



# Techniques and complications of awake fibre-optic intubation – A Survey of Difficult Airway Society members

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## ABSTRACT

**Background:** Awake fibre-optic intubation (AFOI) is a recommended option for managing the anticipated difficult intubation; however, there is no recommended standard technique. We investigated current practice of AFOI among Difficult Airway Society members.

**Methods:** A survey was distributed to members of the Difficult Airway Society (DAS). Questions focussed on technique, complications and caseload within the previous 2 years.

**Results:** Of 588 respondents, most (313; 53%) had performed less than 5 AFOI in the previous 2 years; 61 (10%) had not performed any AFOI and were excluded from further analysis. Of those who had performed AFOI within the preceding 2 years (527), remifentanyl was used most commonly for single-agent sedation (237; 45%). Most anaesthetists (253; 48%) combined co-phenylcaine and lidocaine for airway topicalisation. A spray-as-you-go technique for topical anaesthesia was used most frequently (398; 76%). Of respondents, 109 (21%) encountered complications. Of these, the most frequently reported complications were requiring three or more attempts (41) followed by desaturation <80% (34) and failed AFOI (32). There was no statistically significant difference in complication rate between sedation techniques. **Conclusion:** AFOI remains the gold standard technique for anticipated difficult airway management, but low case numbers is a cause for concern for skill maintenance and difficult airway training. A wide variation in anaesthetic technique for AFOI may be aided by national guidelines for awake tracheal intubation.

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## 1. Introduction

Awake fibre-optic intubation (AFOI) is one of the recommended options for the management of anticipated difficult intubation [1]. The use of a fibre-optic scope to intubate was first documented in 1967 [2], but its use in anaesthetic practice became more established in the 1980's [3]. The technique is a required competence for UK anaesthetists, recognised as part of the Royal College of Anaesthetists syllabus [4] and highlighted as an essential skill in the NAP4 study of major complications of airway management in the United Kingdom [5]. The incidence of AFOI is variable, quoted between 0.7% (Australia) to over 12% (Switzerland) [6]. The incidence in the UK has been quoted as 1.7% of patients undergoing general

anaesthesia [3], with a failure rate of 0–2% [1,3,6–9] and a complication rate of 11–16% [3,7,9].

The Difficult Airway Society (DAS) set up a working party to develop national guidelines for the performance of awake tracheal intubation and these are due for publication in the near future. Previous studies on AFOI have focussed on specific tertiary (university teaching hospitals) centres [1,7–12]; however these have limitations when applied to smaller non-tertiary (non-university teaching hospitals) centres that may lack the experience of and exposure to major airway cases. The aim of our survey was to investigate current practice of AFOI, to include both tertiary and non-tertiary centres and to focus on level of experience, techniques for sedation, and airway topicalisation as well as complications associated with AFOI.

## 2. Methods

We conducted a DAS approved survey, sent to all 1832 DAS

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members in 2016 via an email with a link to an online survey system ([www.surveymonkey.com](http://www.surveymonkey.com) - see appendix 1). A follow-up email reminder was sent after 2 weeks, and data collection closed one month later as per the DAS survey policy. Questions were reviewed for inclusion by the DAS survey committee prior to distribution, and included: grade of respondent, number of AFOIs performed and complications encountered in the previous 2 years, (specifically: desaturation to <80%, local anaesthetic toxicity, trauma to the airway, three or more attempts, cardiovascular instability, abandoned procedure, can't intubate can't oxygenate, negative pressure pulmonary oedema or death), and sedation and topicalisation techniques. Data was collated into a standardised spreadsheet using Microsoft Excel for analysis. Statistical analysis was performed using the Chi-square test (via <https://www.socscistatistics.com/tests/chisquare/default2.aspx>).

Ethics committee approval was not sought for this study.

