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## Airway Injury during Anesthesia

### A Closed Claims Analysis

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**Background:** Airway injury during general anesthesia is a significant source of morbidity for patients and a source of liability for anesthesiologists. To identify recurrent patterns of injury, the authors analyzed claims for airway injury in the American Society of Anesthesiologists (ASA) Closed Claims Project database.

**Methods:** The ASA Closed Claims database is a standardized collection of case summaries derived from professional liability insurance companies closed claims files. All claims for airway injury were reviewed in depth and were compared to other claims during general anesthesia.

**Results:** Approximately 6% (266) of 4,460 claims in the database were for airway injury. The most frequent sites of injury were the larynx (33%), pharynx (19%), and esophagus (18%). Injuries to the esophagus and trachea were more frequently associated with difficult intubation. Injuries to temporomandibular joint and the larynx were more frequently associated with nondifficult intubation. Injuries to the esophagus were more severe and resulted in a higher payment to the plaintiff than claims for other sites of airway injury. Difficult intubation (odds ratio = 4.53, 95% confidence interval [CI] = 2.36, 8.71), age older than 60 yr (odds ratio = 2.97, 95% CI = 1.51, 5.87), and female gender (odds ratio = 2.43, 95% CI = 1.09, 5.42) were

associated with claims for pharyngoesophageal perforation. Early signs of perforation, *e.g.*, pneumothorax and subcutaneous emphysema, were present in only 51% of perforation claims, whereas late sequelae, *e.g.*, retropharyngeal abscess and mediastinitis, occurred in 65%.

**Conclusion:** Patients in whom tracheal intubation has been difficult should be observed for and told to watch for the development of symptoms and signs of retropharyngeal abscess, mediastinitis, or both. (Key words: Esophageal perforation; liability; mediastinitis; medicolegal; pharyngeal perforation; temporomandibular joint disorders; vocal cord injuries.)

INJURIES to the airway are a well-recognized complication of anesthesia.<sup>1-16</sup> In 1991, we briefly described the sites of injury and standard of care in 97 claims for airway trauma in a review of adverse respiratory events in the American Society of Anesthesiologist (ASA) Closed Claims database.<sup>17</sup> The most frequent sites of airway injuries were the larynx, pharynx, and esophagus. Forty-two percent of the claims for airway injuries were associated with difficult intubation.<sup>17</sup> Since this early report, additional claims for airway injuries, which contain more in-depth information, have been entered into the Closed Claims database. The purpose of this study was to identify patient and anesthetic factors associated with the specific sites of airway injuries and to describe the associated features of liability.

### Materials and Methods

The ASA Closed Claims Project is a structured evaluation of adverse anesthetic outcomes obtained from the closed claim files of 35 US professional liability insurance companies. Claims for dental damage are not included in the database. The current study was based on a total of 4,460 claims for adverse outcomes that occurred between 1961 and 1996. Sixty-eight percent of the injuries leading to claims occurred between 1980 and 1990.

The data collection process previously has been described in detail.<sup>18</sup> Briefly, a closed claim file, typically consisting of relevant hospital and medical records, nar-

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rative statements from involved healthcare personnel, expert and peer reviews, summaries of depositions from plaintiffs, defendants, and expert witnesses, outcome reports, and the cost of settlement or jury award, was reviewed by a practicing anesthesiologist. The reviewer used standardized instructions to fill out a standardized form that records information about patient characteristics, surgical procedures, sequence and location of events, critical incidents, clinical manifestations of injury, standard of care, and outcome.<sup>18</sup>

Each claim was assigned a severity of injury score that was designated by the on-site reviewer using the insurance industry's 10-point scale. This ordinal scale rates severity of injury from 0 (no injury) to 9 (death).<sup>18</sup> Values of 1 represent temporary emotional injury, 2-4 reflect temporary physical injuries, 5 reflects permanent, non-disabling emotional and physical injuries, and 6-8 reflect permanent and disabling emotional and physical injuries. For purposes of analysis, injuries were grouped into three categories: temporary-nondisabling (score = 0-5), disabling-permanent (score = 6-8), and death (score = 9). The reliability of reviewer judgments previously has been found to be acceptable.<sup>19</sup>

