

## Pediatric Anesthesia in the Community

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### Keywords

- Pediatric anesthesia • Specialization • Demographics • Outcomes
- Patient experience

### Key points

- Pediatric anesthesia is performed at a wide range of surgical and dental facilities.
- Pediatric anesthesia is performed by Board-certified pediatric anesthesiologists, fellowship-trained but noncertified anesthesiologists, and generalists.
- Pediatric anesthesia, regardless of location or clinician, is generally very safe, with high patient and family satisfaction and rare adverse events.

## INTRODUCTION

Patients aged younger than 18 years account for 15% to 20% of anesthesia case volume in the United States [1]. The number of pediatric surgical cases in the main operating room has increased slightly in recent decades, although many traditional hospital cases are now done in ambulatory surgery facilities. This has been accompanied by a rapid increase in nonoperating room pediatric anesthetics (nonoperating room anesthesia [NORA]), including both diagnostic procedures such as MRI, cardiac catheterization, endoscopy, and an increasing number of minimally invasive therapeutic procedures [2].

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Despite the rapid advancements in anesthesia care, the distribution of pediatric patients is not straightforward and not well described in current literature. Dedicated Children's Hospitals perform most high risk, high complexity cases—as they should—but more routine cases are performed in a variety of other environments including children's hospitals within adult hospitals, mixed adult and pediatric ambulatory surgical centers, pediatric ambulatory surgical centers, and dental offices. Similarly, the anesthesia clinicians caring for these patients range from Fellowship-trained and Pediatric Anesthesia Board-certified anesthesiologists to generalists seeing pediatric patients as less than 10% of their practice [3].

A recent effort by the American College of Surgeons, in consultation with the Society for Pediatric Anesthesia (SPA), created the Children's Surgery Verification (CSV) program [4]. The CSV is a quality improvement effort to establish standards for Level 1, Level 2, and Level 3 pediatric surgical facilities. Publication of these guidelines was applauded by the network of children's hospitals but caused consternation in the broader group of community hospitals providing pediatric surgeries. The guidelines, in specifically recommending fellowship-trained and Board-certified pediatric anesthesiologists, have called into question the capabilities of nonspecialized anesthesiologists, many of whom have been providing care for pediatric patients over many years. On the one hand, more training and a rigorous certification policy are likely to promote better outcomes; however, on the other hand, there are not enough qualified subspecialists to meet the national demand for pediatric anesthesia care, and there is little objective evidence of a difference in outcomes based on the credentials of the clinician, especially with regard to routine cases.

More data are required to understand the needs of the population, including both community access to anesthesia and the demand for higher risk procedures, and to define the difference in outcome between highly specialized care in children's hospitals versus pediatric cases performed by generalist anesthesiologists in community facilities.

Our purpose in producing this review is to pragmatically describe the landscape of pediatric anesthesiology in the United States, using the resources of US Anesthesia Partners (USAP), a nationwide private practice serving a broad swath of facilities (academic hospitals, community hospitals, specialty centers, and ambulatory surgery centers) across the country. USAP includes both pediatric anesthesiology specialists and general practitioners, who collectively completed more than 165,000 anesthetics in 2023 in patients aged younger than 18 years. These cases included a range of patient ages, comorbidities, and surgical case types. While a retrospective review cannot provide definitive data on risk versus outcome in pediatric anesthesia, and while our data is only a convenience sample of US anesthesia practice, we trust that the demographic data provided will guide researchers, policy makers and educators to an understanding of the current landscape of care.

## **METHODS**

The primary source of data for the descriptions below is the USAP Clinical Data Warehouse. USAP is a national anesthesia private practice with local

groups in Seattle, Las Vegas, Denver, Dallas/Fort Worth, Austin, San Antonio, Houston, Ft. Wayne, Nashville, Ft. Myers, Orlando, Jacksonville, Baltimore, and Washington D.C. Clinical decision-making in USAP, including hospital partnerships, hiring, and daily assignment of personnel to cases, resides with physician leadership in each local “platform,” whereas the national practice management infrastructure makes investments in common resources for revenue cycle management, quality improvement (QI), clinician benefits, legal support, and operational efficiency. USAP invests in national-scale data and analytics [5]. Every case is documented in the data warehouse, and used to generate performance scorecards at the group, facility, and individual level [6]. Aggregate data in the Warehouse is used for QI and research projects at multiple levels of the practice.

Captured in the data warehouse are more than 50 demographic, operational, clinical, and quality datapoints for every case, supported by inclusion of the preanesthetic assessment, intraoperative record, and postanesthesia note. USAP conducts routine audits of this information, focused on the correlation between clinician attestation and the medical records and maintains an extremely high rate of compliance with accurate and complete documentation. Case information is further supplemented by inclusion—when available—of patient satisfaction data. Within 10 days of every case USAP solicits the patient (or family) by text and/or email to complete the Anesthesia Patient Satisfaction Questionnaire, Version 2 (APSQ2), a nationally validated instrument used to report Medicare quality measure AQI-48 Patient-Reported Overall Anesthesia Experience. The current USAP survey response rate is 28% to 32% of all patients with demographic data, adding a wealth of unique, and highly actionable, data on patient satisfaction to the Clinical Data Warehouse [7].

