

# Right Ventricular Failure Post Left Ventricular Assist Device Implantation is Associated with a Preoperative Pro-Inflammatory Response

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## Background

- Postoperative right ventricular failure (RVF) complicates 9-44% of left ventricular assist device (LVAD) Implants. It is associated with decreased survival , greater demands on resources and worse long term outcomes [1,2].
- The etiology of RVF is likely a complex interaction of hemodynamic burden with underlying ventricular biology. Indeed, accurate prediction of RVF post LVAD implantation remains elusive [3].
- Various RVF prediction algorithms have been developed but only modestly predicts RVF following external validation studies with C statistics of 0.61-0.66 [2,4].
- There is increasing evidence to implicate the immune response and associated inflammation in heart failure pathophysiology [6].

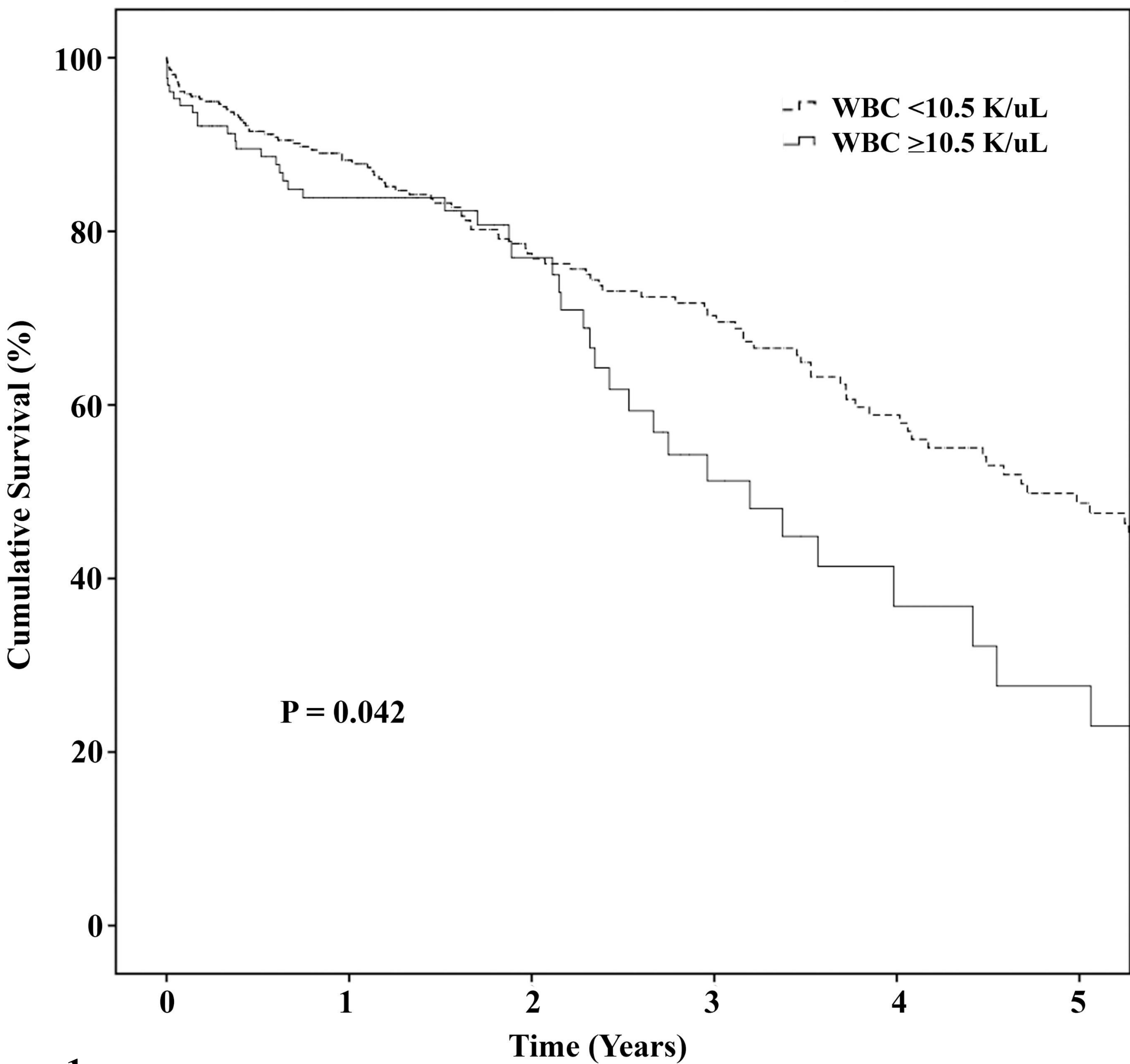
## AIMS

- This study investigates the association of the elevated inflammatory markers (leukocytosis and elevated C-reactive protein (CRP)) preoperatively with subsequent right ventricular failure (RVF) after left ventricular assist device (LVAD) implantation

## METHODS

- Prospective data including demographics, preop clinical characteristics, laboratory and diagnostic studies along with postop outcomes including RVF was collected on 495 patients from 2003 through 2017 who underwent implantation of a durable LVAD.

Table 1	WBC <10.5 (n=362)	WBC ≥10.5 (n=127)	P Value
Age (years)	56.53±12.96	51.21±13.01	<0.001
