

## *Adverse Respiratory Events Infrequently Leading to Malpractice Suits*

### *A Closed Claims Analysis*

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Adverse outcomes associated with respiratory events are the single largest class of injury in the American Society of Anesthesiologists Closed Claims Project (762 of the 2,046 cases, 37%). Inadequate ventilation, esophageal intubation, and difficult tracheal intubation are the most common mechanisms of respiratory-related adverse outcomes. An analysis of closed claims data regarding these mechanisms has been reported previously. This report is concerned with 300 claims for five other less common but important categories of respiratory-related adverse outcomes in which recurrent themes of management error or patterns of injury could be identified: airway trauma, pneumothorax, airway obstruction, aspiration, and bronchospasm. Airway trauma (97 claims, 5% of the database) was associated with difficult intubation in 41 (42%) of the cases and the most frequent sites of injury were the larynx, pharynx, and esophagus. Pneumothorax (67 cases, 3% of the database) was usually either needle-related (block or central vascular catheter placement) or airway management-related (instrumentation or barotrauma). Airway obstruction (56 claims, 3% of the database) occurred in the upper airway in 39 (70%) of the cases. Aspiration (56 claims, 3% of the database) usually occurred during general anesthesia, either during induction prior to tracheal intubation or during maintenance of anesthesia delivered *via* mask. Bronchospasm (40 claims, 2% of the database) tended to occur during induction of general anesthesia in patients with a history of asthma or chronic obstructive pulmonary disease and/or smoking. The incidence of severe injury (brain damage and death) among these cases in the five categories was 47% overall, ranging from 12% in airway trauma claims to nearly 90% in claims for airway obstruction and bronchospasm. Overall, 89% of the adverse events in this report represent problems with airway management, emphasizing the critical nature of this endeavor in providing patient safety during anesthesia. (Key words: Complications, respiratory: airway obstruction; airway trauma; aspiration; bronchospasm; pneumothorax.)

SINCE 1985 the Committee on Professional Liability of the American Society of Anesthesiologists (ASA) has been

conducting a study of closed malpractice claims related to anesthesia care (ASA Closed Claims Project). Caplan *et al.* previously reported<sup>1</sup> that 34% of 1,541 claims were for adverse respiratory events, which were the single largest source of adverse outcomes in the overall database. Three mechanisms of injury accounted for approximately 75% of the adverse respiratory events: inadequate ventilation (38%), esophageal intubation (18%), and difficult tracheal intubation (17%). The purpose of the present report is to provide an analysis of several other categories of respiratory-related adverse outcomes in which recurrent themes of management error or pattern of injury could be identified. These categories include airway trauma, pneumothorax, airway obstruction, aspiration, and bronchospasm.

### Materials and Methods

The ASA Closed Claims Project is a structured evaluation of adverse anesthetic outcomes obtained from the closed claims files of 23 United States professional liability insurance carriers. Claims for dental damage are not included in this project. The database for this report consists of 2,046 closed claims collected since 1985 of which 95% of the adverse events occurred between 1974 and 1987.

A detailed description of data collection procedures has been previously reported.<sup>1-3</sup> In brief, a closed claim for an adverse anesthetic outcome typically consists of relevant hospital and medical records, narrative statements from involved health care personnel, expert and peer reviews, deposition summaries, outcome reports, and the cost of settlement or jury award. Each claim is reviewed by a practicing anesthesiologist on site at the insurance company according to a detailed set of instructions. The background and qualifications of the reviewers have been described in related reports.<sup>2,4</sup> A standardized form is used to record detailed information on patient characteristics, surgical procedures, anesthetic agents and techniques, involved personnel, sequence of events, damaging events, clinical manifestations, and outcome. Reviewers write a brief report of each case that summarizes the sequence of events and provides additional details. Each reviewer also assesses the overall appropriateness of anesthetic care and its contribution to the adverse outcome. Care is rated by the onsite reviewer as standard

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(appropriate), substandard (inappropriate), or impossible to judge based upon reasonable and prudent practices at the time of the event. Practice patterns that may have evolved at a later date are not retrospectively applied when standard of care is rated.

