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ORIGINAL RESEARCH
INTERVENTIONAL

Malpractice Litigation Related to Diagnosis and Treatment of Intracranial Aneurysms

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ABSTRACT

BACKGROUND AND PURPOSE: Approaches to management of intracranial aneurysms are inconsistent, in part due to apprehension relating to potential malpractice claims. The purpose of this article was to review the causes of action underlying medical malpractice lawsuits related to the diagnosis and management of intracranial aneurysms and to identify the factors associated and their outcomes.

MATERIALS AND METHODS: We consulted 2 large legal databases in the United States to search for cases in which there were jury awards and settlements related to the diagnosis and management of patients with intracranial aneurysms in the United States. Files were screened to include only those cases in which the cause of action involved negligence in the diagnosis and management of a patient with an intracranial aneurysm.

RESULTS: Between 2000 and 2020, two hundred eighty-seven published case summaries were identified, of which 133 were eligible for inclusion in the analysis. Radiologists constituted 16% of 159 physicians sued in these lawsuits. Failure to diagnose was the most common medical malpractice claim referenced (100/133 cases), with the most common subgroups being "failure to include cerebral aneurysm as a differential and thus perform adequate work-up" (30 cases), and "failure to correctly interpret aneurysm evidence on CT or MR imaging" (16 cases). Only 6 of these 16 cases were adjudicated at trial, with 2 decided in favor of the plaintiff (awarded $4,000,000 and $43,000,000, respectively).

CONCLUSIONS: Incorrect interpretation of imaging is relatively infrequent as a cause of malpractice litigation compared with failure to diagnose aneurysms in the clinical setting by neurosurgeons, emergency physicians, and primary care providers.

ABBREVIATION: IA = intracranial aneurysm

The natural history of intracranial aneurysms (IAs) is poorly understood, and there is significant variability in their management.[1-3] Increasing use of noninvasive, cross-sectional imaging leads to frequent diagnosis of incidental, small unruptured aneurysms. Unfortunately, their rupture risk is not well-known, and there are no clear guidelines regarding which aneurysms should be treated or the optimal frequency and duration of subsequent surveillance studies.[4,5] In addition, recommendations for screening high-risk populations for IAs should take into consideration the higher baseline prevalence suggested in more recent studies compared with historical publications.[6,7] Ruptured aneurysms, however, are associated with very high morbidity and mortality.[8] Lack of timely diagnosis and treatment can be a source of poor outcome and, potentially, malpractice claims.[9]

Fear of litigation and rising malpractice premiums may encourage defensive medicine practices, including administration of superfluous tests or aggressive use of preventive treatments.[10] In a 2012 survey of >1000 practicing neurosurgeons in the United States, 72% reported ordering additional imaging studies in an effort to reduce the perceived risk of medical malpractice claims.[11] This approach has huge health and economic implications and may lead to increased physician frustration and burnout.[12] An estimated $60 billion of the nearly $3 trillion annual health care expenditure in the United States is attributed to defensive medicine practices.[9]

The high financial and emotional costs of lawsuits create a need to understand the medicolegal risks associated with IAs. This requires an awareness of previous lawsuits associated with

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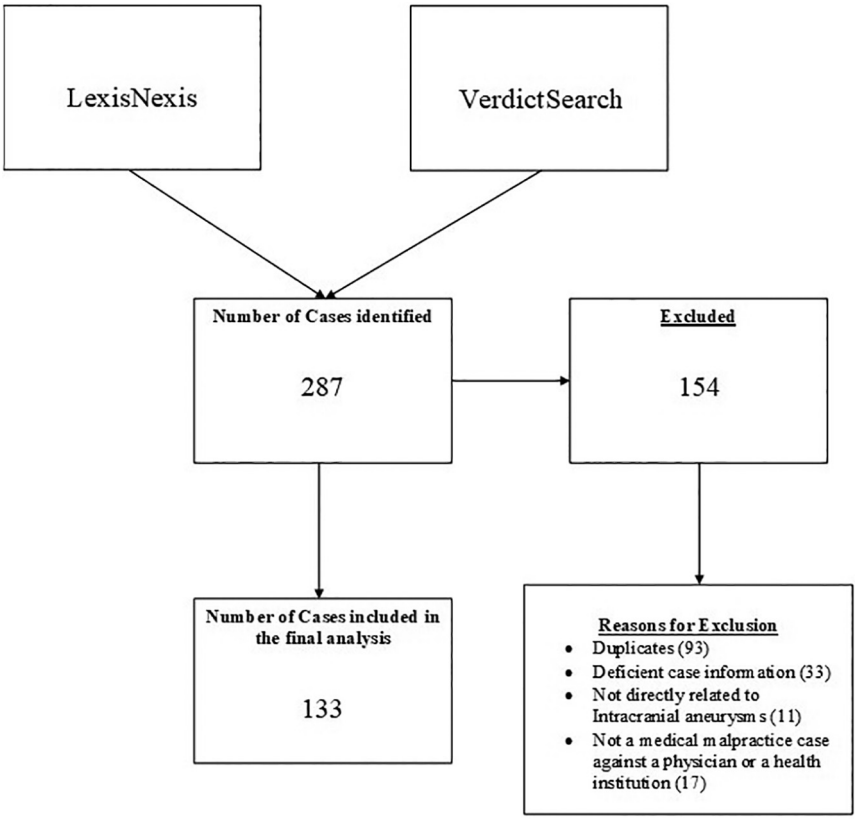

