A Retrospective Study of Success, Failure, and Time Needed to Perform Awake Intubation

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ABSTRACT

Background: Awake intubation is the standard of care for management of the anticipated difficult airway. The performance of awake intubation may be perceived as complex and time-consuming, potentially leading clinicians to avoid this technique of airway management. This retrospective review of awake intubations at a large academic medical center was performed to determine the average time taken to perform awake intubation, its effects on hemodynamics, and the incidence and characteristics of complications and failure.

Methods: Anesthetic records from 2007 to 2014 were queried for the performance of an awake intubation. Of the 1,085 awake intubations included for analysis, 1,055 involved the use of a flexible bronchoscope. Each awake intubation case was propensity matched with two controls (1:2 ratio), with similar comorbidities and intubations performed after the induction of anesthesia (n = 2,170). The time from entry into the operating room until intubation was compared between groups. The anesthetic records of all patients undergoing awake intubation were also reviewed for failure and complications.

Results: The median time to intubation for patients intubated post induction was 16.0 min (interquartile range: 13 to 22) from entrance into the operating room. The median time to intubation for awake patients was 24.0 min (interquartile range: 19 to 31). The complication rate was 1.6% (17 of 1,085 cases). The most frequent complications observed were mucous plug, endotracheal tube cuff leak, and inadvertent extubation. The failure rate for attempted awake intubation was 1% (n = 10).

Conclusions: Awake intubations have a high rate of success and low rate of serious complications and failure. Awake intubations can be performed safely and rapidly. **(Anesthesiology 2016; 125:105-14)**

AWAKE intubation is the standard of care for management of the anticipated difficult airway in adult patients.[1,2] This has traditionally been accomplished using flexible bronchoscopy, although more recently, awake video laryngoscopy (VL)[3–5] has been described. Difficult or impossible ventilation and tracheal intubation can be anticipated in patients with myriad conditions (*e.g.*, atlantooccipital disease, small mandibular space, head and neck malignancies with prior radiation, obesity with sleep apnea), and induction of anesthesia in these patients can lead to potentially life-threatening airway obstruction.[6] Repeated attempts to secure the airway can worsen the situation, and it is therefore prudent to secure the airway in an awake patient when difficulty is anticipated. While the failure rate of this technique may vary by practitioner, Law *et al.*[7] reported an impressive 98% success rate (with few complications) in awake intubations performed at a Canadian tertiary-care center.

In spite of clinical indication and a good safety and success profile, experienced anesthesiologists may incorrectly forego awake intubation.[8] The reasons for avoiding awake intubation are not always clear, but several possible explanations exist. First, practitioners may be worried about patient anxiety or discomfort during an awake intubation.[9] A prior unpleasant patient experience with an awake intubation may dissuade the anesthesiologist from employing this technique. This could lead one to avoid the technique from the outset or to deviate from an initial plan of awake intubation if a patient expresses resistance to the idea during the preoperative discussion. Second, in order to perform successful awake intubation, the airway must be anesthetized. This process requires skill and can take additional time. Production pressure in the

What We Already Know about This Topic

- Awake intubation is recommended in many airway management guidelines when difficult airway is anticipated
- We do not know the average time taken to perform awake intubation or details of the cardiorespiratory effects of the procedure

What This Article Tells Us That Is New

- This large retrospective analyses of 1,085 awake intubations performed in an academic hospital revealed that awake flexible bronchoscopic intubation added approximately 8 min of time in the operating room compared to asleep intubation techniques
- Awake intubation was successfully performed with low failure rate (1%) and low complication rate (1.6%) under hemodynamically stable conditions

This article is featured in "This Month in Anesthesiology," page 1A. This article has a video abstract.

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operating room (OR) may lead physicians to cut corners in general,[10–13] and this may apply to avoidance of awake intubation as well. Third, bronchoscopy skills are challenging to attain and are prone to decay, potentially leading to practitioner discomfort with awake flexible bronchoscopy if not continually practiced.[14,15] Finally, awake intubations may be perceived as potentially dangerous if they cause a pronounced sympathetic response.[16,17] Other reasons may exist, but it may be that these considerations lead to a perception that awake intubation is less desirable than alternative techniques, such as VL after the induction of general anesthesia.[14,18]

While there are data evaluating various sedation and airway topicalization techniques to facilitate awake intubation,[16,17,19–27] we are unaware of reports describing the additional time needed to complete sedation, airway topicalization, and awake intubation, in total. This information is important to the specialty if the perception that awake techniques are undesirable leads anesthesiologists to avoid the safest airway management strategy. In this study, we sought to determine (1) the time required to successfully perform awake intubation (compared to postinduction tracheal intubation); (2) its effects on hemodynamic parameters; (3) its complications and causes of failures; and (4) whether surgeons and anesthesiologists correctly perceive the amount of time it adds to the procedure.

Materials and Methods

Approval was obtained from the Mount Sinai Institutional Review Board/Program for Protection of Human Subjects for this retrospective study. Informed consent was waived. Intraoperative records for all general anesthetics utilizing endotracheal tubes occurring between January 1, 2007, and February 20, 2014, at our hospital were utilized to derive the final data set. This data set is described in table 1. The January 2007 cutoff date was used because awake intubation documentation after that point is uniform at our institution. Records of general anesthetics in adults greater than 18 yr of age were used in the analysis. Exclusion criteria included incomplete data reports and preintubation procedures (arterial or central line placement, neuraxial anesthetic), as this was thought by the investigators to add time before intubation and would confound results (fig. 1).