### 3. Results

Five hundred and eighty-eight responses were received, giving a response rate of 32%. Of these, 445 (76%) were consultants (>10 years post-qualification), 113 (19%) specialist registrars (SpRs; 5–9 years post-qualification) and the remainder, (30; 5%) were either senior house officers (SHOs; 2–4 years post-qualification), associate specialists or fellows (not within a training programme; variable level of experience.) Additional data was provided by 308 respondents who listed their place of work while completing the questionnaire. Of these, 167 (54%) worked in tertiary centres and 141 (46%) worked in non-tertiary centres.

#### 3.1. Experience and complications

The number of AFOI carried out and the incidence of complications encountered in the previous 2 years are summarised in Table 1. Sixty-one (10%) respondents reported that they had not performed any awake fibre-optic intubations (AFOI's) within the previous 2 years. Forty-five (74%) of these respondents were consultants, 11 (18%) SpRs, 4 (7%) associate specialists and 1 (1.6%) SHO. Further data regarding complication rate and standard technique from this group has been excluded from further analysis.

Of the 527 (90%) respondents who had performed AFOI, most (252; 48%) had performed 1–5 AFOI's; 96 (18%) had performed 6–10, 69 (13%) performed 11–15 and 33 (6%) performed 16–20. Only 77 (15%) had performed more than 20 AFOI in the previous 2 years [Table 1].

Of the 167 who reported to work in tertiary centres, 52 (31%) had performed between 1 and 5 AFOIs and only 25 (15%) had performed >20 intubations. This is compared to those who reported to work in non-tertiary centres, where 75 (53%) had performed between 1 and 5 AFOIs and 18 (13%) had performed >20. There was no statistical difference between AFOI case numbers at tertiary vs. non-tertiary centres ( $p = 0.0502$ ). Calculations based on the minimum and maximum reported numbers of AFOI (*minimum [or maximum] number of AFOI per group x number of respondents per*

*group*/527 x 2) estimate that respondents performed an average of 3.1–4.8 AFOI's per annum.

Of respondents undertaking AFOI, 109 (21%) encountered complications; 36 (33%) of these had performed >20 AFOIs within the previous 2 years, compared with 30 (28%) in the 1–5 group, 20 (18%) in the 6–10, 17 (16%) in the 11–15, and 8 (7%) in the 16–20 groups. Most (81; 74%) were consultants, 24 (22%) were SpRs, and the remainder (4, 3.6%) fellows or associate specialists. Of the non-consultant group, most (18; 64%) were supervised when complications were encountered. Two (7%) reported that they were supervised some of the time, 1 (3%) most of the time and 1 (3%) was not supervised.

The types of complication encountered are summarised in Table 2, the commonest of which was requiring three or more attempts at AFOI. Some respondents reported multiple complications. There were two reports of a Can't Intubate, Can't Oxygenate (CICO) scenario, with one episode of negative pressure pulmonary oedema and subsequent death. The incidence of complications between experience groups is statistically significant, with a higher proportion occurring in the more experienced group (1–5 AFOIs vs > 20 AFOIs;  $p < 0.0001$ ).

#### 3.2. Topicalisation techniques

Most anaesthetists (253; 48%) use a combination of co-phenylcaine and lidocaine for routine topicalisation of the airway, with a smaller number (70; 13%) using co-phenylcaine as the sole agent. Cocaine was used by 61 (12%) anaesthetists, either alone (9; 1.7%), in combination with lidocaine (37; 7%), or in multiple combinations with additional agents (15; 2.8%). Lidocaine was used as a single agent by 55 (10%) respondents. The most common concentration used overall was 4% (227; 43%) or a combination of 4% and 10% (121; 23%). Oxymetazoline was used by 57 (11%) clinicians in combination with local anaesthetic and/or additional agents.

Anaesthetists used a combination of techniques to administer local anaesthetic, with spray-as-you-go (SAYGO) being used by the majority (398; 76%) followed by Mucosal Atomising Device® (283; 56%). Nerve blocks were rarely used, being reported by only 3 (0.6%) anaesthetists.

