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Article Title: Anesthesiologist-Related Factors Associated with Risk-Adjusted Pediatric Anesthesia-Related Cardiopulmonary Arrest: A Retrospective Two Level Analysis

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Contributions:

Robert Christensen: This author helped design the study, prepare the database extract, review events for inclusion, review the literature, and structure, draft and edit the manuscript and all tables.

Bishr Haydar: This author helped design the study, prepare the database extract, review events for inclusion, review the literature, and edit the manuscript and all tables.

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All authors edited the manuscript and approved the submitted version.

Abstract:

Background: Pediatric anesthesia-related cardiac arrest is an uncommon but catastrophic adverse event which has been, in a previous study, associated with anesthesiologist-related factors such as number of days per year providing pediatric anesthesia. We aimed to replicate this and assess other anesthesiologist-related risk factors for anesthesia related cardiac arrest after adjusting for known underlying risk factors present in the case mix.

Methods: We analyzed a large retrospectively collected patient cohort of anesthetics administered from 2006- 2016 to children at a tertiary pediatric hospital. Three reviewers independently reviewed cardiac arrests and categorized whether they appeared to be related to anesthesia care. Anesthesiologist-related factors including academic rank, experience, recent case mix and days per year delivering pediatric anesthesia were assessed for association with anesthesia-related cardiac arrest after adjustment for underlying case mix.

Results: Cardiac arrest occurred in 240 of 109,775 anesthetics (incidence 22/10,000 anesthetics); 82 (7/10,000 anesthetics) were classified as anesthesia-related. In univariable analyses, anesthesia-related cardiac arrest was associated with age, (infants ≤180 days, p<0.001) American Society of Anesthesiologists Physical Status, (>2, p<0.001) American Society of Anesthesiologists Physical Status Emergency (p=0.0035) cardiac surgery, (p<0.001) operating room location, (p=0.0066) and resident/fellow supervision (p=0.009), but none of the anesthesiologist factors. Even after adjusting for age and American Society of Anesthesiologist Status, none of the anesthesiologist factors were associated with anesthesia-related cardiac arrest.

Conclusions: Case mix explained all associations between higher risk of pediatric anesthesia-related cardiac arrest and anesthesiologist-related variables at our institution.

Clinical Implications: Previous research has linked pediatric anesthesia related cardiac arrest to anesthesiologist rank and clinical appointment, but after correcting for patient factors, this could not be replicated in our cohort.

Keywords: Cardiopulmonary arrest, anesthesiologists, pediatric

Glossary of Terms:

American Society of Anesthesiology physical status (ASA-PS), certified registered nurse anesthetist (CRNA),

Data Statement: The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to patient privacy restrictions.

Introduction:

Cardiac arrest is one of the most catastrophic complications of pediatric anesthesia. Its causes and treatment have been the subject of active debate for more than 150 years[1] but research has been limited by its thankfully low incidence. There have been many single institution studies[2-5] examining the incidence and risk factors for cardiac arrest. One of the most significant findings is the importance of the underlying case mix as pediatric cardiac surgery carries a higher risk of arrest.[6] Other risk factors identified include patient factors such as young age, American Society of Anesthesiology physical status (ASA-PS) as well as system factors such as emergency surgery, off hours and offsite location.[4-12]

A recent single-institution study incorporated these factors to assess anesthesiologist-related risk factors.[13] Unadjusted analysis indicated a higher risk of anesthesia related cardiac arrest for the most senior anesthesiologists, contrary to a multicenter study,[14] but after risk adjustment, the only association that remained was with lower annual days delivering anesthetics.

The current study sought to replicate that study at our institution, by risk adjusting anesthesia-related cardiac arrest to examine the impact of anesthesiologist-related factors on anesthesia-related cardiac arrest. We hypothesized that case characteristics and anesthesiologist's annual days delivering pediatric anesthetics would be associated with anesthesia-related cardiac arrest.