In the current study, all claims for airway injury were reviewed and included in the analysis, including 97 claims that previously were briefly described.<sup>17</sup> *Airway injury* was defined as injuries in which there were patient complaints or clinical, anatomic, or laboratory findings consistent with damage to the nose, temporomandibular joint (TMJ), larynx, trachea, pharynx, or esophagus. Claims were categorized regarding the site of the injury by the on-site reviewer and were reviewed by the Closed Claims Committee. The nose was the site of injury if it involved injury to the nose or nasopharynx. The TMJ was the site of injury if it involved TMJ pain or physical injury. The site of the injury was classified as the larynx if it involved documented injury to the vocal cords, larynx, or innervation of the larynx, or if it involved hoarseness. The site of injury was classified as the trachea if there was damage to the trachea or if the claim was filed for a tracheotomy. Injuries to the pharynx included injuries to the lips, mouth, tongue, oropharynx, and hypopharynx. The site was classified as esophagus if there was injury or alleged injury to the esophagus. Claims for injuries to multiple sites were classified into the predominant site of injury in 10 of 11 claims with multiple injury. Each standardized closed claim consisted of a data collection form and narrative description for patient characteristics, patterns of injury, quality of care, clinical signs, and other factors that were associ-

ated with injury to the airway during anesthesia. Difficult intubation was determined by the reviewer based on information in the claims file. On this basis, the claims for injuries at the specific sites were classified into subcategories of injuries. A delay in the diagnosis of the injury was classified if it was mentioned in the claims file or was the opinion of an expert or a reviewer.

Differences between proportions were evaluated using the chi-square analysis and the Fisher exact test.<sup>20</sup> Patient demographic characteristics, severity of injury, standard of care, and claim payment for all airway injuries combined were compared to other general anesthesia claims. These variables were also compared for the specific airway injuries to the other airway injuries combined and among the different subcategories of injuries for TMJ, laryngeal, tracheal, and pharyngeal sites. Payments for settlement and jury award were expressed in original dollar amounts, without adjustment for inflation.<sup>18</sup> Because payments did not exhibit a normal distribution, the median and range were used for descriptive purposes. Statistical comparisons of payment distributions were made using the Kolmogorov-Smirnov test.<sup>20</sup> Two-tailed tests were used to determine statistical significance at  $P < 0.05$ . A Bonferroni correction was used to correct for multiple comparisons when comparing the specific airway injuries to all other airway injuries combined.

To identify factors associated with claims for perforation of the pharynx or esophagus compared with other airway injury claims, claims for esophageal or pharyngeal perforation were compared to claims for other airway injuries using logistic regression analysis.<sup>21</sup> A forward-selection multiple logistic regression analysis was used to identify independent risk factors for perforation claims. Based on accepted statistical practice recognizing the total number of claims, only the three variables most significantly associated with perforation on the univariate analysis were included in the multiple logistic regression.<sup>21</sup>

## Results

### Overview

Of 4,460 claims in the database, 266 claims (6%) were for airway injury. Compared with 2,874 other claims involving general anesthesia, a higher proportion of airway injury claims involved females, elective surgery, and outpatient procedures, and a lower proportion of airway injury claims involved children (table 1). Difficult intu-

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**Table 1. Demographic Characteristics for Patients Filing Claims for Airway Injury**