Male	284 (78.5%)	99 (78.0%)	0.906
Height (cm)	174.79±9.76	173.50±10.13	0.205
Weight (kg)	84.72±20.87	87.91±23.66	0.154
BMI	27.61±5.99	29.62±9.04	0.005
Hypertension	179 (49.4%)	54 (42.5%)	0.179
Diabetes	125 (34.5%)	41 (32.3%)	0.645
Stroke or TIA	44 (12.2%)	16 (12.6%)	0.896
Carotid Disease	27 (7.5%)	8 (6.3%)	0.663
Hyperlipidemia	222 (61.3%)	71 (55.9%)	0.284
Atrial Fibrillation	81 (22.4%)	28 (22.0%)	0.939
Dialysis CVVH	0 (0.0%)	1 (0.8%)	0.091



**Figure 1**  
Patients at Risk

	0	1	2	3	4	5
WBC <10.5	362	215	133	96	63	43
WBC ≥10.5	127	78	40	17	8	6

## References

1. Argiriou, M., et al., *Right heart failure post left ventricular assist device implantation*. J Thorac Dis, 2014. **6 Suppl 1**: p. S52-9.
2. Kalogeropoulos, A.P., et al., *The Right Ventricular Function After Left Ventricular Assist Device (RVF-LVAD) study: rationale and preliminary results*. Eur Heart J Cardiovasc Imaging, 2016. **17**(4): p. 429-37.
3. Kormos, R.L., *The right heart failure dilemma in the era of left ventricular assist devices*. J Heart Lung Transplant, 2014. **33**(2): p. 134-5.
4. Hayek, S., et al., *Assessment of right ventricular function in left ventricular assist device candidates*. Circ Cardiovasc Imaging, 2014. **7**(2): p. 379-89. Marchant, D.J., et al., *Inflammation in myocardial diseases*. Circ Res, 2012. **110**(1): p. 126-44.
5. Marchant, D.J., et al., *Inflammation in myocardial diseases*. Circ Res, 2012. **110**(1): p. 126-44.

- Uni- and multivariable correlation with leukocytosis was determined using linear and binary logistic regression.

