

ONLINE SUPPLEMENTARY CONTENT**Table SI - Model 1 and Model 2 AUC (95% CI) scores for each imputed dataset**

Dataset	Model 1		Model 2	
	AUC	95% CI	AUC	95% CI
1	0.861	0.855-0.869	0.858	0.851-0.865
2	0.866	0.860-0.873	0.862	0.855-0.869
3	0.867	0.860-0.873	0.863	0.856-0.869
4	0.863	0.856-0.870	0.859	0.852-0.866
5	0.865	0.858-0.872	0.861	0.854-0.867
6	0.865	0.858-0.871	0.860	0.853-0.867
7	0.861	0.854-0.868	0.856	0.850-0.863
8	0.865	0.858-0.872	0.861	0.854-0.868
9	0.867	0.861-0.874	0.863	0.856-0.870
10	0.866	0.860-0.873	0.863	0.856-0.869
11	0.867	0.860-0.873	0.862	0.856-0.869
12	0.865	0.858-0.872	0.861	0.854-0.868
13	0.865	0.859-0.872	0.862	0.855-0.868
14	0.866	0.859-0.872	0.861	0.854-0.868
15	0.868	0.861-0.874	0.864	0.858-0.871
16	0.867	0.860-0.874	0.863	0.856-0.870
17	0.867	0.861-0.874	0.864	0.857-0.870
18	0.867	0.860-0.873	0.863	0.856-0.869
19	0.868	0.862-0.875	0.865	0.858-0.871
20	0.868	0.861-0.874	0.864	0.857-0.871

Model 1: Red cell transfusion = admission haemoglobin + surgical procedure + age + sex + Charlson score
 Model 2: Red cell transfusion = admission haemoglobin + surgical procedure.

Table SII - Multivariable model output to predict red cell transfusion in elective surgery from admission haemoglobin, surgical procedure, age, sex, comorbidities (Model 1)

Characteristic	Pooled estimate	Pooled standard error	Odds ratio (95% CI)
Admission haemoglobin	-0.05	0.002	0.949 (0.944, 0.953)
Surgical Procedure			
Amputation of ankle or foot	-1.39	0.30	0.25 (0.14, 0.44)
Amputation of pelvis or hip	1.41	0.41	4.09 (1.84, 9.08)
Anterior resection of rectum	0.22	0.25	1.25 (0.76, 2.05)
Arterial bypass graft using composite, sequential or crossover graft	2.23	0.47	9.32 (3.74, 23.27)
Arterial bypass graft using vein	1.10	0.33	2.99 (1.57, 5.69)
Arterial bypass graft using synthetic material	2.00	0.34	7.37 (3.76, 14.42)
Arthroplasty of hip	-0.04	0.24	0.96 (0.6, 1.53)
Arthroplasty of knee	-0.89	0.25	0.41 (0.25, 0.67)
CABG	1.77	0.24	5.85 (3.68, 9.29)
Caesarean section	-1.88	0.27	0.15 (0.09, 0.26)
Cardiac valve repair	1.20	0.44	3.32 (1.41, 7.8)
Cardiac valve replacement	1.23	0.24	3.41 (2.14, 5.43)
Cholecystectomy	-2.02	0.33	0.13 (0.07, 0.25)
Closure of stoma of small intestine	-0.93	0.35	0.39 (0.2, 0.78)
Colectomy	-0.24	0.25	0.78 (0.48, 1.28)
Complete nephrectomy	0.01	0.36	1.01 (0.5, 2.04)
Cystectomy	1.84	0.29	6.29 (3.56, 11.14)
Decompression of lumbar spinal canal	-1.02	0.35	0.36 (0.18, 0.71)
Endarterectomy	0.33	0.28	1.4 (0.81, 2.43)
Endoscopic insertion or removal of ureteric stent	-2.15	0.37	0.12 (0.06, 0.24)
Endoscopic resection bladder lesion/tissue	-2.11	0.35	0.12 (0.06, 0.24)
Excision of lesion of SSCT	-1.88	0.29	0.15 (0.09, 0.27)
Excision proc on salivary gland or duct	-1.21	0.38	0.3 (0.14, 0.63)
Excision procedures on liver	0.41	0.28	1.5 (0.87, 2.59)
Excision procedures on other musculoskeletal sites	-0.77	0.28	0.46 (0.27, 0.8)
Fixation of fracture of pelvis or femur	0.14	0.31	1.15 (0.63, 2.1)
Free flap	1.44	0.40	4.24 (1.93, 9.33)
Kidney transplantation	0.43	0.29	1.53 (0.87, 2.7)
Lobectomy of lung	-1.15	0.39	0.32 (0.15, 0.68)
Mitral valve annuloplasty	1.79	0.32	5.99 (3.21, 11.15)
Nephroureterectomy	0.34	0.39	1.41 (0.66, 3)
Oesophagectomy by abdominal and transthoracic mobilisation	-0.35	0.40	0.71 (0.32, 1.54)
Other excision procedures on abdomen, peritoneum or omentum	1.82	0.35	6.17 (3.08, 12.35)

