Anesthesiology
78:461–467, 1993

A Comparison of Pediatric and Adult Anesthesia Closed Malpractice Claims

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Background: Since 1985, the Committee on Professional Liability of the American Society of Anesthesiologists has evaluated closed anesthesia malpractice claims. This study compared pediatric and adult closed claims with respect to the mechanisms of injury, outcome, the costs, and the role of care judged to be substandard.

Methods: Using a standardized form and method developed for analysis of closed claims, the American Society of Anesthesiologists Closed Claims Data Base was used to compare pediatric with adult anesthesia-related adverse events.

Results: Of the 2,400 total claims, 238 (10%) were in the pediatric age group (15 yr of age or younger). The pediatric claims presented a different distribution of damaging events compared with that of adults. In particular, respiratory events were more common among pediatric claims (43% *versus* 30% in adult claims; $P \leq 0.01$). The mortality rate was greater in the pediatric claims (50% *versus* 35% in adult claims; $P \leq 0.01$), anesthetic care more often was judged less than appropriate (54% *versus* 44% in adult claims; $P \leq 0.01$), the complications more frequently were thought to be preventable with better monitoring (45% *versus* 30% in adult claims; $P \leq 0.01$), and the distribution of payments to the plaintiff was different (median payment, $111,234 *versus* $90,000 in adult claims; $P \leq 0.05$). Many of the differences between pediatric and adult claims were explained by a higher prevalence of patient injury caused by inadequate ventilation in the pediatric claims (20% *versus* 9% in adult claims; $P \leq 0.01$). In pediatric compared with adult inadequate ventilation claims, poor medical condition and/or obesity (6% *versus* 41%; $P \leq 0.01$) were uncommon associated factors. Cyanosis (49%) and/or bradycardia (64%) often preceded cardiac arrest in pediatric claims related to inadequate ventilation, resulting in death (70%) or brain damage (30%) in previously healthy children. Although clinical clues suggested hypoxemia as a common mechanism of injury, the files did not contain enough information to explain the genesis of hypoxemia in these claims.

Conclusions: Comparison of adult and pediatric closed claims revealed a large prevalence of respiratory related damaging events—most frequently related to inadequate ventilation. In the opinion of the reviewers, 89% of the pediatric claims related to inadequate ventilation could have been prevented with pulse oximetry and/or end tidal CO_2 measurement. However, pulse oximetry appeared to prevent poor outcome in only one of seven claims in which pulse oximetry was used and could possibly have done so. (Key words: Anesthesia, pediatric. Complications. Monitoring.)

STUDIES of anesthetic morbidity and mortality have suggested a greater risk for children compared with adults.[1–4] If children are more likely to experience complications, we might see a different profile of liability in pediatric anesthesia. However, a direct comparison of a large sample of pediatric and adult anesthesia-related complications has not been reported to our knowledge.

Since 1985, the Committee on Professional Liability of the American Society of Anesthesiologists (ASA) has been engaged in the collection and study of closed anesthesia malpractice claims.[5] The data base containing these claims provides access to a large collection of both adult and pediatric cases in which an adverse outcome has occurred. The purpose of this report is to present a review of 238 pediatric cases in which a

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Received from the University of Washington School of Medicine, Seattle, Washington. Accepted for publication October 29, 1992. Supported by the American Society of Anesthesiologists. Presented in part at the Annual Meeting of the American Society of Anesthesiologists, New Orleans, Louisiana, October 14–18, 1989. The opinions expressed herein are those of the authors and do not necessarily represent the policy of the American Society of Anesthesiologists.

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claim of malpractice was filed against anesthesia personnel. In comparing pediatric with adult data, emphasis was placed on possible mechanisms of injury, outcome, cost, the role of substandard care, and strategies for prevention.

Methods

The ASA Closed Claims Project is a structured evaluation of closed anesthesia malpractice claims obtained from 28 insurance carriers throughout the United States. The details of the methods were reported elsewhere[5] but are summarized here. One or more practicing anesthesiologists visited each insurance company office to review closed claims according to a detailed set of instructions. The background and qualifications of the reviewers were described in a previous report.[6] Claims for dental damage were excluded from review. Typical components of the claims files included hospital and anesthesia records, narrative statements by the personnel involved, expert and peer review, deposition summaries, outcome reports, and data concerning the cost of the settlement or award.

