

Beyond Binary: Preoperative Hemoglobin as a Continuous Predictor of Postoperative Complications Following Elective Total Hip Arthroplasty

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INTRODUCTION: Preoperative anemia is associated with adverse outcomes following total hip arthroplasty (THA). However, discrete hemoglobin thresholds may obscure meaningful relationships between anemia severity and postoperative risk. This study assessed preoperative hemoglobin as a continuous variable to predict periprosthetic joint infection (PJI), medical, and surgical complications following elective THA.

METHODS: The Premier Healthcare Database was utilized to identify all primary THA patients between 2016 and 2023 with a hemoglobin value available within 28 days preoperatively. The primary outcome was 90-day PJI. Secondary outcomes included aggregate medical and surgical complications. Multivariable logistic regression with restricted cubic splines (RCS) evaluated hemoglobin as a continuous predictor of postoperative risk. Change-points were identified using a Metropolis-Hastings bootstrap simulation.

RESULTS: In total, 25,654 THAs were included, of whom 126 (0.5%) developed PJI within 90 days. RCS analysis identified hemoglobin change-points of 13.5 g/dL for PJI and aggregate medical complications, and 13.3 g/dL for aggregate surgical complications. Compared to 13.5 g/dL, patients with hemoglobin values of 11.0 and 8.0 g/dL had a 1.91-fold (95% Confidence Interval (CI): 1.37 to 2.68) and 4.40-fold (95% CI: 1.91 to 10.14) increased risk of PJI, respectively. Below the identified change-point, relative risk increased in a stepwise fashion, with each 0.5 g/dL decrement associated with an average percent increase of 14.9% from 13.5 to 12.0 g/dL, 23.2% from 12.0 to 11.0 g/dL, and 30.7% from 11.0 to 10.0 g/dL. A similar incremental increase in risk was observed for aggregate medical and surgical complications with each hemoglobin decrement across these ranges.

DISCUSSION AND CONCLUSION: Anemia severity is associated with a nonlinear incremental increase in the risk of PJI, medical, and surgical complications following THA. Identified change-points should inform, not dictate, surgical eligibility and may support individualized optimization. Further research is needed to determine whether anemia correction reduces complication risk.

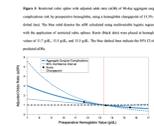
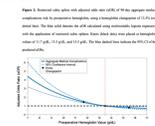
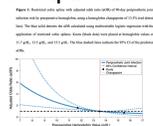


Table 1: Patient demographics and baseline characteristics across outcomes by preoperative hemoglobin (Hb) quartiles.

Characteristic	<math>Hb < 10.0</math> (n=1,234)	$Hb 10.0-11.0$ (n=2,345)	$Hb 11.0-12.0$ (n=3,456)	$Hb > 12.0$ (n=4,567)
Age (mean)	68.5	68.2	67.9	67.6
Female (%)	72.1	71.8	71.5	71.2
White (%)	78.3	77.9	77.5	77.1
Medicare (%)	85.2	84.8	84.4	84.0
Time to surgery (days)	12.5	12.8	13.1	13.4
Preoperative Hb (g/dL)	9.8	10.8	11.8	12.8
90-day PJI (%)	0.8	0.6	0.4	0.3
Medical complications (%)	12.5	10.2	8.1	6.5
Surgical complications (%)	8.3	6.7	5.2	4.1

Table 2: Restricted cubic spline (RCS) coefficients for the relationship between preoperative hemoglobin and 90-day PJI risk.

Category	Relative Risk (95% CI)
<math>Hb < 10.0</math>	4.40 (1.91, 10.14)
$Hb 10.0-11.0$	1.91 (1.37, 2.68)
$Hb 11.0-12.0$	1.00 (Reference)
$Hb > 12.0$	0.50 (0.30, 0.85)

Table 3: Change-points for aggregate medical and surgical complications.

Outcome	Change-point (g/dL)
Aggregate Medical Complications	13.5
Aggregate Surgical Complications	13.3

Table 4: Sensitivity analysis for 90-day PJI risk by preoperative hemoglobin quartiles.

Quartile	Relative Risk (95% CI)
<math>Hb < 10.0</math>	4.40 (1.91, 10.14)
$Hb 10.0-11.0$	1.91 (1.37, 2.68)
$Hb 11.0-12.0$	1.00 (Reference)
$Hb > 12.0$	0.50 (0.30, 0.85)