FIG 1. Flow chart illustrating the search strategy.

the diagnosis and management of IAs and the clinical settings in which they are most likely to arise. This study aimed to characterize the causes, distribution, and nature of malpractice litigation related to the diagnosis and treatment of IAs in the United States.

MATERIALS AND METHODS

No ethics approval was required for this study because no sensitive data were used and all materials were collected from open, published sources. Two online legal data repositories, VerdictSearch (American Lawyer media; https://www.linkedin.com/company/the-american-lawyer) and LexisNexis (RELX; https://www.relx.com/our-business/market-segments/legal) were screened to identify jury awards and settlements related to medical malpractice involving patients with IAs. Information was collected from all jurisdictions, ie, all 50 states and Washington, DC, from January 1, 2000, to December 31, 2020, and the most recently available published court determinations were included. These 2 legal research platforms collectively contain >1.1 million published summaries of jury awards and settlements.[13] Furthermore, they both provide detailed information regarding plaintiff and defendant characteristics, causes of action, list of plaintiff and defendant experts, injury reports, award breakdowns, and other facts of the case. Claims that were dismissed before proceeding to trial or settled out of court, however, are not available in these databases. Both databases were queried using the terms "cerebral" and "aneurysm," and only those cases categorized as "medical malpractice" or "wrongful death" were included. Only those cases in which claims of negligence were made against a doctor and/or a health care institution (including clinics, privately owned hospitals, private radiology firms, and university hospitals) were included. Claims were further categorized as failure to diagnose despite reasonable suspicion, failure to treat, failure to transfer, complications during the treatment of aneurysms, and failure in acquiring proper informed consent. Cases against corporations or doctors prescribing over-the-counter medications that may have indirectly led to aneurysmal rupture were not included (eg, prescription of antihistamines with phenylpropanolamine leading to hypertension and eventual aneurysmal rupture). Cases in which there was a claim made against paramedics or firemen for inappropriate diagnoses or treatments were not included. Finally, claims of negligence and indirect causes of aneurysmal rupture by health care professionals were not included (ie, a nurse practitioner assaulted a patient in the head leading to aneurysmal rupture).

Relevant factors were identified and collected after analysis of each case summary. Such factors included the year of publication of the trial, location of the trial, defendant and plaintiff characteristics, health care setting, case outcomes, award amounts, reasons for the lawsuit/claim, and category of negligence or medical malpractice, eg, failure to diagnose. There were a few cases in which the method of resolution was mixed when multiple parties were involved, ie, 1 plaintiff victory and 1 case dismissal; in such cases, it was counted as 1 plaintiff victory. Descriptive statistics were used for data analysis when appropriate.

RESULTS

Case Details

Case Characteristics. LexisNexis and VerdictSearch returned 287 published case summaries. After screening for inclusion and exclusion criteria and removal of duplicate studies, 133 unique case summaries were identified and included in the analysis (Fig 1). Twenty-seven states were represented, with most of the cases coming from New York (31, 23%), California (15, 11%), and Pennsylvania (11, 8%). Jurisdictions at the federal and state level were included (Online Supplemental Data).

Plaintiff Characteristics. The average age of the plaintiff at the time of the judgment was 47 years (range, 2 weeks to 76 years of age). Only 2 pediatric cases were noted.

