ED SIMULATION MODEL FOR SHORT-TERM DECISION-SUPPORT
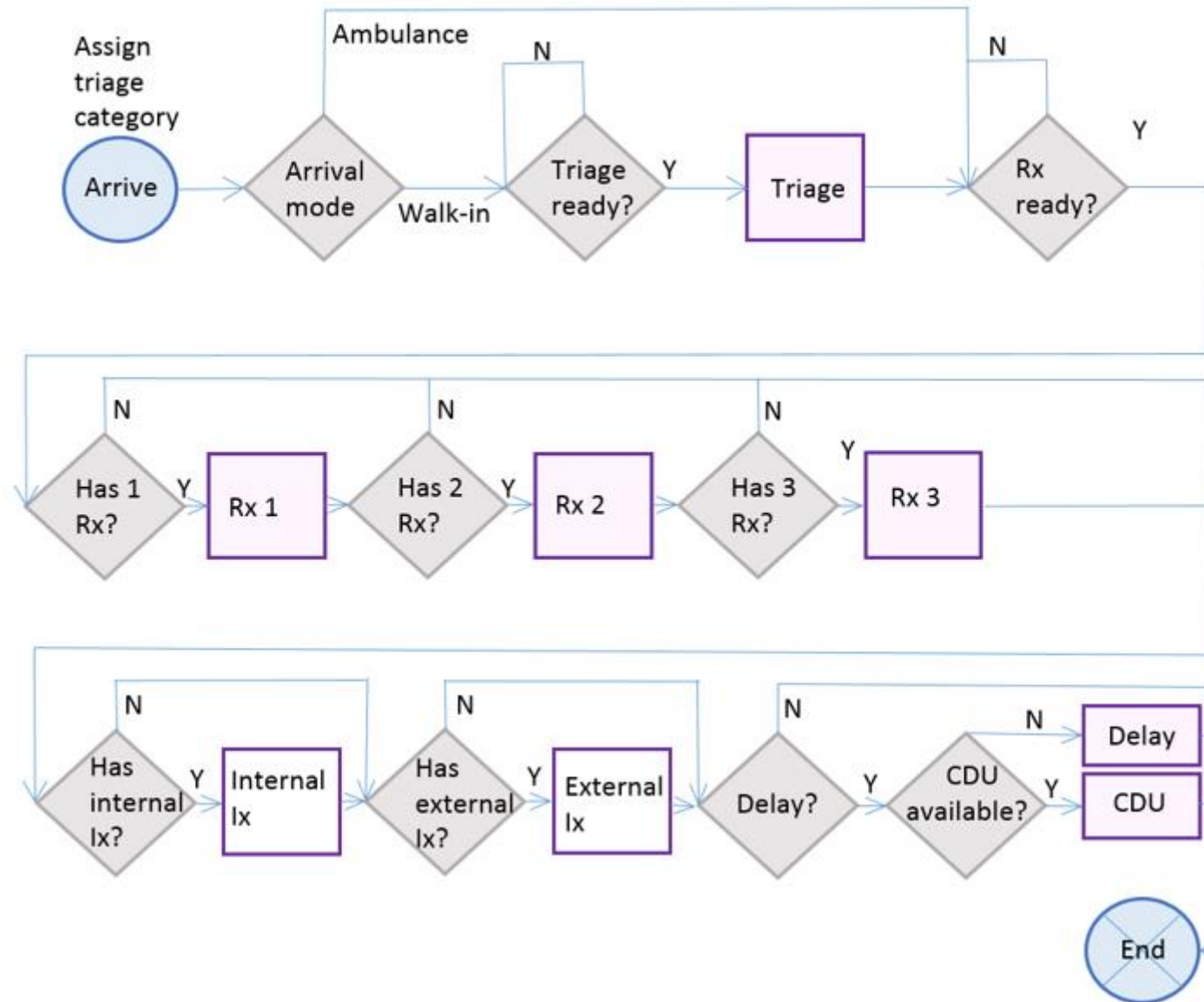
Alison Harper

ED FLOW CHART

ED Simulation


```
// start model with actual current time?
if (cb_StartAtSystemTime.isSelected() == true) {
    Date currentSystemDate = new Date(); // automatically gets system date
    // adjust for warmup period (start that much earlier)
```

p_TriageCategoryDistribution
TriageCategoryHistogram

ArrivalRateTable
ArrivalRatePerHour

f_CanEnterSystem

canEnterSystem

(d)

walkInPatient

triage

whichCat

seize_Trolley

(i)

treat1_Cat1

(c)