Methods:

This study was approved by the Institutional Review Board at our institution (HUM00125954; 2800 Plymouth Road, Building 520, Room 3214, Ann Arbor, MI

48109-2800; irbmed@umich.edu; 734-763-4768; Chairs: Robertson Davenport, Michael Geisser, Alan Sugar) on 3/22/2017 with a waiver of informed consent given the retrospective nature of the study. This study adheres to the applicable STROBE statement guidelines.[15] The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to patient privacy restrictions. The cohort of patients at risk was identified from all patients < 18 years old receiving anesthesia at Mott Children's Hospital between July 1, 2006 and June 30, 2016 and from October 1, 2010 to June 30, 2016 in the cardiac catheterization lab. All anesthetics in Centricity, our anesthetic information management system, performed by pediatric anesthesiologists in the operating rooms, radiology department, endoscopy suites, recovery rooms, and other procedure rooms were included. We then excluded anesthetics for ASA-PS 6 patients. Throughout the duration of the study, the attending anesthesiologists were engaged in a range of coverage patterns (supervision of certified registered nurse anesthetist (CRNA), fellow, and/or resident) in an academic environment. All anesthesiologists were either board certified by the American Board of Anesthesiology or had foreign board certification and additional training and/or extensive experience performing pediatric anesthesia.

The at-risk period for cardiac arrest was defined as during anesthesia care, which comprises the time the patient entered the OR to the time the patient exited the post-anesthesia care unit or was transferred to the intensive care unit team. The Pediatric Perioperative Cardiac Arrest Registry definition of cardiac arrest and the role anesthesia had in the genesis of the cardiac arrest was used in this study.[7,8]

The practitioner assigned responsibility for a cardiac arrest case categorized as an anesthesia-related cardiac arrest was the faculty anesthesiologist caring for the patient at the time of the event. Annual days delivering pediatric anesthetics was defined as the number of days at least one pediatric anesthetic was performed by the practitioner during the academic year (July 1-June 30). Annual caseload was defined as the number of pediatric anesthetics performed by the practitioner during that academic year. Annual infant caseload was defined as the number of anesthetics on patients less than one year performed by the practitioner during that academic year. Annual ASA-PS 3 or greater caseload was defined as the number of anesthetics on patients ASA-PS 3 or greater performed by the practitioner during that academic year. For anesthetics without cardiac arrest with handovers among providers (faculty, residents, fellows and CRNAs) the provider present for the majority of the case time was recorded. Daytime was defined as 7am-7pm.

Cardiac arrests were identified through multiple methods including keyword search of all anesthetic records for cardiac arrest-related terminology and use of institutional quality improvement and Wake Up Safe databases[16] (Table 1). The keyword search was expanded in an iterative fashion until all cardiac arrests identified through other methods were also identified in the keyword search. Potential patient-related anesthesia-related cardiac arrest risk factors included patient demographic information (patient postnatal age and ASA-PS). Potential system-related risk factors for anesthesia-related cardiac arrest included anesthetic location, day of the week, time of anesthetic, and responsible anesthesiologist. Potential provider-related anesthesia-related cardiac arrest risk factors included anesthesiologist characteristics, including years of anesthesia experience, annual number of days in an academic year delivering anesthetics, case volume per academic year, and academic rank at the time of the anesthetic.

Following screening of possible cardiac arrests by one author (RC), each cardiac arrest was reviewed and confirmed by 3 pediatric anesthesiologists (RC, BH, PR). The cardiac arrests were then categorized as (1) anesthesia-related, (2) not anesthesia-related, or (3) unclear according to the definitions used by the Pediatric Perioperative Cardiac Arrest registry.[7,8] In cases of disagreement, the case was discussed until consensus was achieved. The anesthesia-related cardiac arrests were classified by mechanism: cardiovascular, respiratory, medication/blood product related or equipment related.

Statistical Analysis:

All analyses were conducted using SAS v. 9.4 (SAS Institute, Cary, NC). Univariable analyses for the outcome of anesthesia-related cardiac arrest were conducted against patient, case, and anesthesiologist factors using Chi-square or Fisher's Exact test for categorical variables, and independent t or Wilcoxon Rank-Sum tests for continuous variables, as appropriate. Unadjusted odds ratios were computed for all factors using Chi-square or Fisher's Exact tests. All continuous variables were tested for normalcy using the Kolmogorov-Smirnov test, and were also assessed as quartiles computed by provider per academic year. Rates of anesthesia-related cardiac arrest for each variable were computed as the number of events per 10,000 anesthetics. Univariable and multivariable odds ratios for the comparison of case and provider characteristics and anesthesia-related cardiac arrest were computed using generalized linear mixed models approach (GLIMMIX). In particular, these models use the penalized maximum likelihood maximization approach to estimate unbiased effects when the outcome prevalence is small like in this case. Random intercept mixed models that account for the structural nesting of patients within providers were used to estimate adjusted odds ratios for the outcome of anesthesia-related cardiac arrest and the covariates of ASA-PS ≥ 3 and postnatal age ≤ 180 days in addition to the case or provider factor of interest.