Characteristic	Pooled estimate	Pooled standard error	Odds ratio (95% CI)
Surgical Procedure			
Other debridement of SSCT	-0.72	0.33	0.49 (0.26, 0.93)
Other excision procedures on knee or leg	0.69	0.34	2 (1.03, 3.91)
Other gastrectomy	-0.51	0.39	0.6 (0.28, 1.29)
Other procedures on female genital organs	0.97	0.37	2.65 (1.27, 5.52)
Other repair procedures on vascular sites	0.59	0.26	1.81 (1.09, 2.99)
Other repair procedures on shoulder	-1.65	0.37	0.19 (0.09, 0.4)
Other revision procedures on knee	0.52	0.27	1.68 (0.99, 2.85)
Pancreatectomy	0.68	0.26	1.97 (1.19, 3.27)
Partial resection of lung	-1.25	0.38	0.29 (0.14, 0.61)
Procedures for surgically created arteriovenous fistula	-2.59	0.33	0.08 (0.04, 0.14)
Radical nephrectomy	0.24	0.29	1.27 (0.72, 2.23)
Reconstruction procedures on breast	-0.11	0.34	0.89 (0.46, 1.74)
Rectosigmoidectomy or proctectomy	1.23	0.28	3.43 (1.99, 5.91)
Reduction of fracture of pelvis or femur	0.68	0.45	1.98 (0.82, 4.79)
Removal of intracranial lesion	-1.05	0.34	0.35 (0.18, 0.67)
Repair of incisional hernia	-1.24	0.38	0.29 (0.14, 0.61)
Repair procedures on liver	2.26	0.51	9.63 (3.57, 25.98)
Replacement of aortic arch and ascending thoracic aorta	2.73	0.36	15.28 (7.6, 30.72)
Replacement of aneurysm with graft	2.56	0.29	12.96 (7.29, 23.04)
Replacement of ascending thoracic aorta	2.16	0.39	8.68 (4.01, 18.81)
Resection of small intestine	0.67	0.35	1.96 (0.98, 3.89)
Revision arthroplasty of hip	1.54	0.25	4.67 (2.85, 7.66)
Simple mastectomy	-1.77	0.28	0.17 (0.1, 0.29)
Spinal fusion	0.42	0.26	1.51 (0.9, 2.55)
Subcutaneous mastectomy	-0.27	0.32	0.77 (0.41, 1.44)
Total proctocolectomy	1.49	0.36	4.45 (2.21, 8.96)
Transluminal balloon angioplasty	-2.23	0.28	0.11 (0.06, 0.18)
Transplantation of heart or lung	5.24	1.09	187.96 (22.14, 1595.53)
Transplantation of lung	4.62	0.47	101.84 (40.35, 257.05)
Transcatheter embolisation of blood vessels	-2.28	0.35	0.1 (0.05, 0.2)
Age			
Age	0.01	0.002	1.014 (1.01, 1.018)
Sex (Male)			
Sex (Male)	-0.20	0.05	0.82 (0.74, 0.9)
Charlson comorbidity score			
Charlson comorbidity score	0.11	0.01	1.12 (1.09, 1.14)

*Model effect estimates and standard errors from multiple imputation models pooled using Rubin's Rules.
CABS: coronary artery bypass graft surgery; SSCT: skin and subcutaneous tissue.

