

Supplementary material to accompany article: Griffiths P, Saville C, Ball J, Culliford D, Pattison N and Monks T. Performance of the Safer Nursing Care Tool to measure nurse staffing requirements in acute hospitals: a multi-centre observational study. *BMJ Open* 2020. <https://doi.org/bmjopen-2019-035828>

Supplementary tables

Table 1 Association between staffing shortfall and nurse perceptions of staffing adequacy: test for non-linear staffing effects in multivariable models.

Variable	Enough staff for quality			Nursing care left undone			Staff breaks missed		
	Adjusted OR	95% confidence interval	p-value	Adjusted OR	95% confidence interval	p-value	Adjusted OR	95% confidence interval	p-value
Registered nurse shortfall (HPPD)	0.89	[0.86, 0.92]	<0.001	1.15	[1.09, 1.21]	<0.001	1.13	[1.08, 1.19]	<0.001
Nursing support worker shortfall (HPPD)	0.85	[0.83, 0.88]	<0.001	1.15	[1.08, 1.22]	<0.001	1.12	[1.06, 1.19]	<0.001
Registered nurse shortfall squared	1.00	[0.99, 1.00]	0.469	1.01	[1.00, 1.02]	0.021	1.00	[0.99, 1.02]	0.533
Nursing support worker shortfall squared	1.01	[1.00, 1.02]	0.102	0.99	[0.97, 1.01]	0.194	0.99	[0.97, 1.01]	0.165
Day of week- Monday (reference)									
Tuesday							0.71	[0.58, 0.88]	0.002
Wednesday							0.61	[0.49, 0.75]	<0.001
Thursday							0.82	[0.66, 1.00]	0.053
Friday							0.80	[0.65, 0.99]	0.042
Saturday							0.49	[0.39, 0.62]	<0.001
Sunday							0.80	[0.65, 0.98]	0.031
Ward type- other (reference)									
Surgical	0.57	[0.33, 0.96]	0.036	1.98	[1.10, 3.54]	0.022	2.07	[1.18, 3.63]	0.011
Proportion single rooms									
Variance partition coefficient for units	0.22			0.21			0.23		
Variance partition coefficient for hospitals	0.15			0.20			0.13		
Akaike information criterion	20715			8378			8097		
Bayesian information criterion	20779			8442			8209		

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Table 2 Association between staffing shortfall and nurse perceptions of staffing adequacy: test for interactions between significant variables in multivariable models

Variable	Enough staff for quality			Nursing care left undone			Staff breaks Missed		
	Adjusted OR	95% confidence interval	p-value	Adjusted OR	95% confidence interval	p-value	Adjusted OR	95% confidence interval	p-value
Registered nurse shortfall (HPPD)	0.92	[0.89, 0.95]	<0.001	1.14	[1.07, 1.21]	<0.001	1.13	[1.02, 1.25]	0.019
Nursing support worker shortfall (HPPD)	0.87	[0.84, 0.90]	<0.001	1.14	[1.06, 1.22]	<0.001	1.13	[1.00, 1.28]	0.049
Registered nurse shortfall squared (HPPD)				1.01	[1.00, 1.02]	0.044			
Day of week- Monday (reference)									
Tuesday							0.71	[0.57, 0.90]	0.005
Wednesday							0.60	[0.47, 0.76]	<0.001
Thursday							0.84	[0.67, 1.05]	0.135
Friday							0.87	[0.69, 1.09]	0.225
Saturday							0.50	[0.38, 0.65]	<0.001
Sunday							0.81	[0.64, 1.01]	0.064
Unit type- Other (reference)									
Surgical	0.63	[0.37, 1.08]	0.096	2.03	[1.11, 3.69]	0.021	2.04	[1.15, 3.63]	0.015
Proportion single rooms									
Turnover (per nursing hour)									
Registered nurse shortfall : Nursing support worker shortfall	0.99	[0.98, 1.01]	0.315	1.00	[0.98, 1.02]	0.972	1.01	[0.99, 1.03]	0.202
Registered nurse shortfall : Tuesday							0.98	[0.86, 1.11]	0.708
Registered nurse shortfall : Wednesday							0.99	[0.86, 1.13]	0.840
Registered nurse shortfall : Thursday							0.96	[0.84, 1.09]	0.540
Registered nurse shortfall : Friday							0.94	[0.82, 1.07]	0.332
Registered nurse shortfall : Saturday							1.05	[0.89, 1.24]	0.558
Registered nurse shortfall : Sunday							1.04	[0.91, 1.20]	0.566
Registered nurse shortfall : Surgical unit	0.88	[0.82, 0.95]	0.001	1.00	[0.89, 1.13]	0.952	1.00	[0.89, 1.12]	0.961

