DEPARTMENT OF ANESTHESIOLOGY

JOURNAL CLUB

Wednesday October 3, 2012
1800 HOURS

LOCATION:
The University Club at Queen’s
168 Stuart Street

PRESENTING ARTICLES:
Dr. Cara Reimer & Dr. Erika Nguyen

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Two presenters will be assigned to choose and present summaries of their papers. Ideally the two papers will represent similar topics but contrasting research methodologies. The focus remains on critical appraisal of the research and manuscript, more than on the actual contents of the article. Each presenter will then lead an open discussion about the article, based around the guidelines below. The object is to open up the appraisal to wide discussion involving all participants, who will be expected to contribute pending suspension of bar privileges.

GENERAL

1. Title of paper: Does it seem like an important problem? Does it reflect the purpose/results?
2. Authors, institution and country of origin

INTRODUCTION

1. What is the problem being addressed?
2. What is the current state of knowledge of the problem studied?
3. What is the hypothesis being tested?
4. How does testing the hypothesis help solve the stated problem?

METHODOLOGY

1. Study design:
   a) Clinical trial vs. systematic review/meta-analysis
   b) Prospective vs. retrospective
   c) Observational vs. Experimental
   d) Randomized or not
   e) Blinded or not

2. Population studied:
   a) Human, animal, other
   b) Justification
   c) Control groups: experimental vs. historical
   d) Is the sample size/power calculated, and how?
   e) Is the population similar to your own practice?
   f) Single vs. multi-centre

3. Is the study ethically sound?
   a) Clinical equipoise
   b) Does treatment meet standard of care (esp controls)?
   c) Appropriate consent and institutional ethics approval

4. Exclusions: what groups are excluded and why?

5. Experimental protocol
   a) Is it designed to test the hypothesis?
b) Is it detailed enough to be reproducible?
c) Is the methodology validated?
d) Are the drugs/equipment used detailed?
e) How does the randomization take place?

6. What are the primary endpoints?
7. Is power sufficient to justify secondary endpoints?
8. Is the protocol clinically relevant?
9. Data collection and analysis
10. Statistical analysis: Is it appropriate? Are results

RESULTS

1. Are the groups comparable?
2. Were any subjects/data eliminated?
3. Analyzed by intent to treat?
4. Are adequate details of results provided? - data, graphs, tables

DISCUSSION

1. What is the main conclusion of the study?
2. Do the results support this conclusion?
3. Do the results address the stated purpose/hypothesis of the study?
4. How do the authors explain the results obtained?
5. Are there any alternative interpretations to the data?
6. Are the results clinically as well statistically relevant?
7. How do the results compare with those of previous studies?
8. What do the results add to the existing literature?
9. What are the limitations of the methods or analysis used?
10. What are the unanswered questions for future work?

APPLICABILITY OF THE PAPER

1. Have you learned something important from reading this paper?
2. Will the results of this study alter your clinical practice?
3. Was the food and wine up to the high standards expected by self-respecting anesthesiologists?
Failed tracheal intubation in obstetric anaesthesia: 2 yr national case–control study in the UK

A. C. Quinn1*, D. Milne2, M. Columb3, H. Gorton1 and M. Knight4

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

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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. 7 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 (± standard deviation), 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 loge 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 loge 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, WA, 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**

Univariable 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.

**Airway management**

Table 3 shows the airway ‘rescue’ techniques and alternative anaesthesia techniques used after failed intubation. The classical LMA™ (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™, and three iGels™. 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 cLMATM 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 H2 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 (SpO2 <90%) and the lowest recorded SpO2 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).

**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 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

| 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**                   |
| **SpO₂ < 90%**                | 36 (71%)                      | 2 (2%)                        | 89.1 (19.9 – 399)             | <0.0001                      |
| Lowest **SpO₂ (%)**           | 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                         |

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<th>Table 5 Maternal and neonatal morbidity and mortality</th>
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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, 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, so that training opportunities for junior anaesthetists are becoming more rare 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. 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 fiberoptic 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 Israel 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.

A large study of obstetric airway management 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. 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 H2 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 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.

