Platelet Nadir and Postoperative Delirium after Cardiac Surgery with Cardiopulmonary Bypass

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Purpose

- We hypothesize that nadir platelet counts following cardiac surgery with cardiopulmonary bypass (CBP) will be associated with incidence of post-operative delirium.

Background

- Cardiac surgery with CPB has one of the highest rates of postoperative delirium when compared to other surgery types with an estimated incidence of 26-52%[1]
- Risk factors, pathophysiology, and treatment of delirium is still not fully understood.[2]
- Similar mechanisms that have been proposed to explain the development of postoperative delirium have been implicated in CPB-associated platelet activation and decline.[3-7]
- Platelet activation following CPB has been associated with postoperative consequences such as acute kidney injury (AKI), stroke, and mortality.[8-10]

Methods

- Multi-site retrospective cohort of cardiac surgery patients (n = 2,455) at an academic medical hospital and community hospital with cardiac surgery programs
- Primary exposure: platelet nadir
- Secondary exposures: platelet nadir time in minutes and age
- Multivariate logistic regression was performed to develop a prediction model for delirium within 7 days of intensive care unit admission
- Sensitivity analysis was performed to compare the full model, a parsimonious model, and a univariate model using Akaike information criterion

Results

- Patients experiencing delirium compared to those who did not, had a lower platelet nadir, later platelet nadir time, and were older (table 1)
- Age, sex, diabetes, platelet nadir, and platelet nadir time were independently associated with the incidence of delirium (table 2)
  - AUC ROC of 0.685
- A parsimonious model containing age, sex, platelet nadir, and platelet nadir time carried 98.7% of the cumulative model weight (table 3a)
  - AUC ROC of 0.638
- A univariate model with platelet nadir carried 96.9% of the full model weight (table 3b)
  - AUC ROC of 0.601
- The optimal cutoff value for platelet nadir was 83 x 10^9/L using Youden's J statistic

Table 1. Cohort characteristics and comparison between patients with and without a diagnosis of delirium in the first 7 days after cardiac surgery in a univariate analysis

Patient demographics	
Age	62.7 ± 12.9
Sex, male	1724/2433 (71%)
Race, white	1889/2455
Institution, academic	1769/2433 (73%)
Pre-operative characteristics	
Heart failure	804/2433 (33%)
Diabetes	572/2433 (24%)
Obstructive sleep apnea	225/2433 (91%)
Carotid stenosis	195/2433 (8%)
Cognitive impairment	4/2433 (0.2%)
Procedure	
Aortic Procedures	453/2419 (19%)
AVR	532/2419 (22%)
CABG	983/2419 (41%)
Off pump CABG	3/2419 (0.1%)
PVR	26/2419 (1%)
TVR	18/2419 (1%)
Outcomes	
Post-operative Delirium	293/2433 (12%)
Post-operative Death	78/2433 (3%)

Univariate analysis	All n = 2,433	No delirium 2140/2,433	Delirium 293/2,433	P value
Platelet nadir (x10^9/L)	106 ± 42	107 ± 42	94 ± 41	<0.0001
Platelet nadir time (minutes)	3,612±1,763	3551 ± 1694	4028 ± 2,133	0.003
Age (years)	62.7 ± 12.9	62.2 ± 12.9	66.1 ± 12.3	<0.0001

