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Human factors in complex airway management

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Key points

- Human factors are vital to the successful management of an anticipated difficult airway.
- Careful planning and preparation are key to success, with a logical strategy being selected and the airway management being undertaken by a competent anaesthetist.
- Careful consideration of the risks of each technique will assist a thorough preoperative assessment to be undertaken, and the logical plan and equipment selected.
- A detailed pre-anaesthetic briefing of the multidisciplinary team is required to ensure that all personnel are aware of the plan and their role in the anaesthetic room.
- Situational awareness is vital to ensure that fixation errors are avoided. Disciplined communication and thoughtful followership ensure good team dynamics.

Human factors have been defined as 'the environmental, organisational and job factors, and human and individual characteristics which influence behaviour at work in a way which can affect health and safety'[1] and have been described with particular relevance to anaesthesia in the Anaesthetists Non-Technical Skills Framework.[2] When dealing with a patient with a complex airway, exceptional attention to human factors is vital to success. This has been noted extensively in the literature after two high profile cases.[3,4] Recently, there has been adoption of human factors in healthcare at the highest level with the signing of a Concordat from the National Quality Board by organizations such as the General Medical Council, The Care Quality Commission, and Health Education England.[5]

The Fourth National Audit Project of the Royal College of Anaesthetists (NAP4) examined major complications in airway management and concluded that poor human factors could have contributed to 40% of the cases reported. In 25% of these cases, inadequate human factors were felt to be a major contributor to a poor outcome.[6] Further analysis specifically looking at human factors in cases reported to NAP4 reported that there were potentially an average of four human factors issues per reported case.[7] This article sets out to describe our experience of the importance of human factors when dealing with patients with an 'anticipated difficult airway' and describes our strategy, particularly in planning, preparing, briefing the team, and conducting the airway management with an illustrated example.

Our hospital experience

Aintree University Hospital NHS Foundation Trust is a large teaching hospital situated in North Liverpool. It is a tertiary referral centre for head and neck surgery providing specialist services to around 1.5 million residents in Merseyside, Cheshire, South Lancashire, and North Wales. The population served by Aintree includes some of the most socially deprived communities in the country, with high levels of illness. The Head and Neck Unit is the largest in the UK, carrying out ~800 cases per year. This provides our anaesthetists and surgeons with a wealth of experience in dealing with patients with abnormal airway anatomy and frequently, difficult airways. Our department is the home to the nationally recognized Aintree Difficult Airway Management (ADAM) course.[8]

Specific human factors in complex airway management

Leadership

It is important that the team is aware as to who is in charge of the case. The leader will usually (although not always) be the most experienced anaesthetist and their role is to:

- Formulate the airway management plan(s) and communicate this to the team, so they are all 'on the same page'.
- Allocate roles with the team and identify any limitations in skill mix.
- Maintain situation awareness and not become task fixated while the airway is being secured.
- Define the trigger points for moving from Plan A to B (and subsequent plans) if required.

Teamwork

Good teamwork is integral to success in all airway management. This is particularly important in the anticipated difficult airway. Salas and colleagues[9] described a team as 'a distinguishable set of two or more people who interact dynamically, interdependently, and adaptively towards a common and valued goal, who have each been assigned specific roles or functions to perform, and who have a limited life-span membership'. It is therefore very important that the team is aware of the plan(s) for airway management, their role in the process, and anything else that is expected of them. A team brief will ensure that this is achieved with an opportunity to ask questions and clarify any differences in opinion.

Situation awareness

Situation awareness itself has been described as 'the perception of the elements in the environment within a volume of time and space, the comprehension of their meaning and the projection of their status in the near future'.[10] Loss of situation awareness is one of the most common recurring features in adverse incidents involving airway management.[7] The three stages of situational awareness include:

- Gathering information. This will start with taking a history and examining the patient and will be supplemented by other investigations such as nasendoscopy, CT scan, and discussion with surgical colleagues. Once airway management occurs then further information is gathered from monitors, images on fibreoptic cameras, and tactile feedback. Mistakes may occur if the individual misinterprets task-relevant information.
- Interpreting the information. Mistakes may occur if an individual wrongly perceives specific information.
- Anticipating future states. Mistakes may occur if future status is wrongly predicted, either from a poor initial mental model or personal memory failure. (A mental model is an explanation of a person's thought process, or what they expect to happen.)

