outset of this study, we planned to use the National Obstetric Anaesthesia Database, NOAD,[12] of the Obstetric Anaesthetists' Association to provide the denominator for the UKOSS numerator, but the response rate in reporting GA section rates for this period was only 53% of NHS maternity hospitals. The incidence of failed intubation from the NOAD data was then calculated at 1:604 (using an extrapolated rate for all UK units as 8600 GA per year). We felt that this was an overestimate. The UKOSS numerator was estimated from any obstetric GA (not just Caesarean section as in NOAD) given to a parturient over 20 weeks gestation. We calculated the denominator using a unit-based estimation approach from the time interval between the case and controls which we extrapolated to give the annual rate. By this method, we calculated the UK annual obstetric GA denominator rate at nearer 6400 per year. After consideration of these issues, we considered the rate of one in 224 appears to be a more reliable estimate for failed tracheal intubation in UK obstetric anaesthetic practice.

Older age, increasing BMI, and the recording of a Mallampati score in the anaesthetic chart were found to be independent predictors for failed tracheal intubation. The significance of older age in the index cases is unclear. We can speculate that older age at pregnancy is associated with more co-morbidity including obesity and pregnancy complications. Increasing UK obesity rates have been repeatedly reported in the literature, particularly in the obstetric population[13] where nearly one in every 1000 women giving birth in the UK was shown to be extremely obese (BMI 50 or higher). The risk with BMI also echoes the findings from the recent Confidential Enquiry into Maternal Deaths[6] and the finding in the NAP4 chapter on obstetrics and obesity.[14] Extremely obese women have more complications including preeclampsia, gestational diabetes, preterm delivery, GA, and ICU admission and this group has a 50% Caesarean section rate (as opposed to 22%). This is the first prospective national report linking obesity with failed tracheal intubation in obstetrics. In fact, we found that for every 1 kg m^{-2} increase in BMI, there was a 7% increase in the risk of failed intubation.

Airway management

Although the Mallampati score itself when recorded was significant on matched univariate testing, it was not practical to enter it into the multivariate analysis due to the poor compliance in recording this. The failure to assess the obstetric airway properly is a major finding and may reflect poor care or the fact that it is considered to be poorly predictive.[15] It is interesting that the fact of just recording a score is significant. This suggests that it may only be recorded when the anaesthetist has already a suspicion that the particular patient is at higher risk of failed tracheal intubation or that it is recorded after the event and rated higher perhaps. The other methods of airway assessment were poorly charted and non-predictive in this population. We should routinely assess and chart all airways before an obstetric GA.

No case was admitted to the ICU purely for airway management reflecting the complex nature of these patients with multiple problems; mothers in the case group had significantly more co-morbidities than controls. However, it is surprising that a similar percentage from both groups were admitted to ICU (12% *vs* 14% case *vs* control), perhaps reflecting that an obstetric GA is given because it is the preferred technique for sicker mothers and where delivery is urgent. A large percentage of the babies in both groups were admitted to the NICU: 21 (37%) *vs* 29 (27%) cases *vs* controls and three babies died in the control cases. This could reflect the fact that a GA is the anaesthetic of choice for severe fetal distress and emergency delivery. What is noteworthy is the degree of hypoxia reported in the failed intubation group (as low as 40%). This would have detrimental effects on any fetus in distress and so failed tracheal intubation is a concern for all team members including obstetric and neonatal specialists. Team drill on failed tracheal intubation is important to undertake with all team members on delivery suite.