A standardized form was used to record detailed information on patient characteristics, surgical procedures, anesthetic agents and techniques, involved personnel, the sequence of events, the standard of care, damaging events, clinical manifestations, the types of error, and the outcome. The severity of injury was graded on a 0–9 point scale with scores of 0–4 for temporary injury, 5–8 for permanent injury, and 9 for death.[7]

The standard of care was rated as appropriate (standard), less than appropriate (substandard), or impossible to judge, based on reasonable and prudent practices at the time of the event. Practice patterns (*e.g.*, the use of pulse oximetry) that may have become available later were not applied retrospectively when the standard of care was rated. The consistency with which appropriateness of care can be judged by different reviewers has been demonstrated previously.[6,8] The Closed Claims Study Committee reviewed and approved the on-site reviewers assessment of appropriateness of care. The reviewer's judgments were overruled by the Committee in approximately 3% of the cases.

Adverse outcomes were classified as both damaging events and complications. The term "damaging event" refers to the mechanism of injury; the term "complication" refers to the injury itself. A complication was deemed preventable by better monitoring if the reviewer found that the use of any monitor probably would have prevented the complication, whether or not such a monitor was available at the time of the event.

The descriptive term "inadequate ventilation" was assigned to claims in which it was evident that inadequate gas exchange from some cause produced the complication. Indicators of inadequate ventilation included clinically inappropriate hypercarbia and/or hypoxemia, clinically inappropriate tidal volume and/or respiratory rate, and related narrative information, such as, "Patient left unattended while heavily sedated" or "Unable to maintain an adequate mask fit." In some cases of inadequate ventilation, there was sufficient evidence for the on-site reviewer to consider the likelihood of one or more causes (*e.g.*, laryngospasm, airway obstruction from obesity, or bronchospasm) but not enough detail to identify the primary etiologic factor. The data base for the pediatric and adult inadequate ventilation claims underwent an in-depth review by the two authors who are pediatric anesthesiologists. All associated contributing factors were noted.

This report was generated from a total data base of 2,400 claims, accrued as of March 1991. Of these, 238 were pediatric claims (10%), defined as those involving patients 15 yr of age or younger. Claims involving neonates from a complication of obstetric anesthesia or from neonatal resuscitation and claims with missing age data were excluded.

Comparisons between adult and pediatric data were made using the Z, Kolmogorov–Smirnov, and median tests. Two-tailed tests and a significance level of 0.05 were used throughout.

Results

Twenty-eight percent of all pediatric claims involved children younger than 1 yr of age, and 55% involved children 3 yr of age or younger (table 1). Claims involving children 6 months of age or younger accounted for more claims than in any other age group. There was a preponderance of boys in the pediatric claims (65%) and women in the adult claims (62%; $P \leq 0.01$). The pediatric claims had more ASA physical status 1 patients (35% *versus* 22%; $P \leq 0.01$) but fewer ASA physical status 2 (14% *versus* 22%; $P \leq 0.01$) and 3 patients (6% *versus* 13%; $P \leq 0.01$) compared with the adult claims. General anesthesia was used more commonly

Table 1. Demographic Data

	Pediatric (n = 238)			Adult (n = 1,953)	
	No. of Claims	%	*P*	No. of Claims	%
Age					
0–6 mo	50	21	—	NA	—
7–12 mo	17	7	—	NA	—
13–24 mo	40	17	—	NA	—
25–36 mo	24	10	—	NA	—
4 yr	14	6	—	NA	—
5–6 yr	30	13	—	NA	—
7–8 yr	12	5	—	NA	—
9–10 yr	13	5	—	NA	—
11–12 yr	13	5	—	NA	—
13–15 yr	25	11	—	NA	—
Sex					
Male	155	65	≤0.01	739	38
Female	77	32	≤0.01	1,205	62
Unknown	6	3	≤0.05	9	<0.5
ASA physical status					
1	83	35	≤0.01	429	22
2	33	14	≤0.01	427	22
3	15	6	≤0.01	245	13
4	10	4	NS	65	3
5	1	<0.5	NS	11	1
Unknown	96	40	NS	776	40
Year of event					
Before 1970	2	1	NS	2	<0.5
1970–74	4	2	NS	8	<0.5
1975–79	69	29	≤0.05	432	22
1980–84	118	50	NS	1,028	53
1985–89	42	18	NS	446	23
1990	0	0	NS	1	<0.5
Unknown	3	1	NS	36	2