#### 3.3. Sedation techniques

A minority (9; 1.7%) of anaesthetists reported they did not use any sedation for AFOIs. Single-agent sedation was used by 260 (49%) clinicians, most commonly remifentanyl (237; 45%), either as a target-controlled infusion (193; 37%) or by standard infusion (ml/hr) (44; 8%). Others utilised a combination of drugs, the commonest being midazolam – remifentanyl (79; 15%) or propofol – remifentanyl (62; 12%).

Overall, a higher proportion of anaesthetists in the solo remifentanyl group (45; 19%) reported encountering complications compared to those using midazolam-remifentanyl (13; 16%) or propofol-remifentanyl (9; 15%). Specific complications encountered by these groups are detailed in Fig. 1. Some respondents reported

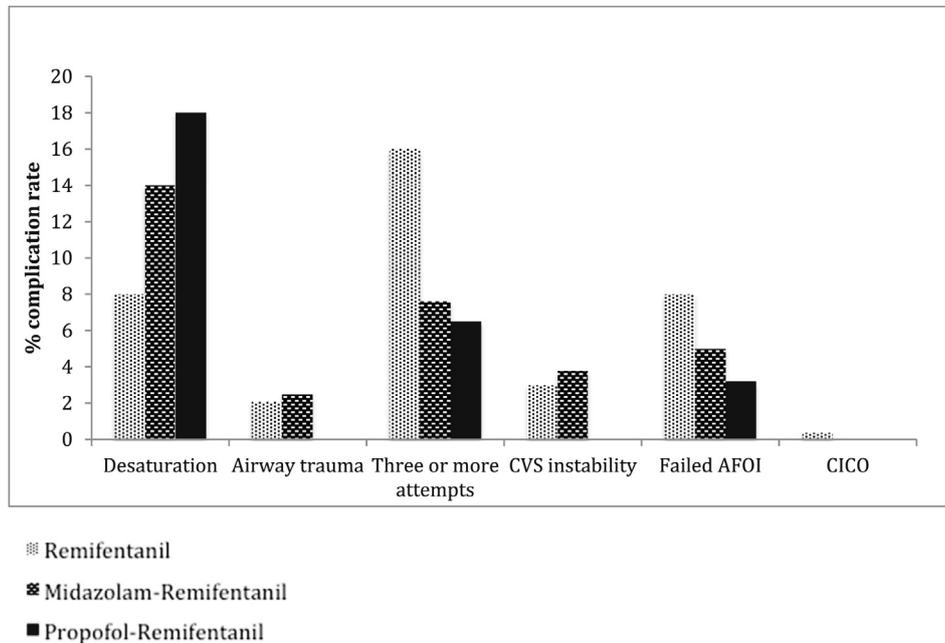
**Table 1**  
Number of AFOIs performed in 2 years.

Number of AFOI in 2 years	Total	No complications	With complications	% complications
0	61	0	0	N/A
1–5	252	222	30	12
6–10	96	76	20	21
11–15	69	52	17	25
16–20	33	27	6	18
>20	77	41	36	47

**Table 2**  
Complications encountered by 527 anaesthetists during AFOI according to grade of anaesthetist.

Complication	Total – n (%)	Consultants	SpRs	Fellows	Associate specialists	SHOs
3 or more attempts <sup>a</sup>	41 (7.7)	35	4	1	1	0
Desaturation to <80%	34 (6.4)	27	7	0	0	0
Procedure abandoned	32 (6)	27	5	0	0	0
Airway trauma	10 (1.8)	8	2	0	0	0
Cardiovascular instability	8 (1.5)	7	0	0	1	0
Local anaesthetic toxicity	3 (0.5)	3	0	0	0	0
Can't intubate, can't oxygenate	2 (0.3)	2	0	0	0	0
Negative pressure pulmonary oedema	1 (0.2)	1	0	0	0	0
Death	1 (0.2)	1	0	0	0	0

<sup>a</sup> An attempt is defined as removal and re-insertion of the fiberoptic scope.



**Fig. 1.** Method of sedation and complications.

multiple complications. There was no statistically significant difference demonstrated between sedation technique and incidence of complications (remifentanyl vs. midazolam-remifentanyl  $p = 0.496$ ; remifentanyl vs. propofol-remifentanyl  $p = 0.457$ ).