Defendant Characteristics. Of 133 case summaries, 159 physicians were sued for medical malpractice, of which 125 (79%) were men, 12 (7%) were women, and 22 (14%) were unidentified. In 60/133 (45%) cases, claims were made against at least 1 doctor

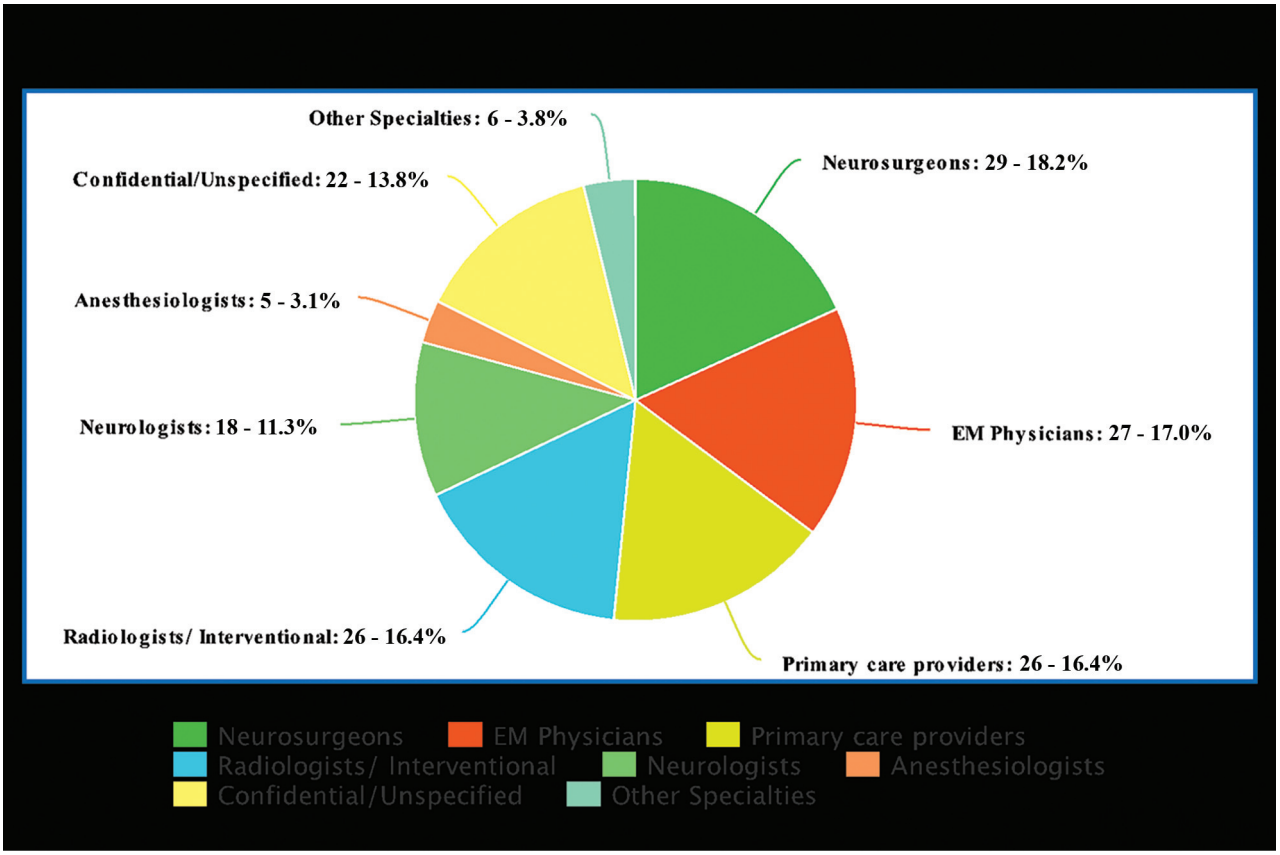

FIG 2. Pie chart showing specialties of physicians involved.

Table 1: Cause of action by specialty

	Diagnostic Radiologists	Neuro-interventional Radiologists	Emergency Medicine Physicians	Internists and Family Medicine Physicians	Neurosurgeons
Nonspecific failure to diagnose	0	1	18	16	2
Failure to include cerebral aneurysm as a differential and failure to perform adequate work-up	0	0	14	12	0
Failure to correctly interpret aneurysm evidence on CT or MR imaging	17	0	0	0	0
Procedural complications	0	6	0	0	18
Failure to timely treat	0	1	2	0	9
Failure to timely transfer	2	0	2	0	0
Failure to refer	0	0	0	4	0

and no health care facility. In another 60/133 (45%) cases, claims were made against both a physician and a health care facility. In 13/133 (10%) cases, claims were made against a health care facility only.