The reasons for the higher incidence of failed intubation in the obstetric population are multiple. Physiological changes in pregnancy may result in airway oedema, weight gain, and gastric aspiration. Additionally, reduced functional residual capacity, effects of position,[16] and an increased metabolic rate in pregnancy lead to a rapid progression to hypoxia after induction and apnoea. This adds pressure on the anaesthetist to intubate the trachea more rapidly and to give up quicker resulting in a failed intubation before desaturation or aspiration occurs. These issues are compounded by the reduced number of obstetric surgical procedures now performed under GA and the impact of the European Working Time Directive,[17] so that training opportunities for junior anaesthetists are becoming more rare[18] [19] and frequently required 'out of hours' when the trainee anaesthetist is likely to be working without consultant supervision. We saw a 2.5-fold increase failed intubation risk for trainee *vs* consultant anaesthetist present at induction. This could be partly explained by the fact that more cases occurred 'out of hours'. Conversely, a small number of first- or second-year trainees were involved with a failed intubation: this may reflect the fact that they are trained during the day with consultants before they are put onto the on-call obstetric anaesthetic rota.

Failure to intubate should lead to the 'failed intubation drill' whereby alternative means of oxygenating and ventilating the patient are pursued. It has been recommended that trainee anaesthetists on delivery suites practice this drill and regular team training including simulator training should be undertaken on delivery suites according to available guidelines and algorithms.[20–23] The Difficult Airway Society (DAS) and Obstetric Anaesthetists' Association (OAA) are currently working on an algorithm for the difficult obstetric airway patient.

This survey has demonstrated that supraglottic airway devices are commonly used. Obstetric anaesthetists should be familiar with a wide range of devices and regularly practice their use in obstetric airway drills including conversion to a tracheal tube using a fibreoptic technique.

Eight of the failed intubation cases continued their operations with anaesthesia delivered by a supraglottic device and were not woken up, even though their deliveries were classified as urgency grades 3 or 4. The major proportion of these had anaesthesia maintained using a cLMA (and so the parturient would be at risk of regurgitation). It is noteworthy that the clinicians chose to continue and not awaken the patients as per conventional teaching and as comprehensive airway management details of these cases are not available, we can only speculate that the anaesthetist considered the airway technique satisfactory enough to continue with surgery.

A study from Jordan[24] reported the use of a supraglottic airway in 3000 elective Caesarean sections (proseal airways). The authors recommended careful patient selection, and antacid prophylaxis and choice of a suitable second-generation supraglottic airway designed for intermittent positive pressure ventilation and gastric suction if required. Obstetric anaesthetists should be familiar with a broad range of these devices, particularly those that provide protection against aspiration and aid insertion of a definitive airway required for prolonged ventilation, that is, the i-gel™, ProSeal LMA™, Supreme LMA™, and the intubating LMA (ILMA™). There were no reports of the use of any video-laryngoscopes to aid failed intubation during the study period 2008–2010. We have seen an increase in the use and availability of these devices over the past 2 yr in the non-pregnant population; this will need evaluation for suitability in our obstetric anaesthetic practice.[25]

A large study of obstetric airway management[26] described the use of supraglottic devices for the difficult airway highlighting the need for a wide a range of supraglottic airway devices available on the difficult airway trolley.

Aspiration

NAP4 identified aspiration of blood or gastric contents as still the most common cause of death after GA today and NAP4 received a report of an obstetric aspiration case that required prolonged intubation and ventilation in ICU as a consequence. We saw four cases of aspiration in our failed intubation group and one in the control group. This resulted in morbidity, although there was no mortality. However, the most recent confidential enquiry reported a death consequent to a massive aspiration of gastric contents after extubation.[6] Obstetric patients are a high-risk group for this complication.

Prophylaxis against acid aspiration

A variety of agents are used, but their relative efficacy remains undetermined. The H_2 receptor blockers were most commonly used in our study often complemented with sodium citrate before induction. A study in 2005 looked at antacid prophylaxis in UK obstetric units[27] and reported a decrease in the routine use of acid aspiration prophylaxis in 32% of units but an increase in recommendation to use in the 'at risk' groups. We reported a large number of omissions in antacid prophylaxis in what were mainly emergency GAs and a larger proportion of our index cases receiving antacids than our controls.

Aspiration of gastric contents was still a problem in four of our failed intubation cases no doubt making the airway management all the more problematic. One patient suffered morbidity from this omission. We must critically examine our management in this area.

Our results confirm the expected incidence of failed tracheal intubation in obstetrics at one in 224 (95% CI 179–281), a rate consistent over the past two decades despite advances in airway techniques.