#### 4. Discussion

This was a retrospective, survey-based study, based on recall of events over the preceding 2 years. Questioning addressed respondents' standard practice in terms of AFOI techniques and complications encountered.

Within this cohort, AFOI remains a recognised option for the management of the anticipated difficult airway. Due to the study design, we were unable to calculate the complication rate for AFOI as our study addressed the complication rate of anaesthetists rather than of the AFOI technique. Previous publications based on AFOI cases quote AFOI complication rates of 11–16% [3,7,9] and overall failure rates of between 0 and 2% [1,7–9,11–15]. However, these studies represent predominantly data from tertiary centres, and are unlikely to be reflective of practice and case exposure at non-tertiary centres, where fewer major and complex head and neck surgery cases are typically performed.

Twenty-one percent of anaesthetists in this survey reported encountering complications within the previous 2 years. Only 6% of

our respondents reported failed AFOI. There were two cases reported that resulted in a Can't Intubate, Can't Oxygenate (CICO) scenario, of which one developed negative pressure pulmonary oedema and died. The commonest reported complication was requiring 3 or more attempts at AFOI. There is no universal standard at present for the maximum number of permitted attempts at AFOI (unlike direct laryngoscopy), so 3 or more attempts was selected as an indication of difficult fibre-optic intubation.

Results show a statistically significant increase in complications with increased experience. This may be a reflection of a higher workload in addition to a caseload of greater complexity or urgency rather than causality. Additionally, more experienced practitioners are likely to have a greater awareness of potential complications, coupled with an increased tendency to report, however further work in this area is warranted. These findings differ from those of El-Boghdady et al., which found that more experienced operators encountered fewer complications [9].

This survey was distributed via the Difficult Airway Society (DAS), thus the recipients were a self-selected group with an apparent interest in the management of difficult airways. Despite this, the majority of respondents (53%) had performed less than 5 AFOI cases within the previous 2 years, with only 15% conducting more than 20 AFOI per year. The majority (74%) of the group who had not performed any AFOI in the previous 2 years were

consultants. This may suggest a growing trend away from the use of AFOI in favour of videolaryngoscopy or alternative techniques, such as prolonged apnoeic oxygenation using high-flow nasal oxygen devices (e.g. THRIVE with positive pressure ventilation), or increased use of second generation supraglottic airway devices and sugammadex [3,5,14,15], and account for an increasing reluctance to utilise AFOI as a technique in the anticipated difficult airway [5,14–16]. This was reflected in NAP-4, where AFOI was not used despite clear indications in 18 cases of subsequent airway-related incident [5], and forms the basis for more recent studies comparing AFOI with videolaryngoscopy [3,15,16] for the anticipated difficult airway.

This survey addressed standard approach to AFOI and may not account for changes to practice in emergency situations or account for variations to standard technique in given clinical situations. In addition, some anaesthetists may have listed all drugs they might use rather than what their standard protocol is. Within this cohort, several sedation strategies were employed, from no sedation to multiple agents being used in combination. Remifentanyl was used as a sole agent by 45% of anaesthetists. These findings differ from the findings of El-Boghdadly et al. [9], which found that in most cases (86%) within their tertiary centre, anaesthetists favoured a remifentanyl TCI – propofol TCI technique, with only 8.7% of AFOIs managed using an opioid-only technique. In our broader cohort, 47% utilised an opioid-only technique. A recent literature review reflected on the breadth of technique employed to achieve conscious sedation for AFOI, recommending either remifentanyl or dexmedetomidine for optimal conditions for AFOI [12]. This is consistent with the survey findings, as dexmedetomidine is not currently widely used in anaesthetic practice in the UK. The variation in sedative strategy may change with the planned publication of national DAS guidelines for awake tracheal intubation. However, the range of techniques described by respondents raises the issue of standardisation at a local level given such disparate current practice. As in previous studies, we found no statistical correlation between sedation technique and incidence of complications [9,17].