For purposes of this review, we abstracted data from every patient aged younger than 18 years cared for by a USAP clinician for a nonobstetric case in calendar years 2016 to 2022. For every case in this dataset, we noted the site of service, the clinicians involved in the patient’s care, the date and time of the surgery, the specific case and anesthesia types, and patient demographics including age, sex, and ASA physical status. When the patient or family returned a satisfaction survey, we included the results. This dataset was linked to the USAP Credentials file, providing the training and Board Certification status of each clinician, and to data describing each of the facilities where pediatric anesthesia was performed, including the type, size, and specialization of the facility.

Clinicians were characterized both by their training and by the percentage of their cases, which were pediatric anesthetics, yielding 2 separate dimensions of expertise. Similarly, facilities were sorted based on the percentage of their cases, which were pediatric.

For each of the demographic metrics, we present both the current state (2022) and, if applicable, changes noted during the 7 years of data collected. USAP Tennessee and Indiana are recent platforms who joined USAP in September of 2022; therefore, this dataset does not represent their full scope of pediatric practice for the year.

## RESULTS

### Location of procedures

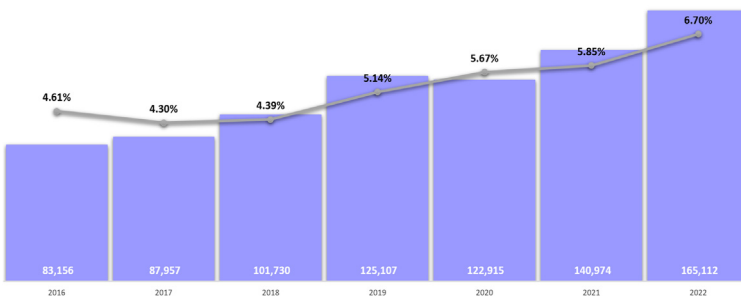
From 2016 to 2022, the number of pediatric anesthetics performed by USAP clinicians increased from 83,000 to more than 165,000 annually (Fig. 1). Cases were performed in 505 sites representing roughly 2.6% of the 6 million pediatric anesthetics performed each year in the United States [8]. Year-on-year growth in pediatric case volume was due to both growth of USAP (expansion into new sites) and to increased volume on a same-facility basis. The trend line on Fig. 1 shows the number of pediatric cases as a percentage of all USAP cases in each year, increasing to the current value of 6.70% of total practice volume. In aggregate, the 7 years of data represent more than 800,000 pediatric anesthetics.

USAP clinicians perform pediatric anesthesia across 10 states (Fig. 2). More than 50% of USAP pediatric anesthetics were performed in the state of Texas at 261 sites of service. In Florida, 32,100 pediatric anesthetics were performed in 52 sites of service, while in Colorado and Nevada roughly 20,000 anesthetics occurred in 83 sites. The number of USAP-served stand-alone and attached-but-dedicated children's hospitals (hospital in a hospital) in each state is represented by a number above each state's bar graph, with 7 facilities in Texas, and one each in Colorado, Florida, Nevada, and Oklahoma. The "hospital in a hospital" model is common in community pediatric care, allowing for concentration of resources and expertise in a building dedicated to pediatric care but attached to a larger adult hospital.

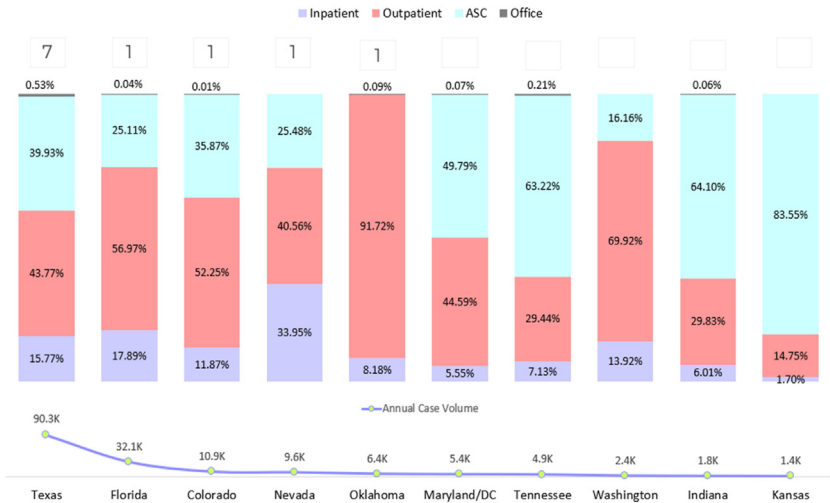
Concordant with the pattern of place of service distribution within each state was the distribution of anesthetizing locations. The majority of all pediatric cases were performed on an outpatient basis, either in hospitals, outpatient facilities attached to the hospital, ambulatory surgical centers, or dental offices. In

## Total Pediatric Cases: Year over Year

[Sans OB]



**Fig. 1.** Total pediatric cases: year over year. Excludes obstetric cases. The trend line shows the percentage of all USAP anesthetics involving pediatric patients.