	Airway Injury (n = 266) [n (%)]*	Other General Anesthesia Claims (n = 2,874) [n (%)]*
Gender		
Female	181 (69%)†	1,592 (56%)†
Male	81 (31%)†	1,255 (44%)†
ASA Status		
I-II	123 (73%)	1,272 (67%)
III-V	45 (27%)	634 (33%)
Age		
Pediatric (≤16 yr)	11 (4%)†	385 (14%)†
Adult (>16 yr)	240 (96%)†	2,340 (86%)†
Obese		
Yes	48 (41%)	454 (43%)
No	69 (59%)	596 (57%)
Emergency surgery		
Yes	31 (17%)‡	527 (26%)‡
No	149 (83%)‡	1,523 (74%)‡
Procedure		
Inpatient	127 (73%)‡	1,449 (82%)‡
Outpatient	48 (27%)‡	325 (18%)‡
Difficult intubation		
Yes	103 (39%)†	251 (9%)†
No	163 (61%)†	2,623 (91%)†

\* The percentage is based on claims without missing data.  
 †  $P < 0.001$  airway injury versus other general anesthesia claims.  
 ‡  $P \leq 0.01$  airway injury versus other general anesthesia claims.  
 ASA = American Society of Anesthesiologists.

bation was a factor in 39% of airway injury claims (103 of 266 claims), compared with 9% of other general anesthesia claims (251 of 2,874 claims,  $P < 0.001$ , table 1). There was no difference in the ASA status and the proportion of obese patients for airway injury claims compared with claims for other injuries during general anesthesia. The severity of injury and payment to the plaintiff generally was less for claims for airway injury than for

other injuries during general anesthesia (table 2). Most airway injuries were temporary or nondisabling (87%), although 8% resulted in death. The standard of care was judged by reviewers to be appropriate in 79% of claims for airway injury, compared with 46% of claims for other injuries during general anesthesia ( $P < 0.001$ , table 2). Both the frequency of payment and the amount of payment were less in claims for airway injury compared with other injuries during general anesthesia ( $P < 0.001$ , table 2). The median payment to the plaintiff was \$26,250 for airway injury claims, compared with \$125,000 for other injuries during general anesthesia (table 2).

*Specific Sites of Injuries*

The most frequent sites of injury were the larynx (n = 87, 33% of airway injury claims), pharynx (n = 51, 19%), esophagus (n = 48, 18%), and the trachea (n = 39, 15%) (table 3).

**Laryngeal Injuries.** The most common types of laryngeal injury included vocal cord paralysis (n = 30, 34% of laryngeal injury claims), granuloma (n = 15, 17%), arytenoid dislocation (n = 7, 8%), and hematoma (n = 3, 3%). Although 80% of laryngeal injuries were associated with routine (nondifficult) tracheal intubation (table 3), intubation was reported to be difficult in more than a quarter of claims for granuloma (n = 4 of 15), arytenoid dislocation (n = 2 of 7), or an unclear cause of hoarseness (n = 7 of 17). Most (85%) of the laryngeal injuries were associated with short-term tracheal intubation because prolonged tracheal intubation (5 h or more post-operatively) occurred in only 15% (n = 13) of the claims. The frequency of payment and the median payment for laryngeal injury (\$20,000; table 4) did not differ significantly with specific sites of laryngeal injury.

**Table 2. Severity of Injury, Standard of Care, and Claim Payment for Airway Injury versus Claims for Other Injuries during General Anesthesia**

Type of Claim	Severity of Injury†			Standard of Care†		Payment		
	Nondisabling (score = 0–5) [n (%)]*	Disabling (score = 6–8) [n (%)]*	Death (score = 9) [n (%)]*	Standard [n (%)]*	Substandard [n (%)]*	Yes [n (%)]*	Median Amount (\$)	Range (\$)
Airway injury (n = 266)	231 (87%)‡	13 (5%)‡	21 (8%)‡	180 (79%)‡	47 (21%)‡	128 (54%)‡	\$ 26,250‡	\$15–\$1,150,000‡
Other general anesthesia claims (n = 2,874)	1,134 (40%)‡	582 (20%)‡	1,152 (40%)‡	1,142 (46%)‡	1,321 (54%)‡	1,739 (66%)‡	\$125,000‡	\$25–\$23,200,00‡

\* The percentage is based on claims without missing data.  
 † These data represent claims where standard of care could be judged. The remainder were impossible to judge.  
 ‡  $P < 0.001$  airway injury versus other general anesthesia claims.

