

Borderline Anemia and Postoperative Outcomes in Women Undergoing Anesthesia: A Retrospective Cohort Study

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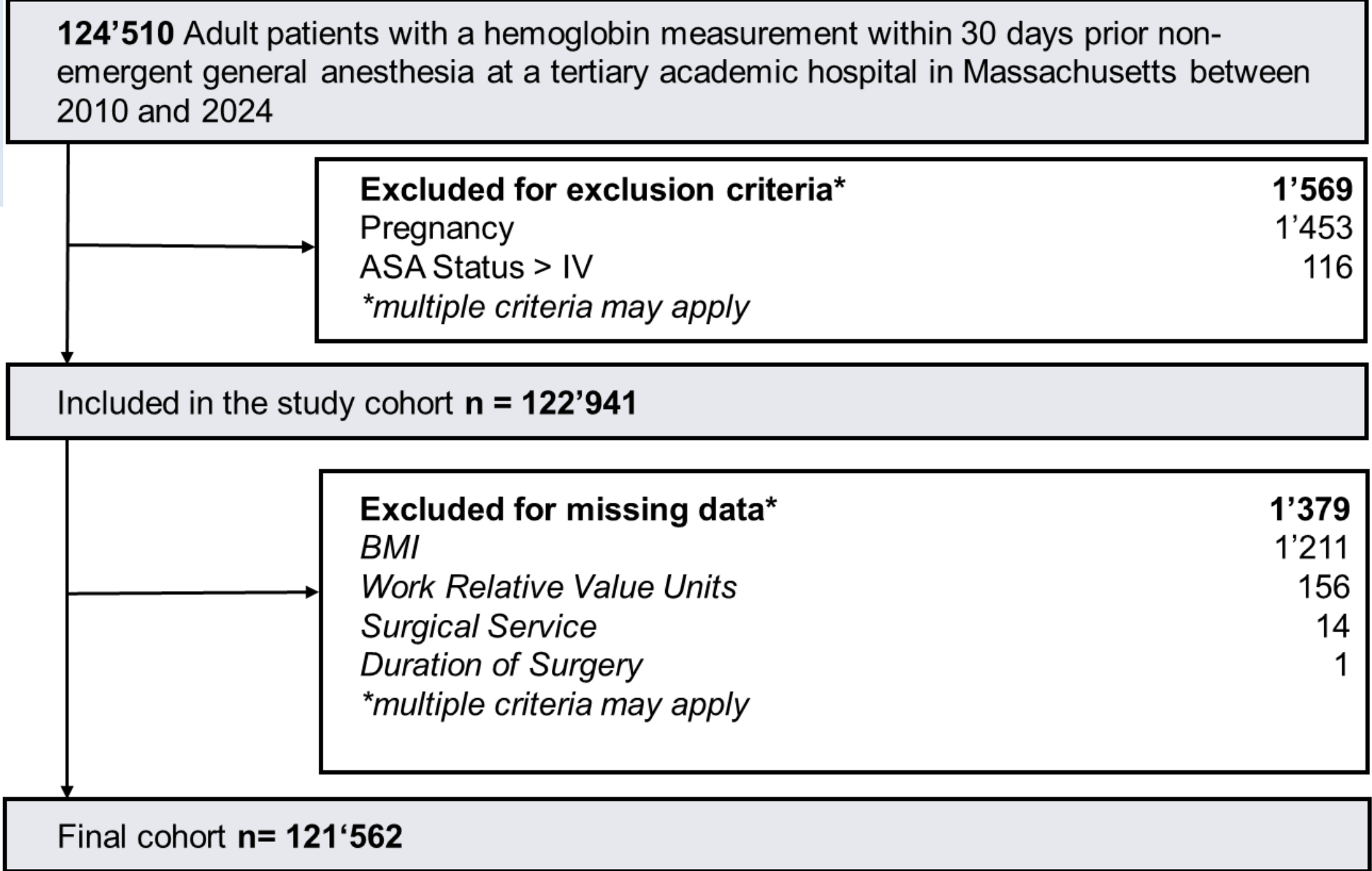
INTRODUCTION

- Anemia is diagnosed by a hemoglobin (Hb) concentration below **12 g/dL in women** and **13 g/dL in men** [1].
- Physiologically, anemia is present when there are insufficient circulating red blood cells to meet **physiological oxygen-carrying needs** [2].
- It is possible that these epidemiological thresholds may contribute to the **under recognition** and under treatment of **anemia in women** [3].