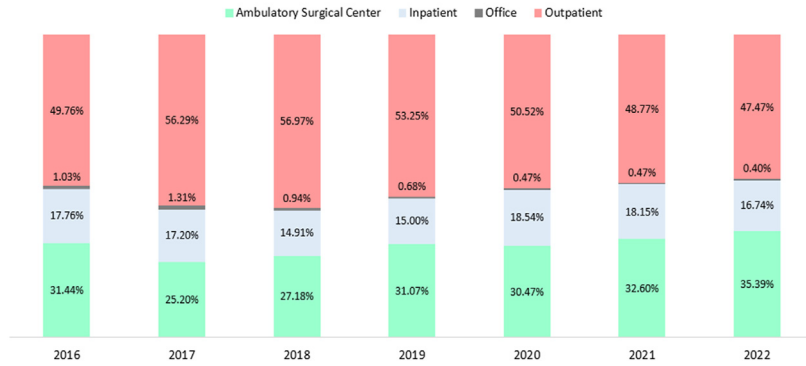


**Fig. 2.** Pediatric volume by state and place of service. The number above each bar is the count of children's hospitals in each state. The states are sorted by pediatric case volume. The trendline shows volume by state. ASC, Ambulatory Surgery Center.

Indiana, Kansas, Maryland/Washington DC, and Tennessee, the majority of pediatric anesthetics were performed in Ambulatory Surgery Centers (ASCs). In Colorado, Florida, Oklahoma, and Washington, most pediatric anesthetic procedures were performed on an outpatient basis in hospital settings or in surgical centers attached to a hospital. Inpatient hospitals included dedicated, freestanding children's hospitals, children's hospitals attached to a larger general or academic hospital, and community hospitals with pediatric cases mixed with adults. Outpatient hospitals were defined as on-campus outpatient operating rooms caring for both children and adults. ASCs included ambulatory surgery centers caring for both children and adults, and ambulatory surgery centers specializing in pediatric procedures. Office-based anesthesia consisted for the most part of pediatric dental procedures.

From 2016 to 2022, the distribution of place of service across all USAP sites has undergone subtle changes because procedures shifted from inpatient to an outpatient setting (Fig. 3). The proportion of cases occurring in the ASC and Outpatient setting outnumbers the number of inpatient cases. Moreover, the 25% to 30% increase in the proportion of pediatric anesthetics performed at ASCs during the 7 years is consistent with the 40% increase in ASC's utilization trend previously observed during a 10 year period (from 1996 to 2006) by the US National Center for Healthcare Statistics [9]. Outpatient cases performed at a hospital were 49.76% in 2016, growing to 56.97% in 2018 before declining steadily to 47.47% in 2022. During the same period, inpatient cases declined marginally from 17.76% to 16.74%. The volatility of the COVID-19 pandemic likely impedes interpretation of this trend.

## Pediatric Place of Service Trend 2016–2022

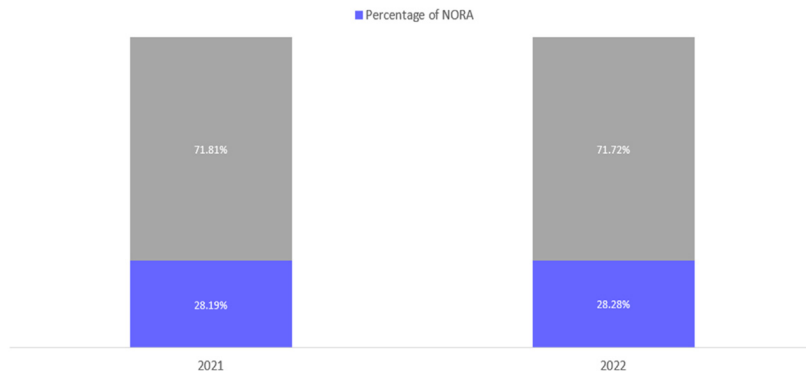


**Fig. 3.** Inpatient versus outpatient trend 2016 to 2022. Outpatients include both ambulatory patients having surgery in a hospital and those having procedures in an ambulatory surgery center or office.

Across 7 years, between 14% and 19% of USAP pediatric cases were performed on an inpatient basis, with one children's hospital and 4 dedicated pediatric units (hospital-in-a-hospital) accounting for more than 40% of all inpatient cases.

The need for NORA service in pediatrics has expanded dramatically during the past decade. Previous reports suggested that NORA represents 10% to 24% of the pediatric cases [10]. Our data (Fig. 4) demonstrated a higher percentage of pediatric NORA cases (28.24% avg during the past 2 years) with an upward

## Percentage of NORA Pediatric Cases



**Fig. 4.** Proportion of remote-site anesthetic procedures.

trajectory from 2021 to 2022 at 28.19% and 28.28%, respectively. This may represent an ongoing evolution in the scope and number of diagnostic and nonsurgical procedures performed at NORA locations.