NA = not applicable.

in pediatric cases (89% *versus* 70% of adult cases; $P \leq 0.01$). Regional anesthesia was used less commonly (3% *versus* 24% of adult cases; $P \leq 0.01$). Halothane was used more commonly in pediatric general anesthesia cases (64% *versus* 13% of adult general anesthesia cases; $P \leq 0.01$), and enflurane (9% *versus* 28%; $P \leq 0.01$) and isoflurane (5% *versus* 20%; $P \leq 0.01$) were used less commonly. There was no difference in the use of nitrous oxide (77% *versus* 72% of adult cases; not significant).

Injuries were more severe in the pediatric claims compared with the adult claims (fig. 1). Fifty percent of the pediatric patients died, and 30% had brain damage compared with 35% and 11% of the adults, respectively ($P \leq 0.01$). Nerve injury was relatively uncommon in the pediatric claims (1%) compared with

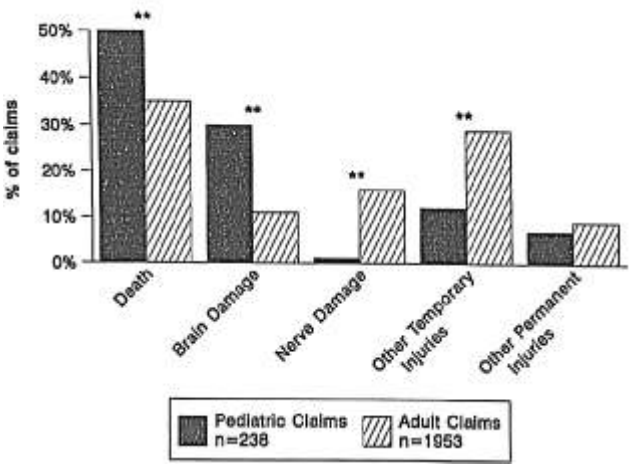

Fig. 1. A comparison of patient injury in pediatric and adult closed malpractice claims. **$P \leq 0.01$.

the adult claims (16%; $P \leq 0.01$). Other temporary injuries were less frequent in pediatric than in adult claims (12% *versus* 29%; $P \leq 0.01$).

Differences also occurred between pediatric and adult claims in issues relating to physician liability. Care was judged to have been less than appropriate in 54% of the pediatric claims compared with 44% in adult claims ($P \leq 0.01$). The reviewers judged that additional monitoring would have prevented the complication in 45% of the pediatric claims compared with 30% of the adult claims ($P \leq 0.01$).

Although there was no difference between the two groups in the percentage of claims in which payment was made (table 2), the distribution of payments was different (median payment $111,234 *versus* $90,000 for adult claims; $P \leq 0.05$). For the pediatric claims, larger payments were awarded for permanent injury

Table 2. Payment Data

	Pediatric (n = 238)			Adult (n = 1,953)	
	No. of Claims	%	*P*	No. of Claims	%
Payment frequency					
Payment	153	64	NS	1,144	59
No payment	61	26	NS	646	33
Data missing	24	10	NS	163	8
Median payment	$111,234		≤0.05	$90,000	
Median payment by severity of injury					
Temporary	$9,000		NS	$11,000	
Permanent	$554,000		≤0.01	$120,000	
Death	$88,000		≤0.01	$200,000	

than for death; for adult claims, the opposite was true (table 2).

Damaging events relating to the respiratory system explained 43% of pediatric claims compared with 30% of adult claims ($P \leq 0.01$, table 3). Inadequate ventilation was responsible for 20% of all pediatric claims compared with 9% of all adult claims ($P \leq 0.01$). General anesthesia was used more frequently and regional anesthesia, less frequently, in pediatric than in adult inadequate ventilation claims ($P \leq 0.01$, table 4). Although there was no difference between the two groups in the methods of airway management, the pediatric inadequate ventilation group had fewer cases in which no mechanical aids were employed in airway management, probably as a result of the less frequent use of regional techniques in the pediatric population. When general anesthesia was used, halothane was employed more frequently in the pediatric inadequate ventilation cases; enflurane, isoflurane, and narcotics were used less frequently (table 4). The pediatric inadequate ventilation claims included less frequent administration of succinylcholine and nondepolarizing muscle relaxants and less frequent use of controlled ventilation ($P \leq 0.01$, table 4).