Good situation awareness when performing a complex task can be maintained in different ways. In the trauma team scenario, the trauma team leader (TTL) maintains a 'hands off' approach and stands at the foot of the bed so they maintain an all round view and are effectively 'driving the bus'.[11] In this way, the TTL is not directly involved in any practical tasks themselves and so are able to observe the patients management in 'real time'.

Decision-making

After assessment of the patient before operation, the clinician should identify the potential difficulties and problem areas for that individual. The risks and benefits of each potential airway management method need to be weighed up. These may vary from case to case. The location of the planned intubation, experience level of staff available, and clinical urgency of the case are all factors that may deem a normally suitable technique, unsuitable. Once a decision has been made and 'Plan A' formulated, it is important to continue to re-evaluate the clinical situation taking into account any significant changes and ensuring that 'Plan A' remains the best plan.

Although the Plan A, B, and C approach is favoured, it is important to recognize that some airway cases are such that there may only be one plan. In such circumstances, the most senior anaesthetist will manage the airway and if this is devolved to a senior trainee, it must be done under close and direct supervision with a clear plan for stepping in.

Followership

Although good leadership is crucial to good teamwork, so too is good followership. A follower is defined as anyone not acting in the position of leader and responding to organizational actions; a person who is active rather than passive.[12] In terms of difficult airway management, this encompasses actions such as anticipation, support of the team leader, and good communication using feedback loops. A feedback loop is where the sender (e.g. the team leader) transmits an instruction to another member of the team who receives it and then feeds back they have understood the instruction (or decoded the message correctly).

Communication

Good communication is paramount to the successful execution of securing the patient's airway and simple steps can ensure that communication flows from the team leader to the other members of the team. Previous work by Gawande and colleagues[13] cited communication failures as being responsible for 43% of errors in three large teaching hospitals in the USA. We have found a team brief to facilitate good communication among the multi-disciplinary team

The team brief allows:

- introduction of team members,
- the team to be reminded of individual levels of training and competencies,
- allocation of tasks,
- discussion of potential problems and highlighting solutions,
- clarification of the team leader's mental model and the airway plan(s).

There are several aspects of communication skills that should be highlighted, particularly in the management of the patient with an anticipated difficult airway.

- 'Sterile Cockpit': During the intubation attempt, the team should aim for what is described in the airline industry as a 'sterile cockpit'. This infers that the noise level is kept to an absolute minimum by having only the required team members present. This enables all monitors, comments, and instructions to be heard clearly ensuring vital information is not lost.

Case history

The importance of human factors in the management of an anticipated difficult airway will be illustrated by the case described in Table 1.

Fascial space infections (dental abscesses) can be considered the archetypal anticipated difficult airway;[14] they can be life-

Table 1 Case history

A 62-yr-old male presented to The Accident and Emergency Department with acute dysphagia for liquids arising on a background of a 3 week history of worsening toothache and facial swelling
On examination, he was pyrexial (39°C), dysarthric, and was drooling as he could not swallow his saliva. He also could not assume the supine position
He had trismus with 1 cm of mouth opening, swelling and erythema over his left cheek, and mandible spreading to the left anterolateral aspect of his neck. He had an old fracture of his nose
He was tachycardic (110 beats min^{-1}) but not hypotensive. His Sa_{O_2} was 92% on room air. Nasendoscopy revealed only the left nares to be patent. The anatomy of the oropharynx at nasendoscopy was found to be severely distorted, full of secretions and with a mucosa prone to contact haemorrhage. The glottis could not be visualized. A full blood count revealed a leucocytosis, and clotting abnormalities

threatening and cause serious postoperative problems. They are heterogenous in their presentation, and can involve the whole upper airway and all the access routes into the airway.

The anticipated difficult airway is different from the management of the unanticipated difficult airway. The anaesthetist knows there are going to be problems in advance and consequently has time to select the best intubation plan to deal with their patient's particular constellation of problems. It is crucial that the plan is enacted precisely, necessitating attention to detail at every step of the intubation plan from positioning and oxygenation through to confirmation of tube placement in the trachea.

The anaesthetist must have a pragmatic approach to assessment, planning, and execution of the intubation plus the human factors involved at each stage. To this end, we advocate a six-step method used by the ADAM website[8] if time allows.

Aintree six-step approach to difficult airway management

Q1: How much time do I have?
Q2: What access to the airway is available (nose, mouth, trachea)?
Q3: How compromised is the airway?
Q4: Which fascial spaces are involved?
Q5: Which management plan(s) best fits the circumstances?
Q6: Could I make the situation worse? If so, how?

