Safe nurse staffing for A&E departments

Appendices

National Institute for Health and Care Excellence

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Contents

1.0 Appendix A – Results tables

This section contains the tables of results used to create the charts shown in the results of the main report. Approximate baseline positions are indicated by bolded and asterisked values in the tables. The inter quartile range (IQR) of outputs measured as averages are presented here as well. Patients who LWBS and deaths are measured at the end of the simulation so there are no IQRs associated with these outputs.

The results presented in each table are coloured according to percentiles. Numbers at or above the 75th percentile are green, numbers at or below the 25th percentile are red. The direction of travel is incorporated so that better results are always shown in green. These are not intended to show the ideal or target numbers, but to help highlight trends in the tables.

Staff numbers and staff skill mix

Table 1 – Average duration in A&E (hours), by staff numbers and staff skill mix.

Staff numbers (day/night)	Staff skill mix 0.5	0.7	0.9	1.1	1.3	1.5
8 / 6	4.59	2.95	2.70	2.38	2.38	2.33
9 / 7	3.59	2.85	2.58	2.44	2.38	2.31
10 / 8	3.44	2.66	**2.58***	**2.31***	2.33	2.24
11 / 9	3.05	2.62	2.48	2.32	2.32	2.23
12 / 10	2.95	2.62	2.45	2.29	2.28	2.22
13 / 11	2.88	2.58	2.43	2.28	2.27	2.22

Table 2 – Average duration in A&E IQR (hours), by staff numbers and staff skill mix.

Staff numbers (day/night)	Staff skill mix 0.5	0.7	0.9	1.1	1.3	1.5
8 / 6	4.5 - 4.7	2.9 - 2.9	2.6 - 2.7	2.3 - 2.4	2.4 - 2.4	2.3 - 2.3
9 / 7	3.5 - 3.6	2.8 - 2.8	2.5 - 2.6	2.4 - 2.4	2.4 - 2.4	2.3 - 2.3
10 / 8	3.4 - 3.5	2.6 - 2.7	**2.5 - 2.6***	**2.3 - 2.3***	2.3 - 2.3	2.2 - 2.3
11 / 9	3.0 - 3.1	2.6 - 2.6	2.4 - 2.5	2.3 - 2.3	2.3 - 2.3	2.2 - 2.3
12 / 10	2.9 - 3.0	2.6 - 2.6	2.4 - 2.5	2.3 - 2.3	2.3 - 2.3	2.2 - 2.3
13 / 11	2.8 - 2.9	2.5 - 2.6	2.4 - 2.4	2.3 - 2.3	2.2 - 2.3	2.2 - 2.3

Table 3 – Average time to assessment (hours), by staff numbers and staff skill mix.

Staff numbers (day/night)	Staff skill mix 0.5	0.7	0.9	1.1	1.3	1.5
8 / 6	0.229	0.026	0.020	0.020	0.020	0.020
9 / 7	0.076	0.020	0.020	0.020	0.020	0.020
10 / 8	0.047	0.020	**0.020***	**0.020***	0.020	0.020
11 / 9	0.032	0.020	0.020	0.020	0.020	0.020
12 / 10	0.031	0.020	0.020	0.020	0.020	0.020
13 / 11	0.021	0.020	0.020	0.020	0.020	0.020

Table 4 – Average time to assessment IQR (hours), by staff numbers and staff skill mix.

Staff numbers (day/night)	Staff skill mix 0.5	0.7	0.9	1.1	1.3	1.5
8 / 6	0.20 - 0.28	0.02 - 0.03	0.02 - 0.02	0.02 - 0.02	0.02 - 0.02	0.02 - 0.02
9 / 7	0.07 - 0.09	0.02 - 0.02	0.02 - 0.02	0.02 - 0.02	0.02 - 0.02	0.02 - 0.02
10 / 8	0.04 - 0.05	0.02 - 0.02	**0.02 - 0.02***	**0.02 - 0.02***	0.02 - 0.02	0.02 - 0.02
11 / 9	0.03 - 0.03	0.02 - 0.02	0.02 - 0.02	0.02 - 0.02	0.02 - 0.02	0.02 - 0.02

12 / 10	0.03 - 0.03	0.02 - 0.02	0.02 - 0.02	0.02 - 0.02	0.02 - 0.02	0.02 - 0.02
13 / 11	0.02 - 0.02	0.02 - 0.02	0.02 - 0.02	0.02 - 0.02	0.02 - 0.02	0.02 - 0.02

Table 5 – Average time to treatment (hours), by staff numbers and staff skill mix.

Staff numbers (day/night)	Staff skill mix 0.5	0.7	0.9	1.1	1.3	1.5
8 / 6	0.47	0.26	0.20	0.17	0.14	0.12
9 / 7	0.39	0.26	0.20	0.17	0.14	0.13
10 / 8	0.36	0.25	**0.20***	**0.17***	0.14	0.12
11 / 9	0.35	0.25	0.20	0.17	0.14	0.12
12 / 10	0.35	0.25	0.20	0.17	0.14	0.13
13 / 11	0.35	0.25	0.20	0.17	0.14	0.13

Table 6 – Average time to treatment IQR (hours), by staff numbers and staff skill mix.

Staff numbers (day/night)	Staff skill mix 0.5	0.7	0.9	1.1	1.3	1.5
8 / 6	0.44 - 0.50	0.26 - 0.26	0.20 - 0.20	0.17 - 0.17	0.14 - 0.14	0.12 - 0.13
9 / 7	0.39 - 0.40	0.25 - 0.26	0.20 - 0.20	0.17 - 0.17	0.14 - 0.14	0.13 - 0.13
10 / 8	0.35 - 0.36	0.25 - 0.25	**0.20 - 0.20***	**0.16 - 0.17***	0.14 - 0.14	0.12 - 0.13
11 / 9	0.35 - 0.35	0.25 - 0.25	0.20 - 0.20	0.17 - 0.17	0.14 - 0.14	0.12 - 0.13
12 / 10	0.35 - 0.35	0.25 - 0.25	0.20 - 0.20	0.17 - 0.17	0.14 - 0.14	0.12 - 0.13
13 / 11	0.35 - 0.35	0.25 - 0.25	0.20 - 0.20	0.17 - 0.17	0.14 - 0.14	0.12 - 0.13

Table 7 – Average number of patients per staff, by staff number and skill mix.

Staff numbers (day/night)	Staff skill mix 0.5	0.7	0.9	1.1	1.3	1.5
8 / 6	2.49	1.47	1.24	1.12	1.11	1.08
9 / 7	1.77	1.25	1.07	0.98	0.96	0.92
10 / 8	1.44	1.03	**0.93***	**0.82***	0.83	0.80
11 / 9	1.14	0.91	0.81	0.75	0.73	0.72
12 / 10	0.99	0.82	0.73	0.66	0.64	0.64
13 / 11	0.87	0.72	0.65	0.59	0.60	0.59

Table 8 – Average number of patients per staff IQR, by staff number and skill mix.

Staff numbers (day/night)	Staff skill mix 0.5	0.7	0.9	1.1	1.3	1.5
8 / 6	1.8 - 3.1	0.8 - 2.1	0.7 - 1.7	0.7 - 1.6	0.6 - 1.5	0.6 - 1.5
9 / 7	1.3 - 2.3	0.7 - 1.7	0.6 - 1.4	0.6 - 1.3	0.6 - 1.3	0.5 - 1.2
10 / 8	0.9 - 2.1	0.5 - 1.4	**0.5 - 1.3***	**0.4 - 1.1***	0.5 - 1.1	0.4 - 1.1
11 / 9	0.7 - 1.6	0.5 - 1.3	0.4 - 1.1	0.4 - 1.0	0.4 - 1.0	0.4 - 1.0
12 / 10	0.6 - 1.3	0.5 - 1.2	0.4 - 1.0	0.3 - 0.9	0.3 - 0.9	0.3 - 0.9
13 / 11	0.5 - 1.2	0.4 - 1.0	0.4 - 0.9	0.3 - 0.8	0.4 - 0.8	0.3 - 0.8

Table 9 – Average occupancy, by staff number and skill mix.

Staff numbers (day/night)	Staff skill mix 0.5	0.7	0.9	1.1	1.3	1.5
8 / 6	72%	43%	37%	33%	33%	32%
9 / 7	60%	42%	36%	34%	33%	31%
10 / 8	55%	40%	**35%***	**31%***	32%	30%
11 / 9	48%	39%	34%	32%	31%	31%
12 / 10	46%	38%	34%	31%	30%	30%
13 / 11	44%	36%	33%	30%	31%	30%

Table 10 – Average occupancy IQR, by staff number and skill mix.

Staff numbers (day/night)	Staff skill mix					
	0.5	0.7	0.9	1.1	1.3	1.5
8 / 6	50 - 96	24 - 62	17 - 50	17 - 46	17 - 46	17 - 46
9 / 7	38 - 79	21 - 62	21 - 49	17 - 46	19 - 46	17 - 46
10 / 8	33 - 79	21 - 58	**17 – 50***	**16 – 46***	17 - 44	17 - 42
11 / 9	28 - 71	21 - 58	17 - 46	17 - 44	17 - 42	17 - 45
12 / 10	25 - 63	21 - 54	17 - 47	17 - 42	16 - 42	17 - 42
13 / 11	25 - 59	20 - 53	17 - 46	15 - 43	17 - 42	16 - 42

Table 11 – Proportion of patients that die in the department, by staff number and skill mix.

Staff numbers (day/night)	Staff skill mix					
	0.5	0.7	0.9	1.1	1.3	1.5
8 / 6	0.69%	0.47%	0.42%	0.69%	0.54%	0.80%
9 / 7	0.47%	0.79%	0.67%	0.45%	0.76%	0.84%
10 / 8	0.58%	0.77%	**0.78%***	**0.91%***	0.74%	0.90%
11 / 9	0.76%	0.94%	0.94%	0.81%	0.84%	0.77%
12 / 10	0.68%	0.63%	0.80%	0.77%	0.59%	0.76%
13 / 11	0.58%	0.67%	1.02%	0.80%	0.64%	0.66%

Table 12 – Proportion of patients leave without being seen, by staff number and skill mix.

Staff numbers (day/night)	Staff skill mix					
	0.5	0.7	0.9	1.1	1.3	1.5
8 / 6	6.36%	1.49%	0.96%	0.96%	1.07%	0.84%
9 / 7	3.00%	1.25%	0.96%	0.96%	1.18%	0.84%
10 / 8	2.36%	1.01%	**0.98%***	**0.98%***	1.07%	0.84%
11 / 9	1.86%	1.01%	0.96%	0.96%	0.96%	0.84%
12 / 10	1.52%	1.01%	0.96%	0.96%	0.96%	0.84%
13 / 11	1.57%	1.01%	0.96%	1.01%	0.96%	0.84%

Attendance volume and staff skill mix

Table 13 – Average duration in A&E (hours), by attendance volume and staff skill mix.

Daily attendances	Staff skill mix					
	0.5	0.7	0.9	1.1	1.3	1.5
100	2.90	2.65	2.43	2.44	2.46	2.36
120	3.22	2.73	2.51	2.40	2.39	2.39
140	3.45	2.72	**2.48***	**2.35***	2.31	2.28
160	3.93	2.78	2.47	2.41	2.35	2.28
180	4.60	2.89	2.58	2.62	2.39	2.29
200	4.91	3.44	2.70	2.60	2.45	2.38

Table 14 – Average duration in A&E IQR (hours), by attendance volume and staff skill mix.

Daily attendances	Staff skill mix					
	0.5	0.7	0.9	1.1	1.3	1.5
100	2.8 - 3.0	2.6 - 2.7	2.4 - 2.5	2.4 - 2.5	2.4 - 2.5	2.3 - 2.4
120	3.1 - 3.3	2.7 - 2.8	2.5 - 2.5	2.4 - 2.4	2.4 - 2.4	2.3 - 2.5
140	3.4 - 3.5	2.7 - 2.8	**2.4 - 2.5***	**2.3 - 2.4***	2.3 - 2.3	2.2 - 2.3
160	3.8 - 4.1	2.7 - 2.8	2.4 - 2.5	2.4 - 2.4	2.3 - 2.4	2.3 - 2.3
180	4.4 - 4.8	2.9 - 2.9	2.6 - 2.6	2.6 - 2.6	2.4 - 2.4	2.3 - 2.3
200	4.8 - 5.0	3.2 - 3.6	2.7 - 2.7	2.6 - 2.6	2.4 - 2.5	2.4 - 2.4

Table 15 – Average time to assessment (hours), by attendance volume and staff skill mix.

