

# Postoperative Infections Are Associated With Retained Blood After Cardiac Surgery: An Observational, Cross-sectional Analysis

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## Background

All patients require chest tubes to drain blood from around the heart after heart surgery. These tubes can occlude with clot, leading to retained blood around the heart and lungs. We have shown that patients who require interventions to remove retained blood after heart surgery have increased complications and mortality. We hypothesized that one mechanism by which patients with retained blood may have worse outcomes is that it might contribute to the development of post-operative wound infections. If confirmed, this may suggest the need to improve systems to minimize retained blood after heart surgery.

## Methods

All patients undergoing cardiac surgery between 2006 and 2013 at a tertiary hospital were included in this observational, cross-sectional analysis. Cardiac surgery was defined as a documented procedure on valves or vessels in proximity to the heart or coronary vessels. Retained blood as defined as any intervention to remove blood, blood clot or bloody fluid, such as interventions for tamponade or pericardial effusion, hemothorax, or pleural effusion during the index hospitalization. This included any re-exploration for bleeding (which uniformly require washout of retained blood), any pericardial window or pericardiocentesis or any placement of a chest tube in the pleural space or thoracentesis. Incidence of postoperative infection was derived from the ICD-10 code T81.4 and further differentiated using additional diagnoses that were documented in patients' records.

With the written consent of the federal data protection officer and the hospital ethics commission, clinical routine data from all eligible patients were extracted from the hospital IT system to an anonymized study database. Descriptive analyses and statistical testing were performed using the R Project of Statistical Computing 3.0.1. Statistical significance among groups was analyzed by the exact nonparametric Kruskal-Wallis test. Multivariate logistic regression with stepwise backwards variable selection was used to adjust for confounders.

## Results

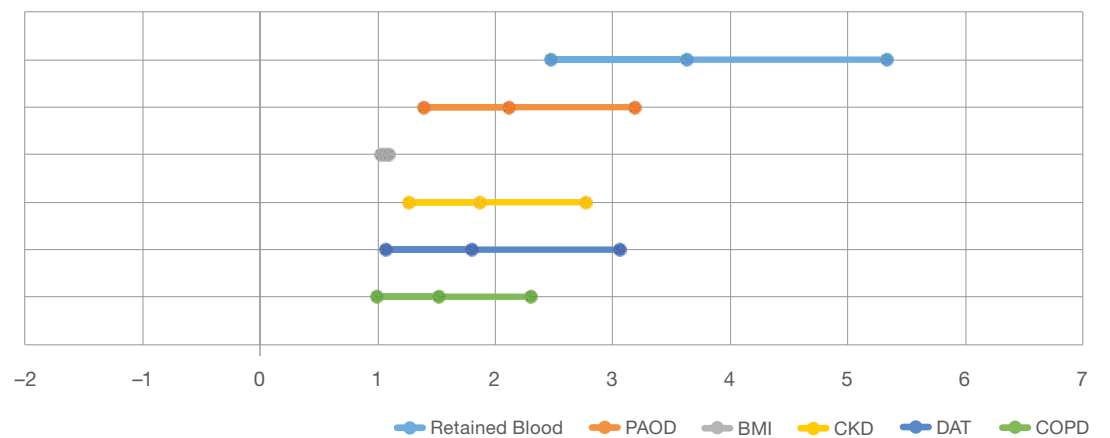
Of 6,909 patients that underwent cardiac surgery during the study period, 1,316 (19%) presented with a retained blood related condition (see Table 1 for patient characteristics). Incidence of postoperative wound infection was significantly higher in the retained blood group (15.8% vs. 4.0%,  $p < 0.001$ , see Table 2). After adjusting for confounders, retained blood was associated with an odds ratio of 3.639 (95% CI: 2.476-5.337,  $p < 0.001$ ) (see Figure 1).