Question 1

Difficult airways are time critical emergencies and can be classified as follows:

(i) No time for assessment and planning: Need to act immediately to avoid hypoxic brain injury/death. Correct use of the DAS algorithms[15] is crucial to outcome.
(ii) Some time for assessment and planning: The six-step approach is used remembering that actions can gain or lose time; airway management is a fluid situation with often incomplete information and so it is necessary to take stock repeatedly and avoid being too rigid in one's approach.
(iii) Adequate time for assessment and planning. A structured approach is required to assess options, evaluate risk, and maximize success. We use the ADAM website[8] and methodology and it is used for illustration here, although of course other methods may be used.

Questions 2–4

The available access routes are first considered. Airway compromise is multi-factorial and for this patient, sepsis indicates urgency, influences management, and is associated with more complications. Trismus is not always due to pain: the joint may be compromised. Pharyngeal involvement causes stridor, drooling, dysphagia, and tongue immobility. Nasendoscopy is the most important investigation. It is simple to perform, confirms nasal patency, and indicates the location of airway distortion and the degree of oedema. Imaging is useful if the patient can lie flat as it accurately defines the fascial spaces involved, differentiates between cellulitis and abscess, reveals vascular sheath involvement, and confirms the diagnosis of mediastinitis if suspected clinically.

Question 5

Once assessment and investigation are completed, the clinician uses the information to decide which airway management plan best fits the patients' circumstances. Airway management should not follow a 'one size fits all' approach. The breadth of techniques means a 'bespoke' plan should be sought that is best suited to deal with the problems at hand. A good way to do this is by considering the limitations of each plan in the context of the patient's problems. When using the ADAM website, each choice of technique is evaluated against the clinical scenario and an analysis of limitations, potential complications, and likely success is used to identify the technique that is most likely to succeed without complications

Question 6

The last step considers how one's actions can make the situation worse. This is done by constructing an intubation plan detailing potential pitfalls and to discuss it with the whole team in advance. The ADAM website generates a printable 'contingency plan' (Table 2) splitting the intubation into its constituent steps and listing the anticipated problems for each step. The left-hand column lists generic potential problems likely to be encountered whenever the equipment is used, in this case awake fibreoptic intubation. The right-hand column highlights how the patient's problems are likely to cause difficulty and at which stage in the intubation this may arise. Used at the team brief, it enables everyone to effectively be on the 'same page'; when to expect specific problems, how they will manifest themselves. Table 2 does not provide solutions but rather highlights potential pitfalls leaving it to the user to formulate a response. It also determines in advance when it would be appropriate to abandon the procedure and consider other options (if any).

How the patient was managed

Assessment and planning

The severe trismus and indurated anterior neck meant that there was only one viable route into the airway: the

Table 2 Contingency table for the patient described in Table 1

Generic problems	Patient-specific problems
1. Check equipment/position patient	
Adverse patient position	
Inadequate nasal patency	
Illumination not satisfactory	
Monitor image not optimized	
Wrong size tube	
Wrong type of tube	
2. Prepare nares, oxygenate, start sedation	
Omit supplemental oxygen	
Increasing airway obstruction (LA effect)	
Apneoa (excess sedation)	
Respiratory depression (excess sedation)	
3. Mount tracheal tube on fibrescope	
Tube not loaded	
Tube loaded via Murphy's eye	
Tube/fibrescope interface not lubricated	
Omit anti-fog solution	
4. Negotiate fibrescope through the nose	Operator traumatizes nasal mucosa causing bleeding: coagulopathy
Fogging of lens	
Secretions obscure view	
Inadequate nasal patency	
Traumatic bleeding obscures view	
Friable tissue obscures view (e.g. polyp)	
Disorientation	
Failure to traverse nose	
Nasal congestion/hyperaemia	
Naso-pharyngeal obstruction (e.g. adenoids)	
5. Explore pharynx, larynx, and trachea	Contaminant obstruction:
Epiglottis obscures glottis	spontaneous or iatrogenic abscess rupture
View becomes 'red out' (blood) or 'white out' (secretions)	iatrogenic bleeding
Prolapsing pharyngeal wall obscures view	Airway distortion (cellulitis)
Excessive vocal cord movement	
Excessive reflex glottic closure	
Unexpected gastric reflux	
Accumulating pharyngeal secretions	
6. Position fibrescope in trachea	
Carina not realized	
7. Railroad tracheal tube over fibrescope into trachea	Tube advancement problem: nares, epiglottis, arytenoid, subglottic
Tube not loaded/loaded incorrectly	Bleeding: trauma, abscess rupture
Tube diameter too large to enter nostril	
Tube/fibrescope step problem	
Tube hold up: nostril, epiglottis, arytenoids, or subglottically	
Inadvertant removal of fibrescope from trachea	
8. Confirm tube position relative to carina	
Cannot identify carina	
Patient distress due to iatrogenic total airway obstruction	
9. Remove fibrescope leaving tracheal tube	
Difficult fibrescope removal (no lubrication)	
10. Re-confirm tube position with CO_2/bag movement	
No capnograph trace	
No ventilation	
Difficult ventilation	
11. Induce anaesthesia and inflate cuff	
Inadvertent loss of i.v. access	
12. Confirm bilateral lung ventilation	
Ruptured tube cuff	
Endobronchial intubation	
Difficult ventilation	