Local anaesthetic choices favoured lidocaine-based strategies, with few clinicians reporting routine use of cocaine for airway topicalisation. This may reflect availability, local protocol, concerns regarding potential adverse effects of cocaine and evidence from a previous study showing no difference between phenylephrine/lidocaine spray and cocaine [18]. Additionally, as with sedative strategy, these choices may include all methods used rather than standard practice. The low use of cocaine in our survey is in contrast to that reported by Heidegger in Switzerland where cocaine was used in 99.2% of the nasotracheal intubations [11]. The commonest delivery technique included a spray-as-you-go (SAYGO) strategy (75.5%). This benefits from a high level of versatility and allows for precise application, both above and below the vocal cords. Trans-tracheal injection was used by 56 (10.6%) anaesthetists. The local anaesthetic techniques in our survey differ significantly from those in Heidegger's paper where SAYGO and transtracheal injection were used in only 6.3% and 93.7% AFOI respectively [11].

A recent study concentrated on practice within tertiary centres [9], reporting that most (64%) operators have performed more than 20 AFOIs. However, these numbers are derived from a full career history, making this survey potentially more representative of current practice, particularly outside of the tertiary care environment. Caseload numbers in this survey indicate that even in tertiary centres only a minority of clinicians are performing large numbers of AFOIs. Given the time period in this cohort, this may further support the notion that anaesthetists are moving away from AFOI in routine anaesthetic practice.

Findings have implications for departmental ability to comply

with NAP-4 recommendations that 'all anaesthetic departments should provide a service where skills and equipment are available to deliver AFOI' [5]. AFOI is known to require regular practice to maintain skills [14]. Degradation of ability to perform complex practical skills in a medical setting has been shown to occur within 6–18 months [19]. This survey suggests that skill maintenance is not achieved by 53% of anaesthetic respondents who perform less than 5 AFOIs over a 2-year period given that 10 is the given accepted number for competence in this procedure [14].

This low number of AFOI cases has additional implications for airway training, as fibre-optic intubation techniques are known to be difficult to learn [14,17]. While there have been some successes using simulation training to increase success rates [20], there remains a training issue due to the lack of case numbers required to achieve competence in fibre-optic techniques [10]. Previous trainee surveys have highlighted significant discrepancies between caseload and perception of competence [21], suggesting that airway training in AFOI remains an issue [22]. Indeed, if caseload numbers from a survey of airway enthusiasts are this low, who will be able to teach trainees this technique in years to come?

Several theories as to the reasons behind lower AFOI rates among UK anaesthetists have been posed, including economic and service pressures with an increasing emphasis on theatre efficiency, a potentially narrower range of considered indications for AFOI, and, as supported by findings in this survey, a perceived or actual lack of skill in this procedure [10].

Following the findings and recommendations from NAP4 [5], issues with airway training, including specifically the provision of training for fibre-optic intubation, have been discussed and debated. In addition to high-fidelity simulation, steps to improve trainee competence in advanced airway techniques within the UK have included designated airway training blocks, dedicated workshops and short courses (including those that use the attendees as live models) and 'bench' models to improve fibre-optic motor skills [22]. The issue of consent for advanced fibre-optic procedures for the sole purpose of training has also been widely debated, with some feeling that this may be an option to aid adequate advanced airway training [22].

Key limitations of this study include a reliance of recall over a 2-year period and a low response rate, recognising that non-responders may influence the available data. This was hampered by an inability to follow up non-responders beyond a routine email distributed via the DAS email system. However, a response from 588 anaesthetists with an average of 3.2 AFOI a year represents data on about 3763 AFOI over a two-year period. Additional limitations include a lack of data on elective vs. emergency cases, standard practice, method of oxygenation during AFOI, type of endotracheal tube or route of intubation, and questions focussed on availability of training opportunities (or lack thereof). Further work in this area would be desirable.

