Adverse Respiratory Events Infrequently Leading to Malpractice Suits

A Closed Claims Analysis

Frederick W. Cheney, M.D.,* Karen L. Posner, Ph.D.,† Robert A. Caplan, M.D.‡

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 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, 3% of the database) was associated with difficult intubation in 76 (49%) of the cases and the most frequent sites of injury were the larynx, pharynx, and esophagus. Pneumothorax (67 claims, 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 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. 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. 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.
ADVERSE RESPIRATORY EVENTS

TABLE 1B. Major Categories of Complications

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

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

<table>
<thead>
<tr>
<th>Claims</th>
<th>Severe Outcome</th>
<th>Standard of Care*</th>
<th>Payment</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Brain Damage</td>
<td>Death</td>
<td>Standard</td>
</tr>
<tr>
<td>Infrequent respiratory (n = 300†)</td>
<td>29 (10%)♀</td>
<td>112 (37%)♀♂</td>
<td>122 (41%)♀♂</td>
</tr>
<tr>
<td>Other respiratory (n = 648)</td>
<td>107 (21%)♀♂</td>
<td>222 (70%)♀♂</td>
<td>55 (19%)♀♂</td>
</tr>
<tr>
<td>Nonrespiratory (n = 1,224)</td>
<td>117 (5%)♀♂</td>
<td>286 (22%)♀♂</td>
<td>698 (54%)♀♂</td>
</tr>
</tbody>
</table>

* 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 516 events is 300.
♀ P ≤ 0.01 compared to other respiratory claims.
♂ P ≤ 0.01 compared to nonrespiratory claims.

---

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

<table>
<thead>
<tr>
<th>Claims</th>
<th>Severe Outcome</th>
<th>Standard of Care*</th>
<th>Payment</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Brain Damage</td>
<td>Death</td>
<td>Standard</td>
</tr>
<tr>
<td>Airway trauma (n = 97)</td>
<td>0</td>
<td>12 (12%)</td>
<td>66 (68%)</td>
</tr>
<tr>
<td>Pneumothorax (n = 67)</td>
<td>7 (10%)</td>
<td>16 (24%)</td>
<td>24 (36%)</td>
</tr>
<tr>
<td>Airway obstruction (n = 56)</td>
<td>13 (23%)</td>
<td>36 (64%)</td>
<td>11 (20%)</td>
</tr>
<tr>
<td>Aspiration (n = 56)</td>
<td>3 (5%)</td>
<td>25 (45%)</td>
<td>14 (25%)</td>
</tr>
<tr>
<td>Bronchospasm (n = 40)</td>
<td>7 (18%)</td>
<td>28 (70%)</td>
<td>12 (30%)</td>
</tr>
<tr>
<td>Total infrequent respiratory</td>
<td>29 (10%)</td>
<td>112 (37%)</td>
<td>122 (41%)</td>
</tr>
</tbody>
</table>
(n = 300†)

* 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.
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 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).](http://anesthesiology.pubs.asahq.org/pdfaccess.ashx?url=/data/journals/jasa/931335/ on 04/06/2018)
TABLE 5. Severe Outcome, Standard of Care, and Incidence and Amount of Payment in Factors Associated with Pneumothorax

<table>
<thead>
<tr>
<th>Factor</th>
<th>Severe Outcome</th>
<th>Standard of Care</th>
<th>Payment</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Brain Damage</td>
<td>Death</td>
<td>Standard</td>
</tr>
<tr>
<td>Block/central vascular catheter (n = 32)</td>
<td>0 (25%)†</td>
<td>10 (42%)†</td>
<td>18 (56%)</td>
</tr>
<tr>
<td>Airway instrumentation/barotrauma (n = 24)</td>
<td>6 (25%)†</td>
<td>18 (75%)†</td>
<td>18 (56%)</td>
</tr>
</tbody>
</table>

NS = not significant.
* The data represent claims where this could be judged. The remainder were impossible to judge.
† P ≤ 0.05 Z test.
‡ P ≤ 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 ≤ 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 ≤ 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 during 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 judg-
ments about standard of care. The less severe the out-
come for a given injury, the more practicing anesthesi-
ologists are apt to judge the care as meeting standards.

It is surprising that despite the wide variability in stan-
dard-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 that the incidence of payment
was much greater if the care rendered was rated less than
standard. The data in the present report specifically deal-
ing with low-incidence respiratory adverse events may in-
dicate 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.

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 inci-
dence of injuries to the pharynx or esophagus in the dif-
cult 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). Circum-
stances 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 in-
tubation may lead to trauma to the larynx, it is less apparent
why laryngeal injuries appeared so frequently in the rou-
tine-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 dif-
cult 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 pres-
ence 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.

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 manage-
ment problems leading to pneumothorax (airway instru-
mentation 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 en-
gendered by anesthetic agents should be preventable or
treatable with standard anesthetic techniques. Airway ob-
struction occurring during surgery on the airway is prob-
lematic 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., 9 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, Tiet et al., 10 reported, from a prospective survey in France, that of 168 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 Tiet et al., 10 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 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 bronchospasm 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 stilet placed down the endotracheal tube to identify the resistance of tracheobronchial cartilage11,12 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, 7 point out the critical nature of airway management in providing for patient safety during anesthesia.


The following organizations gave permission for acknowledgment as a source of closed claims: Anesthesiologists Professional Assurance Trust (Florida); Armed Forces Institute of Pathology; Doctors Company
of Southern California; Massachusetts Joint Underwriters Association; Controlled Risk Insurance Company (Harvard); Medical Association of Georgia Mutual Insurance Company; Medical Inter-Insurance Exchange of New Jersey; Medical Liability Mutual Insurance Company of New York; Medical Mutual Insurance Company of Maine; Minnesota Mutual Insurance Exchange; Mutual Insurance Company of Arizona; National Capital Reciprocal Insurance Company; NORCAL Mutual Insurance Company (California); Pennsylvania Medical Society Liability Insurance Company; PHICO Insurance Company (Pennsylvania); PIE Mutual Insurance Company (Ohio); St. Paul Fire and Marine Insurance Company; Utah Medical Insurance Association; Veterans Administration; and Washington State Physicians Insurance Exchange Association.

The other organizations remain anonymous for the purpose of confidentiality.

The authors also thank Caroline Wilson and Cecile Tortorice for typing and editing the manuscript.

References