(a)

patientEntersSystem

(b)

(h)

(f)

(e)

treat1_Cat2

treat1_Cat3

sendToOtherHospital

treat1_Cat4

(g) Consultant

JuniorDoctor

NursePractitioner

Nurse

trolleysMinor

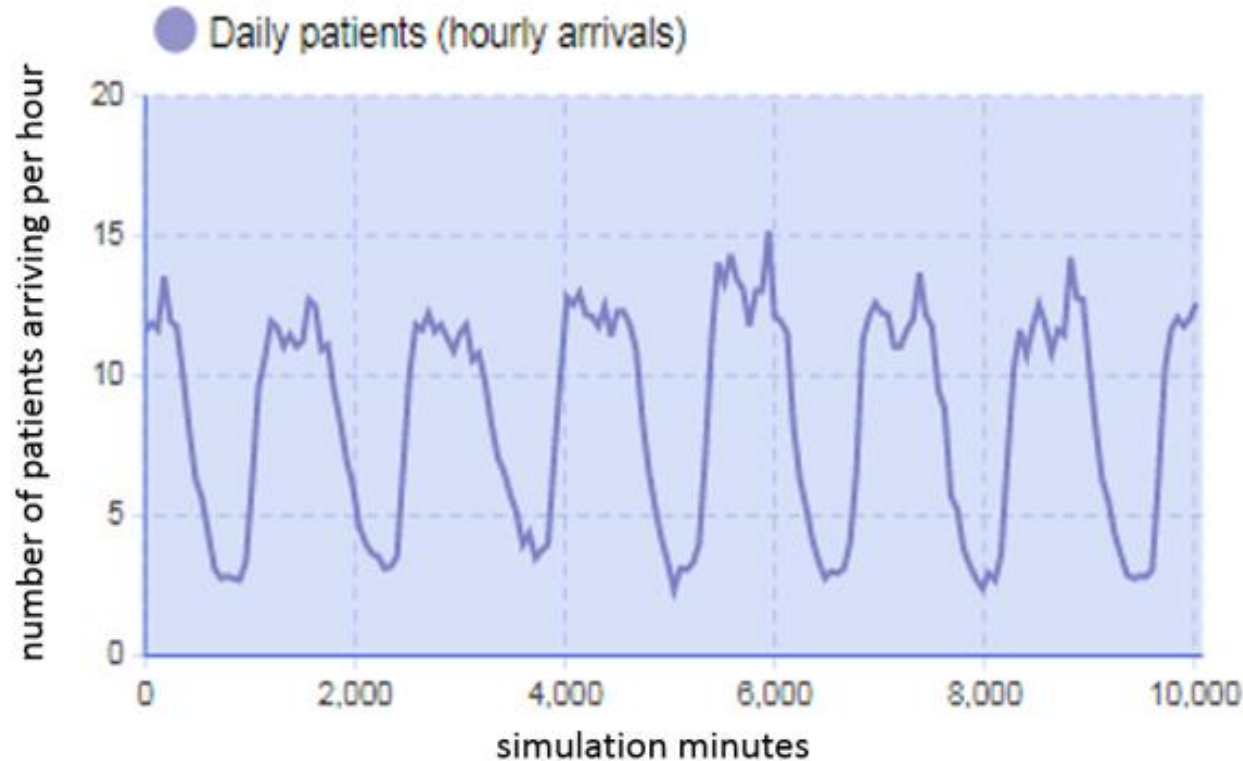trolleysTriage

trolleysMajor

trolleysResus

cdu

treat1_Cat5

ENTITY ARRIVALS INTO THE SIMULATION
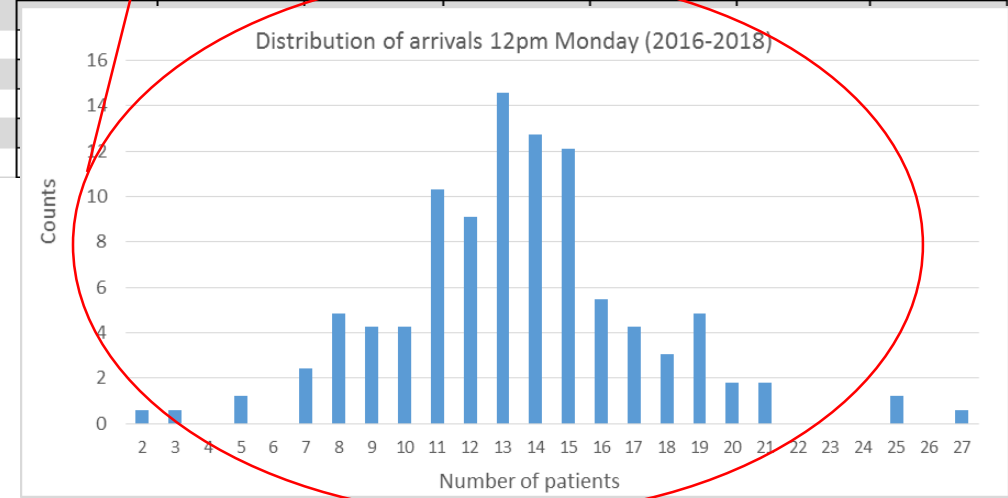
Simulated arrivals per hour for one-week

