

## RESPIRATION AND THE AIRWAY

# Complications of awake fiberoptic intubation without sedation in 200 healthy anaesthetists attending a training course

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**Background.** Two hundred anaesthetists underwent airway endoscopy and attempted awake fiberoptic intubation (FOI) on a training course. Complications were recorded and each subject's response to the procedure was assessed.

**Methods.** Topical airway local anaesthesia was produced with up to 9 mg kg<sup>-1</sup> of lidocaine, sedation was not used. Complications during and after the procedure were noted. Later, the subjects completed an anonymous questionnaire about anxiety, pain, coughing, and side-effects of lidocaine.

**Results.** More than 1300 endoscopies were performed, 180 delegates were intubated, 175 by the nasal route and five orally. Intubation was abandoned in 20 (10%) subjects. Nasal bleeding occurred in 20 (10%) subjects. Symptoms that could be attributed to lidocaine were reported by 71 (36%) subjects. Afterwards, two (1%) subjects experienced rigors and one developed a lower respiratory tract infection.

**Conclusions.** Nasendoscopy and FOI under local anaesthesia are associated with complications, notably those of infection and airway trauma. Side-effects potentially attributable to lidocaine administration were commonly reported.

*Br J Anaesth* 2008; **100**: 850–5

**Keywords:** airway, complications; anaesthetic techniques, local, fiberoptic; education

Accepted for publication: March 11, 2008

Awake fiberoptic intubation (FOI) is regarded as a safe way of managing some airway problems, particularly anticipated difficulty with direct laryngoscopy.<sup>1–3</sup> In order to provide effective training, courses have been developed where anaesthetists act as subjects and practise skills on each other.<sup>4–6</sup> We report the experiences of and complications observed in 200 anaesthetists undergoing fiberoptic endoscopy with tracheal intubation under local anaesthesia. As all subjects underwent endoscopy and intubation on a training course without sedation or an operation, these are eliminated as a possible cause of complications. Our findings may be relevant to the information given to patients and to anaesthetists intending to provide or obtain this form of training.

## Methods

The Local Research Ethics Committee approved this study. Data were collected from anaesthetists undergoing airway endoscopy and FOI on a training course at the

Norfolk and Norwich University Hospital over a 9 yr period from 1999 to 2007. Approximately 6 weeks before the course, prospective delegates were sent an application pack describing the risks of FOI under local anaesthesia and a consent form, this was completed by all subjects. Anaesthetists self-selected themselves and applied to attend as participants or as observers. Participants acted as subjects and underwent fiberoptic endoscopy and intubation, whereas observers did not. Participant exclusion criteria are shown in Table 1. All delegates underwent preparatory training in airway endoscopy using a structured programme.<sup>4</sup>

Subjects fasted for 4 h before endoscopy. Written consent was re-affirmed before the procedure. A full range of resuscitation equipment was immediately available. After initiation of non-invasive monitoring, airway anaesthesia was performed as outlined in Table 2. An Intersurgical<sup>®</sup> Cirrus<sup>™</sup> nebulizer (ref. 1493) was used with oxygen at 8 litre min<sup>-1</sup> as a driving gas. Both nasal passages were inspected by superficial nasendoscopy and

**Table 1** Exclusion criteria for undergoing fiberoptic intubation

Pregnancy
Hypertension
Heart disease
Liver disease
Epilepsy
Diabetes
Asthma
History of epistaxis or nasal problems
Any infectious disease
Allergy to xylometazoline, lidocaine, phenylephrine, or glycopyrrolate
Medication other than oral contraceptive

**Table 2** Summary of the local anaesthetic technique

Intra-venous glycopyrrolate 3–4 $\mu\text{g kg}^{-1}$
Intra-nasal xylometazoline 0.1% spray
Nebulized lidocaine 4% (200 mg)
Lidocaine 5% + phenylephrine 0.5% 2 ml to nose
Spray-as-you-go topical lidocaine
Maximum lidocaine dose 9 mg $\text{kg}^{-1}$

the larger was selected for intubation. Supplementary spray-as-you-go lidocaine was then applied to the airway by course delegates as they carried out serial endoscopies in turn. Subjects were instructed to indicate pain or distress by elevating their arm. This was taken as an indication to cease manipulation of the endoscope and apply more local anaesthetic or to abandon the procedure. Oxygen was provided by nasal cannulae positioned over the subject's open mouth, or lightly gripped by their teeth during the endoscopy. Peak plasma lidocaine concentrations were determined in 25 of the 200 delegates as reported previously.<sup>7</sup> Complications during the procedure were noted.