Defendant Specialties. After analysis of the case summaries, physicians from several specialties were found to be involved in litigation. Claims of malpractice were made against neurosurgeons (29/159, 18%), emergency medicine physicians (27/159, 17%), primary care providers (26/159, 16%), diagnostic/nonspecified radiologists (18/159, 11%), interventional neuroradiologists (7/159, 4%), a diagnostic neuroradiologist (1/159, 0.6%), neurologists (18/159, 11%), and anesthesiologists (5/159, 3%). Less frequently named specialists included ophthalmologists, otolaryngologists, and vascular surgeons. The defendant specialties are presented in Fig 2, and a summary of the malpractice allegations against the 5 most common specialties is presented in Table 1.

Health Care Facility Involvement. There were 75 unique health care facilities involved in 73 cases. Forty-five of 75 (60.0%) health care facilities were identified as private hospitals/clinics, 22/75 (30%) were identified as university-affiliated or university hospitals, 7/75 (9%) were identified as private radiology clinics, and there was 1 claim made against the Office of Veteran Affairs.

Radiology-Specific Analysis. Twenty-six radiologists were involved in a malpractice suit. Eighteen of 26 (69%) were diagnostic/nonspecified radiologists, 7/26 (27%) were neurointerventional radiologists, and there was 1 (4%) neuroradiologist. Sixteen of 18 (89%) diagnostic radiologists and 1 neuroradiologist

Table 2: Settlement and trial outcomes for radiologists

	Settlements	Trials Won	Trials Lost	Dismissals
Diagnostic radiologists	9	4	3	2
Neurointerventional radiologists	5	2	0	0
Neuroradiologist	0	0	1	0

FIG 3. *A*, Award amounts in failure-to-treat cases resolved by trial. *B*, Award amounts in failure-to-treat cases resolved by settlement.

allegedly "failed to correctly interpret aneurysm evidence on CT or MR imaging." Two of 18 (11%) diagnostic radiologists allegedly "failed to timely schedule a patient for imaging." Six of 7 (86%) neurointerventional radiologists allegedly "failed to adequately treat due to procedural error during a diagnostic or treatment intervention." Procedural errors included 5/6 (83%) cases of an attempted coiling with resultant perforation and rupture of an unruptured aneurysm, and 1 (17%) case of "misdiagnosis of an aneurysm as a junctional dilation on cerebral arteriography and failure to treat that aneurysm." Last, 1/7 neurointerventional radiologists allegedly "failed to timely treat and unnecessarily delay a neuro-interventional procedure." A summary of the malpractice allegations against the 5 most common specialties and a summary of the settlement and trial outcomes for radiologists is presented in Tables 1 and 2, respectively.

Causes of Action

Failure to Diagnose. Failure to diagnose was by far the most common medical malpractice cause of action referenced (100 cases). This was further subcategorized into failure to include cerebral aneurysm as a differential and thus perform adequate work-up (30/100, 30%) and "failure to correctly interpret aneurysm evidence on CT or MR imaging" (17/100, 17%). The remainder of the claims were designated as nonspecific failure to diagnose (53/100 cases).

Twenty of 30 (66%) cases in the "failure to work-up" category went to trial, with 12/20 (60%) judgments for the defense and 8/20 (40%) for the plaintiff. Eight of 30 (27%) cases settled, of which 5/8 (63%) cases settled for a specific dollar amount and 3/8 (37%) settled for a confidential/undisclosed amount.

In the failure to correctly interpret a CT or MR imaging category, 16/17 (94%) cases involved diagnostic/nonspecified radiologists and 1/17 (6%) physicians was specified as a neuroradiologist. Fifteen of 17 (88%) incorrect interpretation cases were on CT, and 2/17 (12%) were on MR imaging. Five of 17 (29%) cases occurred in the outpatient setting, and 2/17 (12%), in the emergency setting; the rest of the cases (10/17, 59%) did not specify the radiology setting. Nine of 17 cases (53%) were resolved by settlements, and 5/9 (55%) settlements specified the amount awarded to the plaintiff, while 4/9 (45%) settlements were confidential/undisclosed. Six of 17 (35%) cases went to trial, with 4/6 (67%) trials resulting in judgments for the defense and 2/6 (33%) trials resulting in judgments for the plaintiff. The plaintiffs were awarded $4,000,000 and $43,000,000, respectively. Last, 2/17 (12%) cases were dismissed.