Arrival schedule for one week based on historical data. AnyLogic puts a Poisson distribution around average arrivals

Daily patients (hourly arrivals)

	min Sun	min Mon	min Tue	min Wed	min Thur	min Fri	min Sat
00	0.109	0.088	0.088	0.087	0.092	0.094	0.101
01	0.096	0.070	0.069	0.064	0.073	0.073	0.077
02	0.085	0.056	0.056	0.054	0.060	0.052	0.067
03	0.066	0.039	0.046	0.046	0.048	0.046	0.061
04	0.073	0.052	0.050	0.040	0.046	0.047	0.059
05	0.058	0.051	0.049	0.049	0.047	0.046	0.052
06	0.063	0.055	0.052	0.045	0.047	0.045	0.053
07	0.066	0.066	0.067	0.060	0.051	0.056	0.059
08	0.119	0.119	0.110	0.117	0.106	0.104	0.113
09	0.168	0.188	0.188	0.171	0.170	0.160	0.168
10	0.213	0.234	0.202	0.194	0.194	0.177	0.197
11	0.209	0.222	0.210	0.179	0.201	0.199	0.194
12	0.216	0.239	0.204	0.196	0.196	0.195	0.204
13	0.203	0.224	0.203	0.209	0.201	0.184	0.193
14	0.202	0.218	0.184	0.197	0.210	0.191	0.197
15	0.196	0.196	0.184	0.180	0.193	0.184	0.189
16	0.208	0.217	0.194	0.194	0.198	0.187	0.181
17	0.190	0.217	0.200	0.191	0.194	0.212	0.192
18							
19							
20							
21							
22							
23							

Distribution of arrivals 12pm Monday (2016-2018)

| Category 1	Category 2	Category 3	Category 4	Category 5
0.007	0.037	0.484	0.406	0.066

Triage category distribution

TREATMENT PROBABILITY AND DURATION

Probability per triage category of 0, 1, 2 or 3 treatments

Category	Had 1,2,3 treatments	Had no treatment
1	0.50	0.50
2	0.58	0.42
3	0.52	0.48
4	0.52	0.48
5	0.51	0.49

Category	Had 2,3 treatments	No further treatment
1	0.65	0.35
2	0.65	0.35
3	0.52	0.48
4	0.59	0.41
5	0.66	0.34

Category	Had,3 treatments	No further treatment
1	0.69	0.31
2	0.68	0.32
3	0.56	0.44
4	0.56	0.44
5	0.55	0.45