From the records queried, two groups were established: the awake intubation group consisted of all instances of awake intubation conducted or supervised by an anesthesiologist, and the asleep intubation group consisted of a matched subset of the postanesthetic induction intubations, by any method, conducted or supervised by an anesthesiologist during the same time period. For each awake intubation case, two asleep intubation cases meeting the inclusion/exclusion criteria listed in figure 1 were identified by propensity matching on factors listed in table 1.

Table 1. Characteristics of Study Population

	All Before Exclusion (n = 133,703)	Asleep Before Exclusion (n = 132,363)	Matched Asleep (n = 2,170)	Awake (n = 1,085)	SMD
Age (yr)	47.83 (22.17)	47.73 (22.19)	59.64 (14.55)	59.51 (13.73)	–0.1304
Sex					
Male	62,480 (46.7%)	61,585 (46.5%)	1,467 (67.6%)	726 (66.9%)	–0.0069
Female	71,207 (53.3%)	70,762 (53.5%)	703 (32.4%)	359 (33.1%)	
Undetermined	11 (< 0.01%)	11 (< 0.01%)			
Not recorded	5 (< 0.01%)	5 (< 0.01%)			
ASA status					
1	19,371 (14.5%)	19,358 (14.6%)	29 (1.3%)	11 (1.0%)	0.0092
2	52,191 (39.0%)	51, 999 (39.3%)	382 (17.6%)	160 (14.7%)	
3	45,702 (34.2%)	44,869 (33.9%)	1,291 (59.5%)	705 (65.0%)	
4	16,186 (12.1%)	15,887 (12.0%)	460 (21.2%)	208 (19.2%)	
5	242 (0.2%)	239 (0.2%)	8 (0.4%)	1 (0.1%)	
6	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	
Not recorded		11 (< 0.1%)	0 (0.0%)	0 (0.0%)	
Emergency					
Yes	11,163 (8.3%)	11,021 (8.3%)	218 (10.0%)	111 (10.2%)	0.0018
No	122,540 (91.7%)	121,342 (91.7%)	1,952 (90.0%)	974 (89.8%)	
BMI (kg/m^2)*	27.0 (6.9)	26.9 (6.9)	27.7 (6.9)	27.3 (8.3)	–0.0902
Has hypertension	43,804 (32.8%)	43,164 (32.6%)	1,033 (47.6%)	506 (46.6%)	–0.0051
Has CAD	15,073 (11.3%)	14,888 (11.2%)	229 (10.6%)	127 (11.7%)	0.0115
Has CHF	7,123 (5.3%)	7,070 (5.3%)	53 (2.4%)	29 (2.7%)	0.0023
Has COPD	15,306 (11.4%)	15,089 (11.4%)	365 (16.8%)	183 (16.9%)	0.0041
Has OSA	4,207 (3.1%)	4,114 (3.1%)	151 (7.0%)	76 (7.0%)	0.0005

Age (yr) and body mass index (BMI) are reported as means and SDs.

*BMI values that were missing, as well as those < 15 and > 70, were excluded in order to exclude charting error.

ASA = American Society of Anesthesiologists; CAD = coronary artery disease; CHF = congestive heart failure; COPD = chronic obstructive pulmonary disease; OSA = obstructive sleep apnea; SMD = standardized mean difference between awake and matched asleep.

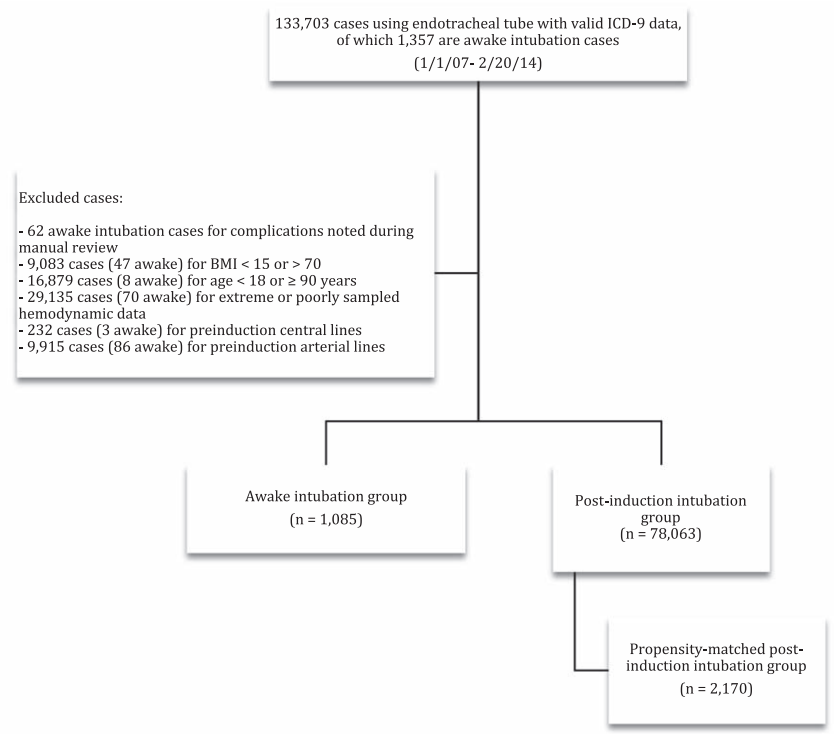

Fig. 1. Flow chart of case selection. A total of 272 awake intubation cases and 55,640 asleep intubation cases were excluded. Some cases were excluded for multiple reasons. BMI = body mass index; ICD-9 = *International Classification of Diseases*, Ninth Revision.