**Table 3. Association of Age, Gender, ASA Status, and Difficult Intubation with Site of Airway Injury (n = 266 Claims)**

Site	Total [n (% of 266)]	Age >60 years [n (% of site)]*	Female Gender [n (% of site)]*	ASA Status 3–5 [n (% of site)]*	Difficult Intubation [n (% of site)]
Larynx	87 (33)	17 (20)	52 (61)	15 (31)	17 (20)‡
Pharynx	51 (19)	16 (33)	33 (65)	8 (25)	26 (51)
Esophagus	48 (18)	22 (48)‡	41 (87)†	8 (28)	30 (62)‡
Trachea	39 (15)	8 (22)	22 (58)	10 (37)	25 (64)†
Temporomandibular joint (TMJ)	27 (10)	1 (4)†	23 (85)	1 (5)†	0 (0)‡
Nose§	13 (5)	1 (8)	9 (69)	3 (38)	4 (31)

\* The percentage is based on claims without missing data.

†  $P < 0.01$  versus other sites combined.

‡  $P < 0.001$  versus other sites combined.

§ Injuries to nose not tested statistically because of small numbers.

**Pharyngeal Injuries.** Claims of pharyngeal injuries included pharyngeal perforation (n = 19, 37% of pharyngeal injuries), lacerations and contusions (n = 16, 31%), localized infection (n = 6, 12%), sore throat without physical evidence of injury (n = 6, 12%), and miscellaneous injuries (n = 4, 8%; *i.e.*, foreign body, burn, hematoma, diminished taste sensation). Half (n = 26, 51%) of all pharyngeal injuries and 68% of pharyngeal perforations were associated with difficult tracheal intubation. Pharyngeal perforations that occurred during nondifficult intubation were attributed to a nasogastric tube (n = 1), a suction catheter (n = 1), jet ventilation (n = 1), and an unclear mechanism of injury (n = 3). The severity of injury, standard of care, frequency of payment, and amount of payment for all types of pharyngeal injuries were similar to all other sites of airway injuries combined (table 4). However, when compared to other types of pharyngeal injuries, pharyngeal perforation was associated with a greater severity of injury ( $P = 0.001$ ),

a greater proportion of substandard care ( $P = 0.029$ ), and a higher payment to plaintiff (median payment = \$80,000 for pharyngeal perforation *vs.* \$2,750 for other pharyngeal injury,  $P < 0.001$ ). All deaths in the pharyngeal injury claims (n = 5) occurred with pharyngeal perforation and were related to the development of mediastinitis.

**Esophageal Injuries.** Most claims for esophageal injuries were for esophageal perforation (n = 43 of 48 esophageal injuries, 90%). Sixty-two percent (n = 30) of all esophageal injuries were associated with difficult intubation ( $P < 0.001$  compared with all other sites combined, table 3). In addition, esophageal injuries involved a significantly greater proportion of females ( $P < 0.001$ ) and patients older than 60 yr of age ( $P < 0.001$ ) compared with other sites combined (table 3). Esophageal perforation involved difficult intubation in 67% (n = 29) of claims. Most claims for esophageal perforation in which intubation was rated nondifficult (n = 14) in-