## RESULTS

- Postop RVF was associated with a higher preop white blood count (WBC, 11±6 vs 9±3) and CRP (5.6±4.3 vs 3.3±4.7) levels.
- Multivariable analysis identified an independent association of the preop need for temporary cardiac support device (TCSD, R=0.31, P<0.001), preop use of epinephrine (R=0.37, P<0.001) and postop RVF (R=0.38, P<0.001) with increased WBC preoperatively.
- For patients not requiring preop TCSD, higher acuity INTERMACS profile (P<0.001) and postop RVF (P=0.034) were independently associated with a higher preop WBC.
- Higher preop WBC and CRP was seen with preop TCSD use (WBC: 12.0±5.7 vs 8.7±3.1, P<0.001, CRP: 9.0+7.4 vs 3.1+4.3, P<0.001) and need for preop vasopressors (WBC: 13.1.0±7.6 vs 8.7±3.1, P=0.022, CRP: 10.7+8.6 vs 3.2+4.2, P=0.032).
- Increased WBC also correlated with increased preop ALT (R=0.170, P<0.001), AST (R=0.206, P<0.001), total bilirubin (R=0.281, P<0.001), and INR (R=0.164, P<0.001).

Table 2	WBC <10.5 (n=362)	WBC ≥10.5 (n=127)	P Value
RV Failure	21 (5.8%)	17 (13.4%)	0.006
RVAD	16 (4.4%)	14 (11.0%)	0.008
Duration of RVAD (median)	17.0 (IQR=18.0)	20.50 (IQR=74.0)	0.452
Nitric Oxide Use	356 (98.3%)	125 (98.4%)	0.950
Nitric Duration (median days)	2.0 (IQR=2.0)	2.0 (IQR=2.0)	0.514
Sternum Closed	213 (58.8%)	82 (64.6%)	0.211
Chest Open Days (median)	1.0 (IQR=1.0)	1.0 (IQR=1.0)	0.808
Device Infection	95 (26.2%)	26 (20.5%)	0.195
Device Exchange Infection	21 (5.8%)	7 (5.5%)	0.904
Neuro Event	94 (26.0%)	32 (25.2%)	0.864
Hemolysis	87 (24.0%)	28 (22.0%)	0.650
Postop Dialysis/CVVH	12 (3.3%)	11 (8.7%)	0.014
Total ICU LOS (mean)	10.95±17.22	15.73±34.92	0.046
Total LOS (mean)	26.06±20.15	30.86±35.58	0.064
Total Days Readmit (mean)	38.14±54.11	31.94±45.47	0.248

## CONCLUSIONS

- Postop RVF occurs in a pro-inflammatory setting that is established preoperatively. This is likely secondary to increased systemic stress of decompensated heart failure.
- The need for preop TCSD and vasopressor use are also associated with this preop inflammatory state.
- Systemic inflammation in the decompensated heart failure may contribute to RVF after durable LVAD implantation.

Table 3	WBC <10.5 (n=362)	WBC ≥10.5 (n=127)	P Value
Redo-Sternotomy	103 (28.5%)	29 (22.8%)	0.220
Concomitant Surgery			
Valve procedure	161 (44.5%)	54 (42.5%)	0.702
AV procedure	27 (7.5%)	6 (4.7%)	0.291
TV Procedure	143 (39.5%)	49 (38.6%)	0.855
MV Procedure	2 (0.6%)	0 (0.0%)	0.401
Intrapericardial	143 (39.5%)	55 (43.3%)	0.452
Preperitoneal	219 (60.5%)	72 (56.7%)	0.452
CPB (min)	83.96±31.61	87.65±35.348	0.273

Table 4	WBC <10.5 (n=362)	WBC ≥10.5 (n=127)	P Value
LVEF (%)	15.33±5.78	15.40±5.60	0.900
Moderate-Severe RVD	182 (50.3%)	73 (57.3%)	0.162
Severe AI	14 (3.9%)	2 (1.6%)	0.211
Severe MR	123 (34.0%)	40 (31.5%)	0.610
Severe TR	53 (14.6%)	14 (11.0%)	0.308
Bridge to Txp	211 (58.3%)	89 (70.1%)	0.019
Destination	151 (41.7%)	38 (29.9%)	0.019
TCS	23 (6.4%)	22 (17.3%)	<0.001
TCS Duration (median)	4.0 (IQR=2.0)	6.0 (IQR=4.0)	0.022
IABP	171 (47.2%)	71 (55.9%)	0.093
IABP Duration (median)	1.0 (IQR=1.0)	2.0 (IQR=3.0)	0.012

• Authors do not have any disclosures