The closed claims study committee, consisting of three practicing anesthesiologists, reviews and approves the on-site reviewers' assessment of standard of care.<sup>2</sup> Reviewers' judgments were overruled by the committee in 3% of the cases. An acceptable level of interrater reliability has been established for reviewer judgments on standard of care.<sup>5,6</sup> The limitations of the methodology used in this closed claims analysis has been described elsewhere.<sup>1-4,7</sup>

Adverse outcomes in the Closed Claims Project are classified as both complications and damaging events. The damaging event is the mechanism by which the complication or injury occurs. In the total database there are more complications than damaging events since a mechanism of injury may not always be apparent, as, for example, in the case of nerve injury.<sup>4</sup> In some cases more than one damaging event may have led to the complication so there may be some overlap of cases in the damaging-event category. This report focuses on three categories of damaging events (aspiration, airway obstruction, and bronchospasm) and two categories of complications (airway trauma and pneumothorax). These categories, rather than being chosen prospectively, were determined on the basis of frequency in case reviews. These particular categories were chosen for concurrent analysis because they represented a significant source of claims against anesthesiologists and as a group had a common thread (relationship to airway) to guide our analysis. For the purpose of this report we collectively designated all five categories as adverse respiratory events.

Differences between proportions were evaluated using the Z test.<sup>8</sup> The cumulative distributions of payments were compared using the Kolmogorov-Smirnov test. For sub-

TABLE 1B. Major Categories of Complications

Complications	Number of Claims	% of 2,046
Death	720	35%
Nerve damage	308	15
Brain damage	253	12
No obvious injury	102	5
Airway trauma*	97	5
Eye damage	71	3
Emotional distress	71	3
Pneumothorax*	67	3
Stroke	52	3

N = 2,046. Only the major categories of damaging events and complications with an occurrence rate of 3% or greater are included. In the respiratory system category only damaging events with an occurrence rate of 2% or greater are included.

\* Category of injury included in this report.

sets of data with n < 40, the median test was used to test for differences in payments between groups. Two-tailed tests were used throughout, with P ≤ 0.05 considered to be statistically significant.

### Results

A summary of the most common categories of damaging events and complications (outcomes) in the project database of 2,046 claims is presented in tables 1A and B. There were a total of 300 claims in the five categories of adverse respiratory events in this report (table 2). There were 462 claims involving other types of adverse respiratory events and 1,284 claims that did not involve the respiratory system (table 2). The overall incidence of severe injury (permanent brain damage or death) in the five categories was 47%. There was a wide range of incidence of injury of this severity, however, from 12% in the airway trauma group to nearly 90% in the airway obstruction and bronchospasm groups (table 3). There was also a wide range in reviewer judgments about the standard of care provided and in the median payment for the injury. The more severe the injury the less likely that the care would be judged as standard and the higher the median payment (table 3). The likelihood of payment for a claim was, overall, about 60% for the low-incidence respiratory events group and did not differ appreciably among the five different categories of injury (table 3). The overall median payment for the five groups was \$60,000, which compares to \$233,000 for the other respiratory-related claims and \$40,000 for non-respiratory-related claims.

### AIRWAY TRAUMA

Claims for airway trauma are subclassified as to whether or not they were associated with a difficult intubation. Of the 97 total claims for airway trauma, 41 (42%) were and 56 (58%) were not noted to be associated with difficult intubation. The most frequent sites of injury in both

TABLE 1A. Major Categories of Damaging Events

Damaging Events	Number of Claims	% of 2,046
Respiratory system	762	37
Inadequate ventilation/oxygenation	237	12
Difficult intubation	130	6
Esophageal intubation	113	6
Aspiration*	56	3
Airway obstruction*	56	3
Bronchospasm*	40	2
Other	130	6
Equipment problems	191	9
Cardiovascular system	123	6
Wrong drug or dose	84	4

N = 2,046. Only the major categories of damaging events and complications with an occurrence rate of 3% or greater are included. In the respiratory system category only damaging events with an occurrence rate of 2% or greater are included.

\* Category of injury included in this report.

TABLE 2. Severe Outcome, Standard of Care, and Incidence and Amount of Payment: Respiratory and Nonrespiratory Adverse Events

Claims	Severe Outcome		Standard of Care*		Payment	
	Brain Damage	Death	Standard	Substandard	Yes	Median Amount (\$)
Infrequent respiratory (n = 300†)	29 (10%)‡	112 (37%)‡§	122 (41%)‡§	130 (43%)‡§	181 (60%)‡§	60,000‡
Other respiratory (n = 462)	107 (23%)	322 (70%)	55 (12%)	378 (82%)	345 (75%)	233,000
Nonrespiratory (n = 1,284)	117 (9%)	286 (22%)	693 (54%)	395 (31%)	634 (49%)	40,000

\* The data represent claims where this could be judged. The remainder were impossible to judge.