Inadequate ventilation in pediatric claims was more likely to be heralded by bradycardia compared with adult claims (table 4). The outcome was poor for both pediatric and adult cases of inadequate ventilation, with a 100% and 95% incidence of death or brain damage, respectively.

The level of care in 81% of pediatric and 86% of adult inadequate ventilation cases was judged to have been less than appropriate, with median payments to plaintiff of $200,000 and $300,000, respectively (not significant). In the opinion of the reviewers, 89% of pediatric and 92% of adult claims of inadequate ventilation could have been prevented with better monitoring. The pulse oximeter and/or capnograph alone, or in combination with other monitors, were cited as preventive in most pediatric (89%) and adult (91%) inadequate ventilation claims (not significant).

Factors associated with inadequate ventilation for both pediatric and adult claims are shown in table 5. Inadequate monitoring (*e.g.*, monitors not used or ignored) was noticed in one half of the claims (51% for the pediatric claims, 53% for the adult claims; not significant). Airway management difficulties and personnel problems, such as impaired vigilance, inadequate supervision, or poor judgment, were also common. Poor patient condition (poor underlying medical condition [ASA physical status > 2] or obesity) was less common among pediatric than adult claims (6% *versus* 41%; $P \leq 0.01$).

Table 3. Comparison of Pediatric and Adult Damaging Events

Damaging Event	Pediatric (n = 238) No. of Claims	Pediatric (n = 238) %	*P*	Adult (n = 1953) No. of Claims	Adult (n = 1953) %
Respiratory system	103	43	≤0.01	587	30
Inadequate ventilation	47	20	≤0.01	179	9
Esophageal intubation	13	5	NS	110	6
Airway obstruction	11	5	NS	40	2
Difficult intubation	9	4	NS	125	6
Inadvertent extubation	8	3	NS	16	1
Premature extubation	8	3	NS	24	1
Aspiration	5	2	NS	33	2
Endobronchial intubation	2	1	NS	13	1
Bronchospasm	0	0	NS	40	2
Inadequate FI_{O_2}	0	0	NS	7	<0.5
Cardiovascular system	30	13	≤0.01	102	5
Unexplained cardiovascular	14	6	≤0.01	27	1
Inadequate/inappropriate fluid therapy	9	4	NS	26	1
Excessive blood loss	2	1	NS	18	1
Air embolism	2	1	NS	11	1
Electrolyte imbalance	2	1	NS	5	<0.5
Inadvertent intravascular injection	1	<0.5	NS	1	<0.5
Wrong blood	0	0	NS	13	1
Other cardiovascular event	0	0	NS	1	<0.5
Equipment problem	30	13	NS	189	10
Wrong drug/dose	7	3	NS	68	3
Convulsion	5	2	NS	35	2

Sixteen claims in the pediatric data base of 238 claims included pulse oximeter monitoring. Of these, nine (56%) had adverse outcomes (*e.g.*, aspiration, air embolism, or malignant hyperthermia) that could not have been prevented using pulse oximetry. Six (38%) had adverse outcomes that could have been prevented with pulse oximetry but were not. In three of these, the oximeter indicated adequate hemoglobin oxygen saturation until sudden loss of blood pressure resulted in loss of the signal without enough warning to prevent a cardiac arrest. One patient had an adult probe in place that did not produce an adequate signal. One had the probe removed before arrest in the recovery room, and one was a case of esophageal intubation in which decreasing saturation apparently was ignored. In one claim (6%), the severity of the complication probably was lessened by the use of pulse oximetry. This was a case of a probable esophageal intubation in a 5-month-