Before the models were run, covariates selected for inclusion were checked for collinearity with a Pearson's correlation matrix. If two covariates were found to have a correlation of >0.70, then they were either collapsed into a single variable or one removed from the model. No variables were found to have high collinearity. Both models of the primary analysis had the random effect of anesthesia caregiver at time of arrest. The first model was a risk-adjusted parsimonious model with the following covariates: cardiac operating room, CRNA, quartile of years of experience of caregiver present at time of anesthesia-related cardiac arrest, quartile of annual caseload, academic rank (instructor/lecturer, assistant professor, associate professor, or professor), and quartile of annual number of days delivering anesthetics. The second model included covariates such as ASA-PS ≥ 3, and postnatal age ≤ 180 days. Measures of effect size were reported as adjusted odds ratios with 95% confidence intervals per 10,000 cases, and the model predictive capability was determined using the area under the receiver operating characteristic curve c-statistic.

A p-value of 0.05 was considered statistically significant for all analyses conducted.

Results:

There were 109,775 total anesthetics delivered and recorded in our electronic medical record over the 10-year period, delivered by 39 anesthesia faculty. The initial screening identified 893 anesthetics with possible cardiac arrest. Cardiac arrest was confirmed in 240 anesthetics (incidence 22/10,000 anesthetics; 95% CI: 19-25/10,000). After review and discussion, anesthesia-related cardiac arrest was confirmed in 82 anesthetics (7/10,000 anesthetics; 95% CI: 6-9/10,000). This represented 34.2% of confirmed cardiac arrests. There was no significant change in the incidence of anesthesia-related cardiac arrest during the 10 years. Seventeen anesthesia-related cardiac arrest cases had to be excluded from analysis due to missing data (Figure 1). Table 2 describes the characteristics of the remaining 65 cases of anesthesia-related cardiac arrest, including mechanism, timing and clinical outcome.

Table 3 shows the relationship between the rate of anesthesia-related cardiac arrest and the investigated patient, practitioner, and system factors. There was a dose-response relationship between anesthesia-related cardiac arrest prevalence and increasing ASA-PS, and that anesthesia-related cardiac arrest was higher in infants <1 year of postnatal age with the highest rates in those ≤180 days of postnatal age.

Most of the anesthesia-related cardiac arrests occurred in the operating rooms (75%) during the daytime hours (91%) and during weekdays (95%), where and when the great majority of anesthetics were delivered. There were 8 anesthesia-related cardiac arrests (12%) in the radiology department and 8 (12%) in the cardiology catheterization and electrophysiology suites. Supervision was split almost evenly between certified registered nurse anesthetists (CRNA) and trainees such as anesthesiology residents or pediatric anesthesiology fellows. Cases involving CRNA were significantly less likely to suffer anesthesia-related cardiac arrest than cases involving trainees ($p = 0.009$).

Twenty-seven of the 39 anesthesiologists (69%) had at least 1 anesthesia-related cardiac arrest. Of the staff who had ≥1 anesthesia-related cardiac arrest event, the median years of experience delivering anesthetics at the time of the anesthesia-related cardiac arrest event was 7 years (interquartile range, 3 to 14). An anesthesia-related cardiac arrest was reported in 0.06% of the cases managed by an instructor/lecturer, 0.06% of those managed by an assistant professor, 0.03% of those managed by an associate professor and 0.17% of those managed by a professor.

A higher rate of anesthesia-related cardiac arrest was significantly associated with younger patient age, higher ASA-PS, operating room procedure, cardiac surgery, and trainee supervision. No anesthesiologist factors were associated with a higher rate of anesthesia-related cardiac arrest. (Table 3)

Of the 82 anesthesia-related cardiac arrest cases, only 44 were present in our quality improvement database (53.7%). Table 4 analyzed for association between anesthesiologist factors and reporting without finding any significant associations.

Table 5 shows univariable and multivariable associations between pediatric anesthesia-related cardiac arrest and practitioner factors and anesthetic setting. The odds ratios were significant for case characteristic factors such as cardiac surgery and CRNA supervision.