Daily attendances	Staff skill mix

	0.5	0.7	0.9	1.1	1.3	1.5
100	0.020	0.020	0.020	0.020	0.020	0.020
120	0.038	0.020	0.020	0.020	0.020	0.020
140	0.030	0.020	**0.020***	**0.020***	0.020	0.020
160	0.376	0.036	0.020	0.020	0.020	0.020
180	0.911	0.100	0.025	0.028	0.023	0.020
200	1.382	0.439	0.080	0.052	0.033	0.033

Table 16 – Average time to assessment IQR (hours), by attendance volume and staff skill mix.

Daily attendances	Staff skill mix					
	0.5	0.7	0.9	1.1	1.3	1.5
100	0.02 - 0.02	0.02 - 0.02	0.02 - 0.02	0.02 - 0.02	0.02 - 0.02	0.02 - 0.02
120	0.03 - 0.04	0.02 - 0.02	0.02 - 0.02	0.02 - 0.02	0.02 - 0.02	0.02 - 0.02
140	0.03 - 0.03	0.02 - 0.02	**0.02 - 0.02***	**0.02 - 0.02***	0.02 - 0.02	0.02 - 0.02
160	0.30 - 0.46	0.03 - 0.04	0.02 - 0.02	0.02 - 0.02	0.02 - 0.02	0.02 - 0.02
180	0.79 - 1.03	0.09 - 0.12	0.02 - 0.03	0.02 - 0.03	0.02 - 0.03	0.02 - 0.02
200	1.19 - 1.56	0.24 - 0.59	0.07 - 0.09	0.05 - 0.06	0.03 - 0.04	0.03 - 0.04

Table 17 – Average time to treatment (hours), by attendance volume and staff skill mix.

Daily attendances	Staff skill mix					
	0.5	0.7	0.9	1.1	1.3	1.5
100	0.35	0.25	0.20	0.17	0.14	0.12
120	0.36	0.25	0.20	0.17	0.14	0.12
140	0.35	0.25	**0.20***	**0.17***	0.14	0.13
160	0.62	0.26	0.20	0.17	0.14	0.12
180	0.95	0.31	0.21	0.17	0.15	0.13
200	1.01	0.52	0.24	0.19	0.15	0.14

Table 18 – Average time to treatment IQR (hours), by attendance volume and staff skill mix.

Daily attendances	Staff skill mix					
	0.5	0.7	0.9	1.1	1.3	1.5
100	0.35 - 0.35	0.25 - 0.25	0.20 - 0.20	0.16 - 0.17	0.14 - 0.14	0.12 - 0.12
120	0.35 - 0.36	0.25 - 0.25	0.20 - 0.20	0.16 - 0.17	0.14 - 0.14	0.12 - 0.12
140	0.35 - 0.36	0.25 - 0.25	**0.20 - 0.20***	**0.17 - 0.17***	0.14 - 0.14	0.12 - 0.13
160	0.56 - 0.68	0.26 - 0.27	0.20 - 0.20	0.17 - 0.17	0.14 - 0.15	0.12 - 0.13
180	0.84 - 1.05	0.30 - 0.32	0.20 - 0.21	0.17 - 0.17	0.15 - 0.15	0.13 - 0.13
200	0.91 - 1.10	0.41 - 0.61	0.23 - 0.24	0.19 - 0.19	0.15 - 0.16	0.13 - 0.14

Table 19 – Average patients per staff, by attendance volume and staff skill mix.

Daily attendances	Staff skill mix					
	0.5	0.7	0.9	1.1	1.3	1.5
100	0.83	0.71	0.63	0.60	0.57	0.56
120	1.05	0.85	0.79	0.76	0.70	0.67
140	1.41	1.04	**0.90***	**0.84***	0.80	0.80
160	1.93	1.29	1.06	0.97	0.98	0.91
180	2.29	1.48	1.28	1.19	1.14	1.09
200	2.33	1.86	1.52	1.37	1.25	1.23

Table 20 – Average patients per staff IQR, by attendance volume and staff skill mix.

Daily attendances	Staff skill mix					
	0.5	0.7	0.9	1.1	1.3	1.5
100	0.5 - 1.1	0.4 - 1.0	0.4 - 0.9	0.4 - 0.8	0.3 - 0.8	0.3 - 0.8
120	0.7 - 1.4	0.5 - 1.1	0.5 - 1.0	0.5 - 1.0	0.4 - 0.9	0.4 - 0.9
140	0.9 - 2.0	0.6 - 1.4	**0.5 - 1.3***	**0.4 – 1.2***	0.5 - 1.1	0.5 - 1.1
160	1.2 - 2.6	0.8 - 1.9	0.6 - 1.4	0.6 - 1.4	0.6 - 1.3	0.6 - 1.2
180	1.7 - 2.9	1.0 - 2.0	0.9 - 1.7	0.8 - 1.5	0.6 - 1.6	0.7 - 1.5
200	1.8 - 2.9	1.3 - 2.4	1.0 - 2.0	0.9 - 1.8	0.8 - 1.7	0.8 - 1.7

Table 21 – Average occupancy, by attendance volume and staff skill mix.

Daily attendances	Staff skill mix					
	0.5	0.7	0.9	1.1	1.3	1.5
100	32%	27%	24%	23%	22%	21%
120	40%	33%	30%	29%	27%	26%
140	54%	40%	**34%***	**32%***	31%	31%
160	72%	50%	41%	37%	38%	35%
180	86%	56%	49%	46%	44%	42%
200	87%	71%	58%	52%	48%	47%

Table 22 – Average occupancy IQR, by attendance volume and staff skill mix.

Daily attendances	Staff skill mix					
	0.5	0.7	0.9	1.1	1.3	1.5
100	17 - 46	17 - 37	13 - 35	13 - 33	13 - 32	13 - 29
120	25 - 54	17 - 44	17 - 41	17 - 42	17 - 38	13 - 35
140	33 - 75	21 - 54	**21 – 46***	**17 – 46***	17 - 42	17 - 42
160	43 - 104	25 - 68	21 - 54	21 - 52	21 - 51	21 - 47
180	65 - 107	33 - 79	29 - 67	29 - 61	25 - 63	25 - 58
200	63 - 107	47 - 96	33 - 76	33 - 70	26 - 67	25 - 66

Table 23 – Proportion of patients that die in the department, by attendance volume and staff skill mix.

Daily attendances	Staff skill mix					
	0.5	0.7	0.9	1.1	1.3	1.5
100	0.77%	0.80%	1.08%	0.58%	1.01%	0.91%
120	0.58%	0.67%	0.96%	0.80%	0.92%	0.86%
140	0.52%	0.66%	**0.81%***	**0.79%***	0.70%	0.74%
160	0.66%	0.52%	0.85%	0.75%	0.57%	0.72%
180	0.78%	0.82%	0.98%	0.93%	0.85%	1.00%
200	1.07%	0.79%	0.97%	0.68%	0.74%	0.81%

Table 24 – Proportion of patients that leave before being seen, by attendance volume and staff skill mix.

Daily attendances	Staff skill mix					
	0.5	0.7	0.9	1.1	1.3	1.5
100	1.47%	1.32%	1.27%	1.25%	1.25%	0.86%
120	1.16%	0.85%	0.85%	0.84%	0.84%	0.71%
140	2.45%	1.37%	**1.31%***	**1.32%***	1.38%	1.15%
160	7.05%	2.00%	1.17%	1.09%	1.09%	0.96%
180	13.68%	2.36%	1.08%	1.25%	1.07%	0.82%
200	15.00%	4.53%	2.60%	2.59%	2.20%	1.76%

Attendance volume and staff numbers

Table 25 – Average duration in A&E (hours), by attendance volume and staff number.

Staff numbers (day/night)	Daily attendances					
	100	120	140	160	180	200
8 / 6	2.49	2.51	2.54	2.67	2.75	2.95
9 / 7	2.37	2.42	2.46	2.49	2.62	2.85
10 / 8	2.47	2.38	**2.49***	2.47	2.58	2.54
11 / 9	2.35	2.34	2.42	2.43	2.45	2.51
12 / 10	2.29	2.32	2.35	2.40	2.46	2.49
13 / 11	2.31	2.31	2.34	2.39	2.42	2.47

Table 26 – Average duration in A&E IQR (hours), by attendance volume and staff number.

Staff numbers (day/night)	Daily attendances					
	100	120	140	160	180	200
8 / 6	2.4 - 2.6	2.5 - 2.5	2.5 - 2.5	2.6 - 2.7	2.7 - 2.8	2.9 - 3.0
9 / 7	2.3 - 2.4	2.4 - 2.4	2.4 - 2.5	2.5 - 2.5	2.6 - 2.6	2.8 - 2.9
10 / 8	2.4 - 2.5	2.4 - 2.4	**2.5 - 2.5***	2.5 - 2.5	2.6 - 2.6	2.5 - 2.6
11 / 9	2.3 - 2.4	2.3 - 2.3	2.4 - 2.4	2.4 - 2.4	2.4 - 2.5	2.5 - 2.5
12 / 10	2.3 - 2.3	2.3 - 2.3	2.3 - 2.4	2.4 - 2.4	2.5 - 2.5	2.5 - 2.5
13 / 11	2.3 - 2.4	2.3 - 2.3	2.3 - 2.4	2.4 - 2.4	2.4 - 2.4	2.4 - 2.5

Table 27 – Average time to assessment (hours), by attendance volume and staff number.

Staff numbers (day/night)	Daily attendances					
	100	120	140	160	180	200
8 / 6	0.020	0.020	0.020	0.025	0.069	0.069
9 / 7	0.020	0.020	0.020	0.020	0.035	0.113
10 / 8	0.020	0.020	**0.020***	0.020	0.020	0.071
11 / 9	0.020	0.020	0.020	0.020	0.020	0.035
12 / 10	0.020	0.020	0.020	0.020	0.023	0.058
13 / 11	0.020	0.020	0.020	0.020	0.020	0.042

Table 28 – Average time to assessment IQR (hours), by attendance volume and staff number.

Staff numbers (day/night)	Daily attendances					
	100	120	140	160	180	200
8 / 6	0.02 - 0.02	0.02 - 0.02	0.02 - 0.02	0.02 - 0.03	0.06 - 0.08	0.06 - 0.08
9 / 7	0.02 - 0.02	0.02 - 0.02	0.02 - 0.02	0.02 - 0.02	0.03 - 0.04	0.09 - 0.14
10 / 8	0.02 - 0.02	0.02 - 0.02	**0.02 - 0.02***	0.02 - 0.02	0.02 - 0.02	0.06 - 0.08
11 / 9	0.02 - 0.02	0.02 - 0.02	0.02 - 0.02	0.02 - 0.02	0.02 - 0.02	0.03 - 0.04
12 / 10	0.02 - 0.02	0.02 - 0.02	0.02 - 0.02	0.02 - 0.02	0.02 - 0.03	0.05 - 0.07
13 / 11	0.02 - 0.02	0.02 - 0.02	0.02 - 0.02	0.02 - 0.02	0.02 - 0.02	0.02 - 0.05

Table 29 – Average time to treatment (hours), by attendance volume and staff number.

Staff numbers (day/night)	Daily attendances					
	100	120	140	160	180	200
8 / 6	0.18	0.18	0.18	0.18	0.22	0.21
9 / 7	0.18	0.18	0.18	0.18	0.19	0.24
10 / 8	0.18	0.18	**0.18***	0.18	0.18	0.22
11 / 9	0.18	0.18	0.18	0.18	0.18	0.19
12 / 10	0.18	0.18	0.18	0.18	0.18	0.21
13 / 11	0.18	0.18	0.18	0.18	0.18	0.20

Table 30 – Average time to assessment IQR (hours), by attendance volume and staff number.