Table 2. Multivariable regression of the full model and ROC curve

Term		Estimate	Std Error	ChiSquare	Prob>ChiSq	Lower 95%	Upper 95%
Intercept	Unstable	-8.6708014	13397.717	0.00	0.9995	-26267.714	26250.3722
age		0.02631976	0.0057674	20.83	<.0001*	0.01518339	0.03780571
gender[Female]		0.29765393	0.0689055	18.66	<.0001*	0.16190199	0.43222425
race[American Indian and Alaska Native]		0.85482514	0.5688468	2.26	0.1329	-0.3486086	1.93480533
race[Asian]		-0.7739371	0.5006746	2.39	0.1222	-1.8771928	0.14182537
race[Black]		-0.1742016	0.3125581	0.31	0.5773	-0.786112	0.46449866
race[Hawaiian or Pacific Islander]		0.43644888	1.0531073	0.17	0.6786	-2.2305965	2.25034217
race[Multiracial]		-0.2701662	0.3776751	0.51	0.4744	-1.0419111	0.46690257
race[Other]		0.00769463	0.2793165	0.00	0.9780	-0.5261659	0.59660866
facility_location[MHC HOSPITAL]	Unstable	6.04219588	13397.717	0.00	0.9996	-26253.001	26265.0852
facility_location[UCH HOSPITAL]	Unstable	6.98630692	13397.717	0.00	0.9996	-26252.057	26266.0293
death[False]		0.1057218	0.1631633	0.42	0.5170	-0.201656	0.44140683
HF[False]		-0.004967	0.0711892	0.00	0.9444	-0.143345	0.13597455
DM[False]		-0.1849295	0.0793816	5.43	0.0198*	-0.3391204	-0.0275819
OSA[False]		0.07506766	0.1166501	0.41	0.5199	-0.1448092	0.31416284
carotid_stenosis[False]		-0.0513175	0.1223284	0.18	0.6748	-0.2823115	0.19922428
cog_impair[False]		-1.1021224	0.5377273	4.20	0.0404*	-2.2359631	0.00987925
plt_nadir		-0.0057334	0.00181	10.03	0.0015*	-0.009356	-0.0022614
Platelet nadir time (minutes)		6.8168e-5	3.6927e-5	3.41	0.0649	-5.0607e-6	0.00013984
Redo[No]		0.10525633	0.2151759	0.24	0.6247	-0.2874498	0.56800038
Procedure[Aortic]		0.0194415	0.259836	0.01	0.9404	-0.4802233	0.57733404
Procedure[AVR]		-0.504086	0.2615987	3.71	0.0540	-1.0081978	0.05590943
Procedure[CABG]		-0.3557173	0.2518905	1.99	0.1579	-0.8391071	0.19003975
Procedure[MVR]		-0.3931199	0.2695738	2.13	0.1448	-0.9140303	0.17897854
Procedure[OFF PUMP CABG]		1.30433323	1.1213201	1.35	0.2447	-1.4070301	3.49358944
Procedure[PVR]		-0.1029323	0.5855568	0.03	0.8605	-1.4179659	0.95482317

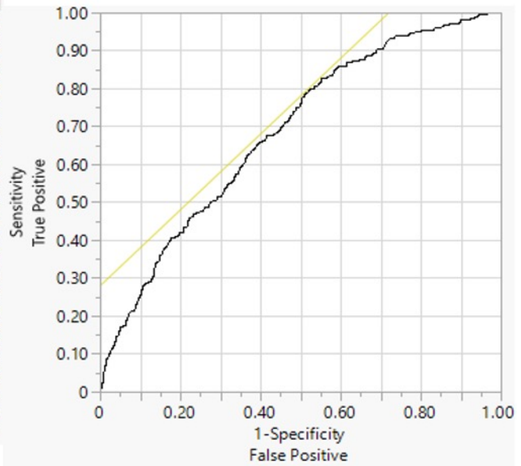
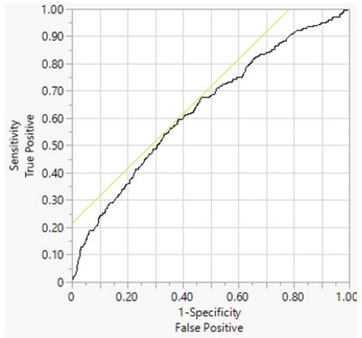
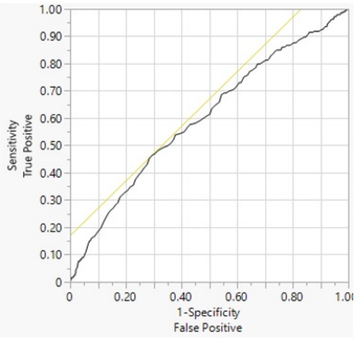


Table 3. Sensitivity analysis of a parsimonious multivariable model and univariate model

Term	Estimate	Std Error	ChiSquare	Prob>ChiSq	Lower 95%	Upper 95%
Intercept	-2.8757515	0.4518502	40.51	<.0001*	-3.7746027	-2.0025015
plt_nadir	-0.0061465	0.0017529	12.30	0.0005*	-0.0096458	-0.0027754
Platelet nadir time (minutes)	6.16115e-5	3.5453e-5	3.02	0.0822	-8.8767e-6	0.00013024
age	0.02133933	0.0053953	15.64	<.0001*	0.01093733	0.03209807
gender[Female]	0.27864991	0.0651193	18.31	<.0001*	0.15020265	0.40568354



Term	Estimate	Std Error	ChiSquare	Prob>ChiSq
Intercept	-1.1357805	0.1732359	42.98	<.0001*
plt_nadir	-0.0085045	0.0016939	25.21	<.0001*



The authors have no financial interests or relationships to disclose

Conclusion

- Platelet count after cardiac surgery with CPB may be a pragmatic indicator for predicting the incidence of delirium in the cardiothoracic intensive care unit

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