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RISK FROM THE ASPIRATION OF VOMIT DURING OBSTETRIC ANAESTHESIA

BY
R. B. PARKER, M.B., Ch.B., M.R.C.O.G.
Lecturer in Obstetrics and Gynaecology, University of Birmingham

In 1937 C. C. Hall, of Oakland, California, lost a normal healthy primigravida as a result of inhalation of vomit which occurred during an anaesthesia given for a low forceps delivery. Impressed by the tragedy of the occurrence, he inquired among his colleagues in the vicinity of San Francisco and Los Angeles, and received records of 13 similar cases, 12 of which occurred within the previous two years, 4 being fatal. When publishing these cases he failed to find "a single detailed report of a similar case in the literature" (Hall, 1940). Following this, reports were published of maternal deaths due to inhalation of vomit by Eastman (1941) and Dieckmann (1945). The latter found 45 cases of aspiration of vomit occurring in 46,000 deliveries under general anaesthesia at the Chicago Lying-in Hospital. Of this number, eight patients were seriously ill and two died.

In 1946 Mendelson published a classical paper on aspiration of the stomach contents during obstetric anaesthesia in which he distinguished the asthmatic type due to aspiration of liquid gastric contents from the very different syndrome of lung collapse due to inhalation of solid material. He offered experimental evidence in rats of the part played by the irritant acid of the gastric contents in the development of the asthmatic type of lesion, and pointed out that it is almost confined to obstetric practice.

Further reports continued to appear in America from obstetricians and from anaesthetists (Gordon, 1947, 1952; Merrill and Hingson, 1951; and others). A full account of the condition now appears in the textbook by Greenhill and DeLee (1951).

In the British literature, Marshall (1947) was quick to point out the serious implication of these reports, and he emphasized the advantage of local (or even spinal) analgesia in operative deliveries performed when the patient is in labour. Wilcox (1949) published two case records, and Gilliatt (1949) commented on three cases of inhaled vomit which appeared in a series of 55 maternal deaths from 23 hospitals occurring in a total of 34,146 deliveries. He stated emphatically that these were deaths "which should not have occurred," and stressed the vital importance of having an experienced anaesthetist attached to every maternity hospital of any size. Despite this, there is still little reference to the seriousness of the condition in most standard British textbooks on obstetrics or anaesthesia.

The following seven cases are presented as further evidence of the dangers which lie in wait for the obstetric patient in labour to whom an inhalational anaesthetic is administered. In each case premedication was by 1/75 or 1/100 gr. (0.87 or 0.65 mg.) of atropine sulphate.

Case 1
This patient, aged 28, had a history of two caesarean sections on account of a grossly contracted pelvis and disproportion. In her third pregnancy arrangements were made for her to have a repeat caesarean section. She was admitted in the 39th week of her pregnancy, and general anaesthesia was begun with nitrous oxide, oxygen, and ether. Inhalation of ether was followed by laryngeal spasm and temporary cyanosis. The spasm recurred, but the anaesthetic was continued and the operation proceeded. A child weighing 7 lb. (3.4 kg.) was extracted, but during wound closure a severe attack of spasm and cyanosis occurred and vomit was found to be coming from the mouth. Despite artificial respiration and nikethamide the patient died before the conclusion of the operation.

Post-mortem Findings.—The body was that of an apparently healthy woman. The dilated stomach contained a large fluid digested meal and in the oesophagus and bronchi contained a quantity of aspirated vomitus.

Comment.—This patient was admitted at 11 a.m. on the day of operation for elective caesarean section on the following day. The operation was in fact performed 12 hours after admission because it was believed that she might be in labour, and it is probable that the patient had food after her admission.

Case 2
This woman, aged 24, was booked for trial of labour. The first stage was slow, but the cervix gradually dilated and she reached full dilatation after 36 hours, during which she received adequate sedatives. Her pulse rate was consistently below 100. During this time, in accordance with the hospital policy of encouraging the intake of fluids and glucose during labour, a total of 108 oz. (3 litres) was given by mouth. She vomited soon after admission, but there was no further vomiting. A total of 84 oz. (2.4 litres) of urine was passed. After two hours in the second stage, the patient had failed to deliver herself and the head was found to be arrested in the deep transverse position. Manual rotation and forceps delivery were carried out under general anaesthesia (nitrous oxide, oxygen, and ether) without any obstetric difficulties. During the induction and progress of anaesthesia, vomiting occurred several times, the vomit being mopped away by the anaesthetist. There was no cyanosis or obstruction of respiration and the patient gave no cause for anxiety at the time. One hour after delivery the pulse was noted to be rapid, and the patient on recovering from the anaesthetic became restless and cyanosed. Her condition improved on administration of oxygen but slight cyanosis remained. One hour later the pulse rate was 152 and the respiration rate 50. Three hours after delivery sudden collapse occurred; she became extremely restless, then the pulse became imperceptible at the wrist, and she died.