## 5. Conclusion

Awake fibreoptic intubation for the management of anticipated difficult airway is a safe technique but requires appropriate training and upkeep of skills. Case numbers demonstrated in this survey are low even in tertiary centres and this may impact on both anaesthetic training in difficult airway management and service delivery in a department. Questions as to how to increase exposure to AFOI, or the decision to embrace alternatives for the management of the difficult airway pose interesting questions for airway experts and trainers in the years to come. There is hope that the publication of the DAS awake tracheal intubation guidelines may help in standardising training in this technique, which is now less familiar to many anaesthetists.

## Details of contributions

KG: Analysis and data interpretation, write up and revisions.

MCM: Conception and design, data acquisition, analysis and interpretation, article revision.

SJ: Conception and design, acquisition of data.

VA: Conception and design, data acquisition and analysis, article revision.

## Declaration of interests

The authors declare that they have no conflict of interest.

Preliminary results of this survey were presented as a poster at the DAS annual scientific meeting, London 2017.

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## Appendix 1

### Questionnaire

- How many Awake Fiberoptic Intubations have you performed in the last two years (approximately)?
- Have you had any complications related to Awake Fiberoptic Intubation in the last two years? YES/NO (if no then proceed to Q. 10)
- Please state number of Patient-related complications, if any (approximately)
  - Abandoned
  - CVS instability
  - Death
  - Desaturation <80%
  - Failure
  - More than 2 attempts
  - Significant nasal bleeding
  - Signs of LA toxicity
  - Trauma to upper airway
  - Other
  - If you noted Abandoned or Failure please state reason/reasons
- Please state number of equipment/unit-related complications, if any (approximately)
  - Equipment failure
  - Lack of drugs
  - Lack of equipment
  - Lack of experience
  - Lack of theatre staff
  - Other (please specify)
- When complications occurred, what sedation techniques were used?
  - Fentanyl
  - Propofol infusion
  - Midazolam
  - Remifentanyl TCI
  - Propofol TCI
  - Remifentanyl infusion
  - Other (please specify)
- When complications occurred, what type of local anaesthesia & vasoconstriction were used?
  - Co-phenylcaine spray
  - Cocaine
  - Oxymetazoline spray
  - Lidocaine 4%
  - Lidocaine 10%
  - Other (please specify)

- When complications occurred, what local anaesthetic administration techniques were used?
  - Spray as you go
  - Mucosal atomising device
  - Mackenzie technique
  - Gargle technique
  - Nebulised lidocaine
  - Needle cricothyroidotomy
  - Nerve blocks
  - Other (please specify)
- Grade of anaesthetist
  - Consultant
  - CT
  - Trust grade
  - SpR
  - Other
- Were you supervised when you experienced complications (if trainee)?
  - All of them
  - None of them
  - Most of them
  - Some of them
  - N/A
- What sedation techniques do you normally use? (Tick all that apply)
  - Fentanyl
  - Midazolam
  - Alfentanil
  - Propofol TCI
  - Propofol infusion
  - Remifentanyl TCI
  - Remifentanyl infusion
  - Other (please specify)
- What type of local anaesthesia & vasoconstriction do you normally use?
  - Co-phenylcaine Spray (5% lidocaine and 0.5% phenylephrine)
  - Cocaine
  - Oxymetazoline Spray
  - Lidocaine 4%
  - Lidocaine 10%
  - Other (please specify)
- What local anaesthetic administration techniques do you use?
  - Spray as you go
  - Mucosal atomising device
  - Mackenzie technique
  - Gargle technique
  - Nebulised Lidocaine
  - Needle Cricothyroidotomy
  - Nerve blocks
  - Cannula Cricothyroidotomy
  - Other (please specify)
- Are you aware of any of the following serious incidents related to awake fiberoptic intubation occurring in your hospital in the past two years?
  - Significant upper airway trauma and bleeding
  - Abandoned/failed awake fiberoptic intubation
  - Development of a Can't intubate can't oxygenate (CICO) situation
  - Development of negative pressure pulmonary oedema
  - Death
  - None
  - Other (please specify)
- Please provide NHS Trust name (optional)

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