### Patient demographics

Fig. 5 illustrates the number of USAP pediatric cases by age as of 2022. Consistent with national data, about 25% of pediatric anesthetics were in neonates or infants, and more than half occurred in patients aged 6 years or younger [8]. Anesthetics for school-age children were relatively less common until the teen years. There were 1683 neonates cared for across the USAP platforms in 2022, with a gradual increase from 779 in 2016 to 1683 in 2022. Although neonatal anesthetics make up only 1% to 2% of all pediatric cases, they are disproportionately complex and are a notable percentage of all neonatal anesthetics each year in the United States.

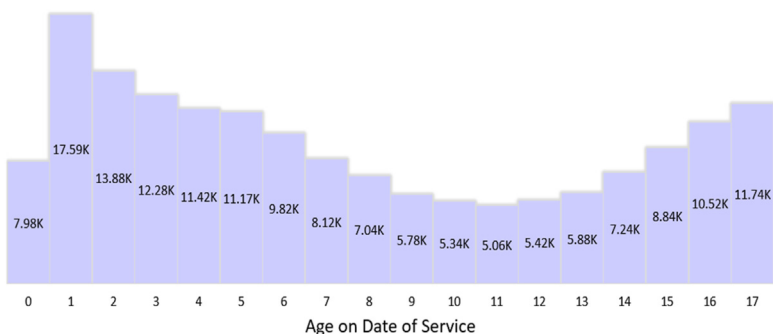
Fig. 6 shows the trend from 2018 to 2022 of patient complexity in pediatric patients. USAP has seen a reduction in ASA 1 and 2 patients and an increase in ASA 3, ASA 4, and ASA 5/6 patients. Patients with life-threatening comorbidities, ASA greater than 3, represented 14.68% of pediatric cases in 2022 (24,238 patients).

### Procedures

Using groupings based on the Agency for Healthcare Research and Quality's Clinical Classification Software, Fig. 7 shows the most common case types for each age of patient [11]. Beginning in infancy, Ear, Nose and Throat (ENT) cases predominate. Orthopedic surgery is common in older children, while cardiac surgery is almost exclusively confined to neonates and infants.

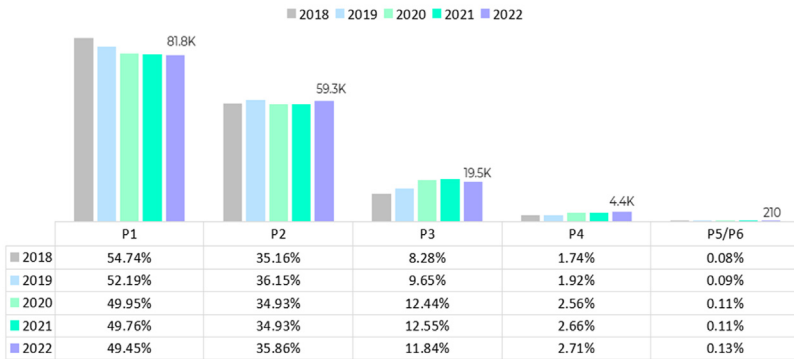
Figs. 8 and 9 show counts of fellow-level index cases by age and service line, as defined by the Accreditation Council for Graduate Medical Education (ACGME) for the purpose of reviewing and accrediting Pediatric Anesthesia

## USAP Pediatric Cases by Age



**Fig. 5.** USAP pediatric cases by age in 2022.

## ASA Status Trend 2018 – 2022

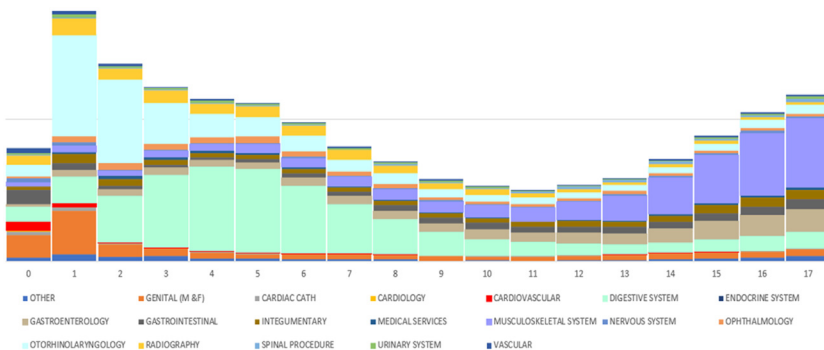


**Fig. 6.** Pediatric cases by ASA physical status trend from 2018 to 2022.

Fellowship programs [12]. Ensuring sufficient availability of these complex cases for Fellows and Anesthesiology Residents is a requirement for specialty training. The number of fellow-level pediatric index cases performed by USAP clinicians supports the necessity of having an expanded case-log requirement in graduating pediatric anesthesia fellows to adequately prepare them for independent clinical practice [13].