In patients who experienced an anesthesia-related cardiac arrest, 89% (57/65) survived to hospital discharge. Eight patients died during the hospitalization. Five deaths occurred within 24 hours, and 2 additional deaths occurred between 24 hours and 30 days after the anesthesia-related cardiac arrest event. One patient died more than 30 days after the event. There was no anesthesia-related cardiac arrest-related mortality in ASA-PS 1 or 2 patients.

Discussion:

Using a large data set of over a decade of pediatric anesthetics allowed us to assess the association between pediatric anesthesia-related cardiac arrest and system-related and pediatric anesthesiologist related potential risk factors, replicating a previous study.[13] Our data was consistent with the known risk factors of ASA-PS,[8] age,[11] and cardiac surgery.[6] We were also able to show that CRNA supervision had a significantly lower rate of anesthesia-related cardiac arrest when compared to supervision of anesthesiology residents or fellows. We were unable to replicate the findings of pediatric anesthesiologist related risk factors in univariate or adjusted analyses.[13] While this may be related to a smaller dataset (65 vs 72 anesthesia-related cardiac arrest), there are also differences in practice patterns, for example our annual days delivering anesthetics showed less variation. We must repeat the call for a large multicenter study to definitively confirm or refute these findings.

Our anesthesia-related cardiac arrest rate of 7/10,000 is concerning and significantly higher than those previously reported in the Pediatric Perioperative Cardiac Arrest Registry,[7] Wake Up Safe[11] or other single institution studies.[5,6,13] This may be related to the need to risk adjust based on case mix, as our population had significantly more cases with ASA-PS ≥III and postnatal age ≤180 days ($p < 0.001$ for both) than those in the study by Zgleszewski et al. when the reported proportions were compared using a chi-squared test. Other possible explanations include differences in definition of anesthesia-related cardiac arrest and differences in anesthesia practice. For example, in this study we judged untreated periods of diastolic hypotension in an infant with single ventricle physiology that resulted in cardiac arrest as an anesthesia-related cardiac arrest.

We believe that the significantly higher anesthesia-related cardiac arrest rate is also likely a result of methodologic differences between this and prior studies. These prior studies all depended entirely[5-7] or mostly[13] on voluntary reporting of anesthesia-related cardiac arrest on quality improvement documentation. Under-reporting is a significant problem in voluntary reporting systems, so we leveraged our electronic medical record to directly search all the perioperative records for documentation of cardiac arrest, arrest level doses of epinephrine or intraoperative death. We also used those cases identified through voluntary reporting to refine a list of keywords to directly search on the perioperative records. While this resulted in many false positive screens (73.2%), it identified 38 anesthesia-related cardiac arrests that were not reported to quality improvement. This has significant implications if current research is based on a potentially biased subset of cardiac arrests. While we were unable to demonstrate an association between anesthesiologist factors and reporting, it may be a factor in other studies.

This study is subject to the limitations of its retrospective nature and the number of anesthesia-related cardiac arrests. Although exhaustive search was made, it is still possible that cardiac arrests were missed. Cases with incomplete data were excluded, which may introduce selection bias. Unmeasured variables such as congenital heart disease patients undergoing non-cardiac surgery[17] or pulmonary hypertension[18] may have impacted the results. Postnatal age, ASA-PS and other patient factors differ between cardiac and non-cardiac surgical patients.[19] Case demographics also likely varied through the study period.[20] Therefore, unmeasured patient anesthesia-related cardiac arrest risk factors could have varied between faculty. The exclusion of those cases in which paper anesthesia records were used in place of the electronic record may have resulted in undercounting. We did not evaluate CRNA experience which may moderate the effect of faculty inexperience on patient outcomes.[21] Lastly, this study was conducted with data from a single tertiary pediatric center, which may hinder the ability to generalize findings to other settings.

Conclusions:

While the association of anesthesia related cardiac arrest with infants under 180 days of age, children with elevated ASA-PS and those undergoing cardiac surgical procedures was replicated in this study, we were unable to replicate the association between proportion of clinical time and anesthesia-related cardiac arrest that had been described previously. A multi-center study is likely needed to fully address these questions.