The primary outcome measure was time, in minutes, to successful intubation. This was defined as the time elapsed from the patient entering the OR ("patient in OR") to the time of intubation ("endointubation"), as recorded by the anesthesia practitioner in the Anesthesia Information Management System (AIMS) (CompuRecord®, Philips Electronics North America Corp, USA). The secondary outcomes were mean arterial pressure (MAP) and heart rate during the periintubation period. These data are passively and routinely recorded by the AIMS. To determine the potential bias introduced by the large number of cases excluded for inaccurate or incomplete records, the primary and secondary outcomes were also measured for cases excluded for those reasons for comparison.

The study group reviewed each chart individually to determine whether there existed any factors that would lead to exclusion of a case from analysis, or whether there were complications associated with the intubation procedure. The anesthetic chart for each awake intubation underwent an initial review by at least one of the authors and was flagged for further review if any complication appeared to be present based on available intraoperative documentation. Subsequently, as a group, four of the authors (T.T.J., J.H., J.S.G., and S.D.) reviewed the anesthetic charts for each awake intubation case that was flagged to (a) determine whether that case met exclusion criteria and (b) make note of the nature of any complications. The hospital electronic medical record was utilized to review the postoperative course as necessary, and any disputes regarding the resultant complication or failure (n = 1) were adjudicated by a fifth author (A.I.L).

In addition, a survey was distributed by electronic mail to the Department of Anesthesiology and Department of Surgery resident and attending physicians. Survey participants were asked: "How much additional time does it add to the anesthetic induction when a patient needs to have their airway secured with an awake fiberoptic technique (*i.e.*, for a difficult airway)?" Responses were collected anonymously using REDCap software version 5.7.3 (Vanderbilt University, USA).

Statistical Analysis

Patient and disease characteristics are described as percents (N), medians (interquartile ranges [IQRs]), or means (SDs). For comparisons between awake and asleep, chi-square or Fisher exact test was used for categorical variables, and Student's *t* test or Mann–Whitney rank test was used for continuous variables, as appropriate. Differences were considered significant if the *P* values were less than 0.05 (two-tailed). Propensity matching was used to produce a set of asleep patients similar to the set of awake intubation patients. Through this, we sought to control for various factors that could affect time to intubation and periintubation hemodynamics. Specifically, we fit a logistic regression model to predict the propensity for receiving awake intubation using preoperative variables, which included age, gender, body mass index (BMI), American Society of Anesthesiologists (ASA) physical status classification, whether the case was an emergency, and whether or not the patient had obstructive sleep apnea (OSA), chronic kidney disease, end-stage

renal disease, hypertension, congestive heart failure (CHF), chronic obstructive pulmonary disease, coronary artery disease (CAD), and atrial fibrillation or flutter. Next, we paired the awake and asleep subjects with a 1:2 ratio based on the propensity scores using the nearest neighbor matching without replacement. Caliper matching was not used. The balance between the two groups was carefully examined based on the standardized mean differences between groups (table 1). The analysis was performed using the MatchIt package in R 3.2.3 (The R Foundation for Statistical Computing, Austria).

In the awake intubation group, we hypothesized that certain factors may impact time to intubation, so we conducted ordinary least-squares multiple linear regression analysis using a set of chosen factors to determine how they affected the time to intubation. The factors that were chosen were common comorbid conditions (*e.g.*, CHF, CAD, OSA, BMI) and procedural factors (*e.g.*, performance of injections for nerve blockade) that may affect time to intubation (table 2).

All regressions were performed with and without logarithmic transformation. Because the results are similar, we present the findings based on untransformed analysis. This was performed on the set of awake intubations.

Results

Before propensity matching, 272 of 1,357 awake intubation cases were excluded (20%) and 55,640 of 133,703 asleep intubation cases were excluded (41%). The majority of exclusions were due to erroneous or incomplete records. The median time to intubation for cases included in the final analysis was 24.0 min (IQR: 19 to 31) for awake intubations and 16.0 min (IQR: 13 to 22) for asleep intubations (P < 0.0001). By comparison, in cases excluded due to erroneous or missing data, the median times to awake and asleep intubation were 21 min (IQR: 16 to 27.2) and 12 min (IQR: 9.0 to 15.0), respectively (P < 0.0001).

Table 2. Factors Influencing the Time to Successful Awake Intubation Using Flexible Bronchoscopy

	Time (min)	SE	95% CI	*P* Value
Intercept	13.940	6.080	2.010 to 25.871	0.022
CAD	1.250	1.021	–0.754 to 3.253	0.221
CHF	2.566	2.057	–1.470 to 6.603	0.212
COPD	–1.075	0.847	–2.737 to 0.587	0.205
OSA	–0.437	1.332	–3.051 to 2.177	0.743
Hypertension	0.093	0.667	–1.15 to 1.401	0.889
BMI (per point)	**0.122**	**0.044**	**0.036 to 0.207**	**0.006**
ASA status	0.826	0.528	–0.211 to 1.862	0.118
Emergency	**–2.664**	**1.041**	**–4.706 to** –0.622	**0.011**
Topical only	5.539	5.812	–5.866 to 16.944	0.325
Injected blocks	**2.643**	**0.627**	**1.413 to 3.874**	**< 0.001**
Nasal intubation	–0.990	0.659	–2.282 to 0.303	0.133

Ordinary least-squares regression analysis. Body mass index (BMI), classification as an emergency, and injected blocks were the only factors to have a significant effect on the time to intubation. The bold factors had *P* values less than 0.05.

ASA = American Society of Anesthesiologists; CAD = coronary artery disease; CHF = congestive heart failure; COPD = chronic obstructive pulmonary disease; OSA = obstructive sleep apnea.

