Academic Achievement After Multiple Exposures to Early Childhood Surgery

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Background

- Large studies of pediatric anesthesia neurotoxicity have many experimental confounders making it difficult for pediatric anesthesiologists to accurately convey the risks associated with anesthesia exposure
- Performance on academic achievement testing (AAT) is a metric easily understood and highly valued by parents, the lay public, policymakers and other stakeholders
- If early exposure to surgery and anesthesia is independently associated with significantly impaired academic performance, it may be appropriate for schools to screen exposed children and consider early educational enrichment programs

Objectives

- We designed an approach that allowed us to examine a large number of medical records and determine the effect size of multiple exposures to early childhood surgery on AAT performance in elementary school
- For context we compared these with the effect sizes of gender and socioeconomic status (SES)
- We also compared our results with the effect size associated with an anesthetic accepted to be non-neurotoxic (spinal anesthesia). This previously determined Cohen's d effect size was 0.16[1]

Methods

- Working with the Agency of Education (AOE), we produced an integrated database of educational and medical records
- We reviewed hospital records for 2,632 patients without existing cognitive deficits and born ≥32 weeks gestational age who had one of nine commonly performed surgeries (Figure 1) prior to age 36 months between 10/01/1995 and 12/31/2007
- Details in the medical record included medical history, ASA rating, type of anesthesia, agents utilized and duration of anesthesia
- AOE records included test scores, gender, and SES as determined by the need for free or reduced price school lunch (FRL)
- Gender, grade, and SES matched controls were selected in a case-control fashion
- A mixed model ANOVA was used to compare exposed vs. controls on raw test scores, adjusting for the effect of the strata, for cases with single and multiple exposures
- A linear regression model was used to examine the effect of total duration of anesthetic exposure on math and reading scores. Independent variables were gender, SES, and anesthesia duration
- A priori power analysis determined that 400 subjects with more than one exposure to anesthesia would be necessary to determine an effect size of 0.20 at 80% power
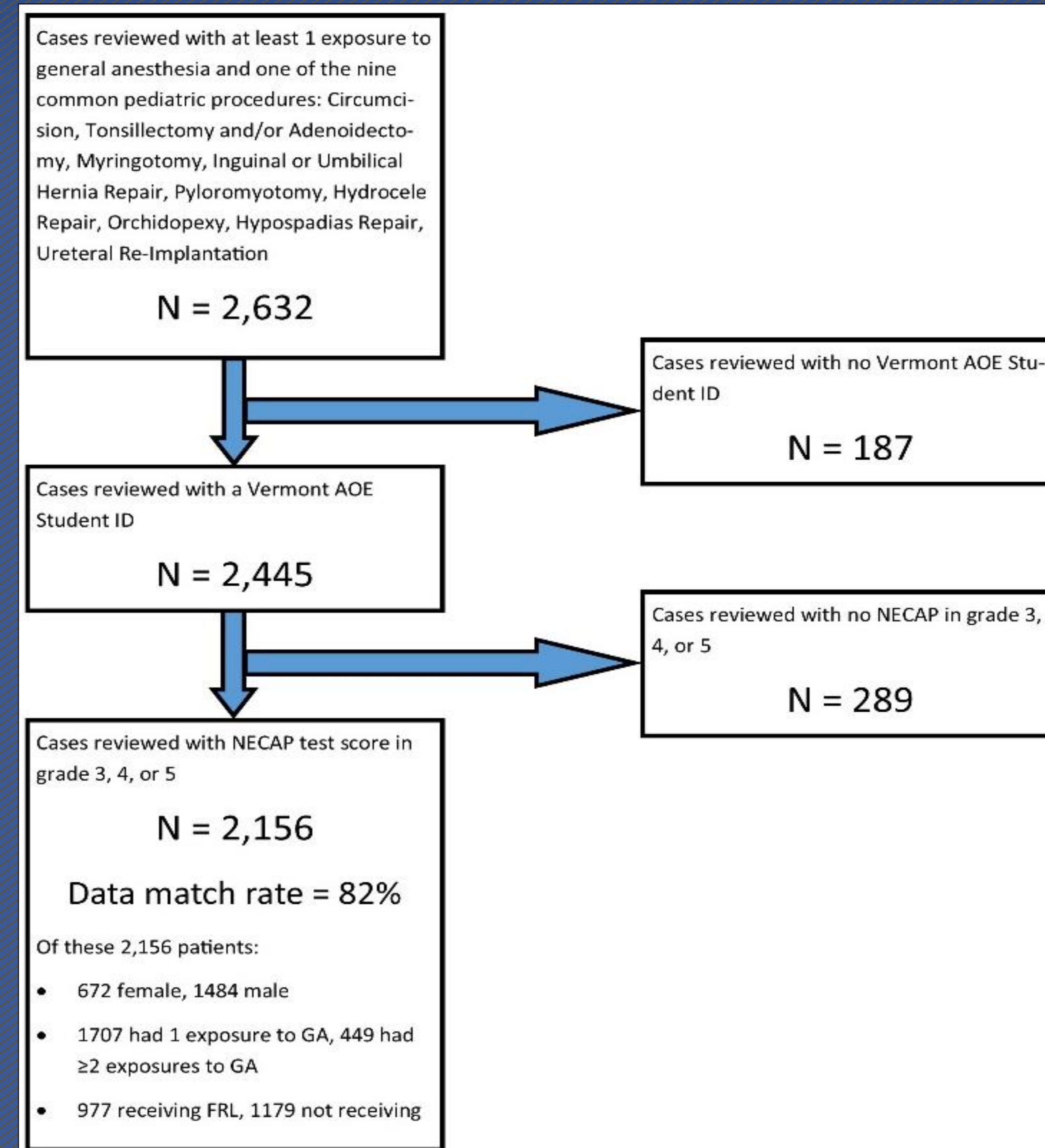