Table SIII - Multivariable model output to predict red cell transfusion in elective surgery from admission haemoglobin and haemoglobin decrease (Model 3)

Haemoglobin	Estimate	Std. Error	Odds Ratio (95% CI)
Admission haemoglobin	-0.18033	0.003461	0.83 (0.83, 0.84)
Haemoglobin decrease	0.175813	0.003238	1.19 (1.18, 1.20)

Table SIV - Model 2 (red cell transfusion = admission haemoglobin + surgical procedure) median accuracy, sensitivity, specificity, positive predictive value, and negative predictive value at various probability cut-off values for each of the 20 imputed datasets

Dataset 1 - resulting from multiple imputation methods for missing values					
Probability cut-off	Accuracy	Sensitivity	Specificity	Positive predictive value	Negative predictive value
0.1	0.829	0.700	0.838	0.247	0.974
0.2	0.903	0.492	0.934	0.360	0.960
0.3	0.926	0.336	0.971	0.466	0.951
0.4	0.933	0.235	0.986	0.560	0.945
0.5	0.934	0.154	0.993	0.634	0.939
0.6	0.934	0.104	0.997	0.697	0.936
0.7	0.932	0.059	0.998	0.744	0.933
0.8	0.931	0.029	1.000	0.860	0.932
0.9	0.930	0.006	1.000	0.857	0.930

Dataset 2 - resulting from multiple imputation methods for missing values					
Probability cut-off	Accuracy	Sensitivity	Specificity	Positive predictive value	Negative predictive value
0.1	0.833	0.709	0.842	0.253	0.974
0.2	0.904	0.501	0.934	0.365	0.961
0.3	0.925	0.343	0.969	0.454	0.951
0.4	0.934	0.250	0.985	0.562	0.946
0.5	0.935	0.171	0.993	0.640	0.941
0.6	0.935	0.112	0.997	0.724	0.937
0.7	0.933	0.064	0.999	0.777	0.934
0.8	0.932	0.034	1.000	0.849	0.932
0.9	0.930	0.009	1.000	0.848	0.930

Dataset 3 - resulting from multiple imputation methods for missing values					
Probability cut-off	Accuracy	Sensitivity	Specificity	Positive predictive value	Negative predictive value
0.1	0.833	0.707	0.843	0.254	0.974
0.2	0.905	0.510	0.935	0.371	0.962
0.3	0.926	0.352	0.970	0.469	0.952
0.4	0.934	0.256	0.985	0.565	0.946
0.5	0.936	0.178	0.993	0.655	0.941
0.6	0.935	0.118	0.996	0.717	0.937
0.7	0.933	0.068	0.999	0.790	0.934
0.8	0.932	0.035	1.000	0.852	0.932
0.9	0.930	0.009	1.000	0.848	0.930

Dataset 4 - resulting from multiple imputation methods for missing values					
Probability cut-off	Accuracy	Sensitivity	Specificity	Positive predictive value	Negative predictive value
0.1	0.833	0.702	0.843	0.252	0.974
0.2	0.903	0.497	0.934	0.363	0.961
0.3	0.926	0.339	0.970	0.460	0.951
0.4	0.934	0.245	0.986	0.563	0.945
0.5	0.935	0.163	0.993	0.647	0.940
0.6	0.934	0.109	0.997	0.730	0.937
0.7	0.933	0.061	0.999	0.769	0.934
0.8	0.932	0.034	1.000	0.871	0.932
0.9	0.930	0.008	1.000	0.885	0.930

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Table SIV - Model 2 (red cell transfusion = admission haemoglobin + surgical procedure) median accuracy, sensitivity, specificity, positive predictive value, and negative predictive value at various probability cut-off values for each of the 20 imputed datasets (continued from previous page)