Endoscopies were performed with either an Olympus LF-2 (3.8 mm OD) or LF-GP (4.1 mm OD) fiberoptic laryngoscope and displayed on a monitor. Intubations were effected using a 6.0 mm uncuffed Portex<sup>R</sup> Ivory tracheal tube (Ref. 10/105/060). Where nasal obstruction prevented nasotracheal intubation, oropharyngeal analgesia was tested and oral intubation attempted instead. Intubation attempts were discontinued if analgesia was inadequate, the subject showed signs of distress, or indicated the procedure should be terminated.

Heart rate (HR), ECG, and oxygen saturation were monitored continuously throughout the procedure. Non-invasive blood pressure, HR, and pulse-oximetry readings were recorded at 5 min time intervals until 5 min after removal of the tracheal tube. The highest recorded values of systolic arterial blood pressure (SBP) and HR for each subject were compared with their baseline value. For each subject, the maximal increase was then expressed as a percentage of the baseline value.

After the practical session, delegates attended lectures and then completed an anonymous questionnaire. They were asked to record any side-effects they attributed to the local anaesthetic and to grade the anxiety, pain, and coughing that they experienced using five-point written scales.

Finally, subjects were medically reviewed and complications documented. They were discharged when oropharyngeal sensation had returned, fluids had been taken and analgesia administered.

Changes to the management of these subjects had been introduced during the life of this training programme. Routine administration of i.v. fluid was introduced after the 20th delegate. Glycopyrrolate administration was increased from 3 to 4  $\mu\text{g kg}^{-1}$  in order to reduce secretions and improve the quality of analgesia. Initially, courses were filled with members of our own department, which made formal follow-up supervision unnecessary. Later, a delegate (number 76) reported rigors afterwards. In response, formal e-mail surveillance was introduced after the 83rd delegate. Subsequently, all participants were given the contact details of an instructor who would be available for advice should a complication develop after the procedure and the authors contacted the last 117 subjects 24–48 h after discharge in order to detect and manage late complications.

## Results

Six subjects developed nodal rhythm and all spontaneously reverted to sinus rhythm. The maximal recorded increase in systolic blood pressure per subject ranged from 0 to 63 mm Hg (0–53%) with a mean increase of 18.3 mm Hg (14%) and 95% confidence limits 16.3–20.2. Twenty-three per cent experienced a peak systolic blood pressure increase of >20%. HR showed wider variability, the increase in HR ranged from 0 to 59 beats  $\text{min}^{-1}$  (0–108%) with a mean increase of 20.7 beats  $\text{min}^{-1}$  (30%), 95% confidence limits 16.6–23. Fifty-eight per cent experienced an increase in HR of >20%. During airway endoscopy, pulse oximetry revealed brief periods of de-saturation to <80% in three subjects.

The immediate complications are summarized in Table 3. Minor nasal bleeding was seen in 20 subjects during endoscopy or after extubation. None of the 20 subjects required suction to control bleeding or clear the airway and in no subject did bleeding interfere with endoscopy. It was noted that visible external bleeding only occurred after tracheal tube removal and external nasal pressure was sufficient to promote haemostasis, though in most subjects this was not needed. Five subjects felt faint during or directly after the endoscopy session; this complication resolved with rest and i.v. fluid administration. Three delegates vomited after extubation, two of these during the same session. One subject experienced sudden onset of severe occipital headache. Before the procedure this subject's HR was 55 beats  $\text{min}^{-1}$ , with a blood pressure of 120/70 mm Hg. During endoscopy, just before intubation, a nodal bradycardia of 38  $\text{min}^{-1}$  developed. Immediately after intubation the systolic blood pressure was 150/90 mm Hg, increasing to 180/95 mm Hg 4 min later, at which time the headache developed.

