

# Postoperative Veno-arterial PCO2 gap and Lactate Levels as Predictors of Primary Graft Dysfunction after Orthotopic Heart Transplant

Shreyas Kiran<sup>1</sup>, Phoebe Miller MD, MS<sup>2</sup>, Andrew Akcelik MD<sup>3</sup>, Jason Smith MD<sup>3</sup>, Amy G. Fiedler MD<sup>3</sup>

<sup>1</sup>School of Medicine, University of California, San Francisco, CA ; <sup>2</sup>Department of Surgery, University of California, San Francisco, CA; <sup>3</sup>Department of Cardiothoracic Surgery, University of California, San Francisco, CA

## Introduction

Orthotopic heart transplantation (OHT) remains the gold standard treatment for patients with end-stage heart failure. In the immediate postoperative period, cardiac surgeons often observe elevated lactate levels and an increased veno-arterial carbon dioxide partial pressure gradient (V–a PCO<sub>2</sub>). While these findings are common after OHT, their clinical relevance and potential prognostic value are not well defined. In particular, few studies have systematically evaluated whether postoperative lactate or V–a PCO<sub>2</sub> levels are associated with primary graft dysfunction (PGD), a major cause of early morbidity and mortality following heart transplantation. Clarifying this relationship may help identify early markers of graft dysfunction and improve postoperative monitoring and management strategies.

## Objective

To evaluate the associations between PGD severity following orthotopic heart transplant (OHT) and early postoperative serum lactate and V–a CO<sub>2</sub> gap.

## Methods

- Single-center retrospective study of adults undergoing orthotopic heart transplant (June 2022–June 2023) with clinical and hemodynamic data collected.
- Postoperative lactate, V–a CO<sub>2</sub> gap (venous minus arterial PCO<sub>2</sub>), and MAP recorded closest to procedure end time.
- PGD defined as moderate (VIS >10 or MAP <70) or severe (mechanical support within 24h); mild PGD excluded due to inconsistent echo timing.

Table 1. PGD Severity vs. Demographic and Clinical Characteristics, Univariate Analysis

|                        | No PGD<br>(n=60) | Moderate<br>PGD (n=39) | Severe PGD<br>(n=13) | Total<br>(n=112) | P-value |
|------------------------|------------------|------------------------|----------------------|------------------|---------|
| Age at Transplant      | 49.95 ± 14.78    | 50.59 ± 14.78          | 46.00 ± 17.01        | 49.71 ± 14.97    | 0.63    |
| Sex, Female            | 16 (26.7%)       | 10 (25.6%)             | 6 (46.2%)            | 32 (28.6%)       | 0.33    |
| Race/Ethnicity         |                  |                        |                      |                  | 0.82    |
| BMI                    | 26.91 ± 5.48     | 27.73 ± 5.37           | 29.29 ± 6.72         | 27.47 ± 5.59     | 0.36    |
| Additional Transplants |                  |                        |                      |                  | 0.1     |
| 1                      | 8 (13.3%)        | 5 (12.8%)              | 2 (15.4%)            | 15 (13.4%)       |         |
| 2                      | 0 (0.0%)         | 0 (0.0%)               | 1 (7.7%)             | 1 (0.9%)         |         |
| DCD vs. DBD            |                  |                        |                      |                  | 0.67    |
| DBD                    | 58 (96.7%)       | 36 (92.3%)             | 13 (100.0%)          | 107 (95.5%)      |         |
| DCD                    | 2 (3.3%)         | 2 (5.1%)               | 0 (0.0%)             | 4 (3.6%)         |         |
| Comorbidities          |                  |                        |                      |                  |         |
| COPD                   | 1 (2.6%)         | 1 (1.7%)               | 1 (7.7%)             | 3 (2.7%)         | 0.55    |
| HTN                    | 19 (48.7%)       | 27 (45.0%)             | 3 (23.1%)            | 49 (43.8%)       | 0.13    |
| HLD                    | 12 (30.8%)       | 13 (21.7%)             | 2 (15.4%)            | 27 (24.1%)       | 0.38    |
| DM                     | 6 (15.4%)        | 18 (30.0%)             | 1 (7.7%)             | 25 (22.3%)       | 0.06    |
| Renal Disease          | 9 (23.1%)        | 19 (31.7%)             | 3 (23.1%)            | 31 (27.7%)       | 0.45    |
| Prior Chest Surgery    | 20 (51.3%)       | 22 (36.7%)             | 7 (53.8%)            | 49 (43.8%)       | 0.37    |