† More than one adverse respiratory event occurred in 16 claims

so the total number of claims for the 316 events is 300.

‡  $P \leq 0.01$  compared to other respiratory claims.

§  $P \leq 0.01$  compared to nonrespiratory claims.

groups were the larynx, pharynx, and esophagus (fig. 1). There was no statistical difference in the incidence of laryngeal injury between the difficult and not-difficult (routine) intubation groups (fig. 1). The pharynx and esophagus were more likely to be the site of injury in claims associated with difficult intubation (fig. 1). Pharyngeal and esophageal injuries most commonly consisted of lacerations or perforations leading to mediastinitis or mediastinal abscess. Injuries to the pharynx and esophagus in the difficult-intubation group were classified as due to laryngoscopy and the attempted passage of an endotracheal tube. None of the temporomandibular joint injuries was associated with difficult intubation (fig. 1). The most common laryngeal injuries in both groups included vocal cord paralysis (14 cases), arytenoid dislocation (4 cases), and granuloma (2 cases). Of the 56 cases in which intubation was routine, the injury was believed to be due to tracheal intubation in 43 cases. Of the 13 cases in the routine-intubation group in which tracheal intubation played no role, 8 were due to passage of a nasogastric tube and 2 to a nasal or oral airway, and 3 were not classified.

### PNEUMOTHORAX

Pneumothorax was related to the performance of a block in 40% of the cases (table 4). Five types of blocks accounted for all 27 cases, with intercostal and supraclavicular brachial plexus being the most frequent (fig. 2). Airway instrumentation (laryngoscopy, endotracheal tube

placement, or bronchoscopy) was associated with pneumothorax in 19% of cases (table 4). The actual mechanism of the pneumothorax associated with airway instrumentation was not anatomically proven in most cases, but in 2 cases esophageal perforation and in 2 others a tracheal tear was documented. Barotrauma, which occurred in 16% of the cases, was due mainly to misapplication or failure of ventilators (7 cases). Pneumothorax associated with ventilator use resulted either from expiratory obstruction of the breathing circuit or use of too high a tidal volume for the size of the patient. The "other" category (table 4) consisted of pneumothorax associated with bronchospasm, air embolism, and blunt trauma. Pneumothorax associated with air embolism occurred during a diagnostic laparoscopy during which the patient suddenly developed massive subcutaneous emphysema when carbon dioxide was insufflated. The pneumothorax associated with blunt trauma occurred when a 94-yr-old patient who had undergone an uneventful open reduction of a hip fracture under spinal anesthesia suddenly moved and fell off the fracture table.

The mechanisms of causation of pneumothorax could be classified into two categories: needle-related (block or central vascular catheter) or airway management-related (airway instrumentation or barotrauma). There was a wide disparity between these two categories with respect to severity of injury, standard of care, and incidence and amount of payment (table 5). None of the patients who

TABLE 3. Severe Outcome, Standard of Care, and Incidence and Amount of Payment: Infrequent Respiratory Adverse Events Claims

Claims	Severe Outcome		Standard of Care*		Payment	
	Brain Damage	Death	Standard	Substandard	Yes	Median Amount (\$)
Airway trauma (n = 97)	0	12 (12%)	66 (68%)	17 (18%)	58 (60%)	22,000
Pneumothorax (n = 67)	7 (10%)	16 (24%)	24 (36%)	28 (42%)	42 (63%)	19,000
Airway obstruction (n = 56)	13 (23%)	36 (64%)	11 (20%)	36 (64%)	35 (63%)	300,000
Aspiration (n = 56)	3 (5%)	25 (45%)	14 (25%)	34 (61%)	37 (66%)	60,000
Bronchospasm (n = 40)	7 (18%)	28 (70%)	12 (30%)	21 (53%)	21 (53%)	218,000
Total infrequent respiratory (n = 300†)	29 (10%)	112 (37%)	122 (41%)	130 (43%)	181 (60%)	60,000

\* The data represent claims where this could be judged. The remainder were impossible to judge.

† More than one adverse respiratory event occurred in 16 claims so the total number of claims for the 316 events is 300.