**Table 4. Severity of Injury, Standard of Care, and Claim Payment for Various Sites of Airway Injury**

Site of Injury	Severity of Injury		Standard of Care†		Payment		
	Nondeath [n (%)]	Death [n (%)]	Standard [n (%)]	Substandard [n (%)]	Yes [n (%)]*	Median (\$)	Range (\$)
Larynx (n = 87)	86 (99)§	1 (1)§	74 (96)‡	3 (4)‡	33 (43)	20,000§	853–900,000§
Pharynx (n = 51)	46 (90)	5 (10)	29 (71)	12 (29)	29 (64)	35,000	112–1,150,000
Esophagus (n = 48)	39 (81)§	9 (19)§	25 (60)§	17 (40)§	31 (69)	138,975‡	1,000–750,000‡
Trachea (n = 39)	33 (85)	6 (15)	20 (63)	12 (38)	20 (56)	23,750	390–450,000
TMJ (n = 27)	27 (100)	0	21 (100)§	0 (0)§	7 (30)	10,000	750–500,000
Nose (n = 13)	13 (100)	0	11 (85)	2 (15)	8 (62)	4,125	15–50,000

\* The percentage is based on claims without missing data.

† These data represent claims where standard of care could be judged. The remainder were impossible to judge.

‡  $P < 0.001$  versus all other sites combined.

§  $P < 0.01$  versus all other sites combined.

|| Injuries to nose not tested statistically due to small number.

TMJ = temporomandibular joint.

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**Table 5. Factors Associated with Claims for Pharyngoesophageal Perforation (n = 62) versus Claims for Other Types of Airway Injuries (n = 204)**

Factor	Univariate Logistic Regression [OR (95% CI)]	Multivariate Logistic Regression [OR (95% CI)]
Difficult intubation	4.92 (2.67, 9.07)*	4.53 (2.36, 8.71)*
Age > 60 yr	3.29 (1.77, 6.13)*	2.97 (1.51, 5.87)†
Female gender	2.79 (1.33, 5.82)†	2.43 (1.09, 5.42)‡

OR = odds ratio; 95% CI = 95% confidence interval.

\*  $P < 0.001$ .

†  $P < 0.01$ .

‡  $P < 0.05$ .

involved instrumentation of the esophagus by esophageal intubation (n = 4) or placement of a nasogastric tube, esophageal dilator, esophageal stethoscope, or a laryngoscope placed by the surgeon for conduct of surgery (n = 7).

Esophageal injuries were more severe than all other types of airway injury combined, with 9 (19%) deaths ( $P = 0.005$ , table 4). Perforation of the esophagus was associated with poor outcome. Although the standard of care was less frequently evaluated as appropriate than in other sites of airway injuries ( $P = 0.001$ ), the anesthetic care still was evaluated as being appropriate in the majority (60%) of claims. The amount of payment (median \$138,975) was higher for esophageal injuries than for other airway injuries combined ( $P < 0.001$ , table 4).

**Pharyngoesophageal Perforation.** Nineteen claims for perforation of the pharynx and 43 claims for perforation of the esophagus were grouped together for subsequent analysis. Three factors were associated positively with claims for perforation of the pharynx or esophagus, compared with other claims for airway injuries: difficult intubation, age older than 60 yr, and female gender (table 5). These factors remained as significant independent predictors of claims for pharyngoesophageal perforation when adjusted for other factors in a multivariate logistic regression (difficult intubation [OR = 4.53], age older than 60 yr [OR = 2.97], and female gender [OR = 2.43], table 5). Obesity, ASA status, and emergency or elective surgery were not associated with claims for pharyngoesophageal perforation.

Early signs of perforation, e.g., subcutaneous emphysema or pneumothorax occurring in the immediate perioperative period, were present in only 51% of cases (table 6). In the remainder of claims, intubation was believed to be atraumatic. A delay in diagnosis of the perforation therefore occurred in half of the claims. Late

infectious sequelae (mediastinitis or mediastinal abscess, retropharyngeal abscess, or pneumonia) developed in 65% of the patients (table 6). Delay in diagnosis was associated significantly with the development of the late infectious sequelae ( $P < 0.001$ ).