Post-mortem Findings.—The air passages were filled with mucoid fluid, but no solid vomited material was found. No further details are available.

Comment.—This case well illustrates the difficulties to be met with in a maternity unit. At the same time as this delivery was being undertaken, a breech extraction became necessary in another theatre. Two anaesthetists (one senior registrar and one trainee) were available. The anaesthesia for the forceps delivery was begun under the eye of the registrar before she went to give the other anaesthetic, which was thought to present the greater difficulty.

Case 3
This patient, aged 30, in her first pregnancy had a premature baby which failed to survive. In her second pregnancy she was admitted in labour when 39 weeks pregnant. She made steady progress, being 15 hours in the first stage of labour, but uterine contractions were poor in the second stage and a forceps delivery was undertaken when the maternal pulse began to rise. An easy extraction of a child weighing 7 lb. (3.4 kg.) was carried out. During induction (nitrous oxide, oxygen, and ether) a substantial amount of vomitus was expelled, but no impairment of colour resulted. The anaesthesia was continued apparently satisfactorily, and at no time did the patient give cause for
anxiety. Immediately after cessation of the anaesthesia some cyanosis of the lips and nail-beds was noted and the pulse rate was 150. One hour after delivery, despite continuous oxygen, the breathing was laboured and the cyanosis more pronounced. The patient then had two fits preceded by two twitches of the face and arms, and she died one and a half hours after delivery. Examination with a laryngoscope showed much debris in the nasopharynx, but the glottis was not obstructed.

Post-mortem Findings.—There was no vomit, blood, or foreign material in the upper respiratory tract. There was, however, a little frothy transudate from the lungs. Both pleural cavities contained several ounces of straw-coloured transudate. The lungs contained a large amount of oedematous fluid.

Case 4

A primigravida, aged 36, was admitted in labour as an emergency because of uterine inertia. A forceps delivery was undertaken after 48 hours of contractions, the head lying in the occipito-posterior position. The extraction was not easy, but a child weighing 7 lb. 3 oz. (3.3 kg.) was delivered in good condition. The anaesthetic used was nitrous oxide, oxygen, and ether. The patient was lightly anaesthetized throughout. On one occasion during manual rotation of the head she appeared to be going to vomit, but no vomitus was seen and the anaesthesia proceeded normally. Her colour remained good and at the end of the operation she showed signs of regaining consciousness. The pulse rate and the respiratory rate were both regular, and there was a little cyanosed. One and a half hours after delivery the theatre sister noted: "Pulse rate 160, quality fair, colour cyanosed." The blood pressure was 96/54. Oxygen, morphine, and nikethamide were given, but there was no material improvement. Twelve hours later the pulse rate was 136 and the respiratory rate 24. The blood pressure was 96/30. The respiratory rate rose further, respiration itself became extremely laboured, and the patient died 48 hours after delivery.

Post-mortem Findings.—The mouth, larynx, and trachea showed no evidence of obstruction, but the air passages all contained frothy fluid. All lobes of the lungs showed marked oedema, rendering the whole of the lung substance airless. The pleural sacs each contained about half a pint (285 ml.) of straw-coloured fluid. The heart was normal in size and showed no obvious dilatation.

Case 5

A primigravida aged 32 was admitted in labour as an emergency on account of a prolonged first stage. On admission her urine contained a large amount of acetone and she received 1,000 ml. of intravenous glucose, 5% solution. The cervix at this stage was three-quarters dilated. Eight hours later it was fully dilated and forceps delivery was undertaken for maternal distress after one hour in the second stage. A child of 7 lb. 13 oz. (3.5 kg.) was extracted satisfactorily. The patient's condition was reported as "good" at the end of the operation. No specific note concerning cyanotic (nitrous oxide, oxygen, and ether was made. Two hours after delivery the theatre sister noted: "Pulse imperceptible, colour extremely cyanosed, coughing up fair amount of mucus." Nikethamide was given. Two hours later the patient was conscious and the colour somewhat better, but the pulse rate was 136 and the respiratory rate 44. She received plasma, penicillin, morphine, and oxygen, but the pulse rate never fell below 120 or the respiratory rate below 28, and 36 hours after delivery she became severely cyanosed and died.