**Table 3** The number and percentage of 200 subjects with each immediate complication

Complication	Number	Percentage
Nasal bleeding	20	10
Nodal rhythm	6	3
Felt faint	5	2.5
Vomited	3	1.5
SaO <sub>2</sub> < 80%	3	1.5
Severe headache	1	0.5
Severe paraesthesia	1	0.5

**Table 4** The number and percentage of 116 subjects with each late complication reported at follow-up

Complication	Number	Percentage
Sore throat	47	35
Stuffy/sore nose	9	7
Voice changes	7	5
Flu-like symptoms	6	4
Cough	6	4
Headache	4	3
Bruised hand	3	2
Rigors	2	1.5
Nasal bleeding	2	1.5
Productive cough	1	<1
Sinusitis	1	<1
Rhinitis	1	<1
Myalgia	1	<1
Globus symptoms	1	<1
Nausea	1	<1
Total	93	

This was the greatest increase in SBP seen in 200 delegates. The headache was associated with nausea. During the following 20 min the delegate rested and the blood pressure returned to normal, but the headache persisted. Physical signs suggestive of intracranial bleeding were absent, but the advice of a neurologist was sought urgently. The subject was admitted to hospital, clinical examination and investigations including head CT scan revealed no cause for the headache which resolved after 8 h. The delegate returned home the same night. A lumbar puncture performed the following day was normal. One subject developed severe paraesthesia of the hands and face. Though they received <9 mg kg<sup>-1</sup> of lidocaine, their symptoms caused concern about possible lidocaine toxicity and the procedure was abandoned.

One hundred and sixteen of the last 117 subjects replied to follow-up. Before routine surveillance was introduced, three delegates spontaneously contacted the organizers and informed them of problems they had experienced after discharge, these complications are also included and listed in Table 4. Forty-seven experienced a sore throat after the procedure, 38 (80%) of these resolved in <24 h, eight (17%) resolved within 48 h, and one persisted for more than 3 days. Forty-four (38%) delegates reported no ill-effects. Nine noted a sore or stuffy nose, seven reported voice changes for more than 24 h, and a transient 'flu-like' illness was experienced by six.

Six hours after endoscopy, a delegate developed fever with rigors; he was treated with antibiotics and suffered no long-term effects. After reading a report of this complication, a delegate from an earlier course reported experiencing rigors which had resolved without treatment. One delegate developed a productive cough with green sputum which persisted for 2 weeks. Nasal bleeding within the first 24 h after discharge was reported by two delegates. A further delegate was diagnosed with allergic rhinitis and suffered recurrent nasal bleeding for 2 weeks. One subject initially reported complete recovery after endoscopy and intubation, but later developed pharyngeal pain with voice changes. Endoscopy was repeated by an ENT surgeon who attributed inflammation of the larynx to acid reflux, which may have occurred while the airway was anaesthetized. The subject subsequently gave a history of pre-existing gastro-oesophageal reflux disease.

Of the 200 subjects who completed post-procedural questionnaires not all completed every section. Table 5 displays each question and the number of replies in each category of the five-point scales used to assess the acceptability of the procedure. Four delegates rated some aspects other than coughing as very uncomfortable: a sensation of airway swelling, nausea, paraesthesia, and the unpleasant taste of local anaesthetic.

Neurological symptoms which the delegates attributed to local anaesthetic toxicity are shown in Table 6. One hundred and twenty-seven of 200 subjects (63%) experienced no symptoms.

All 200 subjects underwent endoscopy to the level of the larynx and all except one to the level of mid-trachea. In total, 1336 endoscopies were performed. The modal number of endoscopies performed on each subject was 7 with a range of 3–8; 180 delegates were intubated, 175 by the nasal route and five by the oral route. Intubation was abandoned in 20. Failure to intubate was attributed to nasal obstruction in 10 subjects and inadequate anaesthesia in eight subjects. The procedure was abandoned because of symptoms suggestive of lidocaine toxicity in one subject and because of extreme agitation and restlessness exhibited by another.

## Discussion

Several authors have reported that FOI can be achieved with considerable haemodynamic stability<sup>8–10</sup> under local anaesthetic when combined with sedation. In this series, 23% experienced an increase in SBP of more than 20%. Heart rate showed greater variability, with a mean increase of 21 beats min<sup>-1</sup> (30%). Fifty-eight per cent experienced an increase in HR of >20%. It would appear that haemodynamic stability has been lost as a consequence of avoiding sedation. This suggests that, in the presence of hypertension or ischaemic heart disease, sedation has an important role in the management of tracheal intubation under local anaesthesia.