ED Length of Stay, Category 5
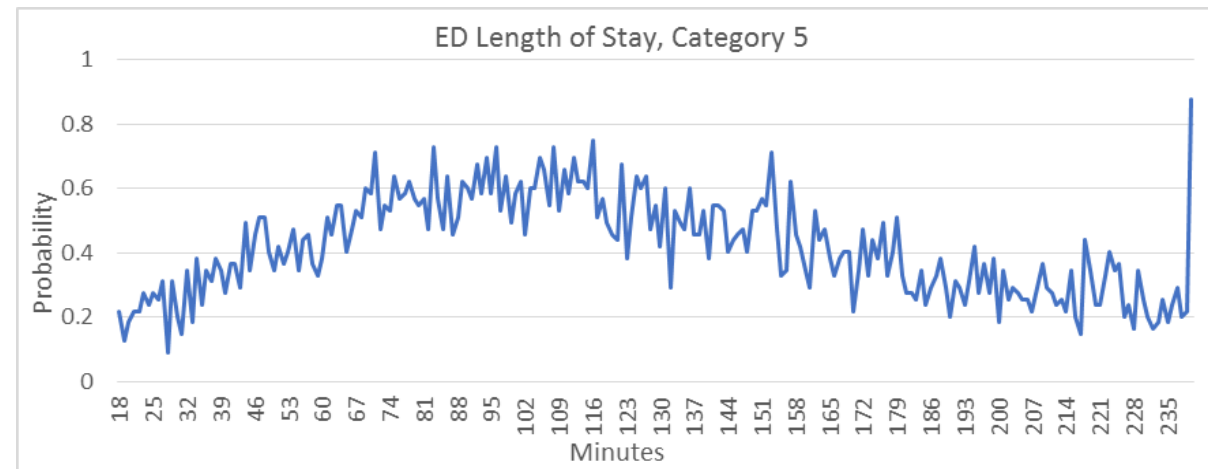
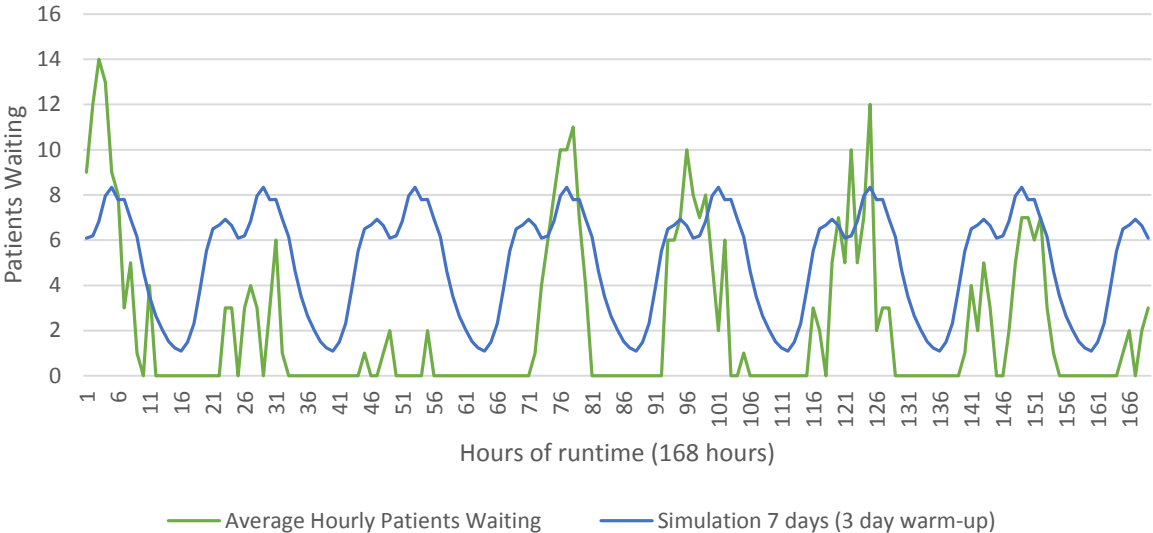| Category	First treatment	Resources
1	Triangular (20, 50, 100)	1 consultant, 1 junior doctor, 1 nurse
2	Triangular (20, 40, 70)	1 nurse, 1 junior doc OR 1 consultant, 1 nurse
3	Triangular (20, 40, 60)	1 nurse, 1 junior doc OR 1 consultant, 1 nurse
4	Triangular (20, 40, 60)	1 junior doc OR 1 nurse OR 1 consultant
5	Triangular (20, 40, 60)	1 junior doc OR 1 nurse practitioner

Category	Subsequent treatments	Resources
1	Triangular (15, 20, 60)	1 junior doc OR 1 consultant OR 1 nurse
2	Triangular (10, 15, 20)	1 junior doc OR 1 consultant OR 1 nurse
3	Triangular (10, 15, 20)	1 junior doc OR 1 nurse
4	Triangular (10, 15, 20)	1 junior doc OR 1 nurse practitioner OR 1 nurse
5	Triangular (10, 15, 20)	1 junior doc OR 1 nurse practitioner OR 1 nurse