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Table 1 Methods Used to Identify Cardiac Arrests

1. Review of cardiac arrests and deaths reported via institutional quality assurance
2. Institutional reporting to Wake Up Safe (after Jan 2011)
3. Keyword search of anesthetic records and operative note for: cardiac arrest, chest comp, PALS, defib, shock, joule, death, resuscitation, CPR, compression
4. Search for intravenous epinephrine administration
5. Search for selection of “Expired intraoperatively” as postoperative disposition

Table 2 Characteristics of Anesthesia-Related Cardiac Arrests (n=65)

	N (%)
Mechanism	
Cardiovascular	19 (29%)

Arrhythmia	2 (3%)
Pulmonary hypertension	2 (3%)
Tetralogy hypercyanotic spell	2 (3%)
Unclear	13 (20%)
Respiratory	22 (34%)
Unplanned extubation	5 (8%)
Difficult intubation	4 (6%)
Laryngospasm	6 (9%)
Bronchospasm	1 (2%)
Inadequate oxygenation	4 (6%)
Unclear	2 (3%)
Medication related	21 (32%)
Equipment related	2 (3%)
Multiple events	1 (2%)
Timing	
Intraoperative	31 (48%)
Induction	23 (35%)
Emergence	7 (11%)
Transport or postanesthesia care unit	4 (6%)
Outcome	
Survived to hospital discharge	57 (89%)
No obvious sequelae	37 (57%)
Temporary injury	14 (22%)
Permanent injury	6 (9%)
In-hospital death	8 (12%)
Within 24 hours of anesthetic	5 (8%)
>24 hours to 30 days after anesthetic	2 (3%)
>30 days after anesthetic	1 (2%)

Table 3. Univariate associations between anesthesia-related cardiac arrest and patient, practitioner, and systems factors.

	N (%)	No. of Anesthesia-related cardiac arrest†	Cardiac arrest rate (per 10,000)	P-Value
Patient Characteristics				
ASA PS§				<0.001
1	27,907 (25.5)	0 (0)	0	
2	43,534 (39.7)	6 (9.2)	1.38	
3	29,677 (27.1)	29 (44.6)	9.77	
4	8,261 (7.5)	28 (43.1)	33.89	
5	260 (0.2)	2 (3.1)	76.92	
ASA PS§ E				
Yes	6,080 (5.5)	9(13.8)	18.8	0.004
No	103,497 (94.5)	56 (86.2)	5.4	
Postnatal Age				<0.001
0-30 Days	3,585 (3.3)	12 (18.5)	33.47	
31-90 Days	3,098 (2.8)	10 (15.4)	32.28	
91-180 Days	4,101 (3.7)	11 (16.9)	26.82	
181-365 Days	6,718 (6.1)	7 (10.8)	10.42	
1-18 Years	92,273 (84.1)	25 (38.5)	2.71	
Case Characteristics				
Cardiac Surgery				<0.001
Yes	8,079 (7.4)	20 (30.8)	24.76	
No	101,696 (92.6)	45 (69.2)	4.42	
Case Location				0.007
Operating Room	64,540 (58.8)	49 (75.4)	7.59	

Non-operating Room	45,235 (41.2)	16 (24.6)	3.54	
Time of Day				0.310
Daytime (7am-7pm)	102,750 (93.6)	59 (90.8)	5.74	
Nighttime (7pm-7am)	7,025 (6.4)	6 (9.2)	8.54	
Day of Week				0.225
Weekday	107,009 (97.4)	62 (95.4)	5.79	
Weekend	2,766 (2.5)	3 (4.6)	10.85	
Supervision				
Certified Registered Nurse Anesthetist	56547 (51.5)	23 (35.4)	4.07	0.009
Trainee‡	53,228 (48.5)	42 (64.6)	7.89	
Provider Characteristics				
Academic Rank				0.114
Instructor/Lecturer	42,479 (39.4)	25 (40.3)	5.89	
Assistant Professor	45,722 (42.4)	28 (45.2)	6.12	
Associate Professor	17,903 (16.6)	6 (9.7)	3.35	
Professor	1,730 (1.6)	3 (4.8)	17.34	
Years of Experience – Quartile				0.901
< 3 years	27669 (25.2)	16(24.6)	5.8	
3 – 6.97 years	27192 (24.8)	18(27.7)	6.6	
7 – 15 years	27409 (25.0)	17(26.2)	6.2	
≥ 15 years	27430 (25.0)	14(21.5)	5.1	
Annual Caseload - Quartile				0.669