Dataset 5 - resulting from multiple imputation methods for missing values					
Probability cut-off	Accuracy	Sensitivity	Specificity	Positive predictive value	Negative predictive value
0.1	0.833	0.701	0.843	0.252	0.974
0.2	0.904	0.502	0.935	0.368	0.961
0.3	0.926	0.347	0.969	0.461	0.952
0.4	0.933	0.250	0.985	0.559	0.945
0.5	0.935	0.171	0.993	0.642	0.941
0.6	0.934	0.110	0.997	0.711	0.937
0.7	0.933	0.065	0.999	0.786	0.934
0.8	0.932	0.033	1.000	0.853	0.932
0.9	0.930	0.008	1.000	0.926	0.930

Dataset 6 - resulting from multiple imputation methods for missing values					
Probability cut-off	Accuracy	Sensitivity	Specificity	Positive predictive value	Negative predictive value
0.1	0.833	0.707	0.842	0.253	0.974
0.2	0.903	0.498	0.934	0.362	0.961
0.3	0.926	0.345	0.970	0.462	0.951
0.4	0.933	0.249	0.985	0.560	0.945
0.5	0.935	0.165	0.993	0.637	0.940
0.6	0.934	0.109	0.997	0.718	0.937
0.7	0.933	0.065	0.999	0.789	0.934
0.8	0.931	0.031	1.000	0.855	0.932
0.9	0.930	0.009	1.000	0.929	0.930

Dataset 7 - resulting from multiple imputation methods for missing values					
Probability cut-off	Accuracy	Sensitivity	Specificity	Positive predictive value	Negative predictive value
0.1	0.828	0.700	0.837	0.246	0.974
0.2	0.903	0.491	0.934	0.359	0.960
0.3	0.926	0.340	0.970	0.465	0.951
0.4	0.932	0.231	0.985	0.545	0.944
0.5	0.934	0.154	0.993	0.633	0.939
0.6	0.934	0.097	0.997	0.709	0.936
0.7	0.932	0.053	0.999	0.751	0.933
0.8	0.931	0.028	1.000	0.875	0.931
0.9	0.930	0.007	1.000	0.955	0.930

Dataset 8 - resulting from multiple imputation methods for missing values					
Probability cut-off	Accuracy	Sensitivity	Specificity	Positive predictive value	Negative predictive value
0.1	0.832	0.704	0.842	0.252	0.974
0.2	0.904	0.504	0.934	0.367	0.961
0.3	0.927	0.351	0.970	0.470	0.952
0.4	0.934	0.252	0.986	0.569	0.946
0.5	0.935	0.171	0.993	0.654	0.941
0.6	0.935	0.117	0.997	0.721	0.937
0.7	0.933	0.067	0.999	0.775	0.934
0.8	0.932	0.033	1.000	0.861	0.932
0.9	0.930	0.010	1.000	0.906	0.930

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Table SIV - Model 2 (red cell transfusion = admission haemoglobin + surgical procedure) median accuracy, sensitivity, specificity, positive predictive value, and negative predictive value at various probability cut-off values for each of the 20 imputed datasets (continued from previous page)

Dataset 9 - resulting from multiple imputation methods for missing values					
Probability cut-off	Accuracy	Sensitivity	Specificity	Positive predictive value	Negative predictive value
0.1	0.835	0.704	0.844	0.255	0.974
0.2	0.905	0.506	0.936	0.373	0.962
0.3	0.926	0.356	0.969	0.465	0.952
0.4	0.934	0.260	0.985	0.568	0.946
0.5	0.936	0.181	0.993	0.660	0.941
0.6	0.935	0.123	0.997	0.740	0.938
0.7	0.933	0.073	0.998	0.781	0.934
0.8	0.932	0.041	1.000	0.891	0.932
0.9	0.930	0.010	1.000	0.879	0.930