Preoperative hemoglobin, g/dL	>= 13 N=55'672	12 to 13 N=21'451	< 12 N=44'439	AMSD
Demographics	14.1 (13.5 - 14.9)	12.5 (12.2 - 12.7)	10.3 (9.1 - 11.3)	3.547
Age, years	58.8 ± 14.5	60.4 ± 15.7	62.9 ± 16.1	0.267
BMI, kg/m²	28.9 ± 6.1	28.7 ± 6.8	28.4 ± 7.1	0.074
Sex, Female	21'747 (39.1%)	13'610 (63.4%)	25'718 (57.9%)	0.503
Ethnicity				0.225
White	42,145 (75.7%)	15,011 (70.0%)	30,587 (68.8%)	
Other	3,556 (6.4%)	2,373 (11.1%)	5,658 (12.7%)	
Black	5,136 (9.2%)	1,934 (9.0%)	4,289 (9.7%)	
Hispanic	2,558 (4.6%)	1,218 (5.7%)	2,277 (5.1%)	
Asian	2,277 (4.1%)	915 (4.3%)	1,628 (3.7%)	
Federal insurance	23,210 (41.7%)	10,446 (48.7%)	25,267 (56.9%)	0.307
Comorbidities				
ASA physical status classification	2.6 ± 0.7	2.7 ± 0.7	2.9 ± 0.7	0.585
Elixhauser score	7.2 ± 9.9	9.0 ± 11.3	14.6 ± 13.6	0.619
Coronary artery disease	8,784 (15.8%)	3,744 (17.5%)	11,587 (26.1%)	0.255
Congestive heart failure	4,159 (7.5%)	2,234 (10.4%)	9,414 (21.2%)	0.399
Chronic kidney disease	3,082 (5.5%)	2,126 (9.9%)	10,619 (23.9%)	0.537
Peripheral vascular disease	5,075 (9.1%)	2,308 (10.8%)	7,727 (17.4%)	0.246
Stroke	1,407 (2.5%)	710 (3.3%)	2,264 (5.1%)	0.134
Hypertension	27,537 (49.5%)	11,067 (51.6%)	23,666 (53.3%)	0.076
Diabetes	9,580 (17.2%)	4,897 (22.8%)	14,666 (33.0%)	0.370
Frailty	7,596 (13.6%)	4,416 (20.6%)	16,331 (36.7%)	0.552
Tobacco	19,123 (34.3%)	7,471 (34.8%)	18,465 (41.6%)	0.149
Alcohol	2,112 (3.8%)	885 (4.1%)	3,467 (7.8%)	0.172
Preexisting anemia diagnosis				
Nutritional Deficiencies	3,519 (6.3%)	2,087 (9.7%)	9,045 (20.4%)	0.422
Chronic Diseases	17,133 (30.8%)	6,776 (31.6%)	15,687 (35.3%)	0.096
Bone Marrow Disorders	420 (0.8%)	284 (1.3%)	2,150 (4.8%)	0.249
Hemolytic Anemia	88 (0.2%)	102 (0.5%)	523 (1.2%)	0.125
Surgery Related				
Admission type				0.901
Inpatient	9,657 (17.3%)	6,076 (28.3%)	25,352 (57.0%)	
Sameday	30,393 (54.6%)	10,045 (46.8%)	12,494 (28.1%)	
Ambulatory	15,622 (28.1%)	5,330 (24.8%)	6,593 (14.8%)	
Duration of surgery, min	193.7 ± 117.8	188.5 ± 120.3	173.0 ± 116.5	0.177
Work relative units	19.3 ± 13.3	18.6 ± 13.3	16.6 ± 13.7	0.202
Transfusion				
Autologous blood	4,918 (8.8%)	1,702 (7.9%)	2,887 (6.5%)	0.084
Packed red blood cells RBC	814 (1.5%)	638 (3.0%)	4,738 (10.7%)	0.274
Fresh frozen plasma FFP	499 (0.9%)	268 (1.2%)	1,383 (3.1%)	0.116
Platelets	650 (1.2%)	302 (1.4%)	1,027 (2.3%)	0.083
Outcomes				
ICU length of stay, days	2.5 ± 3.9	2.9 ± 4.7	3.6 ± 5.9	0.218
Hospital length of stay, days	2.6 ± 4.0	3.3 ± 5.3	6.6 ± 11.1	0.479
30-day readmission	2,550 (4.6%)	1,422 (6.6%)	6,381 (14.4%)	0.339
Major postoperative complications	2,187 (3.9%)	1,052 (4.9%)	2,957 (6.7%)	0.121
30-day mortality	181 (0.3%)	132 (0.6%)	1,309 (2.9%)	0.208

RESEARCH QUESTION

- We hypothesized that **women with preoperative borderline anemia**, defined by Hb levels between 12 and 13 g/dL, **are at increased risk for adverse postoperative outcomes**.