Staff numbers	Daily attendances

(day/night)	100	120	140	160	180	200
8 / 6	0.18 - 0.18	0.18 - 0.18	0.18 - 0.18	0.18 - 0.19	0.21 - 0.23	0.20 - 0.21
9 / 7	0.18 - 0.18	0.18 - 0.18	0.18 - 0.18	0.18 - 0.18	0.19 - 0.19	0.23 - 0.25
10 / 8	0.18 - 0.18	0.18 - 0.18	**0.18 - 0.18***	0.18 - 0.18	0.18 - 0.18	0.21 - 0.23
11 / 9	0.18 - 0.18	0.18 - 0.18	0.18 - 0.18	0.18 - 0.18	0.18 - 0.18	0.19 - 0.19
12 / 10	0.18 - 0.18	0.18 - 0.18	0.18 - 0.18	0.18 - 0.18	0.18 - 0.19	0.20 - 0.21
13 / 11	0.18 - 0.18	0.18 - 0.18	0.18 - 0.18	0.18 - 0.18	0.18 - 0.18	0.18 - 0.21

Table 31 – Average patients per staff, by attendance volume and staff number.

Staff numbers (day/night)	Daily attendances 100	120	140	160	180	200
8 / 6	0.81	0.98	1.22	1.44	1.74	1.97
9 / 7	0.68	0.83	0.99	1.18	1.42	1.66
10 / 8	0.61	0.73	**0.88***	1.06	1.22	1.37
11 / 9	0.55	0.63	0.77	0.91	1.06	1.21
12 / 10	0.48	0.57	0.68	0.81	0.97	1.10
13 / 11	0.44	0.53	0.63	0.74	0.87	0.98

Table 32 – Average patients per staff IQR, by attendance volume and staff number.

Staff numbers (day/night)	Daily attendances 100	120	140	160	180	200
8 / 6	0.5 - 1.1	0.6 - 1.3	0.7 - 1.7	0.8 - 1.9	1.0 - 2.3	1.4 - 2.6
9 / 7	0.4 - 0.9	0.6 - 1.1	0.6 - 1.3	0.7 - 1.6	0.9 - 1.9	1.0 - 2.1
10 / 8	0.4 - 0.8	0.5 - 1.0	**0.5 - 1.2***	0.6 - 1.5	0.8 - 1.6	0.9 - 1.7
11 / 9	0.3 - 0.7	0.4 - 0.8	0.4 - 1.0	0.5 - 1.3	0.7 - 1.4	0.8 - 1.6
12 / 10	0.3 - 0.7	0.3 - 0.8	0.4 - 0.9	0.5 - 1.1	0.6 - 1.3	0.7 - 1.5
13 / 11	0.2 - 0.6	0.3 - 0.7	0.4 - 0.8	0.5 - 1.0	0.5 - 1.2	0.5 - 1.3

Table 33 – Average occupancy, by attendance volume and staff number.

Staff numbers (day/night)	Daily attendances 100	120	140	160	180	200
8 / 6	24%	29%	36%	43%	51%	58%
9 / 7	23%	28%	34%	40%	48%	56%
10 / 8	23%	28%	**34%***	41%	47%	52%
11 / 9	23%	27%	33%	39%	45%	51%
12 / 10	22%	27%	32%	38%	45%	51%
13 / 11	22%	27%	32%	38%	44%	50%

Table 34 – Average occupancy IQR, by attendance volume and staff number.

Staff numbers (day/night)	Daily attendances 100	120	140	160	180	200
8 / 6	13 - 33	17 - 41	18 - 50	25 - 59	29 - 67	38 - 79
9 / 7	13 - 30	17 - 38	17 - 46	25 - 54	29 - 63	33 - 75
10 / 8	13 - 33	17 - 38	**17 – 46***	23 - 58	27 - 64	33 - 68
11 / 9	13 - 33	17 - 38	17 - 46	22 - 54	25 - 62	33 - 71
12 / 10	13 - 29	17 - 38	17 - 44	21 - 53	25 - 63	29 - 68
13 / 11	13 - 29	17 - 38	17 - 45	21 - 51	29 - 63	26 - 68

Table 35 – Proportion of patients that die in the department, by attendance volume and staff number.

Staff numbers (day/night)	Daily attendances					
	100	120	140	160	180	200
8 / 6	0.83%	0.41%	0.59%	0.74%	0.92%	0.77%
9 / 7	1.12%	0.70%	0.61%	0.95%	0.96%	1.01%
10 / 8	1.06%	0.70%	**0.51%***	0.71%	0.97%	1.08%
11 / 9	1.08%	0.75%	0.51%	0.57%	0.90%	0.89%
12 / 10	1.42%	0.65%	0.69%	0.72%	0.98%	1.09%
13 / 11	1.21%	0.88%	0.60%	0.78%	0.89%	0.72%

Table 36 – Proportion of patients that leave without being seen, by attendance volume and staff number.

Staff numbers (day/night)	Daily attendances					
	100	120	140	160	180	200
8 / 6	1.27%	0.85%	1.34%	1.48%	1.71%	2.61%
9 / 7	1.27%	0.85%	1.31%	1.23%	1.21%	2.93%
10 / 8	1.27%	0.85%	**1.36%***	1.25%	0.88%	2.44%
11 / 9	1.27%	0.85%	1.36%	1.09%	0.88%	1.97%
12 / 10	1.27%	0.85%	1.36%	1.09%	0.93%	1.98%
13 / 11	1.11%	0.85%	1.34%	1.09%	0.96%	1.95%

2.0 Appendix B – Model equations

These are the equations that the iThink software automatically generated. They can be found in the "Equation" tab in the model. The order in which the sections is displayed has been modified slightly to be more intuitive. These were taken from the deterministic version of the model. The random functions and distributions included an additional parameter that defines the seed.

{ VERSION 9.1.3 }

{ TIME SPECS }

STARTTIME=1
STOPTIME=336
DT=0.015625
INTEGRATION=EULER
RUNMODE=CYCLETIME
PAUSEINTERVAL=INF

{ ARRAY DIMENSIONS }

: c acuity_dist_em[Acuity]
: I Treatment[Acuity]
: f Attendance_rate[Acuity]
: f Admission_rate[Acuity]
: f Treatment_rate[Acuity]
: c acuity_dist_nem[Acuity]
: c pAdmission[Acuity]
: c Avg_treat_time[Acuity]
: c Staff[Staff_Type]
: c Actual_attendances[Acuity]

: s Waiting_for_admission[Acuity]
: f Ward_transfer_rate[Acuity]
: s Waiting[Acuity]
: c Assessment_status[Acuity]
: c Avg_treatment_time[Acuity]
: c Baseline_treatment_time[Acuity]
: l Assessment[Acuity]
: f Entering_assessment[Acuity]
: f Assessment_rate[Acuity]
: c Adj_assessment_duration[Acuity]
: f Early_discharge[Acuity]
: c pEarly_discharge[Acuity]
: f Leaving_waiting_room[Acuity]
: c pLWBS[Acuity]
: c Avg_time_to_tret[Acuity]
: f Waiting_deaths[Acuity]
: f Treatment_deaths[Acuity]
: c pDeath[Acuity]
: f Emergency_rate[Acuity]
: c Emergency_attendances[Acuity]
: c Non_emergency_attendances[Acuity]
: c wt_avg_time_to_treat1[Acuity]
: c Day_nursing_staff[Staff_Type]
: c Night_nursing_staff[Staff_Type]
: c Staff_skill[Staff_Type]
: c wt_avg_time_to_assess1[Acuity]
: f cpAssessment_Rate[Acuity]
: s cumTreatment[Acuity]
: f cpEntering_Assessment[Acuity]
: s cumAssessment[Acuity]

: c Avg_time_to_assessment[Acuity]

{ SUBSCRIPT NAMES }

Staff_Type=Band_2,Band_3,Band_4,Band_5,Band_6,Band_7
Acuity=1,2,3,4,5

{ INITIALIZATION EQUATIONS }

: c Productivity_scalor = 1.35
: I Treatment[1] = 0
TRANSIT TIME = varies
INFLOW LIMIT = INF
CAPACITY = INF
: I Treatment[2] = 0
TRANSIT TIME = varies
INFLOW LIMIT = INF
CAPACITY = INF
: I Treatment[3] = 0
TRANSIT TIME = varies
INFLOW LIMIT = INF
CAPACITY = INF
: I Treatment[4] = 0
TRANSIT TIME = varies
INFLOW LIMIT = INF
CAPACITY = INF
: I Treatment[5] = 0
TRANSIT TIME = varies
INFLOW LIMIT = INF
CAPACITY = INF

: s Waiting_for_admission[1] = 0
: s Waiting_for_admission[2] = 0
: s Waiting_for_admission[3] = 0
: s Waiting_for_admission[4] = 0
: s Waiting_for_admission[5] = 0
: l Assessment[1] = 0
TRANSIT TIME = varies
INFLOW LIMIT = INF
CAPACITY = INF
: l Assessment[2] = 0
TRANSIT TIME = varies
INFLOW LIMIT = INF
CAPACITY = INF
: l Assessment[3] = 0
TRANSIT TIME = varies
INFLOW LIMIT = INF
CAPACITY = INF
: l Assessment[4] = 0
TRANSIT TIME = varies
INFLOW LIMIT = INF
CAPACITY = INF
: l Assessment[5] = 0
TRANSIT TIME = varies
INFLOW LIMIT = INF
CAPACITY = INF
: s Discharge_hold = 0
: l Home = 0
TRANSIT TIME = 0.015625
INFLOW LIMIT = INF
CAPACITY = INF