The preintubation heart rate medians for cases excluded for erroneous or missing data were 87 beats per minute (BPM; IQR: 72 to 96) for awake intubations and 81 BPM (IQR: 70 to 95) for asleep intubations (P = 0.0947). By comparison, cases included in the final analysis had preintubation heart rate medians of 88 BPM (IQR: 77 to 99) for awake intubations and 75 BPM (IQR: 67 to 86) for asleep intubations (P < 0.0001). Finally, the median MAPs before intubation (awake *vs.* asleep) for excluded cases were 112 mmHg (IQR: 99 to 122) and 96 mmHg (IQR: 83 to 107), compared to 107 mmHg (IQR: 97 to 118) and 101 mmHg (IQR: 91 to 112) for included cases (P values: 0.0094 and < 0.0001).

After all exclusions, 1,085 awake intubations were recorded during the study period of a total of all possible intubations, for a rate of 0.8%. Of these, 886 awake intubations were performed in distinct patients, and 121 patients received 2 or more awake intubations. The set of awake intubation cases were propensity matched, as described in Methods, on a 1:2 basis with asleep intubation cases. Table 1 shows the demographic data for the group undergoing awake *versus* postinduction intubations after matching.

The largest number of awake intubations (n = 747) were performed for patients with head and neck malignancies, OSA, or angioedema. Eighty-five awake intubations were performed in patients with morbid obesity (BMI greater than 39 kg/m^2). For the remainder, the indication for awake intubation was not clear based on the limited data available in the AIMS.

The median time to intubation for patients intubated post induction was 16.0 min from entry into the OR. This was aggregated across all methods of asleep intubation (*e.g.*, direct laryngoscopy [DL], VL, fiberoptic bronchoscopy [FB]). The median time to intubation for awake patients (all devices: DL, VL, and FB) was 24.0 min (table 3). These times were significantly different (asleep *vs.* awake; P < 0.001). Performance of awake intubation, including topicalization, added an average of 8 additional minutes onto the total time from entry into the OR to intubation. The distribution of intubation times was, in both samples, skewed positively, with a minority of cases requiring an extended time before intubation (fig. 2).

There were only three cases where topicalization was documented to begin before OR entry in the holding area. Glycopyrrolate was administered before OR entry in 100 of 1,085 cases. Overall, 9% of awake intubations and 2% of asleep intubations took 40 min or more from entry into the OR. Performing superior laryngeal nerve and/or transtracheal blocks by injection added on average 2.6 min to the intubation process. Time to intubation did not differ significantly for nasal *versus* oral routes, nor by ASA classification or the chosen comorbidities. For each increment of BMI of

Table 3. Time (min) to Intubation from Entry into Operating Room by Device

	All Devices		FB		DL		VL	
	Awake (n = 1,085)	Asleep (n = 2,170)	Awake (n = 1,055)	Asleep (n = 146)	Awake (n = 8)	Asleep (n = 1,889)	Awake (n = 22)	Asleep (n = 135)
All propensity-matched cases								
Mean (SD)	26.1 (10.14)	18.5 (9.44)	26.1 (10.18)	22.5 (11.41)	29.8 (9.76)	17.8 (8.63)	24.8 (7.7)	23.1 (14.35)
Median (IQR)	24 (19–31)	16 (13–22)	24 (19–31)	20 (15–28)	31.5 (21–36)	16 (12–21)	24 (21–29)	19 (15–26)
P value	< 0.00001		< 0.00001		0.00102		0.02084	
	All Devices		FB		DL		VL	
	Awake (n = 886)	Asleep (n = 1,471)	Awake (n = 863)	Asleep (n = 103)	Awake (n = 6)	Asleep (n = 1,277)	Awake (n = 17)	Asleep (n = 91)
First intubation for each patient								
Mean (SD)	26.2 (10.22)	18.5 (9.06)	26.2 (10.27)	21.6 (9.66)	25.8 (7.67)	18.0 (8.53)	25.4 (8.32)	21.9 (13.16)
Median (IQR)	24 (19–31)	16 (13–22)	24 (19–32)	20 (15–25)	25.5 (19–33)	16 (12–21)	24 (21–30)	18 (14–25)
P Value	< 0.00001		< 0.00001		0.01449		0.00929	

Data are presented as means (SD) and medians (interquartile range [IQR]). *P* values are two tailed, reported from two-sided Mann–Whitney U test.
FB = flexible bronchoscopy; DL = direct laryngoscopy; VL = video laryngoscopy.

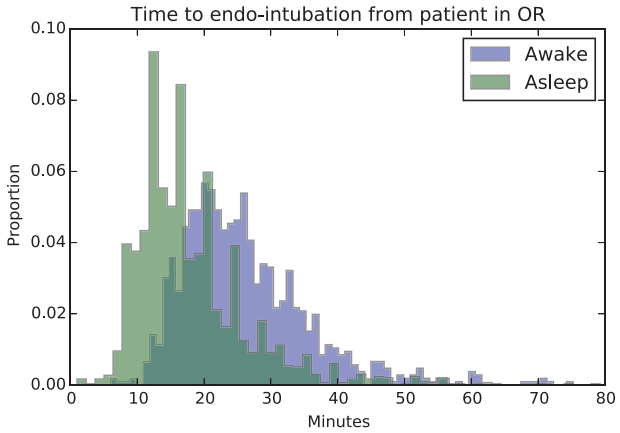

Fig. 2. Time to intubation from entry into operating room (OR) for awake *versus* postinduction intubations in the matched sample. The median time to intubation post induction was 16.0 min from entrance into the OR. The median time to intubation for awake patients was 24.0 min. Performance of an awake intubation added an average of 8 min to the total time from entry into the OR to intubation.