Failure to Treat. Failure to treat was the next most common medical malpractice claim recorded (37 cases). Thirteen of 37 (35%) cases were attributed to failure to timely treat a case of a diagnosed IA resulting in rupture and SAH. Seven of 13 (54%) cases were resolved at trial (Fig 3*A*), with 3/7 (43%) judgments for the plaintiff and 4/7 (57%) for the defendant. The plaintiffs were awarded $1,500,000, $9,000,000, and $7,200,000, respectively. Six of 13 (46%) cases were resolved by settlement (Fig 3*B*). Four of 6 (67%) cases were settled for a specified amount, ie, $4,000,000, $1,300,000, $450,000, and $150,000; and 2/6 (33%) cases were settled for unspecified amounts. Other claims of failure to treat did not provide specific details beyond failure to treat (24 cases).

Failure to Timely Transfer. There were 4 medical malpractice claims relating to the inability or failure to timely transfer a patient for a procedure or imaging that was necessary for diagnosis/work-up of an IA. In most of these cases, there was a high suspicion of IA rupture. In 1/4 (25%) cases, there was a failure to schedule imaging due to a delay in finding an oversized MR imaging machine for a morbidly obese patient. In another case, the plaintiffs claimed that there was a failure to properly triage, and an inappropriate delay in imaging. In 2/4 (50%) cases, there was an inability to transfer a

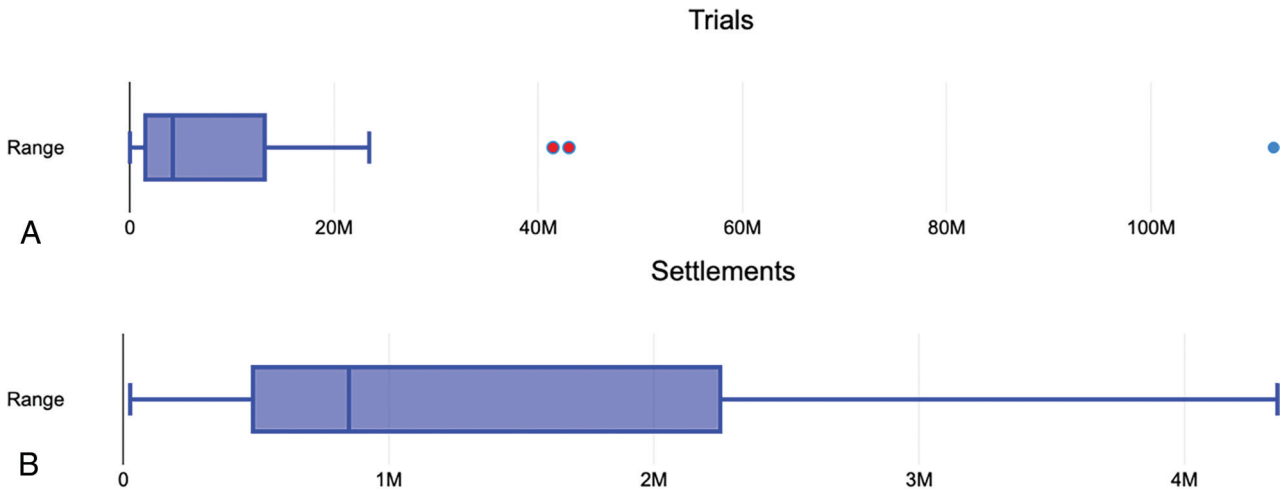

FIG 4. *A*, Award amounts in cases resolved by trial. *B*, Award amounts in cases resolved by settlement.