: I Other = 0
TRANSIT TIME = 0.015625
INFLOW LIMIT = INF
CAPACITY = INF
: I Transfer = 0
TRANSIT TIME = 0.015625
INFLOW LIMIT = INF
CAPACITY = INF
: c Total_patients_in_dept = ARRAYSUM(Treatment[*]) + ARRAYSUM(Waiting_for_admission[*]) + ARRAYSUM(Assessment[*]) + Discharge_hold + Home + Other + Transfer
: c Staff_sens = 0
: c Night_shift = GRAPH(COUNTER(0,24))
(0, 1), (1, 1), (2, 1), (3, 1), (4, 1), (5, 1), (6, 1), (7, 1), (8, 0), (9, 0), (10, 0), (11, 0), (12, 0), (13, 0), (14, 0), (15, 0), (16, 0), (17, 0), (18, 0), (19, 0), (20, 1), (21, 1), (22, 1), (23, 1)
: c Night_nursing_staff[Band_2] = 0
: c Day_nursing_staff[Band_2] = 0
: c Staff_count_night = 8
: c Staff_count_day = 10
: c Staff[Band_2] = IF Staff_sens = 0 THEN
IF Night_shift = 1 THEN Night_nursing_staff[Band_2] ELSE Day_nursing_staff[Band_2]
ELSE IF Night_shift = 1 THEN Staff_count_night/6 ELSE Staff_count_day/6
: c Night_nursing_staff[Band_3] = 0
: c Day_nursing_staff[Band_3] = 0
: c Staff[Band_3] = IF Staff_sens = 0 THEN
IF Night_shift = 1 THEN Night_nursing_staff[Band_3] ELSE Day_nursing_staff[Band_3]
ELSE IF Night_shift = 1 THEN Staff_count_night/6 ELSE Staff_count_day/6
: c Night_nursing_staff[Band_4] = 0
: c Day_nursing_staff[Band_4] = 0
: c Staff[Band_4] = IF Staff_sens = 0 THEN
IF Night_shift = 1 THEN Night_nursing_staff[Band_4] ELSE Day_nursing_staff[Band_4]

```
ELSE IF Night_shift = 1 THEN Staff_count_night/6 ELSE Staff_count_day/6
: c Night_nursing_staff[Band_5] = 0
: c Day_nursing_staff[Band_5] = 0
: c Staff[Band_5] = IF Staff_sens = 0 THEN
IF Night_shift = 1 THEN Night_nursing_staff[Band_5] ELSE Day_nursing_staff[Band_5]
ELSE IF Night_shift = 1 THEN Staff_count_night/6 ELSE Staff_count_day/6
: c Night_nursing_staff[Band_6] = 0
: c Day_nursing_staff[Band_6] = 0
: c Staff[Band_6] = IF Staff_sens = 0 THEN
IF Night_shift = 1 THEN Night_nursing_staff[Band_6] ELSE Day_nursing_staff[Band_6]
ELSE IF Night_shift = 1 THEN Staff_count_night/6 ELSE Staff_count_day/6
: c Night_nursing_staff[Band_7] = 0
: c Day_nursing_staff[Band_7] = 0
: c Staff[Band_7] = IF Staff_sens = 0 THEN
IF Night_shift = 1 THEN Night_nursing_staff[Band_7] ELSE Day_nursing_staff[Band_7]
ELSE IF Night_shift = 1 THEN Staff_count_night/6 ELSE Staff_count_day/6
: c Skill_mix_night_sens = 1
: c Skill_mix_day_sens = 1
: c Staff_skill[Band_2] = 0.64
: c Staff_skill[Band_3] = 0.73
: c Staff_skill[Band_4] = 0.84
: c Staff_skill[Band_5] = 1
: c Staff_skill[Band_6] = 1.22
: c Staff_skill[Band_7] = 1.45
: c Skill_mix = IF Staff_sens = 1 THEN
IF Night_shift = 1 THEN Skill_mix_night_sens ELSE Skill_mix_day_sens
ELSE
((Staff[Band_2]*Staff_skill[Band_2]) +
(Staff[Band_3]*Staff_skill[Band_3]) +
(Staff[Band_4]*Staff_skill[Band_4]) +
```

```
(Staff[Band_5]*Staff_skill[Band_5]) +
(Staff[Band_6]*Staff_skill[Band_6]) +
(Staff[Band_7]*Staff_skill[Band_7])) / ARRAYSUM(Staff[*])
: c staff_ratio = IF Total_patients_in_dept = 0 THEN 0 ELSE (ARRAYSUM(Staff[*]) * Skill_mix)/Total_patients_in_dept
: c Baseline_patients_per_staff = 1.5
: c prod_ratio = IF staff_ratio = 0 THEN 0 ELSE (1/Baseline_patients_per_staff)/staff_ratio
: c treat_adjustment = Productivity_scalor^(prod_ratio-1)
: c Baseline_assessment_duration = 1/6
: c Adj_assessment_duration[1] = Baseline_assessment_duration / Skill_mix
: c Adj_assessment_duration[2] = Baseline_assessment_duration / Skill_mix
: c Adj_assessment_duration[3] = Baseline_assessment_duration / Skill_mix
: c Adj_assessment_duration[4] = Baseline_assessment_duration / Skill_mix
: c Adj_assessment_duration[5] = Baseline_assessment_duration / Skill_mix
: c Baseline_treatment_time[1] = 0.8
: c Avg_treatment_time[1] = Baseline_treatment_time[1] * treat_adjustment
: c Baseline_treatment_time[2] = 0.98
: c Avg_treatment_time[2] = Baseline_treatment_time[2] * treat_adjustment
: c Baseline_treatment_time[3] = 1.72
: c Avg_treatment_time[3] = Baseline_treatment_time[3] * treat_adjustment
: c Baseline_treatment_time[4] = 2.26
: c Avg_treatment_time[4] = Baseline_treatment_time[4] * treat_adjustment
: c Baseline_treatment_time[5] = 2.4
: c Avg_treatment_time[5] = Baseline_treatment_time[5] * treat_adjustment
: s Redirected_away = 0
: s No_treatment = 0
: s Deaths = 0
: s Admitted = 0
: s Waiting[1] = 0
: s Waiting[2] = 0
: s Waiting[3] = 0
```

: s Waiting[4] = 0
: s Waiting[5] = 0
: s Discharges = 0
: s Dischg__exit = 0
: s Adm_exit = 0
: s no_tret_exit = 0
: s LWBS = 0
: s cumTreatment[1] = 0
: s cumTreatment[2] = 0
: s cumTreatment[3] = 0
: s cumTreatment[4] = 0
: s cumTreatment[5] = 0
: s cumAssessment[1] = 0
: s cumAssessment[2] = 0
: s cumAssessment[3] = 0
: s cumAssessment[4] = 0
: s cumAssessment[5] = 0
: c Open_wards = 0
DOCUMENT: A value of 1 will simulate the effect of wards being able to accept patients from A&E 24 hours a day rather than being on a day/night cycle.
: c Ward_cycle = GRAPH(COUNTER(0,24))
(0, 1), (1, 1), (2, 1), (3, 1), (4, 0), (5, 0), (6, 0), (7, 0), (8, 0), (9, 0), (10, 0), (11, 1), (12, 1), (13, 1), (14, 1), (15, 1), (16, 1), (17, 1), (18, 1), (19, 1), (20, 1), (21, 1), (22, 1), (23, 1)
: c WardStatus = IF Open_wards = 1 THEN 1 ELSE Ward_cycle
: c Avg_transfer_time = 0.25
: c Department_capacity = 24
: c available_capacity = Department_capacity - Total_patients_in_dept
: c Overfill_waiting_room = 0
: c Waiting_room_capacity = 20
: c Available_waiting_room_capacity = Waiting_room_capacity - ARRAYSUM(Waiting[*])
: c Attendance_distribution = GRAPH(COUNTER(0,24))

(0, 0.023), (1, 0.02), (2, 0.014), (3, 0.014), (4, 0.013), (5, 0.013), (6, 0.013), (7, 0.019), (8, 0.035), (9, 0.073), (10, 0.07), (11, 0.066), (12, 0.061), (13, 0.061), (14, 0.057), (15, 0.057), (16, 0.058), (17, 0.059), (18, 0.063), (19, 0.058), (20, 0.05), (21, 0.041), (22, 0.034), (23, 0.029)

: c Daily_attendances = 141

: c Total_arrivals = Attendance_distribution*Daily_attendances

: c Emergency_distribution = GRAPH(COUNTER(0,24))

(0, 0.48), (1, 0.53), (2, 0.55), (3, 0.55), (4, 0.55), (5, 0.54), (6, 0.46), (7, 0.32), (8, 0.25), (9, 0.21), (10, 0.22), (11, 0.23), (12, 0.24), (13, 0.25), (14, 0.26), (15, 0.27), (16, 0.26), (17, 0.26), (18, 0.24), (19, 0.24), (20, 0.28), (21, 0.31), (22, 0.36), (23, 0.42)

: c acuity_dist_nem[1] = 0.029

: c Non_emergency_attendances[1] = POISSON(Total_arrivals*(1-Emergency_distribution)*acuity_dist_nem[1], 1)

: c acuity_dist_nem[2] = 0.596

: c Non_emergency_attendances[2] = POISSON(Total_arrivals*(1-Emergency_distribution)*acuity_dist_nem[2], 1)

: c acuity_dist_nem[3] = 0.342

: c Non_emergency_attendances[3] = POISSON(Total_arrivals*(1-Emergency_distribution)*acuity_dist_nem[3], 1)

: c acuity_dist_nem[4] = 0.027

: c Non_emergency_attendances[4] = POISSON(Total_arrivals*(1-Emergency_distribution)*acuity_dist_nem[4], 1)

: c acuity_dist_nem[5] = 0.006

: c Non_emergency_attendances[5] = POISSON(Total_arrivals*(1-Emergency_distribution)*acuity_dist_nem[5], 1)

: c Actual_attendances[1] = IF Overfill_waiting_room = 0 THEN MIN(Available_waiting_room_capacity, Non_emergency_attendances[1]) ELSE Non_emergency_attendances[1]

: c Actual_attendances[2] = IF Overfill_waiting_room = 0 THEN MIN(Available_waiting_room_capacity, Non_emergency_attendances[2]) ELSE Non_emergency_attendances[2]

: c Actual_attendances[3] = IF Overfill_waiting_room = 0 THEN MIN(Available_waiting_room_capacity, Non_emergency_attendances[3]) ELSE Non_emergency_attendances[3]

: c Actual_attendances[4] = IF Overfill_waiting_room = 0 THEN MIN(Available_waiting_room_capacity, Non_emergency_attendances[4]) ELSE Non_emergency_attendances[4]

: c Actual_attendances[5] = IF Overfill_waiting_room = 0 THEN MIN(Available_waiting_room_capacity, Non_emergency_attendances[5]) ELSE Non_emergency_attendances[5]

: c Patients_redirected = ARRAYSUM(Non_emergency_attendances[*]) - ARRAYSUM(Actual_attendances[*])

: f Overflow = PULSE(Patients_redirected)

: c pEarly_discharge[1] = 0.38

```
: f Early_discharge[1] = LEAKAGE OUTFLOW
        LEAKAGE FRACTION = IF RANDOM(0,1,7) <= pEarly_discharge[1] THEN 1 ELSE 0
        NO-LEAK ZONE = 100%
: c pEarly_discharge[2] = 0.259
: f Early_discharge[2] = LEAKAGE OUTFLOW
        LEAKAGE FRACTION = IF RANDOM(0,1,7) <= pEarly_discharge[2] THEN 1 ELSE 0
        NO-LEAK ZONE = 100%
: c pEarly_discharge[3] = 0.136
: f Early_discharge[3] = LEAKAGE OUTFLOW
        LEAKAGE FRACTION = IF RANDOM(0,1,7) <= pEarly_discharge[3] THEN 1 ELSE 0
        NO-LEAK ZONE = 100%
: c pEarly_discharge[4] = 0.1
: f Early_discharge[4] = LEAKAGE OUTFLOW
        LEAKAGE FRACTION = IF RANDOM(0,1,7) <= pEarly_discharge[4] THEN 1 ELSE 0
        NO-LEAK ZONE = 100%
: c pEarly_discharge[5] = 0.052
: f Early_discharge[5] = LEAKAGE OUTFLOW
        LEAKAGE FRACTION = IF RANDOM(0,1,7) <= pEarly_discharge[5] THEN 1 ELSE 0
        NO-LEAK ZONE = 100%
: f no_tret_exit_rate = No_treatment
        TIMESTAMPED
: c pDeath[1] = 0
: f Attendance_rate[1] = PULSE(Actual_attendances[1])
        TIMESTAMPED
: f Waiting_deaths[1] = IF RANDOM(0,1,4) <= pDeath[1] THEN PULSE(1) ELSE 0
: c pDeath[2] = 0
: f Attendance_rate[2] = PULSE(Actual_attendances[2])
        TIMESTAMPED
: f Waiting_deaths[2] = IF RANDOM(0,1,4) <= pDeath[2] THEN PULSE(1) ELSE 0
: c pDeath[3] = 0
```

: f Attendance_rate[3] = PULSE(Actual_attendances[3])
TIMESTAMPED
: f Waiting_deaths[3] = IF RANDOM(0,1,4) <= pDeath[3] THEN PULSE(1) ELSE 0
: c pDeath[4] = 0.002
: f Attendance_rate[4] = PULSE(Actual_attendances[4])
TIMESTAMPED
: f Waiting_deaths[4] = IF RANDOM(0,1,4) <= pDeath[4] THEN PULSE(1) ELSE 0
: c pDeath[5] = 0.098
: f Attendance_rate[5] = PULSE(Actual_attendances[5])
TIMESTAMPED
: f Waiting_deaths[5] = IF RANDOM(0,1,4) <= pDeath[5] THEN PULSE(1) ELSE 0
: c pAdmission[1] = 0.062
: f Admission_rate[1] = LEAKAGE OUTFLOW
LEAKAGE FRACTION = IF RANDOM(0,1,8) <= pAdmission[1] THEN PULSE(1) ELSE 0
NO-LEAK ZONE = 100%
: f Treatment_deaths[1] = IF RANDOM(0,1,5) <= pDeath[1] THEN PULSE(1) ELSE 0
: c pAdmission[2] = 0.134
: f Admission_rate[2] = LEAKAGE OUTFLOW
LEAKAGE FRACTION = IF RANDOM(0,1,8) <= pAdmission[2] THEN PULSE(1) ELSE 0
NO-LEAK ZONE = 100%
: f Treatment_deaths[2] = IF RANDOM(0,1,5) <= pDeath[2] THEN PULSE(1) ELSE 0
: c pAdmission[3] = 0.464
: f Admission_rate[3] = LEAKAGE OUTFLOW
LEAKAGE FRACTION = IF RANDOM(0,1,8) <= pAdmission[3] THEN PULSE(1) ELSE 0
NO-LEAK ZONE = 100%
: f Treatment_deaths[3] = IF RANDOM(0,1,5) <= pDeath[3] THEN PULSE(1) ELSE 0
: c pAdmission[4] = 0.745
: f Admission_rate[4] = LEAKAGE OUTFLOW
LEAKAGE FRACTION = IF RANDOM(0,1,8) <= pAdmission[4] THEN PULSE(1) ELSE 0
NO-LEAK ZONE = 100%