**Tracheal Injuries.** The 39 claims for tracheal injury involved injury from the creation of a surgical tracheotomy (n = 25, 64%), tracheal perforation (n = 13, 33%), and infection (n = 1, 3%). Most (n = 21, 84%) of the tracheotomies were performed for the purpose of emergency airway management associated with difficult tracheal intubation. The remainder of tracheotomies (n = 4, 16%) were necessary because of the development of subglottic or tracheal stenosis as a consequence of tracheal intubation. One patient died of a surgical complication of tracheotomy (unrecognized transection of the trachea).

Most claims for tracheal perforation (9 of 13, 69%) involved routine (nondifficult) tracheal intubation. Perforation of the trachea became clinically evident by the development of subcutaneous emphysema (n = 10) and/or pneumothorax (n = 4), whereas the perforation was evident only on a postoperative chest radiograph (pneumomediastinum) in three patients. The perforation was diagnosed intraoperatively in only five patients, with diagnosis made in the postanesthesia care unit in four patients and postoperatively in four patients. Payment was made in 56% of the claims for tracheal injury, with a median payment of \$23,750, similar to other airway injuries claims combined (table 4). Payment did not differ with type of tracheal injury.

**Temporomandibular Joint Injuries.** Temporomandibular joint injuries accounted for 10% of airway trauma claims (27 of 266 claims) and were associated with routine tracheal intubation in all cases (table 3). Most TMJ claims were submitted by women (n = 23, 85%) and by patients younger than 60 yr (96 vs. 72% of other airway injury claims,  $P = 0.004$ ). Sixteen of the claims were for TMJ pain and 11 were for TMJ dislocation. Preexisting TMJ disease was documented in 8 (30%) of the 27 TMJ claim files. Comparing type of injury (TMJ pain vs. dislocation), the frequency of payment was greater for TMJ dislocation than for TMJ pain ( $P < 0.001$ ). Payment was received in 70% of the dislocated TMJ claims but in none of the claims for TMJ pain.

## Discussion

Claims for airway injuries were relatively frequent (6%) in the ASA Closed Claims database, ranking behind three

**Table 6. Clinical Signs of Perforation of Pharynx or Esophagus\***

Clinical Signs	Site of Perforation		
	Pharynx (n = 17) [n (%)]	Esophagus (n = 36) [n (%)]	Combined (n = 53)* [n (%)]
No early signs	11 (65)	15 (42)	26 (49)
Early signs	6 (35)	21 (58)	27 (51)
Subcutaneous emphysema	5 (29)	15 (42)	29 (38)
Pneumothorax	3 (18)	13 (36)	16 (30)
Chest x-ray only	0 (0)	1 (3)	1 (2)
Late sequelae†	13 (81)	21 (58)	34 (65)
Mediastinitis	7 (44)	18 (50)	25 (48)
Retropharyngeal abscess	8 (50)	4 (11)	12 (23)
Pneumonia	1 (6)	1 (3)	2 (4)

\* Based upon claims with sufficient information. Two claims for pharyngeal perforation and seven claims for esophageal perforation did not contain information on the presence or absence of early signs. One additional claim for pharyngeal perforation did not have sufficient information on late sequelae for analysis.

† Based on 16 claims for pharyngeal perforation and 36 claims for esophageal perforation.

other major types of injury: death (32%), spinal cord or peripheral nerve damage (16%), and brain damage (12%). Although most claims for airway injuries involve a low severity of injury and low payment to the plaintiff, pharyngoesophageal perforation was a serious injury, which frequently resulted in late infectious complications and death. Factors associated with claims for pharyngoesophageal perforation included difficult intubation, age older than 60 yr, and female gender.

#### *Methodological Issues*

Before interpreting the data, it should be emphasized that closed claims analysis has a number of previously described weaknesses.<sup>18</sup> These limitations include the inability to provide numerical estimates of risk because of the lack of denominator data, the absence of rigorous comparison groups, a probable bias toward adverse outcomes, and partial reliance on data from direct participants rather than impartial observers. They spanned a period of time during which practice patterns changed. The analysis also only evaluated the information in the database that was transcribed to the data sheet by the reviewer, who depended on the information contained in the insurance company file. Specific detailed information regarding signs and mechanism of injury may therefore be incomplete compared to a prospective study. The retrospective case review studies included in the database were also selected in a nonrandom fashion, without control over geographic balance.