Table 4. Pediatric *Versus* Adult Inadequate Ventilation Claims

	Pediatric			Adult	
	No. of Claims	%	*P*	No. of Claims	%
Type of anesthetic	(n = 47)			(n = 179)	
General	46	98	≤0.01	142	79
Regional	1	2	≤0.01	29	16
Airway management	(n = 47)			(n = 179)	
Intubated	26	55	NS	74	41
Mask	14	30	NS	47	26
No mechanical aids	1	2	≤0.01	38	21
Primary anesthetic agent (general anesthesia only)	(n = 46)			(n = 142)	
Halothane	34	74	≤0.01	27	19
Enflurane	4	9	≤0.01	43	30
Opioid	2	4	≤0.01	31	22
Isoflurane	1	2	≤0.01	19	13
Muscle relaxant (general anesthesia only)	(n = 46)			(n = 142)	
Succinylcholine	13	28	≤0.05	71	50
Nondepolarizing	3	7	≤0.01	46	32
Mode of ventilation (general anesthesia only)	(n = 46)			(n = 142)	
Unknown	22	48	NS	46	32
Spontaneous	14	30	NS	22	15
Assisted	5	11	NS	11	9
Controlled	5	11	≤0.01	69	49
Clinical clues	(n = 47)			(n = 179)	
Bradycardia	30	64	≤0.05	82	46
Cyanosis	23	49	NS	65	36
Outcome	(n = 47)			(n = 179)	
Death	33	70	NS	124	69
Brain damage	14	30	NS	46	26
Other	0	0	NS	9	5

Missing data not shown.

old child, an event initially detected by decreased saturation.

Discussion

The closed claims data reveal a different distribution of damaging events and severity of injury in pediatric compared with adult claims. Events related to the respiratory system were more prevalent in pediatric claims, and the outcome was significantly worse. In addition, liability was perceived differently. The complications more often were judged to be preventable with additional monitoring, and the care more often was judged to be less than appropriate in pediatric cases. Also, payment was greater for pediatric than for adult claims.

Inadequate ventilation was the most frequently cited damaging event in pediatric cases (1 of every 5 claims compared with 1 of every 10 in adults). Whereas many of the adult inadequate ventilation claims were associated with poor general health or obesity, the pediatric inadequate ventilation claims involved patients who were generally healthy and of normal weight for age. The majority of damaging events in the pediatric inadequate ventilation group occurred during spontaneous ventilation of halothane, nitrous oxide, and oxygen and were preceded by a clinical warning, most commonly bradycardia and/or cyanosis. The outcome was remarkably poor; the children either died or survived with severe brain damage. Hypoxemia as a common mechanism of injury was suggested by the frequency of cyanosis and bradycardia before arrest and perhaps also by the difficulty in achieving a successful resuscitation. Unfortunately, the claim files do not contain enough information to provide a clear explanation or support for specific mechanisms that may have been linked to the genesis of hypoxemia.

Table 5. Factors Associated with Inadequate Ventilation

	Pediatric (n = 47)			Adult (n = 179)	
	No. of Claims	%	*P*	No. of Claims	%
Inadequate monitoring (*e.g.*, monitors not used or ignored)	24	51	NS	94	53
Personnel problems (*e.g.*, inadequate supervision, impaired vigilance)	20	43	NS	67	37
Airway management (*e.g.*, mask, intubation problems)	14	30	NS	63	35
Drug administration (*e.g.*, excess sedation, wrong drug)	8	17	NS	56	31
Patient condition (*e.g.*, obesity, ASA >2)	3	6	≤0.01	73	41
Other factors (*e.g.*, equipment problems, pulmonary problems)	8	17	NS	13	10

Some claims involved multiple associated factors. Every claim had at least one associated factor.

The greater frequency of respiratory-related damaging events (*e.g.*, inadequate ventilation) among pediatric claims may be caused in part by the presence in adult claims of events to which adults were either more susceptible (*e.g.*, nerve injury) or uniquely susceptible (*e.g.*, obstetric complications). More claims were filed for temporary injuries on behalf of adults than children. Perhaps minor injuries occurred more frequently in adults, or perhaps they were merely brought to both medical and legal attention more frequently.