: f Treatment_deaths[4] = IF RANDOM(0,1,5) <= pDeath[4] THEN PULSE(1) ELSE 0
: c pAdmission[5] = 0.828
: f Admission_rate[5] = LEAKAGE OUTFLOW
LEAKAGE FRACTION = IF RANDOM(0,1,8) <= pAdmission[5] THEN PULSE(1) ELSE 0
NO-LEAK ZONE = 100%
: f Treatment_deaths[5] = IF RANDOM(0,1,5) <= pDeath[5] THEN PULSE(1) ELSE 0
: f Ward_transfer_rate[1] = IF WardStatus > 0 THEN 1 / Avg_transfer_time ELSE 0
: f Ward_transfer_rate[2] = IF WardStatus > 0 THEN 1 / Avg_transfer_time ELSE 0
: f Ward_transfer_rate[3] = IF WardStatus > 0 THEN 1 / Avg_transfer_time ELSE 0
: f Ward_transfer_rate[4] = IF WardStatus > 0 THEN 1 / Avg_transfer_time ELSE 0
: f Ward_transfer_rate[5] = IF WardStatus > 0 THEN 1 / Avg_transfer_time ELSE 0
: f adm_exit_rate = Admitted
TIMESTAMPED
: c discharge_rnd = RANDOM(0,1, 9)
: c pDisHome = 0.98
: f Treatment_rate[1] = CONVEYOR OUTFLOW
TRANSIT TIME = EXPRND(Avg_treatment_time[1], 1)
: f Treatment_rate[2] = CONVEYOR OUTFLOW
TRANSIT TIME = EXPRND(Avg_treatment_time[2], 1)
: f Treatment_rate[3] = CONVEYOR OUTFLOW
TRANSIT TIME = EXPRND(Avg_treatment_time[3], 1)
: f Treatment_rate[4] = CONVEYOR OUTFLOW
TRANSIT TIME = EXPRND(Avg_treatment_time[4], 1)
: f Treatment_rate[5] = CONVEYOR OUTFLOW
TRANSIT TIME = EXPRND(Avg_treatment_time[5], 1)
: f home_rate = IF discharge_rnd <= pDisHome THEN PULSE(1) ELSE 0
: c pDisTrans = 0.02
: c pcumDisTrans = pDisHome + pDisTrans
: f transfer_rate = IF discharge_rnd > pDisHome AND discharge_rnd <= pcumDisTrans THEN PULSE(1) ELSE 0
: c pDisOther = 0

: c pcumDisOther = pcumDisTrans + pDisOther
: f other_rate = IF discharge_rnd > pcumDisTrans AND discharge_rnd <= pcumDisOther THEN PULSE(1) ELSE 0
: f Assessment_rate[1] = CONVEYOR OUTFLOW
TRANSIT TIME = NORMAL(Adj_assessment_duration[1], 0.05, 6)
: c Avg_time_to_tret[1] = CTMEAN(Assessment_rate[1], 0 , 1)
: c pLWBS[1] = GRAPH(Avg_time_to_tret[1])
(0, 0.005), (1, 0.02), (2, 0.045), (3, 0.065), (4, 0.095), (5, 0.12), (6, 0.185), (7, 0.27), (8, 0.39), (9, 0.515), (10, 0.695)
: f Leaving_waiting_room[1] = IF RANDOM(0,1, 3) <= pLWBS[1] THEN PULSE(1) ELSE 0
: c Assessment_status[1] = IF ARRAYSUM(Staff[*]) <= ARRAYSUM(Assessment[*]) OR available_capacity <= 0 OR Waiting[2] + Waiting[3] + Waiting [4] + Waiting[5] >= ARRAYSUM(Staff[*])
THEN 0
ELSE MIN(Waiting[1] - Waiting[2] - Waiting[3] - Waiting [4] - Waiting[5], ARRAYSUM(Staff[*]) - ARRAYSUM(Assessment[*]) - Waiting[2] - Waiting[3] - Waiting [4] - Waiting[5])
: f Entering_assessment[1] = PULSE(Assessment_status[1])
: f Assessment_rate[2] = CONVEYOR OUTFLOW
TRANSIT TIME = NORMAL(Adj_assessment_duration[2], 0.05, 6)
: c Avg_time_to_tret[2] = CTMEAN(Assessment_rate[2], 0 , 1)
: c pLWBS[2] = GRAPH(Avg_time_to_tret[2])
(0, 0.005), (1, 0.02), (2, 0.045), (3, 0.065), (4, 0.095), (5, 0.12), (6, 0.185), (7, 0.27), (8, 0.39), (9, 0.515), (10, 0.695)
: f Leaving_waiting_room[2] = IF RANDOM(0,1, 3) <= pLWBS[2] THEN PULSE(1) ELSE 0
: c Assessment_status[2] = IF ARRAYSUM(Staff[*]) <= ARRAYSUM(Assessment[*]) OR available_capacity <= 0 OR Waiting[3] + Waiting [4] + Waiting[5] >= ARRAYSUM(Staff[*])
THEN 0
ELSE MIN(Waiting[2] - Waiting[3] - Waiting [4] - Waiting[5], ARRAYSUM(Staff[*]) - ARRAYSUM(Assessment[*]) - Waiting[3] - Waiting [4] - Waiting[5])
: f Entering_assessment[2] = PULSE(Assessment_status[2])
: f Assessment_rate[3] = CONVEYOR OUTFLOW
TRANSIT TIME = NORMAL(Adj_assessment_duration[3], 0.05, 6)
: c Avg_time_to_tret[3] = CTMEAN(Assessment_rate[3], 0 , 1)
: c pLWBS[3] = GRAPH(Avg_time_to_tret[3])
(0, 0.005), (1, 0.02), (2, 0.045), (3, 0.065), (4, 0.095), (5, 0.12), (6, 0.185), (7, 0.27), (8, 0.39), (9, 0.515), (10, 0.695)

: f Leaving_waiting_room[3] = IF RANDOM(0,1, 3) <= pLWBS[3] THEN PULSE(1) ELSE 0
: c Assessment_status[3] = IF ARRAYSUM(Staff[*]) <= ARRAYSUM(Assessment[*]) OR available_capacity <= 0 OR Waiting [4] + Waiting[5] >= ARRAYSUM(Staff[*])
THEN 0
ELSE MIN(Waiting[3] - Waiting [4] - Waiting[5], ARRAYSUM(Staff[*]) - ARRAYSUM(Assessment[*]) - Waiting [4] - Waiting[5])
: f Entering_assessment[3] = PULSE(Assessment_status[3])
: f Assessment_rate[4] = CONVEYOR OUTFLOW
TRANSIT TIME = NORMAL(Adj_assessment_duration[4], 0.05, 6)
: c Avg_time_to_tret[4] = CTMEAN(Assessment_rate[4], 0 , 1)
: c pLWBS[4] = GRAPH(Avg_time_to_tret[4])
(0, 0.005), (1, 0.02), (2, 0.045), (3, 0.065), (4, 0.095), (5, 0.12), (6, 0.185), (7, 0.27), (8, 0.39), (9, 0.515), (10, 0.695)
: f Leaving_waiting_room[4] = IF RANDOM(0,1, 3) <= pLWBS[4] THEN PULSE(1) ELSE 0
: c Assessment_status[4] = IF ARRAYSUM(Staff[*]) <= ARRAYSUM(Assessment[*]) OR available_capacity <= 0 OR Waiting[5] >= ARRAYSUM(Staff[*])
THEN 0
ELSE MIN(Waiting [4] - Waiting[5], ARRAYSUM(Staff[*]) - ARRAYSUM(Assessment[*]) - Waiting[5])
: f Entering_assessment[4] = PULSE(Assessment_status[4])
: f Assessment_rate[5] = CONVEYOR OUTFLOW
TRANSIT TIME = NORMAL(Adj_assessment_duration[5], 0.05, 6)
: c Avg_time_to_tret[5] = CTMEAN(Assessment_rate[5], 0 , 1)
: c pLWBS[5] = GRAPH(Avg_time_to_tret[5])
(0, 0.005), (1, 0.02), (2, 0.045), (3, 0.065), (4, 0.095), (5, 0.12), (6, 0.185), (7, 0.27), (8, 0.39), (9, 0.515), (10, 0.695)
: f Leaving_waiting_room[5] = IF RANDOM(0,1, 3) <= pLWBS[5] THEN PULSE(1) ELSE 0
: c Assessment_status[5] = IF ARRAYSUM(Staff[*]) <= ARRAYSUM(Assessment[*]) OR available_capacity <= 0
THEN 0
ELSE MIN(Waiting[5], ARRAYSUM(Staff[*]) - ARRAYSUM(Assessment[*]))
: f Entering_assessment[5] = PULSE(Assessment_status[5])
: f home_dur = CONVEYOR OUTFLOW
: f transfer_dur = CONVEYOR OUTFLOW
: f other_dur = CONVEYOR OUTFLOW
: f dischg_exit_rate = Discharges
TIMESTAMPED

: f cpAssessment_Rate[1] = Assessment_rate[1]
: f cpAssessment_Rate[2] = Assessment_rate[2]
: f cpAssessment_Rate[3] = Assessment_rate[3]
: f cpAssessment_Rate[4] = Assessment_rate[4]
: f cpAssessment_Rate[5] = Assessment_rate[5]
: f cpEntering_Assessment[1] = PULSE(Entering_assessment[1])
: f cpEntering_Assessment[2] = PULSE(Entering_assessment[2])
: f cpEntering_Assessment[3] = PULSE(Entering_assessment[3])
: f cpEntering_Assessment[4] = PULSE(Entering_assessment[4])
: f cpEntering_Assessment[5] = PULSE(Entering_assessment[5])
: c acuity_dist_em[1] = 0.01
: c Emergency_attendances[1] = POISSON(Total_arrivals*Emergency_distribution*acuity_dist_em[1], 2)
: f Emergency_rate[1] = PULSE(Emergency_attendances[1])
TIMESTAMPED
: c acuity_dist_em[2] = 0.316
: c Emergency_attendances[2] = POISSON(Total_arrivals*Emergency_distribution*acuity_dist_em[2], 2)
: f Emergency_rate[2] = PULSE(Emergency_attendances[2])
TIMESTAMPED
: c acuity_dist_em[3] = 0.593
: c Emergency_attendances[3] = POISSON(Total_arrivals*Emergency_distribution*acuity_dist_em[3], 2)
: f Emergency_rate[3] = PULSE(Emergency_attendances[3])
TIMESTAMPED
: c acuity_dist_em[4] = 0.063
: c Emergency_attendances[4] = POISSON(Total_arrivals*Emergency_distribution*acuity_dist_em[4], 2)
: f Emergency_rate[4] = PULSE(Emergency_attendances[4])
TIMESTAMPED
: c acuity_dist_em[5] = 0.018
: c Emergency_attendances[5] = POISSON(Total_arrivals*Emergency_distribution*acuity_dist_em[5], 2)
: f Emergency_rate[5] = PULSE(Emergency_attendances[5])
TIMESTAMPED