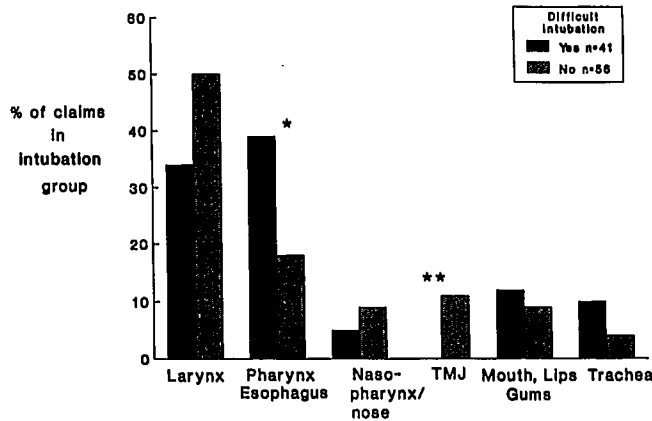


FIG. 1. The site of airway trauma in claims that were and were not associated with a difficult endotracheal intubation. \* $P \leq 0.05$ ; \*\* $P \leq 0.01$ .

filed claims for block or central vascular catheter-related pneumothorax died or had permanent brain damage. In contrast, 16 of the 24 patients with pneumothorax associated with airway instrumentation or barotrauma died or had permanent brain damage. Median payments for block or central vascular catheter-related pneumothorax were lower than for airway instrumentation or barotrauma-related pneumothorax (table 5). Care was judged by the reviewers to have met the standard more frequently in less severe (block- or central vascular catheter-related) injuries than in the more severe (airway instrumentation-related or barotrauma) injuries (table 5).

**AIRWAY OBSTRUCTION**

Most cases in this category (89%) occurred during general anesthesia. The location of airway obstruction was most frequently the upper airway (70% of cases). In about half of the cases of upper airway obstruction, the exact site was not stated in the claim file. Laryngospasm was the cause of obstruction in 11 (28%) of the 39 cases of upper airway obstruction. Other causes of upper airway obstruction included foreign body (4 cases), laryngeal polyps (2), laryngeal edema (1), and pharyngeal hematoma (1). In 10 cases of upper airway obstruction, emergency tracheostomy was performed. Obstruction to the tracheobronchial tree (21% of cases) occurred because of blood clots or mucous plugs in the lumen or external compression due to mediastinal tumor masses or blood. Endotracheal tube obstruction (9% of cases) occurred because of blood clots in the lumen or kinking of the tube itself.

Other factors associated with airway obstruction included concurrent difficult intubation (17 cases, 30%), operation on the airway (13 cases, 23%), and pediatric age group (10 cases, 18%). The primary surgical site was the trachea in 7 cases, the lung in 4, and the epiglottis

TABLE 4. Adverse Outcomes from Pneumothorax During Anesthesia: Associated Factors

	Number	% of Total
Block	27	40
Airway instrumentation	13	19
Barotrauma	11	16
Central line placement	5	7
Spontaneous/unknown	5	7
Other	6	9
Total	67	100

and larynx 1 case each. The incidence of pediatric patients in the category of airway obstruction (18%) was higher than in the database as a whole (10%).

**ASPIRATION**

In the cases of aspiration leading to adverse outcome, the predominant anesthetic technique was general anesthesia (95% of cases). Aspiration occurred usually during induction prior to endotracheal intubation (34% of cases), during maintenance of anesthesia with a mask (41%), or during emergence (18%). Aspiration occurred in 6 cases during rapid-sequence induction and in 6 others in circumstances for which a rapid-sequence technique was believed by the reviewer to have been indicated but was not used. In 2 of the rapid-sequence inductions, cricoid pressure was specifically noted to have been used. Twenty of the 23 cases of aspiration during maintenance of anesthesia occurred during anesthesia delivered *via* mask. In 1 case aspiration occurred during MAC, in another case when the endotracheal tube was removed during general anesthesia to facilitate passage of a nasogastric tube, and in another when the endotracheal tube was being changed because of a leaking cuff. Two cases of aspiration occurred in the postanesthesia care unit after the patients had emerged from anesthesia and 1 occurred on the ward, and in 1 case it was not clear at what point the patient aspirated.

