

Appendix

The Ps14ⁿ model is a modification of the Ps14 model as described by Bouamra in 2015 with the addition of pupil reactivity. It has been derived from 39451 patients recorded in the TARN database with head injuries of AIS 3 or greater severity admitted to hospital between 2012 and 2015. Table 1 describes the characteristics of these patients and table 2 contains the regression coefficients of which the prediction model is formed.

The model is shown to have good discriminant power (AuROC 0.882, 95% CI 0.878 to 0.887). The calibration of the model was assessed using the Brier score, this shows how close predictions are to the actual outcome. Its value varies between 0 (perfect) and 0.25 (useless), the model shows a value of 0.086. The value for the HL-statistic (Hosper & Lemeshow $\chi^2(8)$) is 19.51, P-value 0.0124 (as the p-value is <0.05 the model failed the goodness-of-fit test but this is expected with the HL-test as it is too sensitive to large sample sizes). Figure 1 shows a graphical assessment of calibration using 200 bootstrap simulations and shows an almost perfect calibration: the observed and expected are aligned to the 45° line.

Table 1. Characteristics of the patients

n	39451
Age	
Median (IQR)	62.6 (35.8 - 81.4)
ISS	
Median (IQR)	24 (16 - 26)
GCS	
Median (IQR)	14 (11 - 15)
Gender	
Female	13927 (35.3%)
Male	25524 (64.7%)
Comorbidity	
No comorbidity	19776 (50.1%)
1 - 5	10617 (26.9%)
6 - 10	3417 (8.7%)
> 10	1585 (4.0%)
Not recorded	4056 (10.3%)
Mortality	16.0%

Table 2. Coefficients of the model

Variables	Regression Coefficients	p-value	Odds ratio 95% CI	
$(10/ISS)^2 - 0.1920$	3.3294	<0.0001	22.9	33.8
$(10/ISS)^2 * \log_e(10/ISS) - 0.1584$	8.2092	<0.0001	1719.9	7785.4
GCS				
GCS =3	-3.0652	<0.0001	0.04	0.05
GCS 4 -5	-2.6485	<0.0001	0.06	0.08
GCS 6 -8	-1.8352	<0.0001	0.14	0.18
GCS 9 -12	-1.3348	<0.0001	0.23	0.30
GCS 13 - 14	-0.4704	<0.0001	0.57	0.69
GCS 15 (reference)	0.0000		1	1
Intubated	-2.5212	<0.0001	0.06	0.11
Charlson Index				
0 (reference)	0.0000		1	1
1 - 5	-0.4593	<0.0001	0.58	0.69
6 - 10	-0.7754	<0.0001	0.41	0.52
>10	-1.1841	<0.0001	0.26	0.36
Not recorded	-0.6575	<0.0001	0.46	0.58
Age				
0 - 5	-0.0236	0.92	0.63	1.51
6 - 10	0.5668	0.07	0.95	3.25
11 - 15	0.0356	0.87	0.67	1.60
16 - 44 (reference)	0.0000		1	1
45 - 54	-0.5065	<0.0001	0.51	0.72
55 - 64	-1.0091	<0.0001	0.31	0.44
65 - 75	-1.6125	<0.0001	0.17	0.23
>75	-2.7684	<0.0001	0.05	0.07
Gender				
Male (reference)	0.0000		1	1
Female	-0.0216	0.84	0.79	1.21
Age by gender interaction				
0 - 5 & Female	-0.1968	0.55	0.43	1.58
6 - 10 & Female	-0.3357	0.55	0.24	2.14
11 - 15 & Female	0.8354	0.11	0.83	6.49
45 - 54 & Female	-0.2911	0.11	0.52	1.07
55 - 64 & Female	0.2989	0.09	0.95	1.92
65 - 75 & Female	-0.0281	0.85	0.73	1.30
>75 & Female	0.1084	0.36	0.89	1.40
Pupil reactivity				
Both reactive (reference)	0.0000		1	1
Abnormal (both reactive)	-0.4383	<0.0001	0.57	0.73
Abnormal (1 reactive)	-0.5325	<0.0001	0.50	0.69
Neither reactive	-2.0874	<0.0001	0.11	0.14
Constant	4.9208	<0.0001	119.10	157.59