: c Occupancy = (1- (available_capacity / Department_capacity)) * 100
: c wt_avg_time_to_treat1[1] = cumTreatment[1] * Avg_time_to_tret[1]
: c Avg_treat_time[1] = CTMEAN(Treatment_rate[1], 0, 1)
: c Avg_treat_time[2] = CTMEAN(Treatment_rate[2], 0, 1)
: c Avg_treat_time[3] = CTMEAN(Treatment_rate[3], 0, 1)
: c Avg_treat_time[4] = CTMEAN(Treatment_rate[4], 0, 1)
: c Avg_treat_time[5] = CTMEAN(Treatment_rate[5], 0, 1)
: c WaitingTotal = ARRAYSUM(Waiting[*])
: c AssessmentTotal = ARRAYSUM(Assessment[*])
: c TreatmentTotal = ARRAYSUM(Treatment[*])
: c WaitingForAdmissionTotal = ARRAYSUM(Waiting_for_admission[*])
: c wt_avg_time_to_treat1[2] = cumTreatment[2] * Avg_time_to_tret[2]
: c wt_avg_time_to_treat1[3] = cumTreatment[3] * Avg_time_to_tret[3]
: c wt_avg_time_to_treat1[4] = cumTreatment[4] * Avg_time_to_tret[4]
: c wt_avg_time_to_treat1[5] = cumTreatment[5] * Avg_time_to_tret[5]
: c wt_avg_time_to_treat2 = IF ARRAYSUM(cumTreatment[*]) = 0 THEN 0 ELSE ARRAYSUM(wt_avg_time_to_treat1[*]) / ARRAYSUM(cumTreatment[*])
: c avg_dischg_time_in_dept = CTMEAN(dischg_exit_rate, 0, 1)
UNITS: hr
: c Total_patients = Admitted + Adm_exit + ARRAYSUM(Assessment[*]) + Deaths + Discharges + Discharge_hold + Dischg__exit + Home + LWBS + No_treatment + no_tret_exit + Other + Transfer + ARRAYSUM(Treatment[*]) + ARRAYSUM(Waiting[*]) + ARRAYSUM(Waiting_for_admission[*])
: c Actual_staff = ARRAYSUM(Staff[*])
: c Avg_time_to_assessment[1] = CTMEAN(Entering_assessment[1], 0, 1)
: c wt_avg_time_to_assess1[1] = cumAssessment[1] * Avg_time_to_assessment[1]
: c Avg_time_to_assessment[2] = CTMEAN(Entering_assessment[2], 0, 1)
: c wt_avg_time_to_assess1[2] = cumAssessment[2] * Avg_time_to_assessment[2]
: c Avg_time_to_assessment[3] = CTMEAN(Entering_assessment[3], 0, 1)
: c wt_avg_time_to_assess1[3] = cumAssessment[3] * Avg_time_to_assessment[3]
: c Avg_time_to_assessment[4] = CTMEAN(Entering_assessment[4], 0, 1)
: c wt_avg_time_to_assess1[4] = cumAssessment[4] * Avg_time_to_assessment[4]
: c avg_adm_time_in_dept = CTMEAN(adm_exit_rate, 0, 1)

: c avg_no_tret_time_in_dept = CTMEAN(no_tret_exit_rate, 0, 1)
: c avg_duration_in_dept = IF (Adm_exit+Dischg__exit+no_tret_exit) = 0 THEN 0
ELSE
(((Adm_exit * avg_adm_time_in_dept) + (Dischg__exit*avg_dischg_time_in_dept) + (no_tret_exit*avg_no_tret_time_in_dept)) /
(Adm_exit+Dischg__exit+no_tret_exit))
: c Avg_time_to_assessment[5] = CTMEAN(Entering_assessment[5], 0, 1)
: c wt_avg_time_to_assess1[5] = cumAssessment[5] * Avg_time_to_assessment[5]
: c wt_avg_time_to_assess2 = IF ARRAYSUM(cumAssessment[*]) = 0 THEN 0 ELSE ARRAYSUM(wt_avg_time_to_assess1[*]) / ARRAYSUM(cumAssessment[*])

{ RUNTIME EQUATIONS }

: s Waiting_for_admission[1](t) = Waiting_for_admission[1](t - dt) + (Admission_rate[1] - Treatment_deaths[1] - Ward_transfer_rate[1]) * dt
: s Waiting_for_admission[2](t) = Waiting_for_admission[2](t - dt) + (Admission_rate[2] - Treatment_deaths[2] - Ward_transfer_rate[2]) * dt
: s Waiting_for_admission[3](t) = Waiting_for_admission[3](t - dt) + (Admission_rate[3] - Treatment_deaths[3] - Ward_transfer_rate[3]) * dt
: s Waiting_for_admission[4](t) = Waiting_for_admission[4](t - dt) + (Admission_rate[4] - Treatment_deaths[4] - Ward_transfer_rate[4]) * dt
: s Waiting_for_admission[5](t) = Waiting_for_admission[5](t - dt) + (Admission_rate[5] - Treatment_deaths[5] - Ward_transfer_rate[5]) * dt
: s Discharge_hold(t) = Discharge_hold(t - dt) + (Treatment_rate[1] + Treatment_rate[2] + Treatment_rate[3] + Treatment_rate[4] + Treatment_rate[5] +
Treatment_rate[Acuity] - home_rate - transfer_rate - other_rate) * dt
: s Redirected_away(t) = Redirected_away(t - dt) + (Overflow) * dt
: s No_treatment(t) = No_treatment(t - dt) + (Early_discharge[1] + Early_discharge[2] + Early_discharge[3] + Early_discharge[4] + Early_discharge[5] +
Early_discharge[Acuity] - no_tret_exit_rate) * dt
: s Deaths(t) = Deaths(t - dt) + (Waiting_deaths[1] + Waiting_deaths[2] + Waiting_deaths[3] + Waiting_deaths[4] + Waiting_deaths[5] + Treatment_deaths[1] +
Treatment_deaths[2] + Treatment_deaths[3] + Treatment_deaths[4] + Treatment_deaths[5] + Treatment_deaths[Acuity] + Waiting_deaths[Acuity]) * dt
: s Admitted(t) = Admitted(t - dt) + (Ward_transfer_rate[1] + Ward_transfer_rate[2] + Ward_transfer_rate[3] + Ward_transfer_rate[4] + Ward_transfer_rate[5] +
Ward_transfer_rate[Acuity] - adm_exit_rate) * dt
: s Waiting[1](t) = Waiting[1](t - dt) + (Attendance_rate[1] - Waiting_deaths[1] - Leaving_waiting_room[1] - Entering_assessment[1]) * dt
: s Waiting[2](t) = Waiting[2](t - dt) + (Attendance_rate[2] - Waiting_deaths[2] - Leaving_waiting_room[2] - Entering_assessment[2]) * dt
: s Waiting[3](t) = Waiting[3](t - dt) + (Attendance_rate[3] - Waiting_deaths[3] - Leaving_waiting_room[3] - Entering_assessment[3]) * dt
: s Waiting[4](t) = Waiting[4](t - dt) + (Attendance_rate[4] - Waiting_deaths[4] - Leaving_waiting_room[4] - Entering_assessment[4]) * dt
: s Waiting[5](t) = Waiting[5](t - dt) + (Attendance_rate[5] - Waiting_deaths[5] - Leaving_waiting_room[5] - Entering_assessment[5]) * dt

: s Discharges(t) = Discharges(t - dt) + (home_dur + transfer_dur + other_dur - dischg_exit_rate) * dt
: s Dischg__exit(t) = Dischg__exit(t - dt) + (dischg_exit_rate) * dt
: s Adm_exit(t) = Adm_exit(t - dt) + (adm_exit_rate) * dt
: s no_tret_exit(t) = no_tret_exit(t - dt) + (no_tret_exit_rate) * dt
: s LWBS(t) = LWBS(t - dt) + (Leaving_waiting_room[1] + Leaving_waiting_room[2] + Leaving_waiting_room[3] + Leaving_waiting_room[4] + Leaving_waiting_room[5] + Leaving_waiting_room[Acuity]) * dt
: s cumTreatment[1](t) = cumTreatment[1](t - dt) + (cpAssessment_Rate[1]) * dt
: s cumTreatment[2](t) = cumTreatment[2](t - dt) + (cpAssessment_Rate[2]) * dt
: s cumTreatment[3](t) = cumTreatment[3](t - dt) + (cpAssessment_Rate[3]) * dt
: s cumTreatment[4](t) = cumTreatment[4](t - dt) + (cpAssessment_Rate[4]) * dt
: s cumTreatment[5](t) = cumTreatment[5](t - dt) + (cpAssessment_Rate[5]) * dt
: s cumAssessment[1](t) = cumAssessment[1](t - dt) + (cpEntering_Assessment[1]) * dt
: s cumAssessment[2](t) = cumAssessment[2](t - dt) + (cpEntering_Assessment[2]) * dt
: s cumAssessment[3](t) = cumAssessment[3](t - dt) + (cpEntering_Assessment[3]) * dt
: s cumAssessment[4](t) = cumAssessment[4](t - dt) + (cpEntering_Assessment[4]) * dt
: s cumAssessment[5](t) = cumAssessment[5](t - dt) + (cpEntering_Assessment[5]) * dt
: I Treatment[1](t) = Treatment[1](t - dt) + (Assessment_rate[1] - Treatment_rate[1] - Admission_rate[1]) * dt
: I Treatment[2](t) = Treatment[2](t - dt) + (Assessment_rate[2] - Treatment_rate[2] - Admission_rate[2]) * dt
: I Treatment[3](t) = Treatment[3](t - dt) + (Assessment_rate[3] - Treatment_rate[3] - Admission_rate[3]) * dt
: I Treatment[4](t) = Treatment[4](t - dt) + (Assessment_rate[4] - Treatment_rate[4] - Admission_rate[4]) * dt
: I Treatment[5](t) = Treatment[5](t - dt) + (Assessment_rate[5] - Treatment_rate[5] - Admission_rate[5]) * dt
: I Assessment[1](t) = Assessment[1](t - dt) + (Emergency_rate[1] + Entering_assessment[1] - Assessment_rate[1] - Early_discharge[1]) * dt
: I Assessment[2](t) = Assessment[2](t - dt) + (Emergency_rate[2] + Entering_assessment[2] - Assessment_rate[2] - Early_discharge[2]) * dt
: I Assessment[3](t) = Assessment[3](t - dt) + (Emergency_rate[3] + Entering_assessment[3] - Assessment_rate[3] - Early_discharge[3]) * dt
: I Assessment[4](t) = Assessment[4](t - dt) + (Emergency_rate[4] + Entering_assessment[4] - Assessment_rate[4] - Early_discharge[4]) * dt
: I Assessment[5](t) = Assessment[5](t - dt) + (Emergency_rate[5] + Entering_assessment[5] - Assessment_rate[5] - Early_discharge[5]) * dt
: I Home(t) = Home(t - dt) + (home_rate - home_dur) * dt
: I Other(t) = Other(t - dt) + (other_rate - other_dur) * dt
: I Transfer(t) = Transfer(t - dt) + (transfer_rate - transfer_dur) * dt

: c Total_patients_in_dept = ARRAYSUM(Treatment[*]) + ARRAYSUM(Waiting_for_admission[*]) + ARRAYSUM(Assessment[*]) + Discharge_hold + Home + Other + Transfer
: c Night_shift = GRAPH(COUNTER(0,24))
(0, 1), (1, 1), (2, 1), (3, 1), (4, 1), (5, 1), (6, 1), (7, 1), (8, 0), (9, 0), (10, 0), (11, 0), (12, 0), (13, 0), (14, 0), (15, 0), (16, 0), (17, 0), (18, 0), (19, 0), (20, 1), (21, 1), (22, 1), (23, 1)
: c Staff[Band_2] = IF Staff_sens = 0 THEN
IF Night_shift = 1 THEN Night_nursing_staff[Band_2] ELSE Day_nursing_staff[Band_2]
ELSE IF Night_shift = 1 THEN Staff_count_night/6 ELSE Staff_count_day/6
: c Staff[Band_3] = IF Staff_sens = 0 THEN
IF Night_shift = 1 THEN Night_nursing_staff[Band_3] ELSE Day_nursing_staff[Band_3]
ELSE IF Night_shift = 1 THEN Staff_count_night/6 ELSE Staff_count_day/6
: c Staff[Band_4] = IF Staff_sens = 0 THEN
IF Night_shift = 1 THEN Night_nursing_staff[Band_4] ELSE Day_nursing_staff[Band_4]
ELSE IF Night_shift = 1 THEN Staff_count_night/6 ELSE Staff_count_day/6
: c Staff[Band_5] = IF Staff_sens = 0 THEN
IF Night_shift = 1 THEN Night_nursing_staff[Band_5] ELSE Day_nursing_staff[Band_5]
ELSE IF Night_shift = 1 THEN Staff_count_night/6 ELSE Staff_count_day/6
: c Staff[Band_6] = IF Staff_sens = 0 THEN
IF Night_shift = 1 THEN Night_nursing_staff[Band_6] ELSE Day_nursing_staff[Band_6]
ELSE IF Night_shift = 1 THEN Staff_count_night/6 ELSE Staff_count_day/6
: c Staff[Band_7] = IF Staff_sens = 0 THEN
IF Night_shift = 1 THEN Night_nursing_staff[Band_7] ELSE Day_nursing_staff[Band_7]
ELSE IF Night_shift = 1 THEN Staff_count_night/6 ELSE Staff_count_day/6
: c Skill_mix = IF Staff_sens = 1 THEN
IF Night_shift = 1 THEN Skill_mix_night_sens ELSE Skill_mix_day_sens
ELSE
((Staff[Band_2]*Staff_skill[Band_2]) +
(Staff[Band_3]*Staff_skill[Band_3]) +
(Staff[Band_4]*Staff_skill[Band_4]) +
(Staff[Band_5]*Staff_skill[Band_5]) +