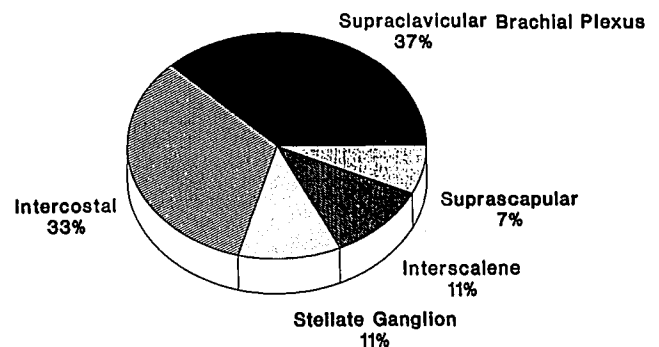


FIG. 2. Type and relative frequency of nerve blocks associated with claims for pneumothorax (n = 27).

TABLE 5. Severe Outcome, Standard of Care, and Incidence and Amount of Payment in Factors Associated with Pneumothorax

	Severe Outcome		Standard of Care*		Payment	
	Brain Damage	Death	Standard	Substandard	Yes	Median Amount (\$)
Block/central vascular catheter (n = 32)	0	0	18 (56%)	5 (16%)	18 (56%)	6,000
Airway instrumentation/barotrauma (n = 24)	6 (25%)†	10 (42%)†	2 (8%)†	18 (75%)†	17 (71%) NS	75,000‡

NS = not significant.

\* The data represent claims where this could be judged. The remainder were impossible to judge.

†  $P \leq 0.05$  Z test.‡  $P \leq 0.01$  median test.

The incidence of cases of aspiration occurring in obstetric patients (16 cases, 29%) was significantly higher than the 12% incidence in the overall database of 2,046 claims ( $P \leq 0.05$ , Z test). In nearly half (25 cases, 45%) of all cases, aspiration occurred during emergency surgery. This compares to an incidence of emergency surgery of 19% ( $P \leq 0.01$ ) in both the database as a whole and in the other categories of respiratory events in this report.

Aspiration occurred during associated airway problems such as difficult intubation (nine cases) and esophageal intubation (four cases) in 23% of the total cases. The aspirated material was gastric contents in 88% of the cases and was blood, pus, and teeth in the others. In two cases hiatus hernia and in one case scleroderma was believed to be a contributing factor to the aspiration. In one patient with hiatus hernia and the patient with scleroderma, aspiration occurred after extubation.

### BRONCHOSPASM

Bronchospasm leading to adverse outcomes occurred during general anesthesia in 80% of the cases and during regional anesthesia in the remainder. Forty-eight percent of the patients had a history of asthma or chronic obstructive pulmonary disease and/or smoking. Of the 22 cases in which bronchospasm first occurred when the patient's trachea was initially intubated, 4 patients had regional anesthesia and were intubated either for induction of general anesthesia after a failed regional anesthetic or for ventilation support after a high block. One patient had general anesthesia administered for treatment of intractable bronchospasm and died when the inhalation anesthetic was discontinued. In the cases in which general anesthesia was administered, bronchospasm initially occurred during induction in 69% of cases, during maintenance in 25%, and during emergence in 6%.

The 20% incidence of claims for adverse outcomes due to bronchospasm in obstetric patients is not significantly higher than the 12% incidence of claims in the obstetric anesthesia group in the database as a whole (Z test). All obstetric patients in the bronchospasm group were undergoing cesarean section. Bronchospasm occurred dur-

ing regional anesthesia in three of the eight patients undergoing cesarean section. The precipitating event for bronchospasm was endotracheal intubation in two cases (one failed block and one high block), and in one case bronchospasm was without an apparent precipitating event. The other five obstetric anesthesia-related cases of bronchospasm occurred at intubation after the induction of general anesthesia. Two of these five patients had a history of asthma.

In ten cases there was difficulty in making a differential diagnosis between bronchospasm and esophageal intubation (six cases) or pneumothorax (four cases). The differential diagnosis between esophageal intubation and bronchospasm was complicated in four cases by the presence of a concurrent difficult intubation.

### Discussion

The most common theme among these five groups is that all except needle-related pneumothorax represent problems with airway management. The five categories of adverse respiratory events presented in this report represent 15% of the total database of 2,046 claims (tables 1A and 1B). Collectively the five categories have a higher incidence (47%) of severe outcomes, defined as brain damage and death, than do the nonrespiratory claims (31%), but have a much lower incidence than do the other adverse respiratory events (93%), which include inadequate ventilation, esophageal intubation, and difficult intubation (table 2). There was, however, a wide range of severe injury among the five categories. Airway trauma was a cause of relatively few severe injuries, whereas airway obstruction and bronchospasm had a nearly 90% incidence of severe injury (table 3).