Post-mortem Findings.—Massive oedema of all lobes of the lungs, the substance of the lungs being completely sodden. The stomach was greatly distended and contained thin, blackish fluid. There were small flecks of black material adherent to the mucous passages of the trachea. The right side of the heart was considerably dilated. The cause of death was given as "massive pulmonary oedema, cardiac failure, inspiration of vomit, and dilatation of the stomach."

Comment.—In this case it seems that the incident of aspiration completely escaped the notice of the operator and anaesthetist; certainly no note of any difficulty was recorded.

Case 6

An infertile primigravida aged 34 was admitted at the 39th week of her pregnancy with early rupture of the membranes. Contractions began soon after admission, and after nine hours she became fully dilated. Delay in the second stage of labour was associated with a posterior position of the occiput, and after two hours she was delivered by Kielland's forceps. The anaesthetic used was nitrous oxide, oxygen, and ether. A note was made that vomiting occurred during the induction of anaesthesia and was followed by troublesome coughing. The pulse rate after delivery was 116 and remained at that rate for two and a half hours, but there was no cause for anxiety. Three hours after delivery the theatre sister's notes read: "Colour cyanosed, coughing thick mucus. Respiration distressed." After the administration of morphine, ½ gr. (11 mg.), and oxygen the patient's colour improved, but she continued to cough up thick mucus.

A summary of the notes of a general physician who was asked to see her reads: "Dyspnoea, cyanosis, tachycardia, productive cough. Signs of partial collapse of both lower lobes, particularly the right. Bronchoscopy under local anaesthesia—much sticky secretion aspirated but no single block present. This was persisting regular. The patient was given an hour after delivery and by the following day her pulse rate had come down to 86. Her breathing, though embarrassed, was not troublesome, but there were plentiful rales over both lungs. She made a good recovery, the chest being free from adventitious signs at the end of a week.

Case 7

This patient, aged 30, was booked for a trial of labour in her second pregnancy on account of a contracted pelvis. Her first child had been a stillborn hydrocephalic. Labour began spontaneously, and after 15 hours in the first stage and one hour in the second manual rotation and forceps delivery were undertaken for deep transverse arrest of the head. Anaesthesia was complicated by vomiting during the induction. The pharynx was cleared by suction with a mechanical pump and the anaesthesia continued smoothly. The patient recovered consciousness soon after completion of the delivery and spoke to the nursing staff.

One and a quarter hours after delivery she became cyanosed. The pulse rate rose to 150 and the respiration rate to 44. The blood pressure was 115/60. On listening to the chest, scattered rales could be heard on both sides, but there was no evidence of collapse. It was difficult to relieve the cyanosis by the use of oxygen, and one hour later she became very restless and was given paraldehyde intramuscularly. Three hours after delivery the pulse was still very rapid but the colour was much improved. Oxygen was administered continuously. The blood pressure was 98/80. The patient herself appeared quite unconscious and her breathing was extremely laboured. It was noted that the chest failed to relax in expiration, and it was difficult to maintain full oxygenation. Digoxin and mephedrine were given, and she improved gradually over the next 12 hours. At that time the pulse was 124 and respiration rate 28. She was removed from the oxygen tent after 48 hours and thereafter made a good recovery. The day after delivery she complained of low sternal pain, and two days later was coughing a rusty sputum. X-ray examination of the chest on the fourth day (Fig. 1) showed oedema of the upper and lower lobes, which had cleared almost entirely by the 14th day (Fig. 2).

Incidence

The above cases were all patients at the Birmingham Maternity Hospital. This hospital books only abnormal or potentially abnormal cases for delivery, and, in addition, accepts a high percentage of emergencies (up to 50% in the earlier years covered by this report). In such a highly
selected group any figures of incidence are of little value and therefore no detailed analysis is presented. During the 10-year period 1943–52, 18,524 cases were delivered in the hospital; 99 maternal deaths occurred, and, of these, five (Cases 1 to 5) are regarded as attributable to aspiration of vomitus under anaesthesia. In a further two or three cases it is felt in retrospect that death may have been due to the syndrome reported here, but the records refer to “left ventricular failure,” “obstetric shock,” and post-mortem examination was refused. Gordon (1952), in a review of maternal deaths, shows that the recorded cause of death is not always an absolutely reliable estimate.

