Intraoperative Arterial Oxygen Content and Postoperative Nausea and Vomiting

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Background

Postoperative nausea and vomiting (PONV) is a common, unpleasant, and potentially dangerous complication of surgery. It is often ranked as the anesthetic complication patients most wish to avoid. Nevertheless, PONV afflicts 30 to 50 percent of all surgical patients. Risk screening is imperfect and has remained relatively unchanged since the late 20th century. Improving PONV screening would allow for better targeted administration of antiemetic therapy. Based on research literature that suggests nausea and vomiting may be affected by oxygen level, the aim of this project was to determine if intraoperative arterial oxygen content level (CaO_2) is associated with PONV.

A retrospective observational research study was completed at Providence Sacred Heart Medical Center (PSHMC).

- Included patients ≥ 18 years old who received general anesthesia from 2015-2019, and who were extubated prior to leaving the operating suite.
- Project was approved by the PSHMC CIRC and deemed exempt by the IRB.
- An a priori power analysis indicated the need for a sample size of 4,322 patients to achieve 80 percent power.
- De-identified patient data was securely extracted and stored in a HIPAA compliant REDCap project database.
- Hemoglobin (Hgb) was deemed usable if extracted within 14 days of surgery.
- CaO_2 was determined by the truncated formula, Hgb*SpO_2*1.34.
- The PONV outcome was determined by nursing documentation of PONV or administration of antiemetic medication in the postoperative period.
- Descriptive analyses were conducted to examine baseline demographics and incidence of PONV.
- Bivariate and multivariable analysis of event rates at various CaO_2 levels with risk and odds ratio were calculated.

Findings

Table 1: Demographic and PONV Risk Characteristics

	CaO_2 Available N = 14,239	CaO_2 Unavailable N = 55,678	P-Value
CaO_2 (mL O_2/dL)	14.5 (3.6)	N/A	N/A
Female	5,803 (40.8%)	32,812 (58.9%)	P<0.001
Age (years)	64 (23)	59 (25)	P<0.001
Case Duration (min)	122 (97)	121 (88)	P<0.001
Body Mass Index (kg/m^2)	27.8 (9.0)	28.8 (8.8)	P=0.03
Physical Status Classification 1-2	3,554 (25.0%)	30,035 (53.9%)	P<0.001
Elective Surgery	8,769 (61.6%)	48,119 (86.4%)	P<0.001

Categorical data in numbers (percentage). Continuous data in medians (interquartile range).

Due to Hgb being a fundamental part of CaO_2, only patients with preoperative Hgb analysis could be studied. Therefore, the study group was dissimilar from the overall surgical population in several ways.

Table 2: Characteristics of Arterial Oxygen Content Subgroups

	CaO_2 < 16 mL O_2/dL N = 9,926	CaO_2 ≥ 16 mL O_2/dL N = 4,313	P-Value
Female	4,960 (50%)	843 (19.6%)	P<0.001
Age (years)	60.6 (22)	60.8 (24)	P=0.56
Case Duration (min)	128 (103)	119 (93)	P<0.001
Body Mass Index (kg/m^2)	28.0 (8.1)	27.7 (9.3)	P=0.14
Physical Status Classification 1-2	2,118 (21.3%)	1,436 (33.3%)	P<0.001
Elective Surgery	5,841 (58.9%)	2,928 (67.9%)	P<0.001

Categorical data in numbers (percentage). Continuous data in medians (interquartile range).

Within the study population, important differences existed between the CaO_2 groups.

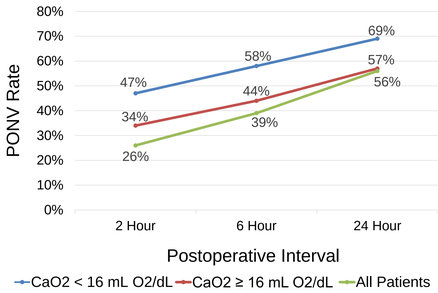
Table 3: Arterial Oxygen Content and PONV Risk

CaO_2 < 16 mL O_2/dL	RR	RR 95% CI	ARI	OR	OR 95% CI
2-hour PONV	1.39	1.33-1.46	0.13	1.74	1.60-1.88
6-hour PONV	1.32	1.27-1.38	0.14	1.70	1.57-1.84
24-hour PONV	1.21	1.17-1.25	0.12	1.57	1.44-1.71

RR = relative risk (unadjusted); OR = odds ratio (adjusted); CI = confidence interval; ARI = absolute risk increase.

CaO_2 less than 16 mL O_2/dL is a risk factor for PONV at all time intervals (P<0.001), with an odds ratio comparable to commonly cited PONV risk factors.

Figure 1: PONV and Arterial Oxygen Content



CaO_2 less than 16 mL O_2/dL was associated with higher PONV rates at each postoperative time interval. PONV was lowest in the group that did not have preoperative Hgb analysis.

Table 4: PONV Risk Factors (Gan et al., 2014)

	Odds Ratio	95% Confidence Interval
Female	2.57	2.32-2.84
History of PONV	2.09	1.90-2.29
Cholecystectomy	1.90	1.36-2.68
Non-Smoking Status	1.82	1.68-1.98
Volatile Anesthetic Use	1.82	1.56-2.13
Age < 50 (years)	1.79	1.39-2.68
History of Motion Sickness	1.77	1.55-2.04
Postoperative Opioid Use	1.47	1.31-1.65
Nitrous Oxide	1.45	1.06-1.98
Gynecological Surgery	1.24	1.02-1.52

Commonly cited PONV risk factors and associated odds ratios.

Discussion

In this observational research, a relationship between CaO_2 and PONV was observed. Overall PONV rates were consistent with the research literature. Analysis demonstrated that CaO_2 below 16 mL O_2/dL was associated with increased PONV in all time intervals compared with physiologically normal CaO_2. Hemoglobin level was also negatively correlated with PONV. In an adjusted model, the increased odds of PONV among patients with sub-physiologic CaO_2 was comparable to commonly accepted PONV risk factors.

Unknown confounding variables limit the utility of observational research to inform treatment decisions. However, analyzing the association of CaO_2 with PONV is not suited to experimental inquiry. If prospective studies reproduce the findings of this research in a cohort of subjects demographically comparable to surgical patients generally, anesthesia providers should begin to use estimates of intraoperative CaO_2 to help guide antiemetic administration practice.

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