The 1194 congenital heart surgeries performed by USAP clinicians further demonstrate complexity in community pediatric anesthesia practice. This number represents 3.5% of the 33,610 pediatric cardiac cases recorded in the STS database for 2021 [14].

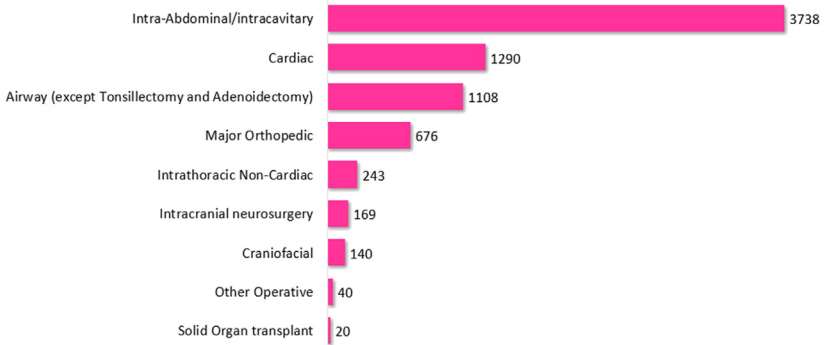
## PROCEDURE MIX BY AGE DISTRIBUTION



**Fig. 7.** Pediatric procedures by age in 2022. Case-type groupings are from the Agency for Healthcare Research and Quality Clinical Classification Software.



## Pediatric: Complex Cases



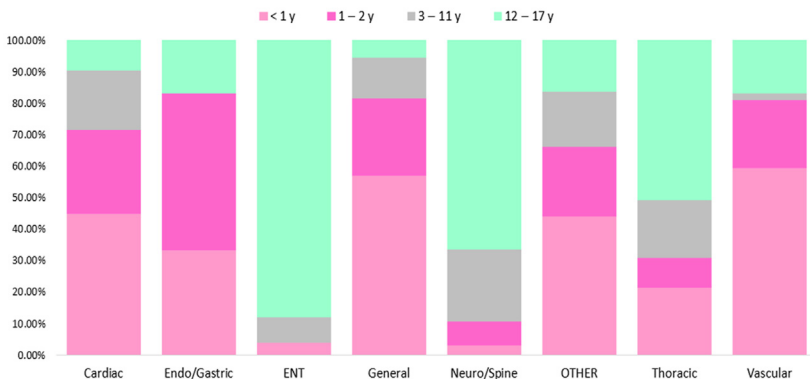
**Fig. 8.** Complex cases performed by USAP clinicians in 2022.

### Clinicians

Fig. 10 describes the population of 4410 USAP clinicians who delivered pediatric anesthesia in 2022 (approximately 90% of all USAP clinicians), their credentials, and the percentage of overall practice dedicated to pediatric anesthesia cases. This total included 2123 anesthesiologists and 2287 Certified Registered Nurse Anesthetists (CRNAs) and Certified Anesthesiologist Assistants (CAAs). For the anesthesiologists involved, we categorized as follows.

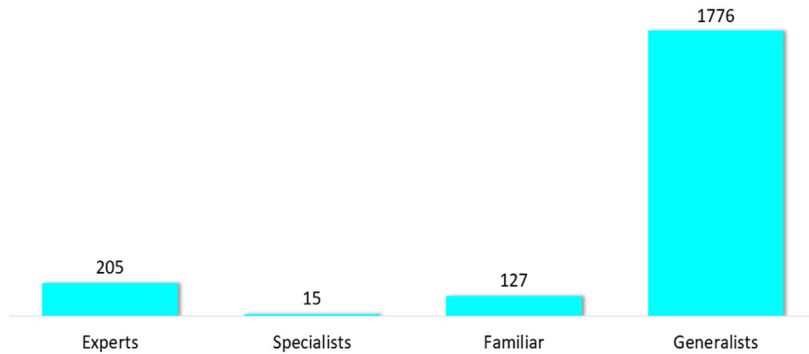
- Experts—Anesthesiologists with Pediatric Anesthesia Subspecialty Boards, or Board Certified in Pediatrics in addition to Anesthesiology

## Complex Case Category by Age



**Fig. 9.** Complex procedures performed by USAP physicians in 2022 across various pediatric age groups.

## Anesthesiologist Categorization



**Fig. 10.** Number of Unique Anesthesiologists Performing Pediatric Cases by Certification and Percent Volume of Pediatric Patients in Total Volume in 2022. “Experts” are defined as anesthesiologists with Pediatric Anesthesia Subspecialty Boards, or Board Certified in Pediatrics in addition to Anesthesiology. “Specialists” are defined as anesthesiologists with greater than 50% of their cases in patients aged 0 to 17 years. “Familiar” are defined as anesthesiologists with greater than 10% and less than 50% of their cases in patients aged 0 to 17 years. “Generalists” are defined as anesthesiologists with less than 10% of their cases in patients aged 0 to 17 years.