Two non-fatal cases (Nos. 6 and 7) are recorded here as examples of serious illness resulting from the same cause. Many other cases showing minor degrees of the “acid aspiration syndrome” occurred, but it is not possible to trace all, and no figure for the incidence of the condition in this hospital can be given. Hartzell and Mininger (1946) recorded 20 cases of “broncho-pneumonia” following ether anaesthesia in obstetric patients which they believed to be due to aspiration of vomit, but of their cases only one required bronchoscopy and none was seriously ill. This would seem to confirm that less severe examples of the condition are not uncommon.

**Labour Ward Management**

In general the policy of the hospital is to permit no solid food in labour. To combat exhaustion and acidosis the mother is encouraged to take fluids and glucose in the first stage of labour. Intravenous dextrose solution is used only in the treatment of established acidosis.

Caesarean section is performed on a surgical operating table. All other deliveries are performed on labour beds, which can be tilted laboriously by hand, but which cannot be dropped into the Trendelenburg position.

During the years under consideration a large majority of the operative deliveries were carried out under general inhalational anaesthesia. From 400 to 500 anaesthetics per annum were given to patients for delivery, most of whom were in labour. Local and spinal analgesics were occasionally used, but together they accounted for less than 10% of cases. Most anaesthetics have consisted of nitrous oxide, oxygen, and ether, but some variations from this routine have taken place in later years. No relaxants were used in the cases under review.

**Clinical Features**

Case 1 illustrates the obstructive type of lesion in which inhalation of solid or partially digested food causes acute asphyxia and, in severe cases, death from acute heart failure.

This type of case is familiar also to those engaged in emergency surgery. Its treatment consists in removal of inhaled material at the earliest possible moment. The remaining cases illustrate the asthmatic type of lesion as described by Mendelson (1946).

The inhalation of a minimal amount of liquid stomach content in the conscious subject will result in intense laryngospasm and an irritant tracheitis which give rise to violent cough, obstruction to the intake of air, and sometimes substernal pain. Such a condition, if it occurs during the phase of recovery from an anaesthetic, may give rise to some alarm, but recovery is usually rapid. The patient’s protective reflexes will prevent more than a small amount of liquid from being aspirated.

Cases 2 to 7 illustrate a much more serious clinical picture than this, and a study of these cases in conjunction with those of Hall (1940) suggests that the seriously ill and fatal cases have all been in the group who vomited during the induction of the anaesthesia as opposed to the recovery phase. On continuing the anaesthetic, the patient’s condition in each case became satisfactory for a time. No anxiety was felt at the conclusion of the operation in several cases, and the surgeon and anaesthetist had on these occasions left the theatre when, after an interval of one to two hours, tachycardia, tachypnoea, and cyanosis developed. In such cases cyanosis is commonly relieved, but not completely banished, by the administration of oxygen. Breathing is laboured and the chest fails to relax during expiration. Widespread adventitious sounds are heard all over the chest, but there is no large area of collapse. If the cyanosis is not relieved, respiration becomes increasingly distressed, and the accessory muscles of respiration are active. This stage is critical. Cerebral anoxia may lead to extreme violence, sometimes maniacal, and the combination of prolonged asphyxia and exhaustion will lead to heart failure, generalized pulmonary oedema, and death.

**Causes and Effects of Aspiration**

The “asthmatic” lesion due to inhalation of liquid vomit is much commoner in obstetrics than asphyxia from aspiration of solid or partially digested food. It is not possible to make a comparison of obstetric cases for the following reasons. It is agreed by all clinical observers that the emptying time of the stomach in labour is considerably prolonged. Yet the consumption of liquid is often encouraged. It is not surprising, therefore, that large amounts of fluid can accumulate in the stomach during labour. With the patient lying flat, regurgitation of stomach contents can occur with exceptional ease, almost silently, without warning retching, and it can be readily induced by changing to the lithotomy position or by the application of fundal pressure during anaesthesia. If, as seems probable, the condition is commoner in patients delivered by forceps than in those undergoing caesaean section, the explanation may depend in part upon the tendency to perform the former with the patient flat and the latter with a slight head-down tilt. Further, the restriction of premedication to atropine only and the diminished respiratory excitation of a patient at term may make the induction of anaesthesia unusually difficult.