Figure 1: Model Calibration

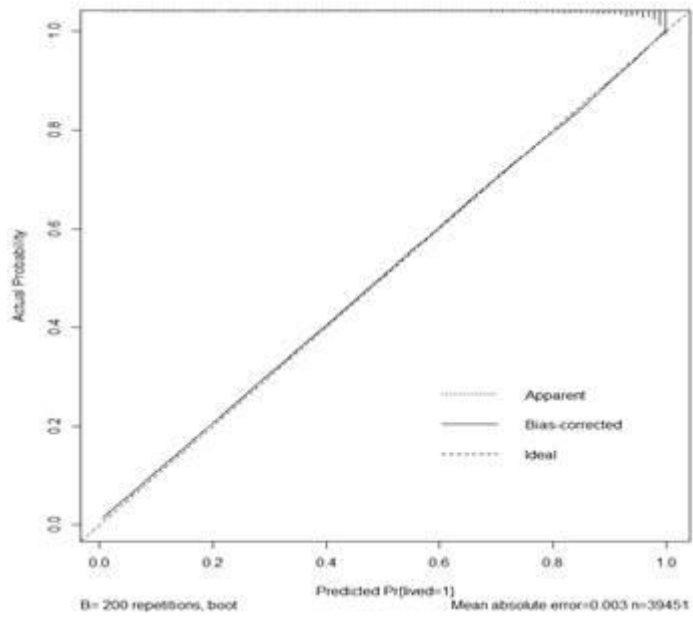


Table 3: Hours to arrival at neurosurgical centre stratified by age

Hours to arrival at neurocentre	Age									
	0 - 10	10 - 20	20 - 30	30 - 40	40 - 50	50 - 60	60 - 70	70 - 80	80 - 90	90+
0 - 4	50 (31.8%)	434 (60.5%)	748 (60.1%)	543 (55.9%)	550 (49.5%)	603 (50.2%)	591 (49.5%)	604 (44.7%)	799 (51.4%)	293 (58.8%)
4 - 12	6 (3.8%)	8 (1.1%)	25 (2%)	6 (0.6%)	28 (2.5%)	31 (2.6%)	27 (2.3%)	19 (1.4%)	39 (2.5%)	8 (1.6%)
12 - 24	31 (19.7%)	112 (15.6%)	162 (13%)	132 (13.6%)	159 (14.3%)	190 (15.8%)	165 (13.8%)	155 (11.5%)	125 (8%)	47 (9.4%)
24 - 48	11 (7%)	19 (2.6%)	35 (2.8%)	35 (3.6%)	41 (3.7%)	56 (4.7%)	46 (3.8%)	51 (3.8%)	43 (2.8%)	9 (1.8%)
48 - 72	1 (0.6%)	7 (1%)	8 (0.6%)	8 (0.8%)	10 (0.9%)	11 (0.9%)	9 (0.8%)	9 (0.7%)	14 (0.9%)	2 (0.4%)
72+	6 (3.8%)	6 (0.8%)	13 (1%)	10 (1%)	28 (2.5%)	28 (2.3%)	34 (2.8%)	53 (3.9%)	94 (6.1%)	27 (5.4%)
Unknown	52 (33.1%)	131 (18.3%)	254 (20.4%)	237 (24.4%)	294 (26.5%)	283 (23.5%)	323 (27%)	459 (34%)	439 (28.3%)	112 (22.5%)

Table 4: Rate of complications by age and transfer status

Age	n	Complications	% with complications
0-10	211	35	16.6%
10-20	863	100	11.6%
20-30	1523	184	12.1%
30-40	1206	189	15.7%
40-50	1443	197	13.7%
50-60	1620	271	16.7%
60-70	1760	277	15.7%
70-80	2380	395	16.6%
80-90	3508	613	17.5%
90+	1305	221	16.9%
Total	15819	2482	15.7%

Age	n	Complications	% with complications
No transfer	10893	1611	14.8%
Transfer	4926	871	17.7%
Total	15819	2482	15.7%

Table 5: Mortality stratified by GCS and Head AIS

TBI severity	n	Mortality			Predicted mortality %
		n	%	95% CI	
Mild TBI	9285	730	7.9%	7.3% - 8.4%	8.6%
Moderate TBI	790	178	22.5%	19.6% - 25.4%	23.6%
Severe TBI	3228	1304	40.4%	38.7% - 42.1%	36.1%*
GCS not recorded	629	98	15.6%	12.7% - 18.4%	12.4%
Total	13932	2310	16.6%	16% - 17.2%	16.0%

AIS TBI severity	n	Mortality			Predicted mortality %
		n	%	95% CI	
3	2480	155	6.3%	5.3% - 7.2%	5.9%
4	5828	475	8.2%	7.4% - 8.9%	9.6%
5	5614	1671	29.8%	28.6% - 31%	26.9%
6	10	9	90.0%	71.4% - 100%	68.0%
Total	13932	2310	16.6%	16% - 17.2%	16.0%

Outcome	n	Outcome at discharge	Outcome at 30 days
Alive	11622	9642	1980
Dead	2310	2310	0
Total	13932	11952	1980

*Although in this cohort of severe TBI patients predicted mortality differs from actual mortality, the model is not specifically calibrated by the severity subsets. Overall, mortality across all patients ('total' row) matches the predicted mortality from the PS14ⁿ model.

Table 6: Complication rate stratified by location of transfer

Transfer status	n	Complications	% with complications
No transfer	10893	1611	14.8%
Transfer	4926	871	17.7%
Total	15819	2482	15.7%