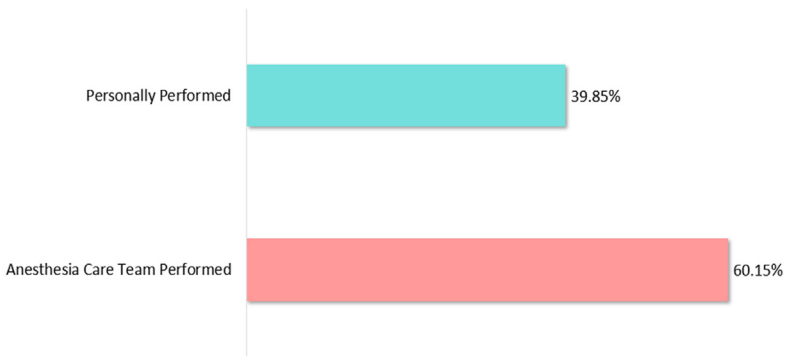
- Specialists—Anesthesiologists with greater than 50% of their cases in patients aged 0 to 17 years but without formal subspecialty training or certification
- Familiar—Anesthesiologists with greater than 10% and less than 50% of their cases in patients aged 0 to 17 years
- Generalists—Anesthesiologists with less than 10% of their cases in patients aged 0 to 17 years

The 220 USAP anesthesiologists comprising the expert and specialist categories, represent 5% of the national supply of 4377 pediatric anesthesiologists in the 2020 US pediatric workforce [15].

Many USAP sites practice predominantly as anesthesia care teams (ACT). Fig. 11 displays that, of the 165,000 cases in 2022, 99,323 (60.15%) involved a CRNA or CAA supervised by an anesthesiologist, while the remaining 65,789 (39.85%) cases were personally performed by an anesthesiologist working alone.

In dedicated pediatric facilities, anesthesia staffing was typically by a group of clinicians specialized in pediatric anesthesia. Where pediatric cases were mixed with an adult population, they were more likely to be cared for by anesthesiologists with a mixed practice. In several USAP cities, more complex or high-risk pediatric cases were assigned to a citywide team of pediatric anesthesia specialists who travel between hospitals to provide this service. This model is effective in community practice because it mirrors activities of the pediatric surgeons. In Las Vegas, for example, pediatric cardiac surgery may be performed in several

## Cases Performed: Anesthesiologist vs Anesthesia Care Team



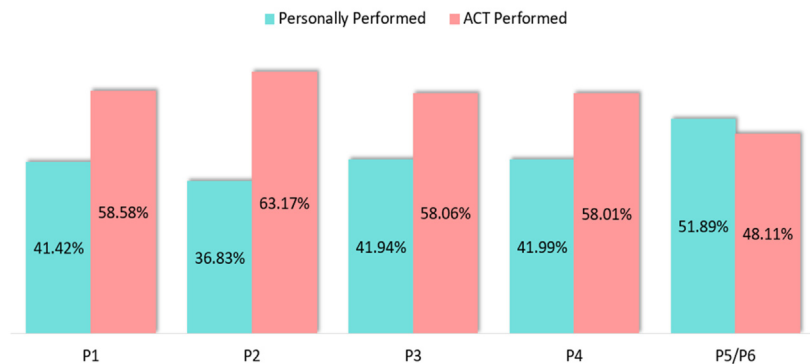
**Fig. 11.** Percentages of cases performed by only anesthesiologist versus anesthesia care team.

hospitals but always by the same team of surgeons, thus enabling a “follow the surgeon” anesthesia model. While moving between hospitals is less time-efficient for the anesthesiologists involved, this ensures consistent surgeon-anesthesiologist dyads for these cases.

Fig. 12 shows the distribution of ASA III, IV, and V patients and the ACT used, whether an ACT or personally performed by only the anesthesiologist. In ASA physical status groups 1 to 4, ACTs cared for most patients.

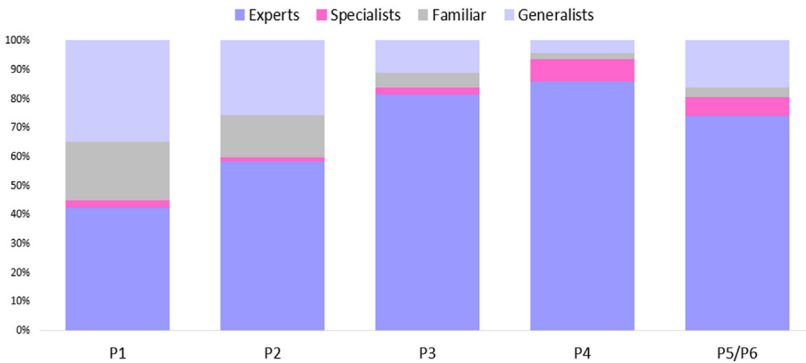
Fig. 13 illustrates the ASA distribution by category of pediatric clinician in 2022. The graphic demonstrates that 82.4% of ASA 3 to 5 patients were cared for by “Expert” anesthesiologists, per the categories above. However, 3.3% of