< 316	26940 (24.7)	20 (30.8)	7.4	
316 – 413	27046 (24.7)	16 (24.6)	5.9	
414 – 500	27611 (25.2)	15 (23.1)	5.4	
≥ 500	28113 (25.2)	14 (21.5)	5.0	
Annual Days Delivering Anesthetics - Quartile				0.054
<85 days	27435 (25.1)	13 (20.0)	4.7	
85 – 113 days	26174 (23.9)	11 (16.9)	4.2	
113 – 137 days	27810 (25.4)	26(40.0)	9.3	
≥137 days	28291 (25.8)	15(23.1)	5.3	
Annual Number of Infant Cases - Quartile				0.189
< 47	18,149 (16.5)	6 (9.2)	3.31	
47 – 66	25,971 (23.7)	14 (21.5)	5.39	
67 – 86	30,531 (27.8)	17 (26.2)	5.57	
≥ 87	35,124 (32.0)	28 (43.1)	7.97	
Annual Number of ASA PSb 3+ Cases - Quartile				0.587
< 113	26306 (24.0)	15(23.1)	5.1	
113 – 146	28080(25.6)	14 (21.5)	5.4	
147 – 191	27823 (25.4)	15(23.1)	5.6	
≥ 191	27501(25.1)	21 (32.3)	7.0	

† Percentages are presented out of those with anesthesia related cardiac arrest

‡ Anesthesiology resident or Pediatric Anesthesiology Fellow

§American Society of Anesthesiology physical status

P-values were computed using Chi-square or Fisher's exact tests, as appropriate

Table 4. Univariate associations between not reported anesthesia-related cardiac arrest and practitioner factors.

	N (%)	No. of Not reported	P-Value
Provider Characteristics			
Academic Rank			0.301
Instructor/Lecturer	15(50.0)	10 (32.3)	
Assistant Professor	10 (33.3)	17 (54.8)	
Associate Professor	4(13.3)	2 (6.5)	
Professor	1 (3.3)	2 (6.5)	
Years of Experience – Quartile			0.558
< 3 years	10(30.3)	6 (19.4)	
3 – 6.97 years	10 (30.3)	8 (25.8)	
7 – 15 years	6 (18.2)	10 (32.3)	
> 15 years	7(21.2)	7 (22.6)	
Annual Caseload - Quartile			0.875
< 316	11 (33.3_	8 (25.8)	
316 – 413	7 (21.2)	9 (29.0)	
414 – 500	8(24.2)	7 (22.6)	
> 500	7(21.2)	7 (22.6)	

P-values were computed using Chi-square or Fisher's exact tests, as appropriate

Table 5: Effect of adjustment for Patient ASA-PS† and Age (<= 180 Days) on association between anesthesia-related cardiac arrest and practitioner factors and anesthetic setting

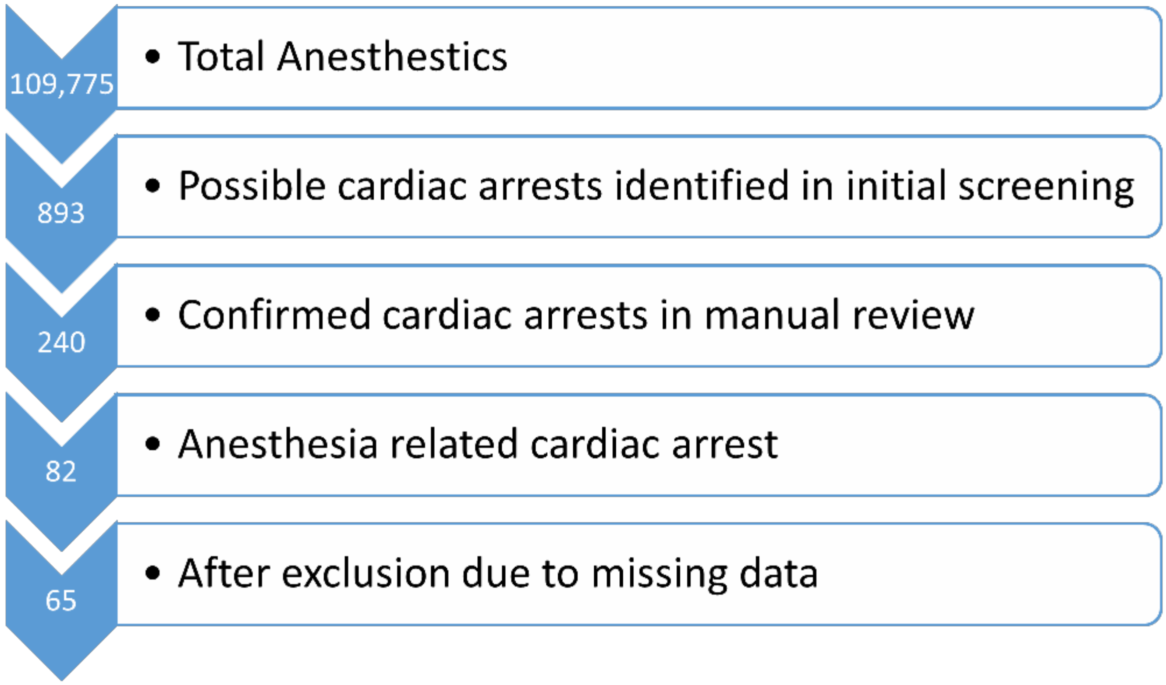
	Unadjusted OR	P-Value	Adjusted OR	P-Value