(Staff[Band_6]*Staff_skill[Band_6]) +
(Staff[Band_7]*Staff_skill[Band_7])) / ARRAYSUM(Staff[*])
: c staff_ratio = IF Total_patients_in_dept = 0 THEN 0 ELSE (ARRAYSUM(Staff[*]) * Skill_mix)/Total_patients_in_dept
: c prod_ratio = IF staff_ratio = 0 THEN 0 ELSE (1/Baseline_patients_per_staff)/staff_ratio
: c treat_adjustment = Productivity_scalor^(prod_ratio-1)
: c Adj_assessment_duration[1] = Baseline_assessment_duration / Skill_mix
: c Adj_assessment_duration[2] = Baseline_assessment_duration / Skill_mix
: c Adj_assessment_duration[3] = Baseline_assessment_duration / Skill_mix
: c Adj_assessment_duration[4] = Baseline_assessment_duration / Skill_mix
: c Adj_assessment_duration[5] = Baseline_assessment_duration / Skill_mix
: c Avg_treatment_time[1] = Baseline_treatment_time[1] * treat_adjustment
: c Avg_treatment_time[2] = Baseline_treatment_time[2] * treat_adjustment
: c Avg_treatment_time[3] = Baseline_treatment_time[3] * treat_adjustment
: c Avg_treatment_time[4] = Baseline_treatment_time[4] * treat_adjustment
: c Avg_treatment_time[5] = Baseline_treatment_time[5] * treat_adjustment
: c Ward_cycle = GRAPH(COUNTER(0,24))
(0, 1), (1, 1), (2, 1), (3, 1), (4, 0), (5, 0), (6, 0), (7, 0), (8, 0), (9, 0), (10, 0), (11, 1), (12, 1), (13, 1), (14, 1), (15, 1), (16, 1), (17, 1), (18, 1), (19, 1), (20, 1), (21, 1), (22, 1), (23, 1)
: c WardStatus = IF Open_wards = 1 THEN 1 ELSE Ward_cycle
: c available_capacity = Department_capacity - Total_patients_in_dept
: c Available_waiting_room_capacity = Waiting_room_capacity - ARRAYSUM(Waiting[*])
: c Attendance_distribution = GRAPH(COUNTER(0,24))
(0, 0.023), (1, 0.02), (2, 0.014), (3, 0.014), (4, 0.013), (5, 0.013), (6, 0.013), (7, 0.019), (8, 0.035), (9, 0.073), (10, 0.07), (11, 0.066), (12, 0.061), (13, 0.061), (14, 0.057), (15, 0.057), (16, 0.058), (17, 0.059), (18, 0.063), (19, 0.058), (20, 0.05), (21, 0.041), (22, 0.034), (23, 0.029)
: c Total_arrivals = Attendance_distribution*Daily_attendances
: c Emergency_distribution = GRAPH(COUNTER(0,24))
(0, 0.48), (1, 0.53), (2, 0.55), (3, 0.55), (4, 0.55), (5, 0.54), (6, 0.46), (7, 0.32), (8, 0.25), (9, 0.21), (10, 0.22), (11, 0.23), (12, 0.24), (13, 0.25), (14, 0.26), (15, 0.27), (16, 0.26), (17, 0.26), (18, 0.24), (19, 0.24), (20, 0.28), (21, 0.31), (22, 0.36), (23, 0.42)
: c Non_emergency_attendances[1] = POISSON(Total_arrivals*(1-Emergency_distribution)*acuity_dist_nem[1], 1)
: c Non_emergency_attendances[2] = POISSON(Total_arrivals*(1-Emergency_distribution)*acuity_dist_nem[2], 1)

: c Non_emergency_attendances[3] = POISSON(Total_arrivals*(1-Emergency_distribution)*acuity_dist_nem[3], 1)
: c Non_emergency_attendances[4] = POISSON(Total_arrivals*(1-Emergency_distribution)*acuity_dist_nem[4], 1)
: c Non_emergency_attendances[5] = POISSON(Total_arrivals*(1-Emergency_distribution)*acuity_dist_nem[5], 1)
: c Actual_attendances[1] = IF Overfill_waiting_room = 0 THEN MIN(Available_waiting_room_capacity, Non_emergency_attendances[1]) ELSE Non_emergency_attendances[1]
: c Actual_attendances[2] = IF Overfill_waiting_room = 0 THEN MIN(Available_waiting_room_capacity, Non_emergency_attendances[2]) ELSE Non_emergency_attendances[2]
: c Actual_attendances[3] = IF Overfill_waiting_room = 0 THEN MIN(Available_waiting_room_capacity, Non_emergency_attendances[3]) ELSE Non_emergency_attendances[3]
: c Actual_attendances[4] = IF Overfill_waiting_room = 0 THEN MIN(Available_waiting_room_capacity, Non_emergency_attendances[4]) ELSE Non_emergency_attendances[4]
: c Actual_attendances[5] = IF Overfill_waiting_room = 0 THEN MIN(Available_waiting_room_capacity, Non_emergency_attendances[5]) ELSE Non_emergency_attendances[5]
: c Patients_redirected = ARRAYSUM(Non_emergency_attendances[*]) - ARRAYSUM(Actual_attendances[*])
: f Overflow = PULSE(Patients_redirected)
: f Early_discharge[1] = LEAKAGE OUTFLOW
	LEAKAGE FRACTION = IF RANDOM(0,1,7) <= pEarly_discharge[1] THEN 1 ELSE 0
: f Early_discharge[2] = LEAKAGE OUTFLOW
	LEAKAGE FRACTION = IF RANDOM(0,1,7) <= pEarly_discharge[2] THEN 1 ELSE 0
: f Early_discharge[3] = LEAKAGE OUTFLOW
	LEAKAGE FRACTION = IF RANDOM(0,1,7) <= pEarly_discharge[3] THEN 1 ELSE 0
: f Early_discharge[4] = LEAKAGE OUTFLOW
	LEAKAGE FRACTION = IF RANDOM(0,1,7) <= pEarly_discharge[4] THEN 1 ELSE 0
: f Early_discharge[5] = LEAKAGE OUTFLOW
	LEAKAGE FRACTION = IF RANDOM(0,1,7) <= pEarly_discharge[5] THEN 1 ELSE 0
: f no_tret_exit_rate = No_treatment
	TIMESTAMPED
: f Attendance_rate[1] = PULSE(Actual_attendances[1])
	TIMESTAMPED
: f Waiting_deaths[1] = IF RANDOM(0,1,4) <= pDeath[1] THEN PULSE(1) ELSE 0

: f Attendance_rate[2] = PULSE(Actual_attendances[2])
TIMESTAMPED
: f Waiting_deaths[2] = IF RANDOM(0,1,4) <= pDeath[2] THEN PULSE(1) ELSE 0
: f Attendance_rate[3] = PULSE(Actual_attendances[3])
TIMESTAMPED
: f Waiting_deaths[3] = IF RANDOM(0,1,4) <= pDeath[3] THEN PULSE(1) ELSE 0
: f Attendance_rate[4] = PULSE(Actual_attendances[4])
TIMESTAMPED
: f Waiting_deaths[4] = IF RANDOM(0,1,4) <= pDeath[4] THEN PULSE(1) ELSE 0
: f Attendance_rate[5] = PULSE(Actual_attendances[5])
TIMESTAMPED
: f Waiting_deaths[5] = IF RANDOM(0,1,4) <= pDeath[5] THEN PULSE(1) ELSE 0
: f Admission_rate[1] = LEAKAGE OUTFLOW
LEAKAGE FRACTION = IF RANDOM(0,1,8) <= pAdmission[1] THEN PULSE(1) ELSE 0
: f Treatment_deaths[1] = IF RANDOM(0,1,5) <= pDeath[1] THEN PULSE(1) ELSE 0
: f Admission_rate[2] = LEAKAGE OUTFLOW
LEAKAGE FRACTION = IF RANDOM(0,1,8) <= pAdmission[2] THEN PULSE(1) ELSE 0
: f Treatment_deaths[2] = IF RANDOM(0,1,5) <= pDeath[2] THEN PULSE(1) ELSE 0
: f Admission_rate[3] = LEAKAGE OUTFLOW
LEAKAGE FRACTION = IF RANDOM(0,1,8) <= pAdmission[3] THEN PULSE(1) ELSE 0
: f Treatment_deaths[3] = IF RANDOM(0,1,5) <= pDeath[3] THEN PULSE(1) ELSE 0
: f Admission_rate[4] = LEAKAGE OUTFLOW
LEAKAGE FRACTION = IF RANDOM(0,1,8) <= pAdmission[4] THEN PULSE(1) ELSE 0
: f Treatment_deaths[4] = IF RANDOM(0,1,5) <= pDeath[4] THEN PULSE(1) ELSE 0
: f Admission_rate[5] = LEAKAGE OUTFLOW
LEAKAGE FRACTION = IF RANDOM(0,1,8) <= pAdmission[5] THEN PULSE(1) ELSE 0
: f Treatment_deaths[5] = IF RANDOM(0,1,5) <= pDeath[5] THEN PULSE(1) ELSE 0
: f Ward_transfer_rate[1] = IF WardStatus > 0 THEN 1 / Avg_transfer_time ELSE 0
: f Ward_transfer_rate[2] = IF WardStatus > 0 THEN 1 / Avg_transfer_time ELSE 0
: f Ward_transfer_rate[3] = IF WardStatus > 0 THEN 1 / Avg_transfer_time ELSE 0

: f Ward_transfer_rate[4] = IF WardStatus > 0 THEN 1 / Avg_transfer_time ELSE 0
: f Ward_transfer_rate[5] = IF WardStatus > 0 THEN 1 / Avg_transfer_time ELSE 0
: f adm_exit_rate = Admitted
TIMESTAMPED
: c discharge_rnd = RANDOM(0,1, 9)
: f Treatment_rate[1] = CONVEYOR OUTFLOW
TRANSIT TIME = EXPRND(Avg_treatment_time[1], 1)
: f Treatment_rate[2] = CONVEYOR OUTFLOW
TRANSIT TIME = EXPRND(Avg_treatment_time[2], 1)
: f Treatment_rate[3] = CONVEYOR OUTFLOW
TRANSIT TIME = EXPRND(Avg_treatment_time[3], 1)
: f Treatment_rate[4] = CONVEYOR OUTFLOW
TRANSIT TIME = EXPRND(Avg_treatment_time[4], 1)
: f Treatment_rate[5] = CONVEYOR OUTFLOW
TRANSIT TIME = EXPRND(Avg_treatment_time[5], 1)
: f home_rate = IF discharge_rnd <= pDisHome THEN PULSE(1) ELSE 0
: c pcumDisTrans = pDisHome + pDisTrans
: f transfer_rate = IF discharge_rnd > pDisHome AND discharge_rnd <= pcumDisTrans THEN PULSE(1) ELSE 0
: c pcumDisOther = pcumDisTrans + pDisOther
: f other_rate = IF discharge_rnd > pcumDisTrans AND discharge_rnd <= pcumDisOther THEN PULSE(1) ELSE 0
: f Assessment_rate[1] = CONVEYOR OUTFLOW
TRANSIT TIME = NORMAL(Adj_assessment_duration[1], 0.05, 6)
: c Avg_time_to_tret[1] = CTMEAN(Assessment_rate[1], 0 , 1)
: c pLWBS[1] = GRAPH(Avg_time_to_tret[1])
(0, 0.005), (1, 0.02), (2, 0.045), (3, 0.065), (4, 0.095), (5, 0.12), (6, 0.185), (7, 0.27), (8, 0.39), (9, 0.515), (10, 0.695)
: f Leaving_waiting_room[1] = IF RANDOM(0,1, 3) <= pLWBS[1] THEN PULSE(1) ELSE 0
: c Assessment_status[1] = IF ARRAYSUM(Staff[*]) <= ARRAYSUM(Assessment[*]) OR available_capacity <= 0 OR Waiting[2] + Waiting[3] + Waiting [4] + Waiting[5]
>= ARRAYSUM(Staff[*])
THEN 0