## Cases by Anesthesia Model & ASA Status



**Fig. 12.** ASA distribution by anesthesia model in 2022.

## Anesthesiologist Category by ASA Physical Status Distribution

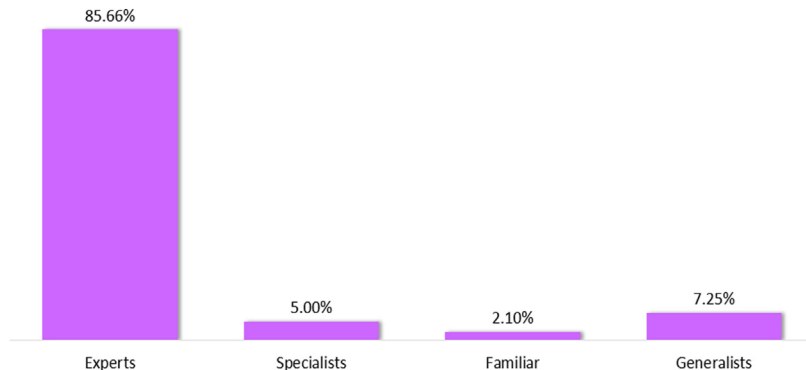


**Fig. 13.** Pediatric Clinician Category by ASA Distribution in 2022. Categories defined above.

ASA 3 to 5 patients were cared for by “Specialist” anesthesiologists and 4.6% by “Familiar” anesthesiologists. The figure also demonstrates that as patient acuity increases, the percent of cases covered by “Generalists” and “Familiar” anesthesiologists decreases.

The distribution of index cases by category of anesthesiologists, as defined above, is represented in Fig. 14. The figure demonstrates that “Experts” and “Specialist” anesthesiologists perform the majority of anesthetics for sicker patients. However, a fraction of these cases is still performed by “generalists” and “familiar.” This reflects the reality of community anesthesia practice that pediatric emergencies can arise at any time or site of service and emphasizes the importance of training and experience in pediatric care for any anesthesia clinician.

## Index Cases by Anesthesiologist Categorization



**Fig. 14.** Distribution of index cases by category of anesthesiologist.

Index cases were more likely to have been performed at a facility that identified itself as a pediatric facility than one that did not (Fig. 15). With the exception of ASA 1 and 2, no index cases were performed at an ASC.

The percentage of index cases performed by each pediatric board-certified anesthesiologist (Expert) is listed in Fig. 16. Pediatric Anesthesiology Board-Certified physicians were 85% more likely to be responsible for the care of an index case. Pediatric board-certified anesthesiologist index cases were performed by single-posted physicians 40% of the time, and by care team 60% of the time.

### Safety and outcomes

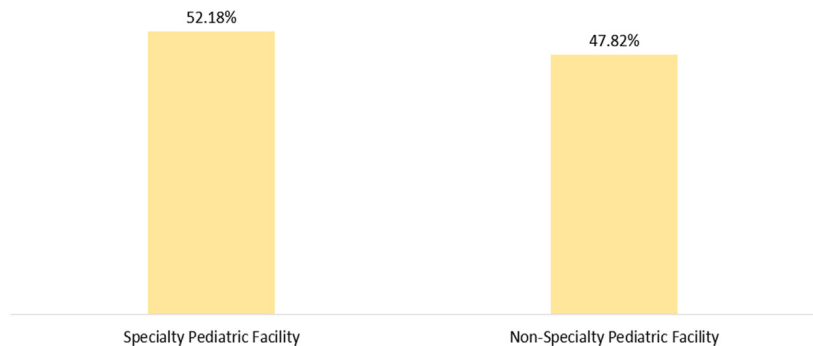
The USAP Quality program records patient safety outcomes for all anesthesia cases, which are reviewed by the local USAP Risk and Quality Directors and Clinical Quality Committees. In addition, for pediatric cases, the USAP Patient Safety Organization shares demographics and narratives with the Wake Up Safe Patient Safety Organization of the SPA [16]. The most common events reported in pediatric patients were laryngospasm/bronchospasm, intraoperative hypothermia, and transient desaturation. A serious adverse event occurred in less than 1% of all pediatric cases, consistent with national experience and the overall safety of anesthesia in ASA 1 and 2 patients of any age.

### Patient satisfaction

Patient experience data has been collected through a robust system for more than 7 years. The adaptive survey, APSQ2, asks questions specific to anesthesia in communication, comfort, easing anxiety, time spent with anesthesiologists/anesthesia care team before and after anesthesia, nausea and vomiting, clinician satisfaction, and overall anesthesia experience. USAP values this feedback; USAP meticulously analyzes that data to provide aggregated feedback to providers and uses the data to further improve patient interactions and experience. Patient and family satisfaction with pediatric anesthesia is generally high,