Age, high BMI, and recording of Mallampati scores are independent risk factors. Airway assessment is not performed frequently enough and may be predictive. The cLMA was the most common rescue technique. We have shown that aspiration still occurs and although not a terminal event, antacid prophylaxis could be improved for these cases. There were no deaths in this survey attributed to failed tracheal intubation, one surgical tracheostomy was performed, and no case was admitted to ICU purely for airway management with similar percentages from both groups being admitted to ICU (12% *vs* 14%) for other reasons. There was significant neonatal morbidity in the failed intubation group and all staff working on the delivery suite including midwifery staff must be aware of the impact of failed tracheal intubation on both mother and baby.

Areas for further study include evaluation of supraglottic devices in obstetric anaesthesia to assess what extent they can safely replace the tracheal tube and as adjuncts for conversion to tracheal intubation with direct fibreoptic vision. The increased use of the video-laryngoscope will also impact on obstetric anaesthesia.

It is essential that we continue to assess the impact of increasing obesity in the obstetric population on the incidence of failed intubation and ensure that appropriate services training and equipment are in place. This information will inform future teaching and training in the difficult obstetric airway and the development of failed intubation drills in obstetrics. We must continue to strive to eliminate the obstetric airway complications that are so prevalent in obstetric GA and still lead to directly cause maternal death in the UK maternal confidential enquiry reports.

Acknowledgements

The authors would like to thank the United Kingdom Obstetric Surveillance System (UKOSS) reporting clinicians who notified cases and completed the data collection forms. We are also grateful for the assistance of Patsy Spark in data checking and validation.

Declaration of interest

A.C.Q. is now a committee member of the Obstetric Anaesthetists Association although was not at the time the award was made.

Funding

UKCRN Portfolio study 7563 Obstetric Anaesthetists Association grant of £12 000 for UKOSS. M.K. was funded by a postdoctoral research fellowship issued by the NIHR. The views expressed in this publication are those of the authors and not necessarily those of the NHS, The National Institute for Health Research, or the Department of Health.

References

1 Samsoon GL, Young JRB. Difficult tracheal intubation: a retrospective study. *Anaesthesia* 1987; **42**: 487–90.

2 Rahman K, Jenkins JG. Failed tracheal intubation in obstetrics: no more frequent but still managed badly. *Anaesthesia* 2005; **60**: 168–71.

3 Barnardo PD, Jenkins JG. Failed tracheal intubation in obstetrics: a 6 year review in a UK region. *Anaesthesia* 2000; **55**: 685–94

4 Hawthorne I, Wilson R, Lyons G, Dresner M. Failed intubation revisited: 17-yr experience in a teaching maternity unit. *Br J Anaesth* 1996; **76**: 680–4

5 Rocke DA, Murray WB, Rout CC, Gouws E. Relative risk analysis of factors associated with difficult intubation in obstetric anaesthesia. *Anesthesiology* 1992; **77**: 67–73.

6 Centre for Maternal and Child Enquiries (CMACE). Saving Mothers' Lives: reviewing maternal deaths to make motherhood safer: 2006–08. The Eighth Report on Confidential Enquiries into Maternal Deaths in the United Kingdom. *BJOG* 2011; **118** (Suppl. 1): 1–203

7 Basaranoglu G, Lyons G, Columb M. Failure to predict difficult tracheal intubation for emergency cesarean section. *Eur J Anaesthesiol* 2010; **27**: 947–9

8 Quinn A, Bogod D. Obstetrics. In: Cook TM, Woodall N, Frerk C, on behalf of the Fourth National Audit Project, eds. *Major complications of airway management in the UK: results of the Fourth National Audit Project of the Royal College of Anaesthetists and the Difficult Airway Society*. Available from: http://www.rcoa.ac.uk/document-store/nap4-section-2-clinical-reviews (accessed 15 August 2012)