Dataset 10 - resulting from multiple imputation methods for missing values					
Probability cut-off	Accuracy	Sensitivity	Specificity	Positive predictive value	Negative predictive value
0.1	0.835	0.708	0.845	0.256	0.975
0.2	0.905	0.507	0.935	0.371	0.962
0.3	0.927	0.359	0.970	0.473	0.952
0.4	0.934	0.262	0.985	0.574	0.946
0.5	0.936	0.185	0.993	0.665	0.942
0.6	0.935	0.123	0.997	0.729	0.938
0.7	0.933	0.071	0.999	0.795	0.934
0.8	0.932	0.037	1.000	0.881	0.932
0.9	0.930	0.009	1.000	0.844	0.930

Dataset 11 - resulting from multiple imputation methods for missing values					
Probability cut-off	Accuracy	Sensitivity	Specificity	Positive predictive value	Negative predictive value
0.1	0.832	0.704	0.842	0.252	0.974
0.2	0.905	0.513	0.934	0.371	0.962
0.3	0.926	0.353	0.970	0.469	0.952
0.4	0.935	0.261	0.986	0.579	0.946
0.5	0.936	0.179	0.993	0.663	0.941
0.6	0.935	0.121	0.997	0.731	0.937
0.7	0.933	0.071	0.999	0.801	0.934
0.8	0.932	0.035	1.000	0.874	0.932
0.9	0.930	0.011	1.000	0.889	0.930

Dataset 12 - resulting from multiple imputation methods for missing values					
Probability cut-off	Accuracy	Sensitivity	Specificity	Positive predictive value	Negative predictive value
0.1	0.833	0.702	0.843	0.253	0.974
0.2	0.904	0.506	0.934	0.366	0.961
0.3	0.927	0.354	0.970	0.475	0.952
0.4	0.935	0.261	0.986	0.577	0.946
0.5	0.935	0.171	0.993	0.644	0.941
0.6	0.934	0.113	0.997	0.719	0.937
0.7	0.933	0.066	0.998	0.756	0.934
0.8	0.932	0.032	1.000	0.843	0.932
0.9	0.930	0.008	1.000	0.926	0.930

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Table SIV - Model 2 (red cell transfusion = admission haemoglobin + surgical procedure) median accuracy, sensitivity, specificity, positive predictive value, and negative predictive value at various probability cut-off values for each of the 20 imputed datasets (continued from previous page)

Dataset 13 - resulting from multiple imputation methods for missing values					
Probability cut-off	Accuracy	Sensitivity	Specificity	Positive predictive value	Negative predictive value
0.1	0.832	0.707	0.841	0.252	0.974
0.2	0.904	0.504	0.934	0.366	0.961
0.3	0.926	0.349	0.970	0.468	0.952
0.4	0.934	0.252	0.986	0.573	0.946
0.5	0.935	0.172	0.993	0.649	0.941
0.6	0.934	0.114	0.997	0.714	0.937
0.7	0.933	0.066	0.998	0.762	0.934
0.8	0.932	0.037	1.000	0.887	0.932
0.9	0.930	0.009	1.000	0.875	0.930

Dataset 14 - resulting from multiple imputation methods for missing values					
Probability cut-off	Accuracy	Sensitivity	Specificity	Positive predictive value	Negative predictive value
0.1	0.832	0.702	0.842	0.252	0.974
0.2	0.905	0.509	0.935	0.371	0.962
0.3	0.927	0.357	0.970	0.476	0.952
0.4	0.935	0.257	0.986	0.582	0.946
0.5	0.936	0.176	0.993	0.662	0.941
0.6	0.935	0.118	0.997	0.735	0.937
0.7	0.934	0.075	0.999	0.808	0.934
0.8	0.932	0.039	1.000	0.879	0.932
0.9	0.930	0.012	1.000	0.897	0.930

Dataset 15 - resulting from multiple imputation methods for missing values					
Probability cut-off	Accuracy	Sensitivity	Specificity	Positive predictive value	Negative predictive value
0.1	0.833	0.706	0.842	0.253	0.974
0.2	0.905	0.511	0.935	0.371	0.962
0.3	0.926	0.353	0.969	0.467	0.952
0.4	0.935	0.267	0.985	0.580	0.947
0.5	0.936	0.185	0.993	0.663	0.942
0.6	0.935	0.123	0.996	0.724	0.938
0.7	0.933	0.072	0.998	0.766	0.934
0.8	0.932	0.036	1.000	0.877	0.932
0.9	0.930	0.010	1.000	0.912	0.930