VALIDATION

Average Total Patients (NHSquicker) and Simulated Total Patients

— Average Hourly Total Patients — Simulation 7 days (3 day warm-up)
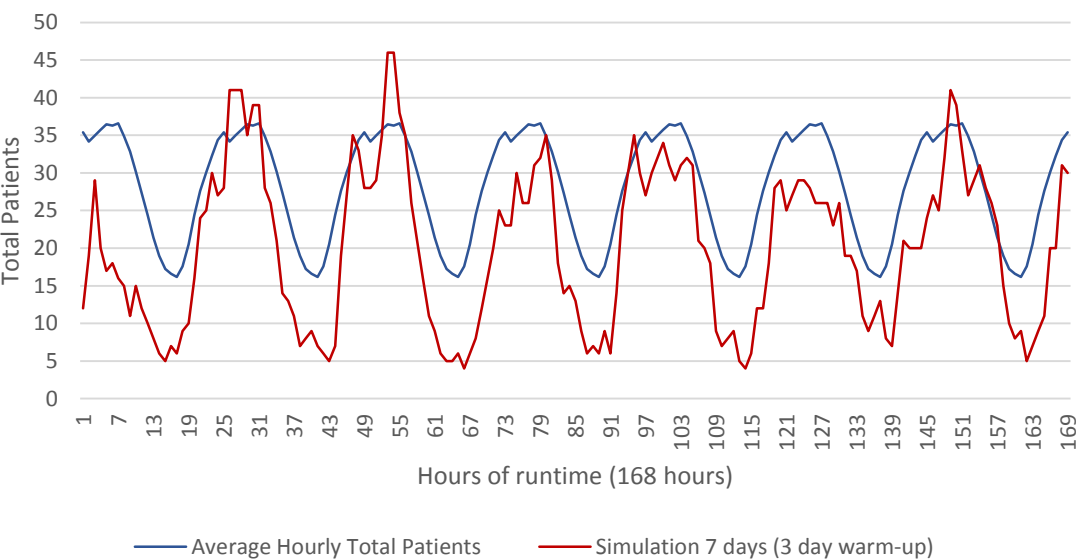
Patients Waiting and Simulated Patients Waiting

— Average Hourly Patients Waiting — Simulation 7 days (3 day warm-up)

Replications = 7 days	Total Patients NHSquicker	Simulated Total Patients	Patients Waiting NHSquicker	Simulated Patients Waiting
Minimum	3	3	0	0
Maximum	63	49	27	27
Average	28	21	4	3
Std Dev.	10.53	9.98	3.07	4.93

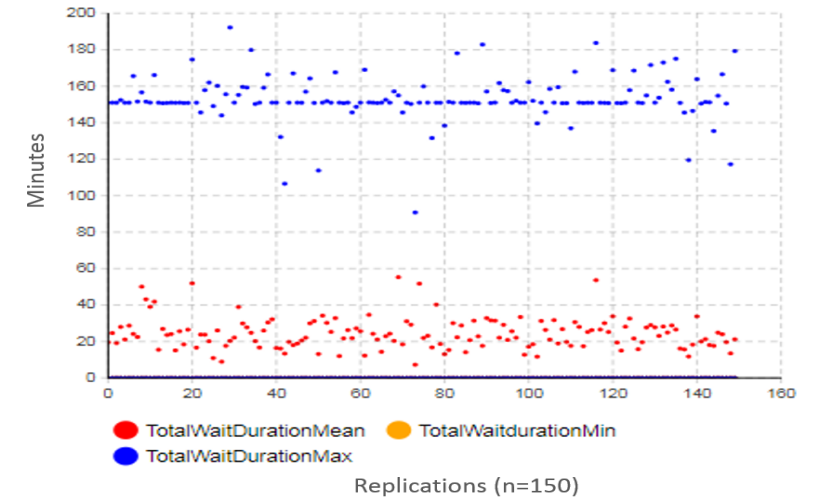| Replications = 150	Wait time (ED)	Simulated Wait Time	LoS (ED)	Simulated LoS
Minimum	0	0	0	0
Maximum	214	192	800	679
Average	23	24.3	194	141

Scenario 2 – Redirect a proportion of Category 3, 4 and 5 patients to MIU when the number of patients in the department is forecasted to reach the hourly trigger (in 2-4 hours' time, i.e. predictive trigger). Simulation is initialised using simulated real-time data.

Summary (min, mean, max) simulated wait times for first treatment

● TotalWaitDurationMean ● TotalWaitdurationMin
● TotalWaitDurationMax

Replications (n=150)

KPIs for Scenario 2: Number of patients redirected = 8		
KPI	**Baseline**	**Redirect 15% Cat3; 30% Cat4; 50% Cat5**
Total Patients	Max = 50 patients	Max = 30 patients
Length of Stay	Max = 550 min Mean = 150 min	Max = 450 min Mean = 80 min
Wait for initial treatment	Max = 150 min Mean = 20 min	Max = 100 min Mean = 5 min

Summary (min, mean, max) simulated wait times for first treatment

Replications (n=150)