9 Knight M, Kurinczuk JJ, Tuffnell D, Brocklehurst P. The UK Obstetric Surveillance System for rare disorders of pregnancy. *BJOG* 2005; **112**: 263–5

10 Pilkington S, Carli F, Dakin MJ, *et al.* Increase in Mallampati score during pregnancy. *Br J Anaesth* 1995; **74**: 638–42

11 Cook TM, Woodall N, Frerk C; Fourth National Audit Project. Major complications of airway management in the UK: results of the Fourth National Audit Project of the Royal College of Anaesthetists and the difficult Airway Society. Part 1: anaesthesia. *Br J Anaesth* 2011; **106**: 617–31

12 NOAD overview. Available from http://www.oaa-anaes.ac.uk/content.asp?ContentID=241

13 Knight M, Kurinczuk JJ, Spark P, Brocklehurst P; UK Obstetric Surveillance System. Extreme obesity in pregnancy in the United Kingdom. *Obstet Gynecol* 2010; **115**: 989–97.

14 Cook TM, Woodall N, Frerk C; Fourth National Audit Project. Major complications of airway management in the UK: results of the Fourth National Audit Project of the Royal College of Anaesthetists and the Difficult Airway Society: Part 1: anaesthesia. *Br J Anaesth* 2011; **106**: 617–31.

15 Lundstrøm LH, Vester-Andersen M, Møller AM, Charuluxananan S, L'hermite J, Wetterslev J; Danish Anaesthesia Database. Poor prognostic value of the modified Mallampati score: a meta-analysis involving 177 088 patients. *Br J Anaesth* 2011; **107**: 659–67. Epub September 26, 2011

16 Hignett R, Fernando R, McGlennan A, et al. A randomized cross-over study to determine the effect of a 30° head-up versus a supine position on the functional residual capacity of term parturients. *Anesth Analg* 2011; **113**: 1098–102

17 Sim DJ, Wrigley SR, Harris S. Effects of the European Working Time Directive on anaesthetic training in the United Kingdom. *Anaesthesia* 2004; **59**: 781–4

18 Johnson RV, Lyons GR, Wilson RC, Robinson AP. Training in obstetric general anaesthesia, a 'vanishing art'. *Anaesthesia* 2000; **55**: 712–3

19 Russell R. Failed intubation in obstetrics: a self-fulfilling prophecy? *Int J Obstet Anesth* 2007; **16**: 1–3

20 Tunstal ME. Failed intubation drill. *Anaesthesia* 1976; **31**: 850

21 Cook TM, McCrirrick A. A survey of airway management during induction of general anaesthesia in obstetrics. *Int J Obstet Anaesth* 1994; **3**: 143–5

22 Henderson JJ, Popat MT, Latto IP, Pearce AC. Difficult Airway Society guidelines for the management of the unanticipated difficult intubation. *Anaesthesia* 2004; **59**: 675–94

23 Obstetric Association of Anaesthetists failed intubation guidelines. Available from http://www.oaa-anaes.ac.uk/content.asp?ContentID=357

24 Halaseh BK, Sukkar ZFL, Hassan HAJ, Sia ATH, Bushnaq WA, Adarbeh H. The use of ProSeal laryngeal mask airway in caesarean section—experience in 3000 caesareans. *Anaesth Intensive Care* 2010; **38**: 1023–8

25 Niforopoulou P, Pantazopoulos L, Demestiha T, Koudouna E, Xanthos T. Videolaryngoscopes in the adult airway management: a topical review of the literature. *Acta Anaesthesiol Scand* 2010; **54**: 1050–61

26 McDonnell NJ, Paech MJ, Clavisi OM, Scott KL; the ANZCA Trials Group. Difficult and failed intubation in obstetric anaesthesia: an observational study of airway management and complications associated with general anaesthesia for caesarean section. *Int J Obstet Anesth* 2008; **17**: 292–7

27 Calthorpe N, Lewis M. Acid aspiration prophylaxis in labour: a survey of UK obstetric units. *Int J Obstet Anesth* 2012; **14**: 300–4

Handling editor: M. M. R. F. Struys