ELSE MIN(Waiting[1] - Waiting[2] - Waiting[3] - Waiting [4] - Waiting[5], ARRAYSUM(Staff[*]) - ARRAYSUM(Assessment[*]) - Waiting[2] - Waiting[3] - Waiting [4] - Waiting[5])
: f Entering_assessment[1] = PULSE(Assessment_status[1])
: f Assessment_rate[2] = CONVEYOR OUTFLOW
TRANSIT TIME = NORMAL(Adj_assessment_duration[2], 0.05, 6)
: c Avg_time_to_tret[2] = CTMEAN(Assessment_rate[2], 0 , 1)
: c pLWBS[2] = GRAPH(Avg_time_to_tret[2])
(0, 0.005), (1, 0.02), (2, 0.045), (3, 0.065), (4, 0.095), (5, 0.12), (6, 0.185), (7, 0.27), (8, 0.39), (9, 0.515), (10, 0.695)
: f Leaving_waiting_room[2] = IF RANDOM(0,1, 3) <= pLWBS[2] THEN PULSE(1) ELSE 0
: c Assessment_status[2] = IF ARRAYSUM(Staff[*]) <= ARRAYSUM(Assessment[*]) OR available_capacity <= 0 OR Waiting[3] + Waiting [4] + Waiting[5] >= ARRAYSUM(Staff[*])
THEN 0
ELSE MIN(Waiting[2] - Waiting[3] - Waiting [4] - Waiting[5], ARRAYSUM(Staff[*]) - ARRAYSUM(Assessment[*]) - Waiting[3] - Waiting [4] - Waiting[5])
: f Entering_assessment[2] = PULSE(Assessment_status[2])
: f Assessment_rate[3] = CONVEYOR OUTFLOW
TRANSIT TIME = NORMAL(Adj_assessment_duration[3], 0.05, 6)
: c Avg_time_to_tret[3] = CTMEAN(Assessment_rate[3], 0 , 1)
: c pLWBS[3] = GRAPH(Avg_time_to_tret[3])
(0, 0.005), (1, 0.02), (2, 0.045), (3, 0.065), (4, 0.095), (5, 0.12), (6, 0.185), (7, 0.27), (8, 0.39), (9, 0.515), (10, 0.695)
: f Leaving_waiting_room[3] = IF RANDOM(0,1, 3) <= pLWBS[3] THEN PULSE(1) ELSE 0
: c Assessment_status[3] = IF ARRAYSUM(Staff[*]) <= ARRAYSUM(Assessment[*]) OR available_capacity <= 0 OR Waiting [4] + Waiting[5] >= ARRAYSUM(Staff[*])
THEN 0
ELSE MIN(Waiting[3] - Waiting [4] - Waiting[5], ARRAYSUM(Staff[*]) - ARRAYSUM(Assessment[*]) - Waiting [4] - Waiting[5])
: f Entering_assessment[3] = PULSE(Assessment_status[3])
: f Assessment_rate[4] = CONVEYOR OUTFLOW
TRANSIT TIME = NORMAL(Adj_assessment_duration[4], 0.05, 6)
: c Avg_time_to_tret[4] = CTMEAN(Assessment_rate[4], 0 , 1)
: c pLWBS[4] = GRAPH(Avg_time_to_tret[4])
(0, 0.005), (1, 0.02), (2, 0.045), (3, 0.065), (4, 0.095), (5, 0.12), (6, 0.185), (7, 0.27), (8, 0.39), (9, 0.515), (10, 0.695)
: f Leaving_waiting_room[4] = IF RANDOM(0,1, 3) <= pLWBS[4] THEN PULSE(1) ELSE 0

: c Assessment_status[4] = IF ARRAYSUM(Staff[*]) <= ARRAYSUM(Assessment[*]) OR available_capacity <= 0 OR Waiting[5] >= ARRAYSUM(Staff[*])
THEN 0
ELSE MIN(Waiting [4] - Waiting[5], ARRAYSUM(Staff[*]) - ARRAYSUM(Assessment[*]) - Waiting[5])
: f Entering_assessment[4] = PULSE(Assessment_status[4])
: f Assessment_rate[5] = CONVEYOR OUTFLOW
TRANSIT TIME = NORMAL(Adj_assessment_duration[5], 0.05, 6)
: c Avg_time_to_tret[5] = CTMEAN(Assessment_rate[5], 0 , 1)
: c pLWBS[5] = GRAPH(Avg_time_to_tret[5])
(0, 0.005), (1, 0.02), (2, 0.045), (3, 0.065), (4, 0.095), (5, 0.12), (6, 0.185), (7, 0.27), (8, 0.39), (9, 0.515), (10, 0.695)
: f Leaving_waiting_room[5] = IF RANDOM(0,1, 3) <= pLWBS[5] THEN PULSE(1) ELSE 0
: c Assessment_status[5] = IF ARRAYSUM(Staff[*]) <= ARRAYSUM(Assessment[*]) OR available_capacity <= 0
THEN 0
ELSE MIN(Waiting[5], ARRAYSUM(Staff[*]) - ARRAYSUM(Assessment[*]))
: f Entering_assessment[5] = PULSE(Assessment_status[5])
: f home_dur = CONVEYOR OUTFLOW
: f transfer_dur = CONVEYOR OUTFLOW
: f other_dur = CONVEYOR OUTFLOW
: f dischg_exit_rate = Discharges
TIMESTAMPED
: f cpAssessment_Rate[1] = Assessment_rate[1]
: f cpAssessment_Rate[2] = Assessment_rate[2]
: f cpAssessment_Rate[3] = Assessment_rate[3]
: f cpAssessment_Rate[4] = Assessment_rate[4]
: f cpAssessment_Rate[5] = Assessment_rate[5]
: f cpEntering_Assessment[1] = PULSE(Entering_assessment[1])
: f cpEntering_Assessment[2] = PULSE(Entering_assessment[2])
: f cpEntering_Assessment[3] = PULSE(Entering_assessment[3])
: f cpEntering_Assessment[4] = PULSE(Entering_assessment[4])
: f cpEntering_Assessment[5] = PULSE(Entering_assessment[5])
: c Emergency_attendances[1] = POISSON(Total_arrivals*Emergency_distribution*acuity_dist_em[1], 2)

: f Emergency_rate[1] = PULSE(Emergency_attendances[1])
TIMESTAMPED
: c Emergency_attendances[2] = POISSON(Total_arrivals*Emergency_distribution*acuity_dist_em[2], 2)
: f Emergency_rate[2] = PULSE(Emergency_attendances[2])
TIMESTAMPED
: c Emergency_attendances[3] = POISSON(Total_arrivals*Emergency_distribution*acuity_dist_em[3], 2)
: f Emergency_rate[3] = PULSE(Emergency_attendances[3])
TIMESTAMPED
: c Emergency_attendances[4] = POISSON(Total_arrivals*Emergency_distribution*acuity_dist_em[4], 2)
: f Emergency_rate[4] = PULSE(Emergency_attendances[4])
TIMESTAMPED
: c Emergency_attendances[5] = POISSON(Total_arrivals*Emergency_distribution*acuity_dist_em[5], 2)
: f Emergency_rate[5] = PULSE(Emergency_attendances[5])
TIMESTAMPED
: c Occupancy = (1- (available_capacity / Department_capacity)) * 100
: c wt_avg_time_to_treat1[1] = cumTreatment[1] * Avg_time_to_tret[1]
: c Avg_treat_time[1] = CTMEAN(Treatment_rate[1], 0, 1)
: c Avg_treat_time[2] = CTMEAN(Treatment_rate[2], 0, 1)
: c Avg_treat_time[3] = CTMEAN(Treatment_rate[3], 0, 1)
: c Avg_treat_time[4] = CTMEAN(Treatment_rate[4], 0, 1)
: c Avg_treat_time[5] = CTMEAN(Treatment_rate[5], 0, 1)
: c WaitingTotal = ARRAYSUM(Waiting[*])
: c AssessmentTotal = ARRAYSUM(Assessment[*])
: c TreatmentTotal = ARRAYSUM(Treatment[*])
: c WaitingForAdmissionTotal = ARRAYSUM(Waiting_for_admission[*])
: c wt_avg_time_to_treat1[2] = cumTreatment[2] * Avg_time_to_tret[2]
: c wt_avg_time_to_treat1[3] = cumTreatment[3] * Avg_time_to_tret[3]
: c wt_avg_time_to_treat1[4] = cumTreatment[4] * Avg_time_to_tret[4]
: c wt_avg_time_to_treat1[5] = cumTreatment[5] * Avg_time_to_tret[5]
: c wt_avg_time_to_treat2 = IF ARRAYSUM(cumTreatment[*]) = 0 THEN 0 ELSE ARRAYSUM(wt_avg_time_to_treat1[*]) / ARRAYSUM(cumTreatment[*])

: c avg_dischg_time_in_dept = CTMEAN(dischg_exit_rate, 0, 1)
UNITS: hr
: c Total_patients = Admitted + Adm_exit + ARRAYSUM(Assessment[*]) + Deaths + Discharges + Discharge_hold + Dischg__exit + Home + LWBS + No_treatment + no_tret_exit + Other + Transfer + ARRAYSUM(Treatment[*]) + ARRAYSUM(Waiting[*]) + ARRAYSUM(Waiting_for_admission[*])
: c Actual_staff = ARRAYSUM(Staff[*])
: c Avg_time_to_assessment[1] = CTMEAN(Entering_assessment[1], 0, 1)
: c wt_avg_time_to_assess1[1] = cumAssessment[1] * Avg_time_to_assessment[1]
: c Avg_time_to_assessment[2] = CTMEAN(Entering_assessment[2], 0, 1)
: c wt_avg_time_to_assess1[2] = cumAssessment[2] * Avg_time_to_assessment[2]
: c Avg_time_to_assessment[3] = CTMEAN(Entering_assessment[3], 0, 1)
: c wt_avg_time_to_assess1[3] = cumAssessment[3] * Avg_time_to_assessment[3]
: c Avg_time_to_assessment[4] = CTMEAN(Entering_assessment[4], 0, 1)
: c wt_avg_time_to_assess1[4] = cumAssessment[4] * Avg_time_to_assessment[4]
: c avg_adm_time_in_dept = CTMEAN(adm_exit_rate, 0, 1)
: c avg_no_tret_time_in_dept = CTMEAN(no_tret_exit_rate, 0, 1)
: c avg_duration_in_dept = IF (Adm_exit+Dischg__exit+no_tret_exit) = 0 THEN 0
ELSE
(((Adm_exit * avg_adm_time_in_dept) + (Dischg__exit*avg_dischg_time_in_dept) + (no_tret_exit*avg_no_tret_time_in_dept)) /
(Adm_exit+Dischg__exit+no_tret_exit))
: c Avg_time_to_assessment[5] = CTMEAN(Entering_assessment[5], 0, 1)
: c wt_avg_time_to_assess1[5] = cumAssessment[5] * Avg_time_to_assessment[5]
: c wt_avg_time_to_assess2 = IF ARRAYSUM(cumAssessment[*]) = 0 THEN 0 ELSE ARRAYSUM(wt_avg_time_to_assess1[*]) / ARRAYSUM(cumAssessment[*])