**Table 5** Question and responses expressed by 200 subjects on the five-point written scale

Please assess the discomfort you experienced during airway endoscopy					
Subjects	0	4	103	88	2
	Very painful	Painful	Slightly painful	No pain	Enjoyable
Please assess the anxiety you experienced before, or during airway endoscopy or intubation					
Subjects	0	9	101	81	5
	Very worrying	Worrying	Slightly worrying	Not worrying	Enjoyable
Please assess coughing or gagging you experienced during airway endoscopy or intubation					
Subjects	5	20	99	70	2
	Very uncomfortable	Uncomfortable	Slightly uncomfortable	Not uncomfortable	Enjoyable
Please assess any other sensation you experienced during airway endoscopy or intubation					
Subjects	4	20	43	28	0
	Very uncomfortable	Uncomfortable	Slightly uncomfortable	Not uncomfortable	Enjoyable
Please assess the experience of endoscopy or intubation on yourself?					
Subjects	0	4	158	25	4
	Very distressing	Distressing	Acceptable	Enjoyable	Very enjoyable

**Table 6** The number and percentage of 200 subjects reporting each neurological symptom

Symptom	Number	Percentage
Light-headedness	28	14
Drowsiness	9	5
Dysphoria	9	5
Dizziness	8	4
Nausea	7	4
Circumoral tingling	6	3
Paraesthesia	6	3
Euphoria	5	3
Fatigue	3	2
Difficulty swallowing	2	1

Hypoxia was observed in three delegates despite the routine administration of supplementary oxygen. This may be because of displacement of nasal cannulae or breath holding. Demonstration of hypoxia endorses the need for supplemental oxygen even when sedation is avoided in healthy subjects.

Nasal bleeding was a common immediate complication seen in 20 (10%) subjects. Heidegger and colleagues<sup>11</sup> reported severe nasal bleeding, requiring the use of suction in 1.3% of nasotracheal intubations. Although the incidence of bleeding is higher in our series, this may be because of inclusion of minor bleeding. None of the 20 subjects required suction to control bleeding or clear the airway, and in no subject did bleeding interfere with endoscopy.

The doses of lidocaine used in this study were comparable with the current practice<sup>12</sup> and published evidence.<sup>13, 14</sup> However, during an early course, the procedure was abandoned in one subject who developed severe paraesthesia of the hands and face. Although that subject received less than the calculated maximum dose of lidocaine (9 mg kg<sup>-1</sup>), these symptoms caused concern about possible lidocaine toxicity. Peak plasma lidocaine concentrations were later determined in 25 delegates.<sup>7</sup> Side-effects and symptoms of lidocaine absorption were commonly

observed despite peak plasma lidocaine concentration of <2.5 mg litre<sup>-1</sup> in 23 of 25 subjects. The highest measured plasma lidocaine concentration reached 4.5 mg litre<sup>-1</sup>. Absorption and peak plasma concentrations varied widely and the study group was small. It is possible that some subjects outside of the plasma lidocaine study group had achieved a greater plasma lidocaine concentration. Foldes and colleagues<sup>15</sup> measured blood lidocaine concentrations during i.v. infusions of lidocaine in volunteers and observed objective signs of toxicity requiring infusions to be discontinued when blood concentrations reached a mean of 5.29 mg litre<sup>-1</sup>. Though our subjects reported light-headedness, drowsiness, and dysphoria as the commonest side-effects they attributed to lidocaine administration; no overt signs of toxicity were seen. The death of a healthy volunteer undergoing diagnostic bronchoscopy for research purposes has been reported.<sup>16</sup> A blood sample obtained 3 h after that endoscopy showed a lidocaine concentration of 12.9 mg litre<sup>-1</sup>, and back extrapolation<sup>16</sup> suggested a maximum possible blood lidocaine concentration of 36 mg litre<sup>-1</sup>. Investigation by the State of New York<sup>17</sup> found the research protocol contained no upper dose limit for lidocaine, and lidocaine dosage was not recorded. Furthermore, it was stated 'Research protocols involving health [*sic*] volunteers who are to receive no clinical benefits from undergoing a procedure must at a minimum offer all of the safety precautions that are provided to clinical patients undergoing the same procedures'. We suggest that this must also apply to volunteers undergoing procedures for training purposes. Though we observed no overt signs of lidocaine toxicity using a maximal dose of 9 mg kg<sup>-1</sup>, involuntary movements have been noted in volunteers undergoing awake FOI with doses of up to 15 mg kg<sup>-1</sup> of topical lidocaine.<sup>5</sup> The need for a strict upper dose limit and caution over the use of >9 mg kg<sup>-1</sup> has been urged.<sup>18</sup>