Standard of care as judged by the reviewers varied widely among the five groups of adverse respiratory events (table 3). Care was considered to have met standard in claims for airway trauma in 68% of the cases, whereas care met standards considerably less than half of the time in claims for pneumothorax, airway obstruction, aspiration, and bronchospasm. The high incidence of standard-care judgments in the airway trauma claims is perhaps

because this is considered an expected complication of a difficult intubation or even an uncomplicated intubation. Another possibility is that airway trauma injuries were significantly less severe than in the other categories so that the reviewers were more lenient in their judgments about standard of care. Caplan *et al.* have previously shown that the severity of injury has a significant impact on judgments about standard of care.<sup>7</sup> The less severe the outcome for a given injury, the more practicing anesthesiologists are apt to judge the care as meeting standards.<sup>7</sup>

It is surprising that despite the wide variability in standard-of-care judgments by the reviewers among the five categories (18–64% substandard care), there was little variability in the likelihood of payment (53–66%) (table 3). This relationship between likelihood of payment and standard of care differs from that seen in the database as a whole. We reported in a study of 1,004 lawsuits for all injuries from this database<sup>2</sup> that the incidence of payment was much greater if the care rendered was rated less than standard. The data in the present report specifically dealing with low-incidence respiratory adverse events may indicate that anesthesiologists are held more strictly liable by the tort system (as opposed to their peers) for injuries related to airway management.

The median amount of payment is directly proportional to the severity of injury (tables 2 and 3), a relationship we have previously observed.<sup>2</sup>

#### AIRWAY TRAUMA

The data were subclassified into difficult intubation and not-difficult (routine) intubation because we expected that the site of injury may have been different under these two circumstances. With the exception of a greater incidence of injuries to the pharynx or esophagus in the difficult intubation group and the temporomandibular joint injuries in the routine intubation group, the site of injury was essentially the same in both groups (fig. 1). Circumstances surrounding difficult intubation clearly put the tissues of the pharynx and esophagus at risk. The clinical implication is that patients in whom tracheal intubation has been difficult should be observed for, or told to watch for development of, signs and symptoms of pharyngeal abscess or mediastinitis, which may occur several days after surgery. Most of the injuries to the pharynx or esophagus in the routine intubation group were due to nasogastric tubes or airways and were not associated with tracheal intubation.

Although it is easy to understand why a difficult intubation may lead to trauma to the larynx, it is less apparent why laryngeal injuries appeared so frequently in the routine-intubation group. The reason for vocal cord paralysis, granuloma, and arytenoid dislocation in the routine in-

tubation group was not apparent from the data available in the claim file. It is curious also that temporomandibular joint injury was present only in the routine-intubation group. It would seem logical that temporomandibular joint injury would be more commonly associated with difficult intubation, in which the force applied to the jaw during laryngoscopy would be expected to be higher than during a routine intubation. The occurrence of injuries to the larynx and temporomandibular joint in the presence of routine intubating conditions suggest that patients may have had predisposing factors for development of these injuries of which we are unaware. Kroll *et al.* also observed this phenomenon in our closed claims review of nerve injury, in which most of the nerve injuries seemed to occur without identifiable mechanism.<sup>4</sup>

#### PNEUMOTHORAX

The pneumothorax category was unique in that there was a wide disparity in the severity of injury among the associated factors. The outcomes from airway management problems leading to pneumothorax (airway instrumentation or barotrauma) were more severe, received higher payment, and were more often believed by the reviewer to be due to substandard care (table 5). The larger payments for the airway management problems reflect the high incidence of severe injury. Care was judged as standard by the reviewers in 56% of the needle-related cases but in only 8% of the airway management cases. These judgments about standard of care are not surprising, since pneumothorax is a highly unusual and unexpected sequela of airway management, whereas pneumothorax is a known complication of nerve blocks or central vascular catheter placements performed close to the pleura.