left nostril. Awake fibreoptic intubation was considered the only option (awake tracheostomy would have been very difficult).

Preparation

All equipment was prepared and checked in advance. The patient was told why an awake intubation was necessary so that they

Table 3 Airway team

Name	Role
Consultant anaesthetist	Airway team leader Responsible for final plan based on all the available information Ultimately responsible Conducts team brief Supervises advanced trainee
Advanced trainee (ST6–7) in Anaesthesia	Perform the airway management within their competency under the supervision of the consultant anaesthetist Helps formulate the airway management plan
Intermediate trainee anaesthetist (ST3) in anaesthesia	Perform sedation using TCI remifenanil Induces patient once position of the tracheal tube has been confirmed
Operator department practitioner	Prepare the airway equipment Assist the anaesthetist undertaking the airway management
Support worker	Act as a 'runner' should an emergency arise or additional equipment is or help is needed
Consultant ENT surgeon	Contributes to the airway management plan Undertake an emergency surgical airway if indicated Perform a rigid laryngoscopy if indicated Support the anaesthetic team
ENT speciality trainee (ST4)	Work under the supervision of the ENT Consultant and perform the roles of the ENT consultant under their supervision
Theatre nurse	Has available equipment ready to allow an immediate surgical airway or rigid bronchoscopy. Needs to be ready in the operating theatre

understood the reasoning behind the decision and what the procedure actually involved. We also explained that the nature of his infection would mean he would be kept sedated and ventilated on ITU for between 12 and 48 h to allow his airway to improve before extubation.

We do not premedicate with benzodiazepines nor do we administer anti-sialogues; in a case such as this, they will be ineffectual. We do prepare the nares with a topical vasoconstrictor to minimize bleeding from the turbinate's vessel-rich mucosal bed and avoid any concomitant topical local anaesthetic. We believe that the use of local anaesthetic in this instance could worsen the airway.[16] Our technique for AFOI has previously been described using single-agent sedation with target-controlled infusion (TCI) remifentanil to facilitate awake fibreoptic intubation,[17] but this may be considered controversial by other anaesthetists in the UK and is just one technique. It provides analgesia and sedation and we believe it is more likely to preserve upper airway reflexes than topicalization with local anaesthetics. This advanced airway technique should not be used for the first time on a complex case without first gaining experience in lower risk cases.

It is advisable to anaesthetize such patients on the operating table rather than a trolley. The former allows better patient positioning, better access to the patient for the anaesthetist (and surgeon should a surgical airway be necessary), and reducing the chance of an accidental extubation when transferring the anaesthetized patient. A decision was also made as to where to manage the airway: in the anaesthetic room or in the theatre itself? The advantage of the anaesthetic room is privacy while the advantage of theatre is its space and lighting should a surgical airway be needed. We elected to anaesthetize the patient in theatre.

All cases of anticipated difficulty should have their neck surface anatomy assessed beforehand. In this case, the thyroid and cricoid cartilages were impalpable because of overlying induration and swelling. The neck itself felt 'woody' in terms of its poor tissue compliance and immobility. This alerted us to the fact that a surgical airway would be a difficult undertaking.

Team briefing

The introduction and implementation of the WHO Surgical Checklist has been reported to reduce in-hospital 30 day mortality.[18] We implemented a team brief at the start of each operating list led by the consultant anaesthetist. In this instance, he clearly stated that this was a 'high stakes' airway with only one clear route of access (LEFT nostril) and that an awake fibreoptic intubation would be performed. Using the ADAM contingency plan (Table 2), it was made clear that bleeding was a real threat and that should the AFOI be abandoned, it would be due to bleeding or the inability to railroad the tracheal tube. In such circumstances, it was extremely unlikely that the sedation could be aborted and the patient returned to full consciousness with a clear airway. In which case, a surgical airway would be needed and that this would be difficult to perform. The composition of the 'airway team' is described in Table 3.