Fever with rigors was reported by two delegates. Bacteraemia is well described after endoscopic procedures within the airway.<sup>19</sup> Infective organisms may be endogenous



or be introduced to the airway by instruments or tracheal tubes. After the report describing pyrexia with rigors,<sup>20</sup> we reviewed the cleaning and decontamination process used for fiberoptic endoscopes at the Norfolk and Norwich University Hospital and sought to exclude all possible sources of exogenous contamination from the drugs and equipment used. All endoscopes were leak tested before and after each use. Single use items were already extensively used and only new unopened bottles of local anaesthetic solution were used. Before the occurrence of pyrexia and rigors, endoscopes were placed on a surface covered by absorbent, plastic-backed paper sheets before use, and endoscopists wore non-sterile disposable gloves while handling the instrument. We subsequently modified our practice to include the use of sterile gloves and a sterile surface to receive the endoscope. There were no reported episodes of pyrexia or rigors after these changes were introduced, although one delegate reported a productive cough with green sputum after the procedure. Flu-like symptoms have been reported by six subjects; these symptoms may represent a muted systemic response to bacteraemia.

Reflux of gastric acid was thought to have produced laryngitis in one subject. Although we received no prior indication of susceptibility, this development reinforces the need for antacid prophylaxis in susceptible subjects.

As all subjects underwent endoscopy and intubation without an operation, surgery is eliminated as a possible cause of complications but caution must be exercised when considering the complications reported here as the circumstances differ markedly from the clinical situation. Complications observed, notably bleeding and sore throat may be higher than those experienced in routine clinical practice, as all subjects underwent multiple airway endoscopies performed by relatively inexperienced endoscopists. Equally, it could be suggested that as the endoscopists had been intensively prepared, observed, and assessed and were performing endoscopy under direct supervision of experienced trainers, fewer complications might be expected. Furthermore, subjects deemed to be susceptible to known complications of airway local anaesthesia or endoscopy (e.g. those with nasal pathology, taking immunosuppressive drugs, or those with medical problems listed in Table 1) were excluded. Though these would not necessarily be exclusion criteria in clinical practice, extreme caution is required when selecting subjects for a training course in order to avoid unnecessary risks.

Despite adopting a low threshold for abandoning the procedure, three delegates rated the intubation as distressing and under the circumstances this figure must be regarded as too high. As subjects, the delegates were all highly motivated otherwise they would not volunteer and some were reluctant to allow attempts at intubation on themselves to be abandoned. It was for these reasons that the procedure was often discontinued by the instructor rather than at the request of the subject.

Heidegger and colleagues<sup>11</sup> reported a failure rate of 1.8% in a series of 955 patients undergoing awake nasotracheal intubation. However, in that series, patients received fentanyl 0.1–0.2 mg and etomidate 0.3–0.4 mg kg<sup>-1</sup> i.v. before intubation. Our failure rate of 10% is higher as intubation was abandoned because of nasal discomfort or obstruction in 10 subjects and inadequate suppression of airway reflexes in 8. Sedation makes greater or more vigorous manipulation tolerable, but this option was not available to course delegates. In the absence of sedation and with no clinical need for intubation, a low threshold for abandonment of intubation attempts was adopted. As a result, there were 20 failures of 200 FOI attempts. The endoscope was passed into the trachea of all subjects except one.

In conclusion, repeated nasendoscopy and FOI under local anaesthesia is associated with complications, notably those of infection and local trauma. Side-effects of lidocaine administration are common. Other complications such as allergic reactions are known but rare and were not seen. It is still possible that serious unanticipated complications may develop. Since they are unknown the incidence and risk cannot be quantified. The use of volunteers for this form of training carries risks and needs further evaluation. Meticulous attention to the care of the subject is needed in order to minimize the development of serious complications.

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