1 kg/m^2, the time to awake intubation increased by approximately 7 s (table 2). If the case was considered an emergency, the time to intubation decreased by 2.7 min.

Two attending anesthesiologists (out of 87) with a clinical focus in anesthesia for otolaryngology procedures performed 423 of the 1,085 awake intubations included in our study. Including these two attendings, 18 attendings performed more than 10 awake intubations during the study period. The remaining 69 performed 10 or fewer, with 29 attendings performing only one or two awake intubations over the 7-yr study period (fig. 3). The median time to awake intubation from entry in the OR for the two attendings, with the greatest number of awake intubations, was 24 min (IQR: 19 to 30). With those attendings excluded, the median was also 24 min (IQR: 19 to 31). A resident was involved in 1,038 of the 1,085 awake intubations.

Hemodynamic parameters in the period around intubation are presented in figure 4. During the period between entry into the OR and intubation, the median heart rates of patients intubated awake were 13 BPM higher than those intubated post induction (88 *vs.* 75 BPM, $P < 0.0001$). In this same period, MAPs in the awake intubation group were 7 mmHg higher: median 107 mmHg, (IQR: 93 to 118) *versus* 100 mmHg (IQR: 91 to 111) ($P < 0.0001$). In the first 8 min after intubation, heart rate in the awake group was a median of 83 BPM (IQR: 74 to 96) *versus* 76 BPM (IQR: 66 to 87) in the asleep group ($P < 0.0001$), and the median MAP was 88 mmHg (IQR: 76 to 101) compared to 85 mmHg (73 to 101; $P = 0.0238$). Before intubation, 79.5% of patients undergoing awake intubation received glycopyrrolate. By contrast, 7.1% of patients in the matched asleep intubation group received glycopyrrolate before intubation.

The most common medication administered for sedation before awake intubation was midazolam (74.0%); 44.7% of patients received fentanyl, and 29.5% of patients received both midazolam and fentanyl. Remifentanil infusions were administered in 14.0% of cases and dexmedetomidine infusions in 7.3% of cases. A propofol infusion was employed in nine cases.

A 1.6% complication rate (17 of 1,085 cases) was observed. The details regarding these 17 complications are described in table 4. The rate of failed awake intubation by flexible bronchoscopy was 1% (n = 10). These cases are described in detail in appendix 1. In most cases (8 of 10), the failure involved inability to pass the endotracheal tube past the vocal cords, with only 2 of the 10 failures involving complete inability to visualize the larynx. Four of the failures resulted in awake tracheostomy, and the remainder were rescued with postanesthetic induction DL (n = 5) or VL (n = 1). Based upon

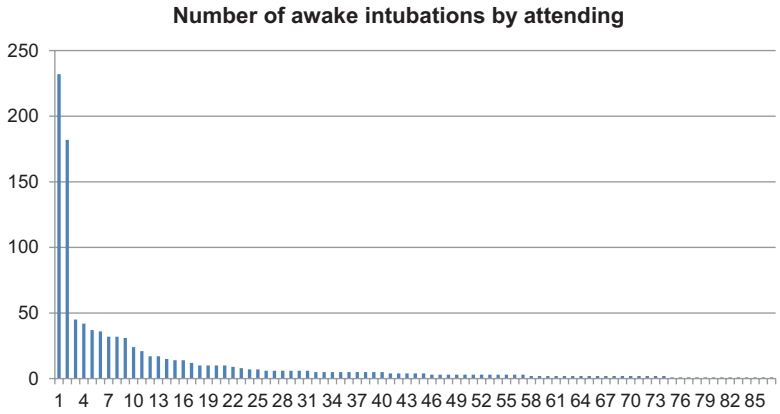

Fig. 3. Graphic representation of the number of awake intubations (y-axis) over the 7-yr study period for each of the 87 attending anesthesiologists (x-axis).