Dataset 16 - resulting from multiple imputation methods for missing values					
Probability cut-off	Accuracy	Sensitivity	Specificity	Positive predictive value	Negative predictive value
0.1	0.835	0.706	0.844	0.255	0.974
0.2	0.905	0.512	0.934	0.371	0.962
0.3	0.927	0.364	0.970	0.476	0.953
0.4	0.935	0.270	0.985	0.581	0.947
0.5	0.936	0.180	0.993	0.657	0.941
0.6	0.935	0.120	0.997	0.726	0.937
0.7	0.934	0.074	0.999	0.804	0.934
0.8	0.932	0.037	1.000	0.918	0.932
0.9	0.930	0.012	1.000	0.946	0.930

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Table SIV - Model 2 (red cell transfusion = admission haemoglobin + surgical procedure) median accuracy, sensitivity, specificity, positive predictive value, and negative predictive value at various probability cut-off values for each of the 20 imputed datasets (continued from previous page)

Dataset 17 - resulting from multiple imputation methods for missing values					
Probability cut-off	Accuracy	Sensitivity	Specificity	Positive predictive value	Negative predictive value
0.1	0.835	0.709	0.845	0.257	0.975
0.2	0.906	0.513	0.936	0.377	0.962
0.3	0.927	0.357	0.970	0.473	0.952
0.4	0.935	0.267	0.986	0.586	0.947
0.5	0.936	0.184	0.993	0.669	0.941
0.6	0.935	0.127	0.997	0.741	0.938
0.7	0.934	0.080	0.998	0.784	0.935
0.8	0.932	0.040	0.999	0.839	0.932
0.9	0.930	0.012	1.000	0.878	0.930

Dataset 18 - resulting from multiple imputation methods for missing values					
Probability cut-off	Accuracy	Sensitivity	Specificity	Positive predictive value	Negative predictive value
0.1	0.833	0.706	0.843	0.254	0.974
0.2	0.904	0.507	0.934	0.368	0.962
0.3	0.927	0.353	0.970	0.471	0.952
0.4	0.934	0.256	0.986	0.573	0.946
0.5	0.936	0.178	0.993	0.658	0.941
0.6	0.935	0.125	0.997	0.743	0.938
0.7	0.934	0.075	0.999	0.792	0.935
0.8	0.932	0.038	0.999	0.827	0.932
0.9	0.930	0.013	1.000	0.884	0.930

Dataset 19 - resulting from multiple imputation methods for missing values					
Probability cut-off	Accuracy	Sensitivity	Specificity	Positive predictive value	Negative predictive value
0.1	0.835	0.709	0.845	0.257	0.975
0.2	0.905	0.511	0.935	0.373	0.962
0.3	0.927	0.364	0.970	0.477	0.953
0.4	0.935	0.269	0.985	0.581	0.947
0.5	0.936	0.186	0.993	0.667	0.942
0.6	0.935	0.124	0.997	0.733	0.938
0.7	0.934	0.077	0.998	0.793	0.935
0.8	0.932	0.040	1.000	0.864	0.932
0.9	0.930	0.012	1.000	0.881	0.930

Dataset 20 - resulting from multiple imputation methods for missing values					
Probability cut-off	Accuracy	Sensitivity	Specificity	Positive predictive value	Negative predictive value
0.1	0.835	0.710	0.845	0.257	0.975
0.2	0.904	0.509	0.934	0.369	0.962
0.3	0.926	0.362	0.969	0.469	0.953
0.4	0.935	0.262	0.986	0.586	0.946
0.5	0.936	0.187	0.993	0.671	0.942
0.6	0.935	0.127	0.996	0.727	0.938
0.7	0.934	0.077	0.999	0.802	0.935
0.8	0.932	0.040	1.000	0.869	0.932
0.9	0.930	0.011	1.000	0.865	0.930