Managing the airway

The patient was arranged in an upright sitting position on the operating table as the patient did not tolerate lying down. Nasal spectacles were fitted and oxygen commenced at 15 litre min^{-1}. I.V. access was obtained and an infusion of Hartmann's solution commenced. The sedationist titrated the TCI remifentanil while maintaining constant verbal communication; the endpoint being a drowsy but cooperative patient. The sedationist was then tasked with monitoring the patient and not the image of the patient's airway on the monitor. Remifentanil has a profound effect on respiration; the patient can be awake but apneoic. The sedationist placed a hand on the patient's chest to assist respiratory monitoring and if movement stopped, he prompted the patient to breathe.

Once the patient had achieved an appropriate level of sedation, the airway operator instructed the ODP to load a warmed 6.0 nasal RAE tube onto a lubricated fibrescope. We ensured the scope had not traversed the Murphy's eye and taped the pilot

balloon tubing to the tube adjacent to the connector so it could not dangle across the patient's face and eyes. Anti-fog solution was carefully applied to the lens of the scope, then the position of the prong of the nasal spec in the left nostril adjusted to allow the scope to enter the nose and the procedure began.

The nostril was easily traversed without traumatizing to the mucosa, but once the oropharynx was entered, no anatomical landmarks could be identified due to tissue oedema and collections of secretions. However, by only advancing the scope into black airspace, the operator soon found himself in the trachea, despite the lack of any recognizable intervening anatomy. The scope was then held in the mid-trachea, avoiding contact with the carina (which could trigger coughing) while preparations were made to deliver the tracheal tube.

The scope was handed to the ODP, who was then instructed to hold its position in the trachea. The airway operator lubricated the tip and cuff of the tube before using two hands to gently advance the tube into the nostril ensuring the bevel faced laterally and so was less likely to traumatize the turbinates. Once through the nostril, the tube was rotated 90° clockwise so the bevel faced the epiglottis (minimizing hold up). Should hold up be experienced the tube would have been rotated 180° anti-clockwise so the bevel now faced the arytenoids: the next point of hold up. Once the tube had entered the trachea, we confirmed its position visually before smartly removing the scope, allowing the patient to breathe easily again as the oedematous airway had been completely occluded by the scope and tube. The anaesthetic circuit with 100% oxygen at 15 litre min^{-1} was attached, bag movement and most importantly CO_2 trace observed before anaesthesia was induced with propofol, and surgery commenced. The lowest recorded Sa_{O_2} during the procedure was 93%. I.V. dexamethesone was administered.

Intraoperative management

The surgeons incised and drained the collections. The erythema and induration on the anterior neck extended towards the sternoclavicular joints, its extent outlined with a marker pen. As airway oedema is expected to worsen in the first 12–48 h after operation, we elected to keep him intubated and sedated. However, before transferring him to the critical care unit, we performed a CT scan to exclude the diagnosis of mediastinitis (suspected in view of the extensive cellulitis and the degree of sepsis). No collection was seen.

Postoperative care

After operation, we closely monitored the airway by nasendoscopy and had a low threshold for re-imaging if considered necessary. Regular reviews were made of microbiology, surgical drains, and whether all sources of infection had been removed. The decision to extubate was taken after 36 h once the airway oedema had resolved. During the interim, great care was taken by nursing staff to avoid accidental extubation.

Extubation strategy

Extubation can be considered as, if not more, challenging than intubation.[19] Consideration was given as to where the extubation should take place: critical care or the operating theatre? In our institution, critical care has the equipment and the personnel with the experience to deal with a patient such as this. A Cook Staged Extubation kit was utilized to facilitate blind reintubation as this was an 'at risk' extubation according to the DAS guidelines.[19] After siting the kit's guide wire under direct vision with a fibrescope and preoxygenation, the patient was sat up and extubated easily under remifentanil sedation (so that the patient was awake and tolerating the tube with appropriate reflex suppression), leaving the guide wire in place. The extubation was successful, and the patient remained on the critical care unit for another 12 h with the staged extubation guide wire *in situ* before it was removed and the patient discharged to the ward. Should the patient have required re-intubation, the Cook re-intubation catheter would have been advanced over the guide wire into the trachea and used as a bougie to facilitate rapid blind reintubation.