METHODS

EXPOSURE

- Last Hb value within 30 days prior to the procedure

OUTCOME

- Composite of **all-cause mortality, hospital readmission and major postoperative complications** within 30 days

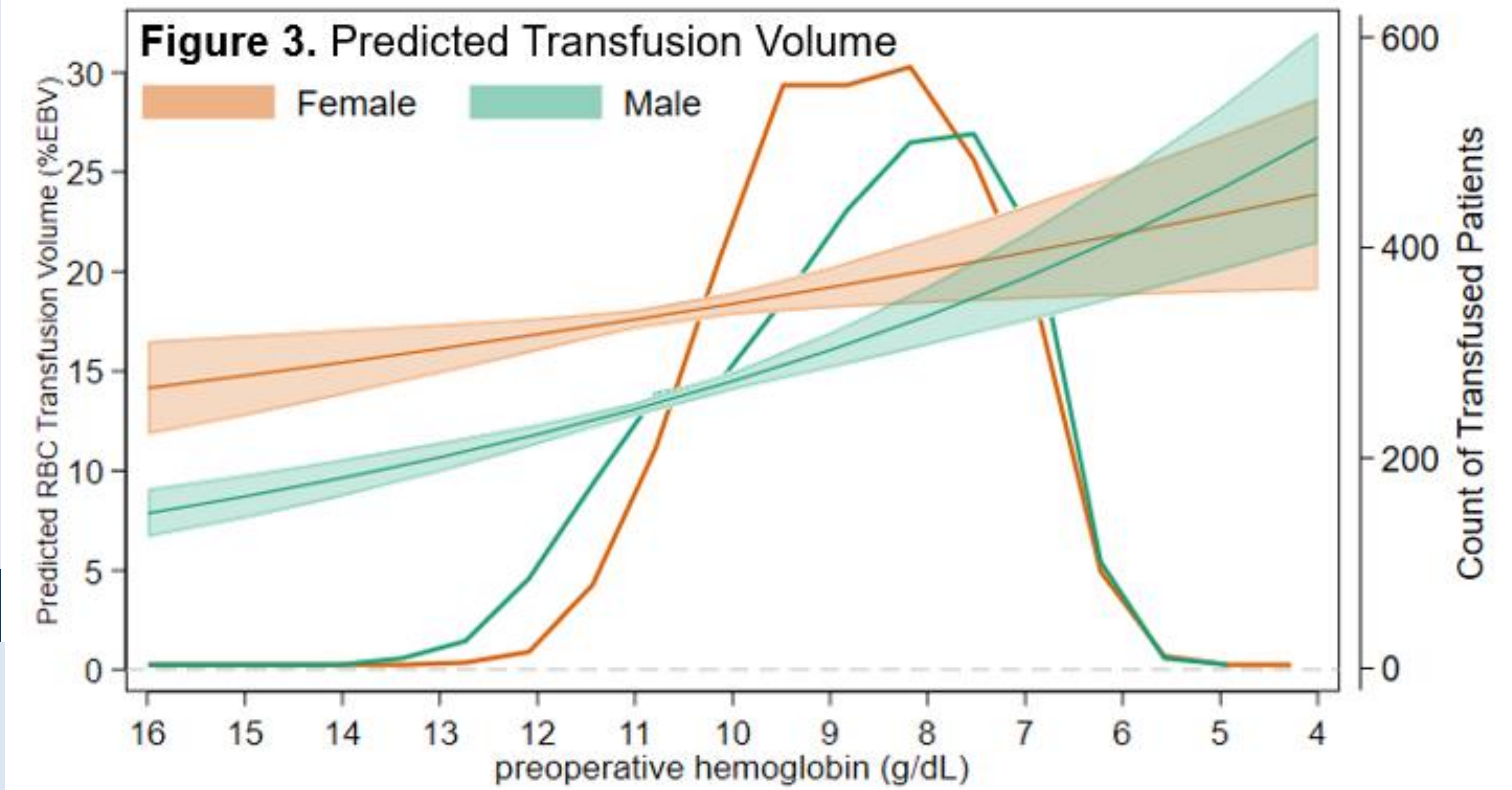
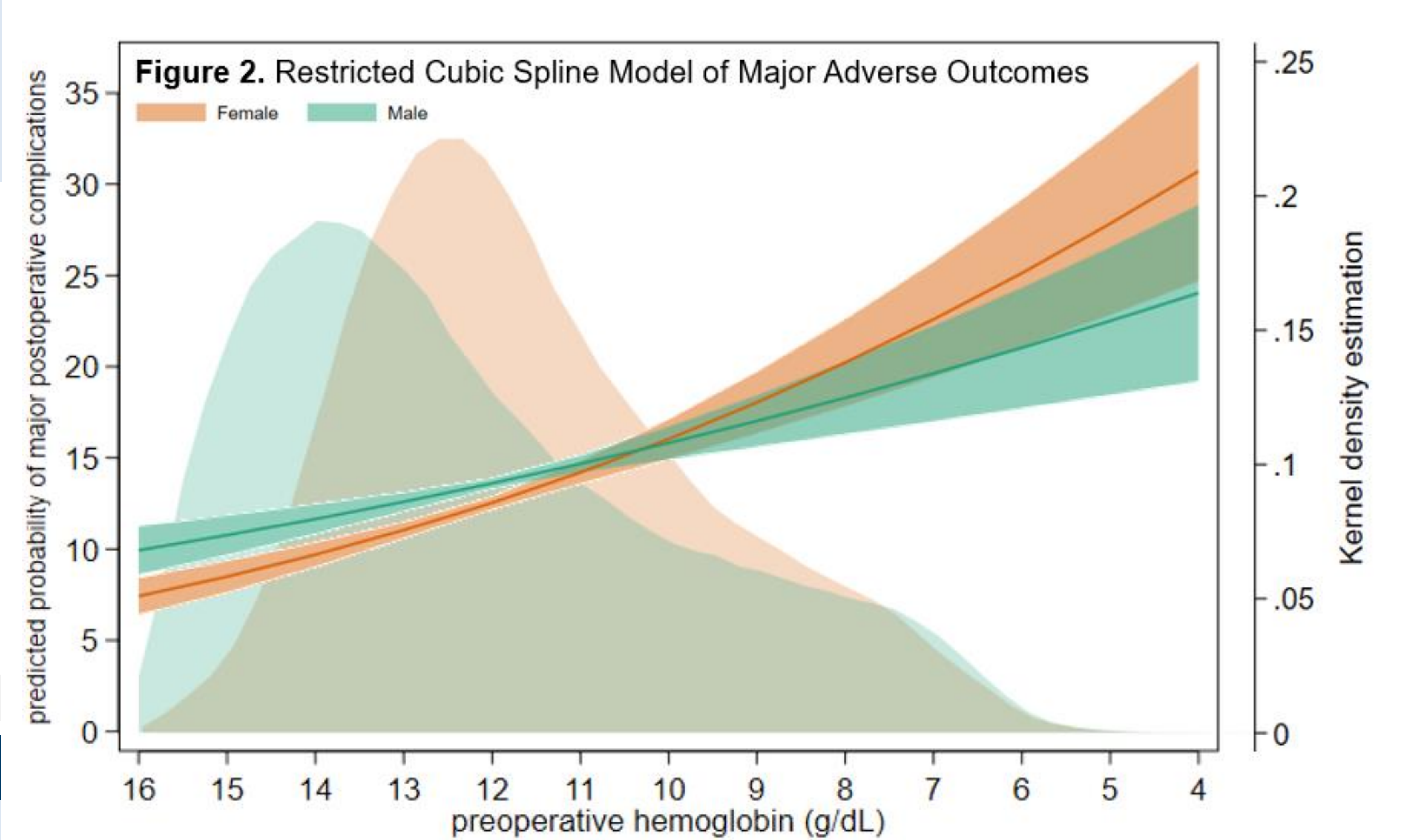
STATISTICAL ANALYSIS