The following hypothesis is therefore proposed: when liquid inhalation occurs during the induction of anaesthesia the patient with reflexes partially inhibited may not readily expel the irritant fluid. If removal by coughing or suction is not complete when the anaesthesia is recommenced and deepened, the inspired vomit is free to spread further into the air passages.

The precise pathological lesion present in the individual will vary with the amount and character of the matter inhaled (whether solid or liquid) and with the duration of the exposure to the foreign matter. A tracheitis is the slightest lesion which will result from aspiration. Further extension
of the irritant liquid down the respiratory tree will result in contamination of the bronchi, bronchioles, and even the alveoli of certain areas of the lung field. This, however, may have little immediate effect on pulmonary efficiency, since much of the total lung area is unaffected and this is compensated for by the remaining 2 to 7 patients who remained under the effects of the anaesthetic. When wide-spread obstruction to the lower lobes has developed, pulmonary oedema results. As oxygen consumption is abnormally increased during labour, the safety of anaesthesia should be considered for each patient. In our hands it has never been successful in abolishing pain, but the introduction of hyaluronidase has been of great assistance, and Greenhill (1951) considers hypotension to be a further advantage in inducing analgesia. He states that its power of diffusion is such that accurate anatomical pin-pointing of nerves is no longer essential.

Summarizing, local analgesia is the safest method available. When its use is not permissible and if the patient is not in labour, general anaesthesia will probably be the method of choice, as the risks of inhalation are then minimal. When the patient is in labour the merits of spinal as opposed to general anaesthesia should be given due consideration, but the final choice must be an individual one, depending upon many factors, including the wishes of the patient and the experience of the anaesthetist.

Prevention of Vomiting
In the past much emphasis was laid on maintaining the nutrition of the patient. While solid foods have usually been forbidden in labour, intake of glucose and of fluids has often been encouraged (this can be seen from the records of Case 2). If local or spinal anaesthesia is the method to be employed in the event of operative delivery being necessary, no change from this plan is required, but in hospitals where general anaesthesia is used for delivery many anaesthetists now insist that intake by mouth be reduced to a minimum, maintaining that if acidosis develops treatment should be by intravenous administration of dextrose (500 to 1,000 ml of 10% or 5% solution, given as required). If it is desired to maintain the policy of giving water and glucose liberally in labour the only real safeguard for the patient due to have a general anaesthetic is to empty the stomach through a wide-bore stomach tube. If this unpleasant procedure be omitted (at the discretion of the anaesthetist) the following conditions should be satisfied: (a) an experienced anaesthetist to be in charge of the case; (b) operation to be performed on an operating table where tilting of the patient can be performed within seconds; (c) an efficient mechanical sucker to be available for the anaesthetist's use; (d) a laryngoscope and bronchoscope to be readily at hand.

Mendelson also recommends a transparent face-piece. The use of Clauson's harness is widely condemned in these cases. In some cases there is obviously an advantage in the use of a cuffed intratracheal tube, if this is possible.
TREATMENT

Where vomiting occurs during the induction of anaesthesia, the anaesthetist, appreciating the danger of the situation, will encourage the patient, by tilting and suction, to get rid of all vomitus, and the decision to continue with the anaesthesia will be left to his judgment that no aspiration has occurred. If asphyxia develops, solid vomit may have been inhaled. Immediate endoscopy is then indicated for removal of the foreign material. Merrill and Hingson (1951) describe a case in which tracheotomy was required for the removal from the trachea of leaves of spinach, eaten 18 hours before.

When, despite precautions, respiratory spasm develops on recovery from the anaesthetic, treatment should be given along the following lines:

1. If not already performed, bronchoscopy should be undertaken, since the presence of solid debris in the air passages cannot otherwise be excluded. In order to do this it is suggested that the patient should be re-anaesthetized. If it be true that spasm is the main cause of the cyanosis, this measure alone should restore the patient to a satisfactory condition. Through the bronchoscope a suction tube should be passed well down the respiratory tree.