Table 2. PGD Severity vs. Postoperative Variables, Univariate Analysis

| Variable    | No PGD<br>(n=60) | Moderate<br>PGD (n=39) | Severe PGD<br>(n=13) | Total<br>(n=112) | P-value |
|-------------|------------------|------------------------|----------------------|------------------|---------|
| 0h CO2 Gap  | 5.62 ± 2.54      | 9.05 ± 5.31            | 14.38 ± 5.08         | 7.83 ± 4.90      | <0.01   |
| 24h CO2 Gap | 5.32 ± 4.41      | 5.81 ± 3.07            | 10.00 ± 5.27         | 5.96 ± 4.30      | <0.01   |
| Δ CO2 Gap   | -0.30 ± 5.24     | -3.69 ± 6.19           | -5.92 ± 8.53         | -2.13 ± 6.32     | <0.01   |
| 0h Lactate  | 4.69 ± 3.07      | 6.75 ± 4.22            | 8.65 ± 3.96          | 5.88 ± 3.84      | <0.01   |
| 24h Lactate | 1.69 ± 0.80      | 2.29 ± 1.46            | 2.25 ± 1.12          | 1.96 ± 1.13      | 0.03    |
| Δ Lactate   | -2.95 ± 3.07     | -4.63 ± 4.34           | -6.74 ± 3.66         | -3.98 ± 3.81     | <0.01   |