	(95% CI)		(95% CI)	
Case Characteristics				
Cardiac Surgery	6.07 (2.9, 12.72)	<0.001	2.05(1, 4.19)	0.049
Certified Registered Nurse Anesthetist Supervision	0.66 (0.51, 0.86)	0.002	0.69 (0.54,0.89)	0.004
ASA PS† E	2.61 (1.04,6.54)	0.0414	1.00 (0.99, 1.00)	0.152
Provider Characteristics				
Years of Experience – Quartile				
< 3 years	REF		REF	
3 – 6.9 years	1.09 (0.76, 1.54)	0.646	0.83 (0.54,1.28)	0.401
7 – 14.9 years	0.99 (0.72, 1.38)	0.973	0.62 (0.38,1.03)	0.067
≥ 15 years	0.97 (0.58, 1.6)	0.892	0.66 (0.34,1.26)	0.203
Academic Rank				
Instructor	REF		REF	
Assistant Professor	0.99 (0.99, 1.00)	0.1928	0.99 (0.97, 1.00)	0.032
Associate Professor	0.92 (0.78, 1.10)	0.3237	0.97 (0.92, 1.02)	0.315
Professor	0.92 (0.78, 1.10)	0.3188	0.97 (0.92, 1.03)	0.302
Annual Caseload – Quartile				
< 316	1.24 (0.87, 1.78)	0.233	0.96 (0.7,1.31)	0.800
316 – 413	1.1 (0.81, 1.48)	0.548	0.97 (0.73,1.28)	0.823
414 – 499	0.93 (0.7, 1.23)	0.598	0.84 (0.64,1.1)	0.196
≥ 500	REF		REF	
Annual Days Delivering Anesthetics – Quartile				
<85 days	0.93 (0.66, 1.32)	0.694	1.24 (0.63,2.44)	0.535
85 – 112 days	0.96 (0.68, 1.35)	0.795	1.28 (0.64,2.58)	0.484
113 – 136 days	1.43 (0.9, 2.27)	0.127	1.52 (1.05,2.21)	0.027
≥137 days	REF		REF	
Annual Number of Infant Cases – Quartile				
< 47	0.42 (0.17, 1.00)	0.050	0.68 (0.28, 1.65)	0.393

47 – 66	0.68 (0.36, 1.28)	0.232	0.90 (0.47, 1.71)	0.739
67 – 86	0.70 (0.38, 1.28)	0.243	0.86 (0.47, 1.57)	0.612
≥ 87	REF		REF	
Annual Number of ASA PS[a] 3+ Cases – Quartile				
< 113	0.87(0.59, 1.29)	0.4936	0.93 (0.66,1.3)	0.664
113 – 146	0.77(0.55, 1.06)	0.1096	0.8 (0.6,1.07)	0.129
147 – 190	0.8(0.53, 1.19)	0.2661	0.81 (0.54,1.2)	0.286
≥ 191	REF		REF	

†American Society of Anesthesiology physical status

For the adjusted odds ratios, separate models were run for each variable above adjusting for age < 180 days and American Society of Anesthesiology physical status > 2.



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