- Multivariable **logistic regression** analysis **adjusted** for several factors (**Table 1**)
- Restricted cubic splines** and logistic Model

REFERENCES

- [1] Braat S et. al. Lancet Haematol. 2024
[2] Shander A et. al. Ann Surg. 2023
[3] Ripoll JG et. al. Anesth Analg. 2021

RESULTS



RESULTS

13,610 women (11.2%) and 7,841 men (6.5%) had a preoperative Hb value between 12 to 13 g/dL, of whom **1,192 women (7.5%)** and **1,070 men (6.7%)** experienced major adverse outcomes.

PRIMARY ANALYSIS

- The **odds of major adverse outcomes including mortality increased** by 15% per each g/dL decrease in preoperative Hb for (OR_{adj} 1.15, 95%CI 1.14 to 1.16, p<0.001) irrespective of sex (**Figure 2**).

CO-PRIMARY ANALYSIS

- Women with **borderline anemia were at higher risk** of major adverse outcomes (OR_{adj} 1.09, 95%CI 1.00 to 1.18, p=0.047) compared to non-anemic women.

TRANSFUSION VOLUME

- The adjusted predicted volume of red blood cell transfusion is shown in **Figure 3** as a standardized parameter, expressed as a percentage of the patient's estimated blood volume (%EBV), allowing for comparison relative to total blood volume.

CONCLUSION

- Preoperative anemia was linked to a **higher risk** of adverse postoperative outcomes including 30 day mortality in a **magnitude-dependent** manner.
- This was comparable between men and women, but only within distinct hemoglobin thresholds.
- Further evidence is needed to determine whether clinicians should consider using **universal hemoglobin thresholds** in the perioperative setting.

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