The difference in distribution of injury between pediatric and adult claims may explain the significant differences in the liability profile. The level of care more often was judged to be substandard in pediatric claims. This difference is not surprising, given that pediatric claims for death or permanent injury were more frequent and claims for temporary injury were less frequent than in adult claims. Patient outcome has been shown to influence reviewer decision concerning appropriateness of care.[9]

In addition, the median payment to the plaintiff was greater for pediatric than for adult claims. A variety of factors may influence the payment amount, including the severity of injury and the age and life expectancy of the plaintiff. Payment for permanent injury in pediatric claims was nearly fivefold that in adult claims; payment for death was less than one half as much (table 2). Thus, the increased frequency of permanent brain injury in pediatric claims may have explained some of the difference between pediatric and adult claims in the median payment amount.

Pulse oximetry and/or capnography were cited by the reviewers as potentially preventive in 89% of pediatric inadequate ventilation cases. Coté *et al.* found that pulse oximetry provided an earlier warning of developing hypoxemia in children than did attention to vital signs alone.[10] Although the pulse oximeter appeared to be superior to either the capnograph or to clinical judgment in detecting major untoward events, the capnograph also was recommended to reduce the incidence of hypercarbia.[11] However, of the seven pediatric claims in the closed claims data base that used both pulse oximetry and had damaging events that pulse oximetry could have prevented, only one had an outcome that probably was improved by the technique. This level of protection from pulse oximetry was similar to that reported in Eichhorn's[12] study, in which only 3, and at most 5, of 11 damaging events could have been prevented by pulse oximetry. Although pulse oximetry will prevent some complications, others will occur nonetheless because of the sudden onset of the damaging event or poor judgment or inadequate data interpretation on the part of the care giver.[13]

Closed claims analysis has a number of limitations that affect the interpretation of the data. These have been discussed in detail in a previous report.[5] Most significantly, it is impossible in closed claims analysis to calculate incidence data because the necessary denominators (*e.g.*, total number of anesthetics administered, total number of injuries, or total number of malpractice claims made) are unknown. Thus, calculation of the incidence of specific anesthesia-related injuries is not feasible. For example, the fact that more claims were reviewed involving children 6 months of age or younger than for any other age group does not necessarily imply that the anesthetic risk is highest in this group. Also, the analysis can examine only the information in the data base that is made available by the

reviewers, who depend, in turn, on the information in the insurance company file. Thus, a number of issues of interest, such as the presumed benefit of having only pediatric anesthesiologists care for infants and young children, cannot be addressed.

Closed claims analysis does allow a comparison of the claims profile of subsets of the total data base, such as pediatric and adult claims. Such a comparison revealed a large prevalence of pediatric respiratory-related damaging events, most frequently caused by inadequate ventilation. These events resulted in a severe degree of patient injury and significant liability. The specific mechanism of injury in most cases of pediatric inadequate ventilation remains undefined.

The authors thank the following American Society of Anesthesiologists members who served as reviewers: R. Dennis Bastron, M.D.; John Bonner, M.D.; David E. Byer, M.D.; Michael Cassaro, M.D.; Melvin Cohen, M.D.; Fred G. Davis, M.D.; John H. Eichhorn, M.D.; Herbert A. Ferrari, M.D., J.D.; James S. Gessner, M.D.; Christopher M. Grande, M.D.; Gordon Heckel, M.D., J.D.; Peter L. Hendricks, M.D.; William Hetrick, M.D.; Theodore Heynecker, M.D.; Sandra Jelenich, M.D.; Rosemarie Johnson, M.D.; Donald Kroll, M.D., Ph.D.; John Kruse, M.D.; Monte Lichtiger, M.D.; Stanley Mogelnicki, M.D.; Lee S. Perrin, M.D.; L. Anthony Simons, M.D.; Carl Smith, M.D.; Daniel Sullivan, M.D., J.D.; Philip Villandry, M.D.; Russell Wall, M.D.; Richard Ward, M.D.; Maxwell Weingarten, M.D.; Gary Welch, M.D.; Harry Wong, M.D.; and Gerald Zeitlin, M.D.

The following organizations have given permission for acknowledgement as a source of closed claims: Anesthesia Service Medical Group, Inc. (CA), Anesthesiologists Professional Assurance Trust (FL), 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 (PA), PIE Mutual Insurance Company (OH), St. Paul Fire and Marine Insurance Company, State Volunteer Mutual Insurance Co. (TN), Utah Medical Insurance Association, Veterans Administration, Washington State Physicians Insurance Exchange Association.

The other organizations remain anonymous for the purpose of confidentiality.

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