The logistic regression analysis compared patient and anesthetic variables associated with claims for pharyngoesophageal perforation with other airway injury claims. The usual investigation of risk factors compares

patients in whom a specific adverse outcome develops (e.g., pharyngoesophageal perforation) with patients in whom the specific outcome does not develop. Because the Closed Claims Project only involves a select group of patients who file malpractice claims, the associated factors reported represent a risk for a claim for pharyngoesophageal perforation compared with a claim for another airway injury. The associated factors, therefore, are not necessarily risk factors important in the cause of pharyngoesophageal perforation.

#### *Pharyngoesophageal Perforation*

Although numerous case reports have been published,<sup>4-17,22-28</sup> including reports during routine anesthesia care,<sup>4-17</sup> pharyngoesophageal perforation remains an underappreciated complication of tracheal intubation. Perforation of the pharynx or esophagus is a serious, life-threatening injury. In the Closed Claims database, 14 of 62 (23%) patients filing claims for pharyngoesophageal perforation died. In addition, a higher payment was made than for other airway injuries, with a median payment of \$80,000 for pharyngeal perforation and \$138,975 for esophageal perforation.

The Closed Claims data show that difficult intubation, age older than 60 yr, and female gender increased the relative frequency of claims for esophageal or pharyngeal perforation compared with claims for other airway injuries (table 5). Difficult intubation,<sup>4-17,22-28</sup> emergency intubation,<sup>13,22,23,25,26</sup> and intubation by inexperienced personnel<sup>13,22-26,28</sup> have been described in the literature as risk factors for pharyngoesophageal perforation. Other risk factors mentioned in case reports as potentially associated with perforation include variables

that contribute to difficult intubation (*e.g.*, obesity, cervical arthritis, improper head positioning, poor muscle relaxation, and haste), application of a cricoid pressure, long-term indwelling nasogastric tube, a rigid or flexible stylet (even without exposure of the tip), and the rigid bevel of an endotracheal tube.<sup>4-17,22-28</sup> Claims in the Closed Claims database for which tracheal intubation was judged as nondifficult involved instrumentation of the pharynx or esophagus. Esophageal perforation has also been described in the literature as a complication of orogastric or nasogastric tube insertion,<sup>29-33</sup> use of a Combitube™ (Sheridan Catheter Corp., Argyle, NY),<sup>34</sup> and transesophageal echocardiography.<sup>35</sup> The independent association of pharyngoesophageal perforation with advanced age and female gender found in our study has not been previously reported. The mechanism for the possible increased risk of injury in elderly women is unknown and deserves further study.

The Closed Claims data suggest that prompt diagnosis of pharyngoesophageal perforation may be difficult. Perforation has been previously reported to occur at the pyriform sinus,<sup>11,13,23-26</sup> the hypopharynx posterior to the cricopharyngeal muscle,<sup>4,6-8,22,28</sup> and the posterior wall of the cervical esophagus.<sup>5,8-10,13-16</sup> Air may dissect along cervical fascial planes and lead to subcutaneous emphysema, pneumomediastinum, or a pneumothorax.<sup>4-6,9,11,13-15,23,24,26,28</sup> Early symptoms of perforation are relatively nonspecific and include sore throat, deep cervical pain, chest pain, and cough. Later symptoms include fever, dysphagia, and dyspnea as bacterial invasion results in the delayed development of deep cervical or retropharyngeal abscess, mediastinitis, or pneumonia.<sup>7,8,10,12,16,22,25,27</sup> In the Closed Claims database, early signs of a perforation were absent in half of the cases, and the intubation was believed by the anesthesiologist to be atraumatic. A delay in diagnosis was significantly associated with the development of late infectious sequelae in the Closed Claims database. Consequently, a delay in diagnosis may exacerbate patient morbidity and mortality. Survival after esophageal perforation has been reported to be improved by early diagnosis and initiation of treatment within 24 h.<sup>36</sup> However, overall mortality after esophageal perforation was reported to be high (25%), even with rapid diagnosis and treatment, including limitation of oral intake, administration of antibiotics, and surgical closure and drainage.<sup>37</sup>