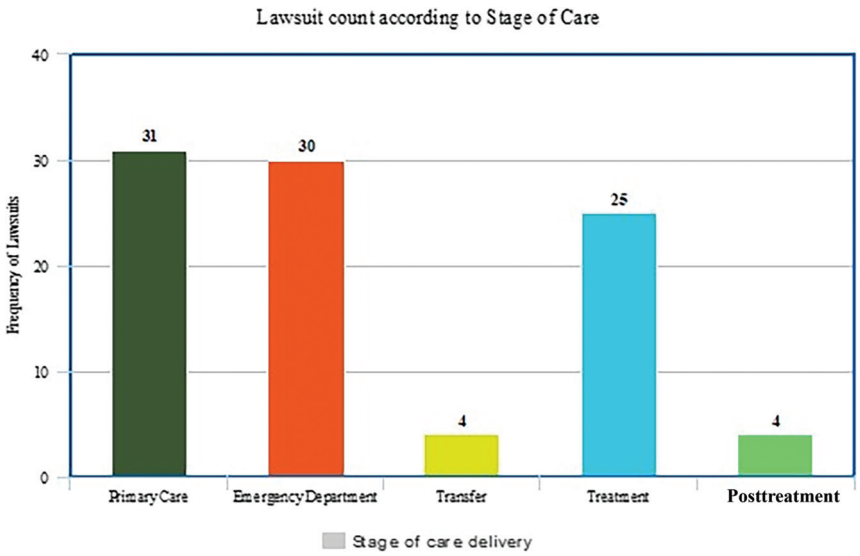

FIG 5. Incidence of lawsuits relative to the stage of care delivery.

patient due to unavailable beds caused by patient overflow. Three of 4 (75%) cases went to trial, resulting in awards for the plaintiff of $9,000,000, $8,000,000, and $112,000,000, respectively. There was 1 case that was settled for $450,000.

Failure to Refer. Last, there were 4 medical malpractice claims made against primary care providers and their inability to timely refer the patient to a neurology specialist. Primary care providers included internal medicine physicians and family medicine practitioners. Two of 4 (50%) were resolved at trial with 1 judgment for the defense and 1 for the plaintiff, with an award of $1,500,000. Two of 4 (50%) cases were resolved by settlement, in the amounts of $3,600,000 and $450,000, respectively.

The causes of action related to treatment of aneurysms are detailed in the Online Supplemental Data.

There were 37 cases related to failure to treat an IA and 24 that were related to surgical procedures or postoperative complications (4 of these were for ruptured IAs and 9 for unruptured IAs, and 11 were nonspecific). There were 3 cases in which the defendant physicians diagnosed an unruptured cerebral aneurysm and scheduled follow-up for a procedure or further imaging at a later date. However, in all 3 cases, the diagnosed aneurysm ruptured before the scheduled follow-up. Two of these cases were settled when plaintiffs were awarded $150,000 and $3,600,000, respectively.

Judgment Awards and Settlements

One hundred thirty-three cases were identified from 2000 to 2020. Fifty-two of 133 (39%) of these cases resulted in settlement, and 70/133 (53%) cases went to trial. Nine of 133 (7%) cases were dismissed without a trial, and there were 2/133 (1.5%) cases in which the method of resolution was mediation. There was only 1 case in which the awarded amount had to be reduced to the statutory cap ($7,000,780 reduced to $2,050,000).

Of the cases that went to trial (Fig 4*A*), 44/70 (63%) cases resulted in a judgment for the defendant and 26/70 (37%) cases resulted in a judgment for the plaintiff, with an average award of $12,620,953 (range, $0–$112,000,000). Of the 52 cases that were settled (Fig 4*B*), 35/52 (67%) cases were settled for an undisclosed or confidential dollar amount. Seventeen of 52 (33%) cases provided specific information regarding settlement amounts. The average settlement amount was $1,491,928 (range, $25,000–$4,350,000).

Incidence of Lawsuits Relative to the Stage of Care Delivery

The highest incidence of lawsuits occurred in the primary and emergency care settings (Fig 5). We identified 31/133 (23%) claims of medical malpractice occurring in the primary care

setting; the most common cause of action consisted of a nonspecific failure to diagnose (14/31, 45%) or a failure on the part of a primary care provider to include unruptured or ruptured IA as one of the differential diagnoses for vague presentations, thus a failure to perform further work-up (12/31, 39%). We also found 5/31 (16%) cases of failure to correctly identify an unruptured intracranial aneurysm in an outpatient setting by a radiologist, with subsequent rupture of the aneurysm.

Thirty of 133 (22%) claims of medical malpractice were in the emergency care setting; almost all the claims were against emergency medicine physicians (26/30, 87%). Only 2/28 (7%) cases in the emergency setting were due to failure on the part of the radiologist to identify a ruptured IA in an emergency setting.