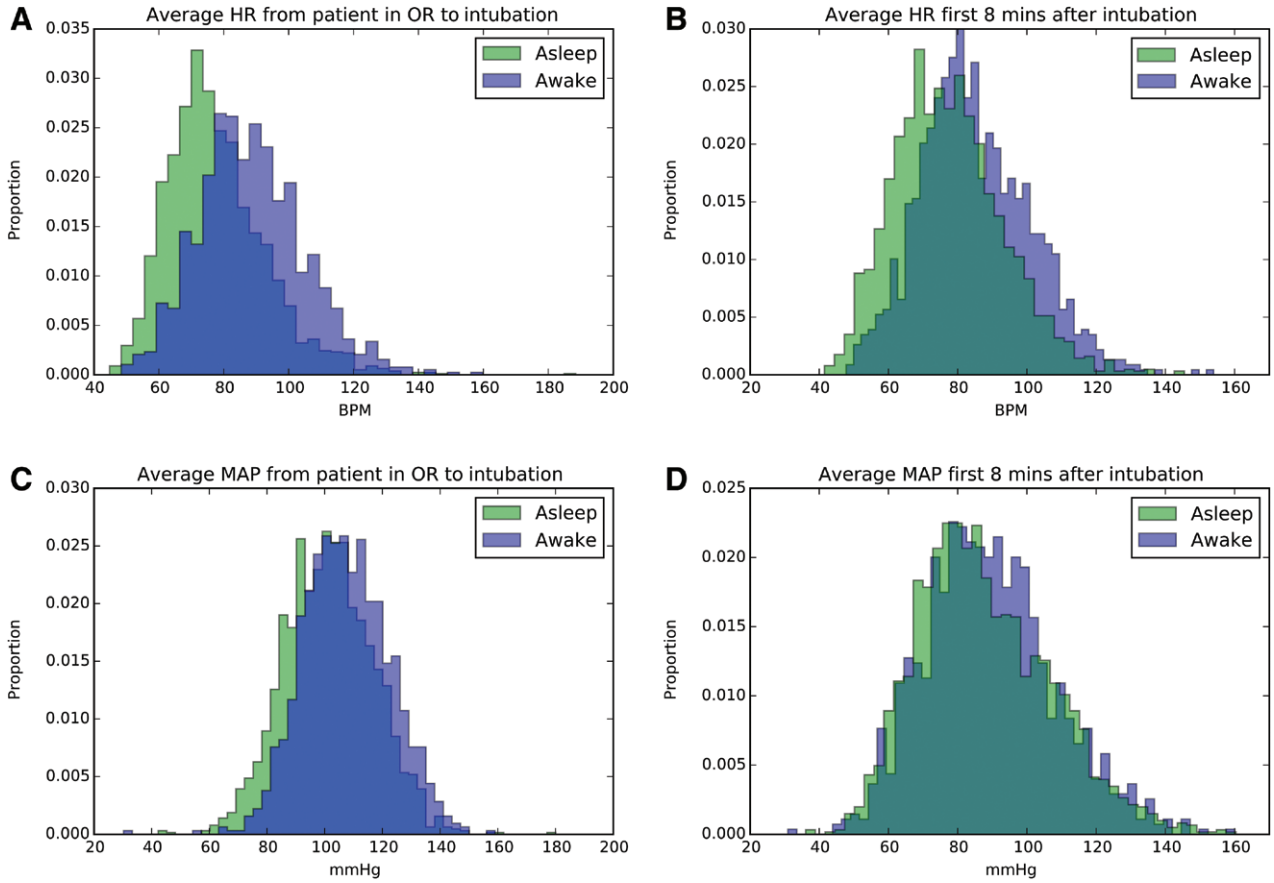

Fig. 4. (*A*) Average heart rate (HR) from entry into the operating room (OR) to intubation. (*B*) Average HR in the first 8 min after intubation. (*C*) Average mean arterial pressure (MAP) from entry into the OR to intubation. (*D*) Average MAP in the first 8 min after intubation. The HR of patients intubated awake were 10 to 12 beats per minute (BPM) higher than those intubated post induction ($P < 0.01$).

review of the electronic medical record, none of the patients with failed awake intubation, or intraoperative complication of awake intubation, suffered any long-term sequelae such as unplanned intensive care unit admission, prolonged hospital length of stay, or hospital-acquired pneumonia.

The vast majority of awake intubations were performed using flexible bronchoscopy, and 2.8% of awake intubations were performed with methods other than flexible bronchoscopy. Twenty-two awake intubations were successfully performed with VL. Four attempted awake video laryngoscope intubations were unsuccessful. In one of these, the patient subsequently underwent awake tracheostomy on an emergent basis. In two cases, awake flexible bronchoscopy was successfully performed after failed awake VL. In the fourth case,

Table 4. Complications Associated with Awake Intubation

Complication	Patient Characteristics
1. Mucous plug	Tongue cancer
2. Mucous plug	Bilateral vocal cord paralysis
3. Mucous plug*	Tongue cancer
4. Local anesthetic toxicity (seizure)	Cervical spine fracture
5. Epistaxis	Cervical myelopathy
6. Epistaxis	Goiter
7. Vomiting	Obesity (BMI, 37.7 kg/m^2), OSA, gastric cancer
8. Vomiting	Obesity (BMI, 52 kg/m^2)
9. Inadvertent extubation after induction	Laryngeal cancer, neck radiation
10. Inadvertent extubation after induction	Cervical myelopathy, obesity (BMI, 37.9 kg/m^2)
11. Inadvertent extubation after induction	Oral cancer, neck radiation, MP 4
12. Cuff leak	Tonsillar cancer
13. Cuff leak	Cervical myelopathy, OSA, MP 3
14. Cuff leak	Tongue cancer, neck radiation
15. Oversedation with desaturation	Neck mass, MP 4
16. Oversedation with desaturation	Laryngeal cancer, neck radiation
17. Blood clot obstructing ETT	Tonsillar cancer

*Case was cancelled after induction/intubation due to profound desaturation and rescheduled for later date.
BMI = body mass index; ETT = endotracheal tube; MP = Mallampati classification; OSA = obstructive sleep apnea.

general anesthesia was induced once a view of the larynx was obtained and the endotracheal tube was passed after induction.

There were 15 cases where awake flexible bronchoscopy was performed after emergence from anesthesia when a patient could not be intubated after anesthetic induction. Eight of these cases were unanticipated difficult airways (appendix 2).

Survey Results

One hundred and ten anesthesiologists (89% response rate) and 84 surgeons (92% response rate) answered a survey by electronic mail (appendix 3) concerning perceptions of time taken to perform an awake intubation (table 5). Both surgeons and anesthesiologists overestimated the time added by awake intubation, with surgeons overestimating to a greater degree: 76% of surgeons believed that awake intubation adds more than 10 min, and 48% believed it adds more than 20 min, compared to 49% and 11% of anesthesiologists, respectively ($P < 0.001$).