Summary

Human factors are vital in the safe and successful management of a patient presenting with an anticipated difficult airway for a surgical procedure. Careful planning and preparation are essential and rely on an accurate history and examination supplemented by specialist imaging such as nasendoscopy. It is important to determine the 'best plan' as sometimes there is only one plan. A team brief allows all members to be aware of their roles and responsibilities and to be on the 'same page' and this must be multi-disciplinary. Clear communication is vital not only with initial intubation but throughout the whole case with an airway team leader coordinating activities and facilitating decision-making.

Declaration of interest

S.M. and P.G. are both faculty members of the Aintree Difficult Airway Management Course. Neither have any financial gain from this course.

MCQs

The associated MCQs (to support CME/CPD activity) can be accessed at https://access.oxfordjournals.org by subscribers to *BJA Education*.

References

1. Health and Safety Executive. *Reducing Error and Influencing Behaviour*. *HSG48*. London: HSE books, 1999; 2
2. Fletcher GC, McGeorge P, Flin RH *et al.* The role of non-technical skills in anaesthesia: a review of current literature. *Br J Anaesth* 2002; **88**: 418–29
3. The case of Elaine Bromiley. Available from http://www.chfg.org/resources/07_qrt04/Anonymous_Report_Verdict_and_Corrected_Timeline_Oct_07.pdf (accessed 29 October 2013)
4. Sheriffdom of Glasgow and Strathkelvin under the fatal accidents and sudden deaths (Scotland) ACT 1976. Determination of Sheriff Linda Margaret Ruxton in Fatal Accident. Available from http://www.scotcourts.gov.uk/opinions/2010FAI15.html (accessed 29 October 2013)
5. National Quality Board. Human Factors in Healthcare: A Concordat from the National Quality Board. London: NHS England, 2013. Available from http://www.england.nhs.uk/wp-content/uploads/2013/11/nqb-hum-fact-concord.pdf (accessed 21 February 2015)
6. Shaw J, Frerk C, Russell J. A commentary on human factors aspects of cases reported to NAP 4. In: Cook TM, Woodall N, Frerk C, eds. *Fourth National Audit Project of the Royal College of*

Anaesthetists and Difficult Airway Society. Major Complications of Airway Management in the United Kingdom. Report and Findings, Chapter 24. London: Royal College of Anaesthetists, March 2011; 193–201
7. Flin R, Fioratou E, Frerk C *et al*. Human factors in the development of complications of airway management: preliminary evaluation of an interview tool. *Anaesthesia* 2013; **68**: 817–25
8. The Aintree Difficult Airway Management Course. Available from http://adam.liv.ac.uk/adam8/login.aspx (accessed 21 February 2015)
9. Salas E, Dickinson TL, Converse S *et al*. Toward an understanding of team performance and training. In: Swezey RW, Salas E, eds. *Teams: Their Training and Performance*. Norwood: Ablex, 1992; 3–29
10. Endsley M. Toward a theory of situational awareness in dynamic systems. *Hum Factors* 1995; **37**: 32–64
11. Mercer S, Park C, Tarmey NT. Human factors in complex trauma. *BJA Education* 2015; **15**: 231–36
12. Rost J. *Leadership for the Twenty-First Century*. Prague: Westport, 1993
13. Gawande AA, Zinner MJ, Studdert DM *et al*. Analysis of errors reported by surgeons at three teaching hospitals. *Surgery* 2003; **133**: 614–21
14. Darshane S, Groom P, Charters P. Responsive contingency planning: a novel system for anticipated difficulty in airway management in dental abscess. *Br J Anaesth* 2007; **99**: 898–905
15. Henderson JJ, Popat MT, Latto IP *et al*. Difficult Airway Society guidelines for management of the unanticipated difficult intubation. *Anaesthesia* 2004; **59**: 675–94
16. Ho AM, Chung DC, To EW, Karmakar MK. Total airway obstruction during local anesthesia in a non-sedated patient with a compromised airway. *Can J Anaesth* 2004; **51**: 838–41
17. Vennila R, Hall A, Ali M *et al*. Remifentanil as primary agent to facilitate awake fibreoptic nasal intubation: an observational study. *Br J Anaesth* 2010; **104**: 522P
18. Van Klei WA, Hoff RG, Van Aarnhem EEHL *et al*. Effects of the introduction of the WHO 'Surgical Safety Checklist' on in-hospital mortality: a cohort study. *Ann Surg* 2012; **255**: 44–9
19. Mitchell V, Dravid R, Patel A. Difficult Airway Society guidelines for the management of tracheal extubation. *Anaesthesia* 2012; **67**: 318–40