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Registered nurse shortfall: Proportion single rooms									
Nursing support worker shortfall: Tuesday							1.01	[0.85, 1.20]	0.905
Nursing support worker shortfall: Wed							1.04	[0.87, 1.24]	0.694
Nursing support worker shortfall: Thursday							0.95	[0.81, 1.11]	0.536
Nursing support worker shortfall: Friday							0.87	[0.74, 1.02]	0.097
Nursing support worker shortfall: Saturday							0.92	[0.76, 1.11]	0.390
Nursing support worker shortfall: Sunday							0.95	[0.80, 1.12]	0.522
Nursing support worker shortfall: Surgical unit	0.95	[0.88, 1.04]	0.263	0.98	[0.86, 1.11]	0.766	1.07	[0.94, 1.21]	0.325
Nursing support worker shortfall: Proportion single rooms									
Variance partition coefficient for units	0.22			0.21			0.23		
Variance partition coefficient for hospitals	0.14			0.20			0.13		
Akaike information criterion	20708			8384			8116		
Bayesian information criterion	20780			8464			8341		

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Table 3: Association between overall (registered nurse and assistant) shortfall and nurse perceptions of staffing adequacy

Variable	Enough staff for quality			Nursing care left undone			Staff breaks missed		
	Adjusted OR	95% confidence interval	p-value	Adjusted OR	95% confidence interval	p-value	Adjusted OR	95% confidence interval	p-value
Overall shortfall (HPPD)	0.88	[0.86, 0.90]	<0.001	1.14	[1.09, 1.19]	<0.001	1.11	[1.07, 1.16]	<0.001
Skill mix (registered nurse HPPD/ total HPPD)	0.81	[0.62, 1.06]	0.117	0.74	[0.47, 1.17]	0.195	0.88	[0.57, 1.38]	0.586
Patient turnover (per care hour)	0.91	[0.30, 2.77]	0.869	3.51	[0.63, 19.65]	0.153	4.99	[0.96, 26.02]	0.057
Unit type- other (reference)									
Surgical	0.54	[0.31, 0.93]	0.025	2.14	[1.20, 3.83]	0.010	2.16	[1.23, 3.80]	0.007
Proportion single rooms	0.53	[0.17, 1.64]	0.271	3.01	[0.93, 9.69]	0.065	2.06	[0.65, 6.57]	0.222
Day of week- Monday (reference)									
Tuesday	1.12	[0.99, 1.26]	0.078	0.86	[0.69, 1.06]	0.159	0.71	[0.58, 0.88]	0.001
Wednesday	1.28	[1.13, 1.45]	<0.001	0.96	[0.77, 1.18]	0.676	0.61	[0.49, 0.76]	<0.001
Thursday	1.09	[0.96, 1.23]	0.195	0.91	[0.73, 1.13]	0.379	0.81	[0.66, 1.00]	0.045
Friday	1.03	[0.91, 1.17]	0.604	0.92	[0.74, 1.15]	0.481	0.79	[0.64, 0.97]	0.028
Saturday	1.30	[1.14, 1.48]	<0.001	0.75	[0.60, 0.95]	0.016	0.50	[0.40, 0.64]	<0.001
Sunday	1.02	[0.90, 1.15]	0.795	1.11	[0.90, 1.37]	0.316	0.82	[0.66, 1.01]	0.058
Variance partition coefficient for units	0.22			0.22			0.23		
Variance partition coefficient for hospitals	0.12			0.17			0.11		
Akaike information criterion	20700			8376			8094		
Bayesian information criterion	20812			8488			8206		

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Table 4: Association between staffing shortfall and nurse perceptions of “enough staff for quality”: comparison of coefficients from models with full sample versus model excluding the hospital Trust where recoding occurred

Variable	Model with full sample			Model excluding 'hospital D'		
	Adjusted OR	95% confidence interval	P-value	Adjusted OR	95% confidence interval	P-value
Registered nurse shortfall (HPPD)	0.89	[0.87, 0.92]	<0.001	0.89	[0.86, 0.91]	<0.001
Nursing support worker shortfall (HPPD)	0.86	[0.83, 0.89]	<0.001	0.84	[0.81, 0.87]	<0.001
Turnover (per care hour)	0.91	[0.30, 2.75]	0.863	0.83	[0.26, 2.63]	0.747
Ward type – other (reference)						
Surgical	0.54	[0.31, 0.92]	0.023	0.45	[0.27, 0.76]	0.003
Proportion single rooms	0.54	[0.18, 1.66]	0.283	0.61	[0.24, 1.57]	0.304
Day of week- Monday (reference)						
Tuesday	1.12	[0.99, 1.26]	0.079	1.20	[1.05, 1.37]	0.008
Wednesday	1.28	[1.13, 1.45]	<0.001	1.31	[1.15, 1.50]	<0.001
Thursday	1.08	[0.96, 1.23]	0.2000	1.13	[0.99, 1.29]	0.071
Friday	1.03	[0.91, 1.17]	0.610	1.08	[0.94, 1.24]	0.278
Saturday	1.29	[1.14, 1.47]	<0.001	1.40	[1.21, 1.61]	<0.001
Sunday	1.02	[0.90, 1.15]	0.811	1.03	[0.90, 1.17]	0.697