The clinical implication of the Closed Claims findings is that patients in whom tracheal intubation has been difficult should be observed and told to watch for the development of symptoms and signs of retropharyngeal

abscess, mediastinitis, or both. Symptoms such as severe sore throat, deep cervical or chest pain, and fever should be thoroughly investigated after difficult tracheal intubation or difficult insertion of a nasogastric tube. Surgeons should also be alerted to the possibility of such a complication after a difficult intubation, so they can respond appropriately if the patient contacts them initially.

#### *Laryngeal and Tracheal Injuries*

Claims for laryngeal injuries represented one third of the claims ( $n = 87$ ) for airway injury in the Closed Claims database. Most claims for laryngeal injury occurred with routine tracheal intubation. Most cases of laryngeal damage have been reported to be caused by abrasion of the mucosa by movement of the endotracheal tube and pressure necrosis of the posterior laryngeal mucosa by the endotracheal tube.<sup>1</sup> Only a minority of claims (15%) for laryngeal injury in the Closed Claims database involved prolonged tracheal intubation. However, laryngeal injury after prolonged intubation may result in a claim against a pulmonologist or another nonanesthesia physician caring for the patient.

Most (64%) of the tracheal injuries involved creation of a surgical tracheotomy. The tracheotomy was performed for the purpose of emergency airway management in the majority of these claims. Although the severity of injury was low, a lower proportion of these claims were judged to represent standard care compared with most other airway injury claims.

One third of the claims for tracheal injury were for tracheal perforation ( $n = 13$ ), a rare, but severe injury.<sup>2,3</sup> Most of the claims for tracheal perforation involved routine tracheal intubation and appropriate anesthesia care. However, the severity of injury was high, with tracheal perforation contributing to five of the six deaths in the tracheal injury group. Although the classic sign of tracheal injury is the acute development of subcutaneous emphysema or pneumothorax, or both, delayed presentation in the postanesthesia care unit or postoperatively was noted in 8 of 13 of the claims for tracheal perforation. Three cases were detected only by postoperative chest radiography taken to investigate chest pain and other nonspecific respiratory complaints. These findings are consistent with two recent case reports, which emphasize that a delayed presentation of tracheal perforation may occur more commonly than appreciated.<sup>2,3</sup>

#### *Temporomandibular Joint Injuries*

The preponderance of claims for TMJ injuries submitted by young women is consistent with the known

epidemiology of temporomandibular disorders. TMJ pain occurs in 10% of the population and is twice as common in women as in men.<sup>38</sup> It is a disorder of primarily young and middle adulthood, and it is rare in children and the elderly. The consistent epidemiologic profile of the TMJ claims and their association with routine tracheal intubation suggest that most TMJ injuries that occur during anesthesia are secondary to underlying temporomandibular disorders. The relatively small number of claims compared to the high incidence of temporomandibular disorders within the population may be caused by a reluctance to pursue claims with expected low financial compensation. None of the claims for TMJ pain in the database received any payment and the median payment of claims for TMJ dislocation was only \$10,000. Huycke and Huycke<sup>39</sup> reported that plaintiff's attorneys are unlikely to pursue claims with an estimated financial recovery for damage of less than \$50,000.

In summary, claims for airway injuries are frequent in the closed claims database. Although most claims for airway injuries involve a low severity of injury and low payment to the plaintiff, pharyngoesophageal perforation may result in death because of severe infection from mediastinitis. A high index of suspicion by the anesthesiologist and the surgeon may reduce the risk of severe complications.

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