	[ALL] N=6,909	No Retained Blood N=5,593 (81%)	Retained Blood N=1,316 (19%)	p value
<b>Basic data</b>				
Age [y]	69.0 [61.0;75.0]	69.0 [61.0;74.0]	71.0 [64.0;77.0]	<0.001
Sex: F	1964 (28.4%)	1524 (27.2%)	440 (33.4%)	<0.001
Body Mass Index (BMI)	26.9 [24.3;30.1]	27.0 [24.4;30.2]	26.3 [23.8;29.7]	0.001
<b>Surgery</b>				
Type of surgery:				<0.001
CABG	3954 (57.2%)	3377 (60.4%)	577 (43.8%)	
Valves	2093 (30.3%)	1592 (28.5%)	501 (38.1%)	
Both	862 (12.5%)	624 (11.2%)	238 (18.1%)	
Duration of surgery [m]	195 [160;240]	195 [160;235]	200 [160;255]	<0.001
Priority of surgery:				<0.001
elective	4361 (76.8%)	3606 (79.0%)	755 (68.1%)	
urgent	519 (9.15%)	394 (8.63%)	125 (11.3%)	
emergency	795 (14.0%)	566 (12.4%)	229 (20.6%)	
RBC transfusion (pat. %)	1829 (29.6%)	1320 (26.2%)	509 (44.5%)	<0.001
RBC transfusion [units]	1.95 (1.05)	1.88 (0.97)	2.16 (1.23)	<0.001
ACEF score	1.28 [1.13;1.60]	1.27 [1.12;1.54]	1.42 [1.22;1.95]	<0.001
APACHE II	18.0 [14.0;24.0]	18.0 [14.0;23.0]	21.0 [16.0;27.0]	<0.001
<b>Preexisting medical conditions</b>				
Coronary heart disease	5383 (77.9%)	4418 (79.0%)	965 (73.3%)	<0.001
Left heart failure (>NYHA II)	2069 (29.9%)	1487 (26.6%)	582 (44.2%)	<0.001
COPD	1184 (17.1%)	879 (15.7%)	305 (23.2%)	<0.001
Endocrine disease	6334 (91.7%)	5074 (90.7%)	1260 (95.7%)	<0.001
Peripheral artery occlusive disease (PAOD)	1333 (19.3%)	1006 (18.0%)	327 (24.8%)	<0.001
Atrial fibrillation	2054 (29.7%)	1432 (25.6%)	622 (47.3%)	<0.001
Chronic kidney disease (CKD)	1684 (24.4%)	1234 (22.1%)	450 (34.2%)	<0.001
Haematocrit pre op	41.0 [37.0;43.0]	41.0 [38.0;44.0]	39.0 [35.0;43.0]	<0.001
Haemostatic disorder	754 (10.9%)	570 (10.2%)	184 (14.0%)	<0.001
Antiaggregation				0.044
Mono antiplatelet therapy	2309 (45.5%)	1950 (46.3%)	359 (41.7%)	
Dual antiplatelet therapy (DAT)	1097 (21.6%)	903 (21.4%)	194 (22.6%)	
<b>Retained blood related factors</b>				
Pericardial effusion	135 (1.95%)	0 (0.00%)	135 (10.3%)	
Hemothorax	212 (3.07%)	0 (0.00%)	212 (16.1%)	
Tamponade	34 (0.49%)	0 (0.00%)	34 (2.58%)	
Thoracentesis	588 (8.51%)	0 (0.00%)	588 (44.7%)	

**Table 1: Patient characteristics and retained blood related factors**

	[ALL] N=6,909	No Retained Blood N=5,593 (81%)	Retained Blood N=1,316 (19%)	p value
<b>Outcome</b>				
Mortality (In-hospital)	475 (6.88%)	216 (3.86%)	259 (19.7%)	<0.001
LOS (Hospital) [d]	13.0 [9.00;21.0]	12.0 [9.00;17.0]	25.0 [15.0;47.0]	<0.001
LOS (ICU) [d]	5.00 [3.00;9.00]	5.00 [3.00;7.00]	14.0 [7.00;30.0]	<0.001
Time of ventilation [h]	23.0 [10.0;54.0]	20.0 [9.00;40.0]	80.0 [26.0;308]	<0.001
Incidence of hemodialysis	1117 (16.2%)	563 (10.1%)	554 (42.1%)	<0.001
Postoperative transfusion (pRBC)	1273 (18.4%)	561 (10.0%)	712 (54.1%)	<0.001
<b>Postoperative infection</b>				
Pneumonia	179 (2.59%)	56 (1.00%)	123 (9.35%)	<0.001
Sepsis	138 (2.00%)	42 (0.75%)	96 (7.29%)	<0.001
Clostridium difficile	21 (0.30%)	7 (0.13%)	14 (1.06%)	<0.001
Superficial wound infection	46 (0.67%)	16 (0.29%)	30 (2.28%)	<0.001
Deep wound infection	22 (0.32%)	6 (0.11%)	16 (1.22%)	<0.001
Urinary tract infection	82 (1.19%)	29 (0.52%)	53 (4.03%)	<0.001

**Table 2: Selected outcome criteria including sub-analysis on postoperative infection**



**Figure 1: Forest plot of multivariate logistic regression analysis on factors influencing postoperative infection. Retained blood was associated with an OR of 3.639 (95% CI: 2.476-5.337,  $p < 0.001$ ).**

## Conclusions

The need for procedures to address retained blood after cardiac surgery is common and associated with worse outcomes. One mechanism by which outcomes are worsened might be a propensity to develop post-operative infections. Further studies are needed to evaluate ways to reduce retained blood, and determine if this might reduce infections after cardiac surgery.