Figure 1. Pie-chart of PGD Severity in Sample

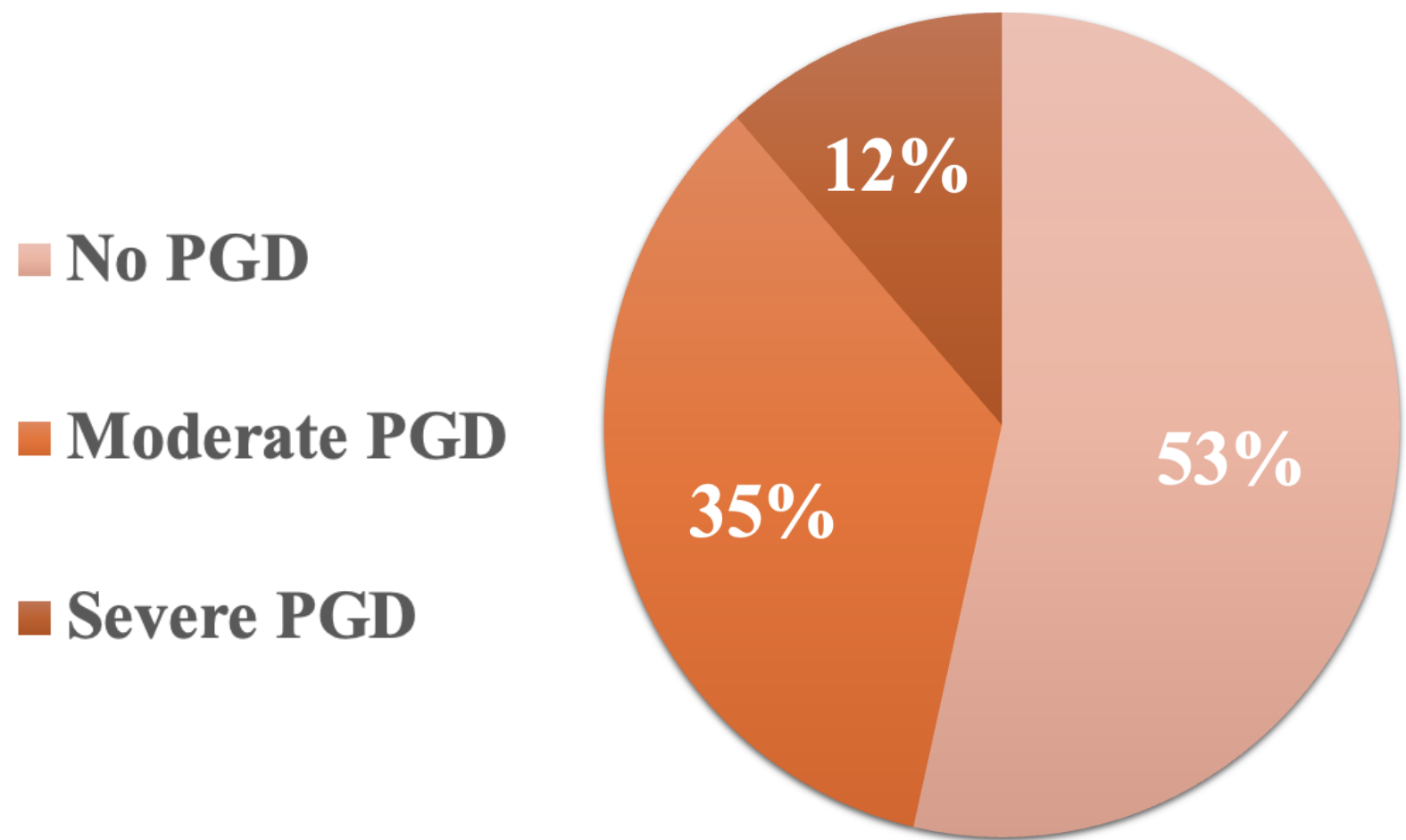


Table 4. Multivariate Regression of Postoperative CO2 Gap and Lactate vs. Moderate PGD

| Variable               | OR   | 95% CI       | P-Value |
|------------------------|------|--------------|---------|
| 0h CO2 Gap             | 1.49 | (1.15, 1.93) | <0.01   |
| 0h Lactate             | 1.21 | (1.03, 1.43) | 0.03    |
| Age at Tx              | 1.01 | (0.98, 1.04) | 0.66    |
| BMI                    | 1.01 | (0.93, 1.10) | 0.86    |
| Additional Transplants | 0.88 | (0.24, 3.31) | 0.85    |

Table 6. Multinomial Regression of Postoperative CO2 Gap and Lactate with No, Moderate, and Severe PGD

| Variable               | Moderate |                |         | Severe |                 |         |
|------------------------|----------|----------------|---------|--------|-----------------|---------|
|                        | OR       | 95% CI         | P-Value | OR     | 95% CI          | P-Value |
| 0h CO2 Gap             | 0.665    | (0.545, 0.812) | <0.01   | 1.169  | (1.019, 1.341)  | 0.026   |
| 0h Lactate             | 0.826    | (0.711, 0.960) | 0.013   | 1.124  | (0.940, 1.345)  | 0.2     |
| Age at Tx              | 0.99     | (0.958, 1.024) | 0.559   | 0.98   | (0.933, 1.029)  | 0.417   |
| BMI                    | 0.979    | (0.896, 1.069) | 0.634   | 0.996  | (0.870, 1.140)  | 0.952   |
| Additional Transplants | 1.396    | (0.337, 5.783) | 0.645   | 2.468  | (0.465, 13.111) | 0.289   |

## Key Findings

- Both postoperative V-a CO<sub>2</sub> gap and Lactate are significant predictors of any PGD.
- Binomial analysis shows only postoperative V-a CO<sub>2</sub> gap is a significant predictor of severe PGD
- Multinomial analysis confirms that postoperative V–a CO<sub>2</sub> gap predicts both moderate and severe PGD, while lactate predicts only moderate PGD