#### AIRWAY OBSTRUCTION

The high incidence of severe injury in this category, in which 87% of patients had permanent brain damage or died (table 3), points out the importance of airway management in the practice of anesthesia. The mechanism of obstruction of the airway leading to injury should be preventable in the event of upper airway obstruction or blocked endotracheal tube. Laryngospasm and airway obstruction due to central nervous system depression engendered by anesthetic agents should be preventable or treatable with standard anesthetic techniques. Airway obstruction occurring during surgery on the airway is problematic for this type of surgery and may not always be preventable. Like pneumothorax from needle placement, airway obstruction by tumor, extrinsic masses, and blood are known complications that nevertheless may result in a malpractice claim.

## ASPIRATION

Many of the risk factors commonly associated with aspiration were observed in the group of claims for adverse outcomes from aspiration. Anesthesia delivered *via* mask, obstetric procedure, emergency surgery, and associated airway difficulties such as esophageal intubation and difficult intubation were prominent risk factors. The presence of associated airway difficulties as a risk for aspiration has also been noted by Olsson *et al.*,<sup>9</sup> who reported the incidence of aspiration from a large series of consecutive anesthetics.

The unexpected finding in this group of cases is that the incidence of aspiration was only 7% of respiratory-related damaging events and only 3% of the total of anesthesia-related adverse events. In contrast, Tiret *et al.*<sup>10</sup> reported, from a prospective survey in France, that of 163 complications totally attributable to anesthesia, aspiration represented 30% of the respiratory-related complications and 17% of the total complications. These investigators also reported that nearly 50% of the cases of aspiration occurred in the postanesthetic period, whereas in the present database only 23% occurred during emergence from anesthesia or later. The higher incidence of aspiration in the postanesthetic period in the study by Tiret *et al.*<sup>10</sup> was due most likely to the lack of postanesthesia care units in French hospitals at the time.

It should be pointed out that because of the lack of denominator data in our database we cannot make inferences about the overall incidence of a particular injury. The incidence of claims for injuries due to aspiration in our database was relatively low, perhaps because aspiration pneumonitis is a treatable disease that should neither lead to permanent injury nor result in a claim of malpractice. The claims for aspiration observed in this study involved significant injury, as illustrated by the finding that the 50% of patients in this group died or had permanent brain damage (table 3). It may also be that the low incidence of aspiration in this collection of adverse outcomes is because the strategies used to prevent aspiration in clinical practice in this country are generally successful.

## BRONCHOSPASM

It is not surprising that anesthesia-related bronchospasm leading to adverse outcome often occurred in patients with a history of predisposing factors (asthma, chronic obstructive pulmonary disease, and/or smoking), during induction of general anesthesia, and during initial intubation of the patient's trachea. It is notable that in about half the claims, bronchospasm occurred in patients without significant risk factors for its occurrence. It should also be noted that regional anesthesia was the primary anesthetic technique in 20% of the cases in which bron-

chospasm occurred, suggesting that this technique is not devoid of risk for the asthmatic patient.

In the obstetric anesthesia group, reflex bronchospasm seemed to occur due to endotracheal intubation in the presence of light levels of anesthesia. This occurred in two of the regional anesthesia cases in which insufficient or no general anesthetic agent was administered prior to intubation. This potential exists during general anesthesia for obstetric procedures because anesthesia is usually induced with relatively modest doses of intravenously administered agents in order to minimize the effects of the anesthetic on the fetus.

End-tidal carbon dioxide concentration was not used in the six cases where the failure to make the correct differential diagnosis between esophageal intubation and bronchospasm in a timely fashion led to an adverse outcome. Since end-tidal carbon dioxide is now an ASA standard of care for verification of tracheal placement of endotracheal tubes, it is likely that this differential diagnosis may become easier to make. Difficulty in differentiating between esophageal intubation and bronchospasm may still occur in cases in which bronchospasm is so severe that ventilation is totally impossible and carbon dioxide does not reach the detector. In this circumstance the use of a fiberoptic bronchoscope would be most helpful if the instrument were immediately available. Otherwise the use of a semirigid intubating stylet placed down the endotracheal tube to identify the resistance of tracheobronchial cartilages<sup>11,12</sup> may be useful.

In summary, the five adverse respiratory events described in this report represent 15% of the total ASA Closed Claims Project database of 2,046 claims. Overall, 89% of the adverse events in this report represent problems with airway management. A combination of the adverse respiratory events in this report and esophageal intubation and difficult tracheal intubation, which were the subject of an earlier report,<sup>1</sup> point out the critical nature of airway management in providing for patient safety during anesthesia.

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