Figure 1 (above) shows the flow of eligible participants through the study. AOE = Agency of Education. NECAP = New England Common Assessment Program. GA = General Anesthesia

Table 1 (below) shows the mean ± standard error for math and reading scores for patients exposed once to anesthesia and more than once to anesthesia. The same information is presented for matched controls. Mean difference = control mean – exposed mean. SE = standard error. GA = general anesthesia. CI = confidence interval.

		Exposed Patients Mean [95% CI]	Control Patients Mean [95% CI]	Mean Difference [95% CI]	p-value	Cohen d effect size
Single GA Exposure	Math Score n = 1707	36.9 [32.0, 41.8]	37.6 [32.7, 42.5]	0.7 [-0.1, 1.6]	0.083	0.008
	Reading Score n = 1708	30.8 [28.0, 33.6]	31.7 [28.9, 34.4]	0.9 [0.2, 1.5]	0.01	0.017
Multiple GA Exposure	Math Score n = 449	35.7 [31.9, 39.6]	37.4 [33.5, 41.2]	1.7 [-0.1, 3.4]	0.065	0.045
	Reading Score n = 448	29.2 [26.3, 32.1]	31.8 [28.9, 34.7]	2.6 [1.2, 4.0]	<0.001	0.094

Results

- 82% of hospital records were matched with AOE data.
- Cohen's d effect size differences between exposed and control patients were very small, even for patients with more than one exposure (Table 1)
- For context, Table 2 shows the effect of gender and SES in the control population only
- Table 3 shows the regression coefficients for anesthesia duration from a linear regression model when adjusting for gender and SES
- The duration of GA exposure had no statistically significant effect on test performance
  - There was a trend towards a minor effect on reading scores

	Math	Reading
Gender	d = 0.01 p = 0.95	d = 0.17 p < 0.001
SES	d = 0.71 p < 0.001	d = 0.62 p < 0.001

Table 2 (above) shows the effect of gender and socioeconomic status (SES) on math and reading scores in the control population. For gender, a positive effect size means females scored higher than males. For SES, a positive effect size means that those not receiving FRL scored higher than those receiving FRL. d = Cohen's d effect size

	Anesthesia Duration Regression Coefficient	p-value
Math	0.003	0.61
Reading	-0.008	0.06

Table 3 (above) shows the linear regression coefficients for anesthesia duration on math and reading scores. For every 1 minute increase in anesthetic duration, math scores would be expected to increase by 0.003 points and reading scores would be expected to decrease by 0.008 points

Conclusion

- There was no significant difference between math scores for one or more exposures to anesthesia compared to controls
- The effect size on reading scores associated with one or more exposures to anesthesia is less than that of gender and less than the effect size previously observed by a non-neurotoxic anesthetic
- Low SES had a much larger impact on AAT than gender, exposures to surgery and anesthesia, or total duration of anesthesia

References

1. Anesth Analg.2014;119(3):651-60.