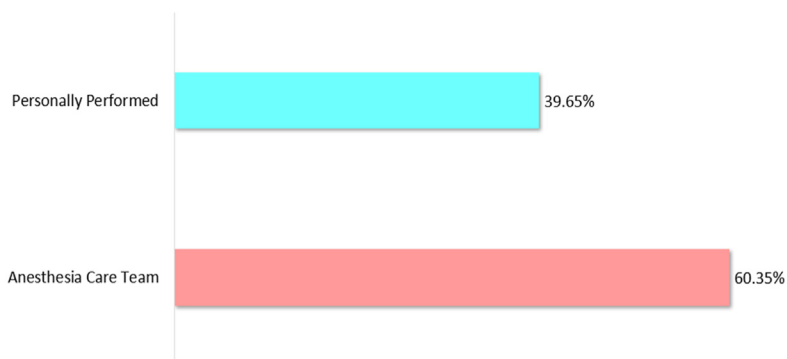
## Index Cases by Facility Type

*Specialty Pediatric Facility = Pediatric case volume  $\geq$  40% of total volume at facility*



**Fig. 15.** Distribution of index cases performed by facility.

## Index Cases Personally Performed vs ACT



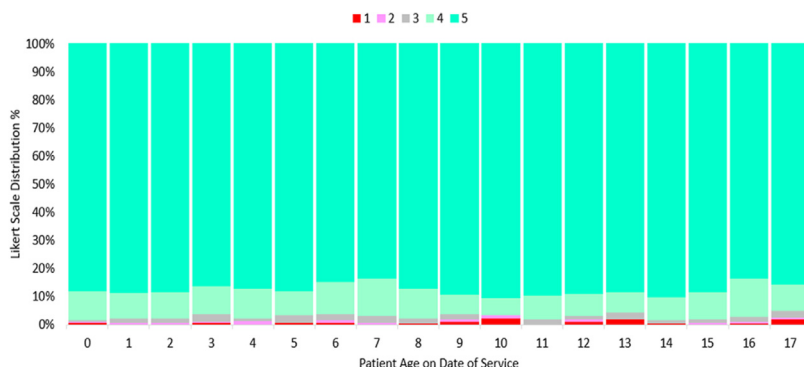
**Fig. 16.** Distribution of index cases performed by single pediatric board-certified anesthesiologists versus by an ACT.

with greater than 96.94% of returned surveys rating overall anesthesia care as 4 “good” or 5 “great” out of 5 on a Likert scale (Fig. 17). Positive comments outnumber negative comments by a wide margin.

### STRENGTHS AND LIMITATIONS

The data presented here are a convenience sample from a nationwide anesthesia private practice and may not reflect the demographics of pediatric anesthesia in other locations. Urban and suburban sites in Texas, Colorado, and Florida are overrepresented. Although USAP practice sites range from free-standing children’s hospitals to individual dentist offices, we do not know if

## Overall Anesthesia Care Experience



**Fig. 17.** Overall anesthesia care experience by patient age.

the relative volumes across sites are representative of national practice. These data will be most useful as an illustration of what pediatric anesthesia looks like in nonacademic practice, and as an example of the range of cases, patients, and clinicians involved.

## SUMMARY

The practice of pediatric anesthesiology continues to evolve in step with requirements of pediatric surgical societies, regulatory oversight, voluntary hospital verification programs, and credentialing changes. Previous research in this area relied on surveys, membership databases, and enrollment in pediatric anesthesia board certification process to glean geographic distribution, workforce quality, and daily responsibilities of pediatric anesthesiologists [3]. Notable has been the lack of perspective from nonacademic pediatric anesthesiologists. The collective experience of USAP allows a detailed view of pediatric anesthesiologists taking care of children across a wide variation of geographies and facilities, and across the continuum from office-based care, ASCs, community hospitals to dedicated children's facilities. In USAP's experience, a higher percentage of pediatric cases are done in ASCs than for adult anesthesia.

The literature contains relatively little information about the private practice of pediatric anesthesiology. Our report may be valuable for stakeholders, including pediatric anesthesiology fellowship directors, residency program directors, policy makers and, perhaps most importantly, to resident anesthesiologists interested in pursuing a career in pediatric anesthesiology. This last group will benefit from an understanding of opportunities for practice outside of dedicated children's hospitals. As the USAP data illustrate, there is an abundance of cases available in the community, and many nonacademic centers performing substantial volumes of high-acuity work.

One commonly heard description is that private practice pediatric anesthesiology consists of mostly simple cases in healthy patients for whom subspecialized training is not needed. Our experience confirms that, in general, most pediatric patients are healthy, ASA 1 or 2. However, USAP pediatric anesthesia specialists exceed the required number of ACGME Verification Index number of cases used to define a Pediatric Anesthesiologist, each year, while caring for thousands of ASA 3 to 6 patients. Moreover, ACTs are highly involved in the care of our patients, indicating an ongoing need for pediatric-focused CRNAs and CAAs as well as anesthesiologists.

## CLINICS CARE POINTS

- Every anesthesiologist must be prepared to care for pediatric patients.
- Most pediatric patients are ASA status 1 or 2, having short and simple procedures.
- Private practice pediatric anesthesia includes the full range of cases and patient acuity.

## DISCLOSURE

All authors contributed to preparation of the article, figures, and tables, and approved the final article.

## FUNDING SOURCE

None.

## CONFLICTS OF INTEREST

The authors have no conflicts of interest related to this topic.

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