2. The use of oxygen is obviously essential, and it might be found advantageous to combine it with helium in a ratio of helium:oxygen, 70:30.

3. Antispasmodics should be given—intravenous amino- phylline or morphine will be the first choice, but intravenous A.C.T.H. might be tried in the light of reported success in the treatment of status asthmaticus.

4. If the patient improves on being re-anaesthetized and deteriorates on regaining consciousness, the possibility of maintaining her under anaesthesia for a further period of time should be considered.

SUMMARY

Six cases, four fatal, of the “acid aspiration syndrome” following inhalational anaesthesia in obstetrics are described, together with one case who died from inhalation of solid vomit.

The grave examples of the syndrome generally follow vomiting during the induction of anaesthesia, and a hypothesis is proposed to explain this.

No single method of anaesthesia is adequate for all obstetric cases, but a plea for the wider use of local analgesia is advanced.

In inhalational anaesthesia the importance of the stomach tube, a tilting table, and a mechanical sucker are emphasized in the prevention of disaster. The passage of a bronchoscope is regarded as a first essential in the treatment of the established condition. It is suggested that benefit may come from recommencing the anaesthetic in order to do this.

I wish to thank the consultant staff of the Birmingham Maternity Hospital for permission to publish case records of patients in their care and for much helpful advice in the preparation of this report.

REFERENCES


BODIES WEIGHT AFTER GASTRECTOMY

BY

ANTHONY BARON, M.Chir., F.R.C.S.
Research Fellow, St. George's Hospital, London, S.W.1; Consultant Surgeon, Epping Group of Hospitals

Patients who have undergone subtotal gastric resection often show subsequent loss of weight. Muir (1949) considered weight loss to be second to the "dumping syndrome" as a cause of dissatisfaction with the result of operation, and found that 40% of his patients had lost 7 lb. (3.2 kg.) in weight six months afterwards. Wells and Welbourn (1951) estimated that on the average their patients had lost 17 lb. (7.7 kg.) from their best or pre-illness weight before operation, and that they registered an average gain of 3 lb. (1.4 kg.) after it. Such loss of weight was mainly seen in patients who had previously maintained their weight fairly well: thus in those whose pre-operative weight was within 14 lb. (6.4 kg.) of their best weight there was an average loss after surgery of 7 lb., whilst in those who had lost more than 14 lb. before operation there was an average gain of 18 lb. (8.2 kg.) subsequently.

The use of the best or "pre-illness" weight as a yardstick is open to the objection that it is often wrongly estimated and that it is not possible to distinguish between those patients who were once considerably over-weight and those who, while still in normal health, weighed relatively little considering their age and height. This difficulty can be overcome by relating the pre-operative and post-operative weights for each individual to the standard weight for the appropriate sex, height, and age. Though Wells and Welbourn state that the body weight is stabilized by one year after operation, there are no available data showing when loss of weight occurs, and whether it is a sudden or a gradual process.

Wollaeger et al. (1946) stated that impaired fat absorption is found in patients who have lost weight after gastrectomy, and Muir (1949) noted the presence of steatorrhoea in five out of seven underweight patients. Wells and Welbourn suggested that the steatorrhoea was due to small-intestinal "hurry," and Brain and Stammers (1951), reporting the condition after total gastrectomy, attributed it to a faulty admixture of food with bile as a result of "dumping" of food into the jejunum. These authors also found that fat absorption is low when the diet has a high fat content than when this is low. These studies have been made on small numbers of selected patients, and no control experiments are reported. Attempts to increase fat absorption by increasing the dietary fat (Brain and Stammers, 1951) and by the use of emulsifying agents (Badenoch et al., 1951) have met with little success in producing a gain in weight.

METHODS AND MATERIAL

The observations reported here have been made upon 285 patients submitted to subtotal gastrectomy for peptic ulcer at St. George's Hospital, all of whom have been personally followed from the time of operation for at least one year. A gastro-jejunal anastomosis was carried out on 225 patients, and a Billroth I operation of comparable extent in 60. The problem of body weight after operation has been studied in the following way:

1. The weight of each patient has been related to the standard figure for sex, height, and age, and expressed as a percentage of this. The weight has been studied immediately before operation, on discharge from hospital, and at two, six, and twelve months after operation. The