Discussion

When faced with a potentially difficult airway, the anesthesiologist must devise a management plan that maximizes the likelihood of safety and efficiency. Practitioner training and experience, local departmental culture, and available resources all play a role in this plan. For example, postinduction VL has an increasing role in the management of difficult DL with its addition to the latest ASA Difficult Airway Algorithm, but it has limitations (lack of provider experience, previous neck surgery or radiation, and head and neck masses).[28] Hence, most still consider awake intubation to be the gold standard for difficult airways, because it maximizes the time that a cooperative patient can protect his or her own airway. Awake intubation should be considered when the provider lacks confidence in his/her ability to accomplish intubation (by DL or VL), the ability to achieve ventilation and oxygenation by facemask or supraglottic airway, or when the patient with a potentially difficult laryngoscopy is considered to be at increased risk of aspiration of gastric contents.

However, awake intubation is not without risk, and many perceive it as time-consuming, distressing to the patient, and potentially unsafe. Our brief survey showed that misconceptions regarding the time taken to perform awake intubation

Table 5. Survey Results on Perception of Time (min) Added with Awake Intubation: Surgical and Anesthesia Providers

Time (min)	Surgical Resident	Anesthesiology Resident	Surgery Attending	Anesthesiology Attending	All Surgeons	All Anesthesiologists
< 5	3 (11%)	2 (3%)	0 (0%)	3 (6%)	3 (4%)	5 (5%)
5–10	8 (29%)	19 (33%)	9 (16%)	20 (39%)	17 (20%)	39 (35%)
11–20	10 (36%)	34 (59%)	14 (25%)	20 (39%)	24 (29%)	54 (49%)
> 20	7 (25%)	3 (5%)	33 (59%)	9 (17%)	40 (48%)	12 (11%)
Total	28	58	56	52	84	110

Participants were asked: "How much additional time does it add to the anesthetic induction when a patient needs to have their airway secured with an awake fiberoptic technique (*i.e.*, for a difficult airway)?" Data are presented as number of individual responses in each category. Chi-square $P < 0.001$ comparing surgery *versus* anesthesiology. Response rate for surgery = 92%. Response rate for anesthesiology = 89%.

may exist even among anesthesiologists. Nearly half of anesthesiologists (49%) and the majority of surgeons (76%) overestimated the time added when performing an awake intubation. In this retrospective review of more than 1,000 awake intubations, we found that awake intubation added approximately 8 min of time in the OR compared to intubation performed after the induction of general anesthesia. This time added did not differ significantly in cases excluded from analysis due to erroneous or missing records (9 min in excluded cases *vs*. 8 min in included cases). Time to intubation did not increase significantly when the two attending anesthesiologists with a much greater number of intubations were excluded. Additionally, residents performed the vast majority of intubations, in many cases supervised by attendings who did fewer than 10 awake intubations over the 7-yr study period. We also found relatively low complication (1.6%) and failure rates (1%), with most complications being minor (*e.g.*, mucous plug, cuff leak, inadvertent extubation).

Our reported rates of complications and failures are consistent with a historical cohort study from a Canadian tertiary-care center.[7] The authors report an incidence of awake intubations of 1.06% of all cases with general anesthesia with tracheal intubation (1,554 of 146,252 cases over 11 yr). Our rate was 1.01% (1,357 of 133,703 cases over 7 yr). The rate of failed awake intubation was similar in both studies (2% in the Canadian study and 1% in our study) and is similarly in line with previous rates of 1.2 to 1.8%.[29,30] Self-reported complications were 15.7% in the Canadian study and 1.6% in our study. This disparity is likely due to the inclusion of minor complications in the Canadian study, including greater than one attempt at intubation or cough during intubation, which are not typically reported in our AIMS. The Canadian study reported failures due to lack of patient cooperation (n = 9) and gagging/coughing/vomiting (n = 13). We did not find any failures for these reasons, which may have been a limitation of our documentation methods. In this study, awake intubation failures were most commonly due to inability to pass the endotracheal tube over the fiberscope (n = 8). In the 10 failed awake intubations recorded, four led to emergent surgical airways and six were rescued with either DL or VL. Finally, awake intubation served as a rescue in several instances where DL and VL failed, three of which were potentially life-threatening cannot-intubate, cannot-ventilate scenarios.

Patient comorbidities, (*i.e.*, OSA, CAD, CHF, chronic obstructive pulmonary disease, and hypertension) did not significantly alter the time taken for successful awake intubation. However, an increase in BMI was associated with incremental increases in time required. This was statistically significant, but likely has limited clinical significance given the small increase in time observed (7 s per 1 kg/m^2). Also, the performance of nerve blocks (*i.e.*, superior laryngeal and/or transtracheal nerve blockade) tended to add approximately 2.6 additional minutes.

Unlike reported concerns by other authors, we found that awake intubation did not lead to significant hemodynamic perturbations. There were no clinically significant differences in MAPs when comparing patients who underwent awake *versus* asleep intubation. The heart rates of patients intubated awake were slightly higher (by 13 BPM), although this difference may be explained by the administration of glycopyrrolate to the majority of the group undergoing awake intubation.

The results of this study must be tempered by its limitations. This was a retrospective study performed at a single academic medical center. The findings may not be generalizable to other practice settings or non-OR locations such as the emergency department or intensive care unit. The study design relied on provider documentation to identify the type of intubation (awake *vs.* asleep) and the device used to intubate (*e.g.*, DL, VL, FB), as well as details regarding complications. It is possible that some awake intubations performed during the study period were not identified due to poor documentation, and the same is true regarding complications and failures. In particular, we did not find cases where awake intubations were attempted but aborted because the patient could not tolerate the procedure. It is possible that these occurred, but were not documented as awake intubations in the AIMS, and therefore not captured in our search. Due to the retrospective nature of this study, the number of awake intubations considered by a provider, but ultimately avoided due to concerns over patient comfort, provider confidence, or production pressure, could not be assessed.