DISCUSSION

Our review of 2 large legal databases resulted in 133 unique malpractice claims between 2000 and 2020 filed in 27 states in the United States relating to patients with IAs. One hundred fifty-nine physicians were sued in 120/133 cases, most frequently involving neurosurgeons (18.2%, 29/159), emergency medicine physicians (17%, 27/159), and primary care physicians (16.4%, 26/159). Radiologists were sued in 26 cases.

Failure to diagnose in a timely manner (75%, 100/133) was the most frequent cause of action for malpractice litigation. More than two-thirds of cases were due to failure to include cerebral aneurysm as a differential and thus perform adequate work-up or due to failure on the part of the primary care physician to refer or transfer the patient in a timely manner for neurologic consult/imaging. Management of patients with thunderclap headache and the utility/effectiveness of CTA versus lumbar puncture after negative findings on a CT of the head study are areas of active debate.[14-16] Unfortunately, the legal case summaries did not provide adequate details to analyze these issues further in this study.

Of 30 claims of medical malpractice in the emergency care setting, only 2 were due to failure on the part of the radiologist to identify a ruptured IA in an emergency setting. In 1 case of a fall at home, CT of the brain was allegedly erroneously interpreted as having negative findings by a radiologist. The patient returned a day later with new neurologic deficits that were ascribed to barbiturates the patient had recently taken. Repeat CT at a different local hospital showed evidence of a ruptured aneurysm. A facilitated settlement was reached among all parties of $4,000,000. The other case was nonspecific and only mentioned a failure to diagnose ruptured aneurysms and SAH, which went to trial and resulted in a judgment for the defense. The sensitivity of noncontrast CT for SAH decreases after 6 hours of the onset of thunderclap headache.[17]

Of 31 claims of medical malpractice in the primary care setting, we found 5 cases of failure to correctly identify an unruptured IA in an outpatient setting by a radiologist, with subsequent rupture of the aneurysm. Increasing use of noninvasive imaging has shown the prevalence of IAs to be >7% in the general population, and most of these incidental aneurysms are small. Artificial intelligence has also been proposed to facilitate the detection of IAs.[18] However, the role and medicolegal implications of the incorporation of artificial intelligence have not yet been fully determined.[19]

Of the 17 cases in the failure to correctly interpret the CT or MR imaging category, 6 went to trial and only 2 resulted in judgments in favor of the plaintiff. In 1 case of blunt head trauma presenting as headache, findings of MR imaging of the brain were normal, but a subsequent CT showed SAH from a ruptured aneurysm. In this case, the plaintiff was awarded $43,000,000. The second case presented with syncope and severe headache in which CT of the head was read as an "unremarkable study." The patient was discharged and had worsening symptoms but did not have further imaging until 2 weeks later when a CT showed a large intracranial bleed. The plaintiff was awarded $4,000,000.

Limitations

Various factors influence a plaintiff's decision to file a claim, including the relationship with the physician and/or hospital or perceived financial incentives, which may influence cases going to trial but cannot be assessed in this analysis.

The legal databases used in the study do not contain a comprehensive list of all litigation filed across the United States. Cases that are resolved privately in the prelitigation setting before reaching trial would not be included in these data sets. Previous studies have reported that up to 85% of malpractice cases may be dropped, dismissed, or settled before trial.[9,20] The available content varies by jurisdiction; some jurisdictions are more robust in sharing litigation materials with legal databases than others. However, these legal data sets are frequently used as a representation of legal precedent in outcome and value.

Case details within the database were not consistently clearly presented, making it difficult to accurately characterize some cases. There were multiple cases in which there were claims made against >1 party. There were also a handful of cases in which the method of resolution was mixed; ie, one party went to trial while another claim was dismissed. In such cases, the case was counted as 1 trial. A number of trials and settlements reported an undisclosed award amount, making it difficult to find accurate associations between award amounts and types of malpractice claims.

CONCLUSIONS

A review of the malpractice lawsuits in 2 major legal databases suggests a failure to clinically consider IA or do adequate imaging/work-up and failure to treat as the most frequent cause of action. Failure to correctly interpret imaging studies was a less frequent claim but may lead to significant financial liability. Although detection and treatment of IAs have increased in the past 2 decades, we did not see a corresponding increase in the frequency of lawsuits.

Disclosure forms provided by the authors are available with the full text and PDF of this article at www.ajnr.org.

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