To the best of our knowledge, all topicalization began within the OR, with the exception of three cases where it was initiated in the holding area. It is possible that there were other cases in which patients began to receive topicalization before OR entry, but it was not documented. We know that in at least 813 of the awake intubation cases, premedication, topicalization, and injections could not have been initiated outside of the OR because they were performed in locations without an appropriate holding area where procedures requiring monitoring could take place.

The exclusion of patients with preinduction arterial lines may bias this study, as those patients may be more susceptible to hemodynamic perturbations. Similarly, because noninvasive blood pressure measurements occur only every 3 to 5 min, the peaks and nadirs of blood pressure values may have been missed. Since patients with invasive monitoring placed before induction were excluded and comorbidities were categorical, the medical conditions of the awake patients were likely to have been relatively mild. A limitation of the propensity matching was inability to control for airway factors that would indicate planned advanced airway management. Propensity matching pertained to medical conditions and body habitus rather than airway characteristics. For example, a patient with a head and neck tumor known to impinge on the airway was nearly always intubated awake, so no comparable patient existed in the asleep intubation group. We could not include airway exam findings,

such as Mallampati score, thyromental distance, or mandibular protrusion, in the propensity matching because these were not documented in a uniform manner in our electronic medical record. Future studies that are multicenter and prospective in design could further elucidate the time added with awake intubation in a wider scope of practice settings, as well as better define the risk of complications with awake intubation.

In conclusion, awake flexible bronchoscopy remains the mainstay for management of the anticipated difficult airway, particularly for patients at increased risk of aspiration and difficult face mask or supraglottic ventilation. In an era of increasing production pressure, it is helpful to have an estimation of the amount of additional time added when performing awake intubation as a way of managing expectations. Despite common perception (at least as noted in our institutional survey), awake intubation adds an average of approximately 8 min to OR time. Furthermore, awake intubations are nearly always successful and the rate of serious complications or hemodynamic perturbations are fairly low.

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Competing Interests

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Appendix 1. Description of Failed Awake Intubations by Flexible Bronchoscopy

Failure	Action Taken	Patient Characteristics	Outcome
1. Unable to pass ETT	Direct laryngoscopy	Glottic stenosis	S
2. Unable to pass ETT	Direct laryngoscopy	Obesity (BMI, 37.7 kg/m^2), OSA, gastric cancer	S
3. Unable to pass ETT	Surgical airway	Laryngeal cancer, OSA	T
4. Unable to pass ETT	Direct laryngoscopy	Tongue cancer, neck radiation	S
5. Unable to pass ETT	Direct laryngoscopy	Tongue cancer	S
6. Unable to pass ETT	Direct laryngoscopy	Thyroid/mediastinal mass, obesity (BMI, 38.8 kg/m^2)	S
7. Unable to pass ETT	Video laryngoscopy	Laryngeal cancer	S
8. Unable to pass ETT	Surgical airway	Paraesophageal mass	T
9. Unable to visualize larynx	Surgical airway	Recurrent oral cancer, MP 3	T
10. Unable to visualize larynx	Surgical airway	Supraglottic mass	T

BMI = body mass index; ETT = endotracheal tube; MP = Mallampati classification; OSA = obstructive sleep apnea; S = successful intubation with alternate device; T = tracheostomy (successful).

Appendix 2. Cases Where Awake Intubation Served as a Rescue

Patient Factors	No. Devices Used Unsuccessfully	Type of Devices Unsuccessful	CICV?	LMA Used?
1. Unanticipated	3	DL, VL	N	N
2. Unanticipated	2	DL, VL	N	N
3. 114 kg, male, acromegaly	3	DL, VL	Y	N
4. Unanticipated	3	DL, VL	N	N
5. Unanticipated	0++	N/A	N	N
6. Unanticipated	3	DL, VL	N	N
7. Unanticipated	3	DL, VL	N	N
8. Unanticipated	2	DL, VL	N	Y
9. Cervical spine fusion	3	DL, VL	Y	N
10. Poor mouth opening, GERD	3	DL, VL	Y	Y
11. Unanticipated	3	DL, VL	Y	Y
12. BMI > 40 kg/m^2	3	DL, VL	N	N
13. BMI > 50 kg/m^2, mandibular mass	3	DL, FB	N	N
14. BMI > 40 kg/m^2	3	DL, VL	N	N
15. BMI > 50 kg/m^2	2	DL, VL	N	N

All used flexible bronchoscope (FB) as primary device for rescue, and no patients experienced permanent sequelae. Unanticipated = BMI < 40 kg/m^2, no other nonreassuring airway findings documented.

BMI = body mass index; CICV = cannot-intubate, cannot-ventilate situation; DL = direct laryngoscopy; GERD = gastroesophageal reflux disease; LMA = laryngeal mask airway; N = no; VL = video laryngoscopy; Y = yes; ++ = patient could not be ventilated and no attempts at asleep intubation were then made.

Appendix 3. Survey Questions Sent by Electronic Mail to Physicians in the Department of Surgery and Department of Anesthesiology

1. Your department (surgery or anesthesiology)
2. Your level of training (resident or attending)
3. "How much additional time does it add to the anesthetic induction when a patient needs to have their airway secured with an awake fiberoptic technique (*i.e.*, for a difficult airway)?" (< 5, 5–10, 11–20, > 20 min)