



Hospital digital twin for
better resourcing and care
in dynamic situations

DECISION LAB



Gloucestershire Health and Care
NHS Foundation Trust

01

Background

Who was the project for?



Gloucestershire Health and Care
NHS Foundation Trust

- ≈8,000 employees
- Trust Analytical Team has ≈20 members

Requirements

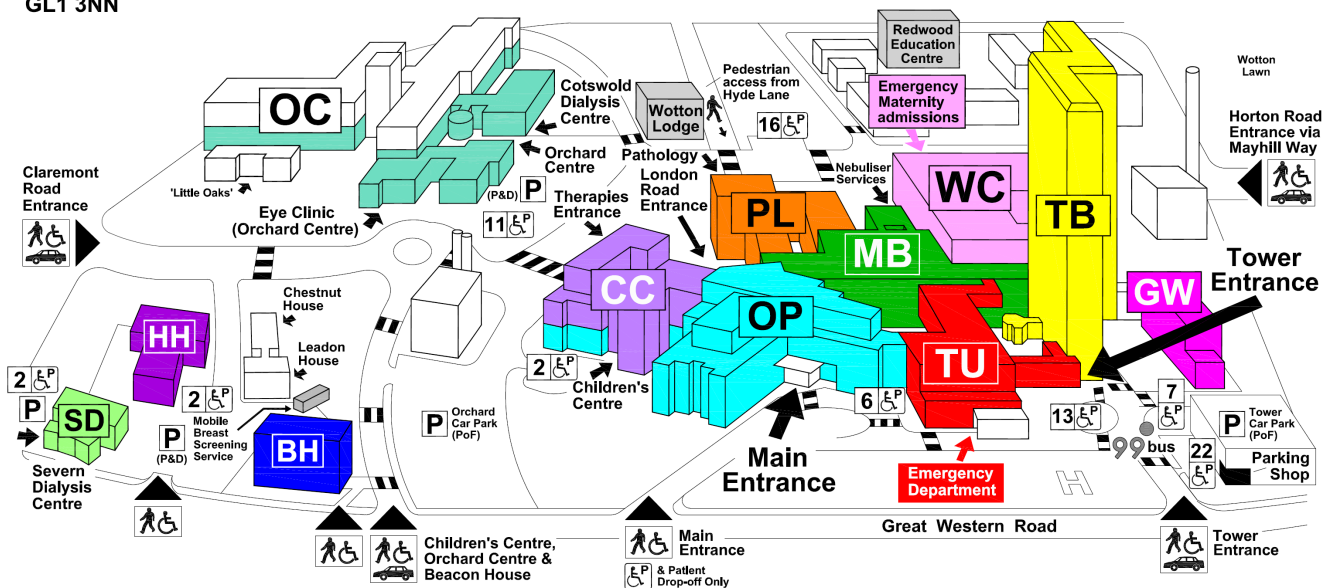
A digital twin to investigate what-if scenarios at a hospital level
Support optimising hospital procedures and resources to offer best care possible in dynamic situations
Full journey of both non-elective and elective patients modelled from arrival to exit

Sites

- 2 sites (CGH & GRH) within same local Trust
- Some specialties are unique to a site
- 75 locations to model

Gloucestershire Royal Hospital

Great Western Road
Gloucester
GL1 3NN



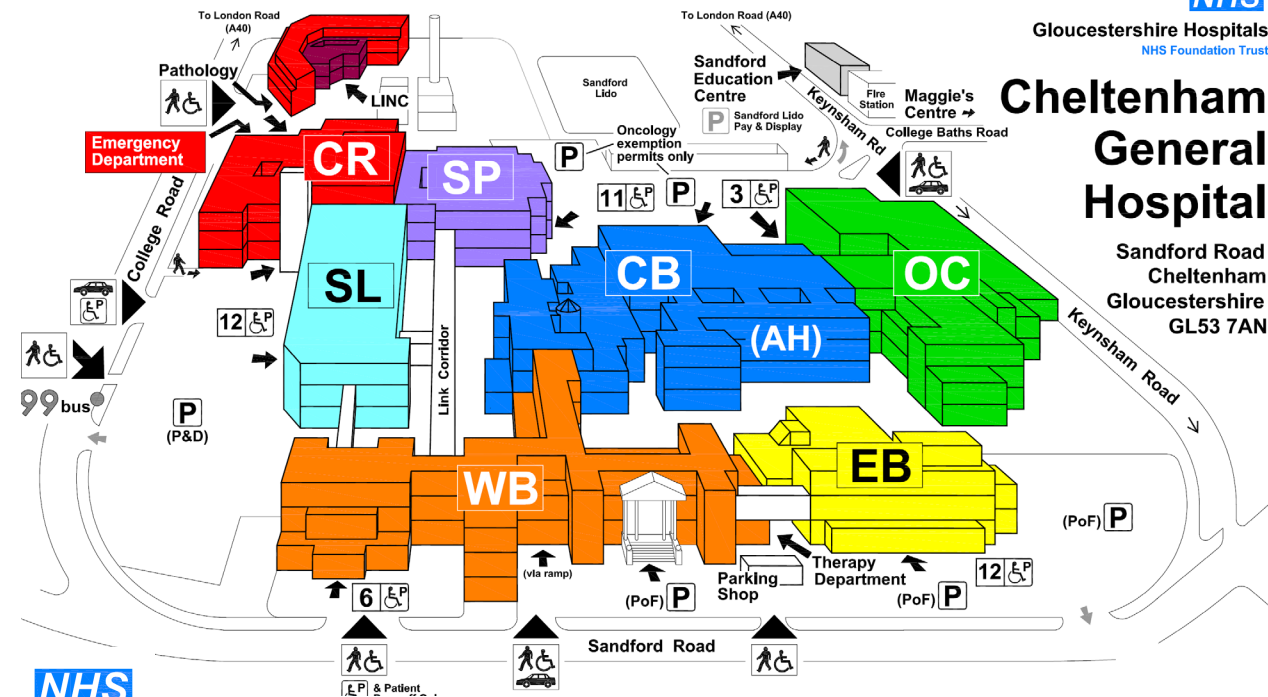
Gloucestershire Hospitals
NHS Foundation Trust



Gloucestershire Hospitals
NHS Foundation Trust

Cheltenham General Hospital

Sandford Road
Cheltenham
Gloucestershire
GL53 7AN



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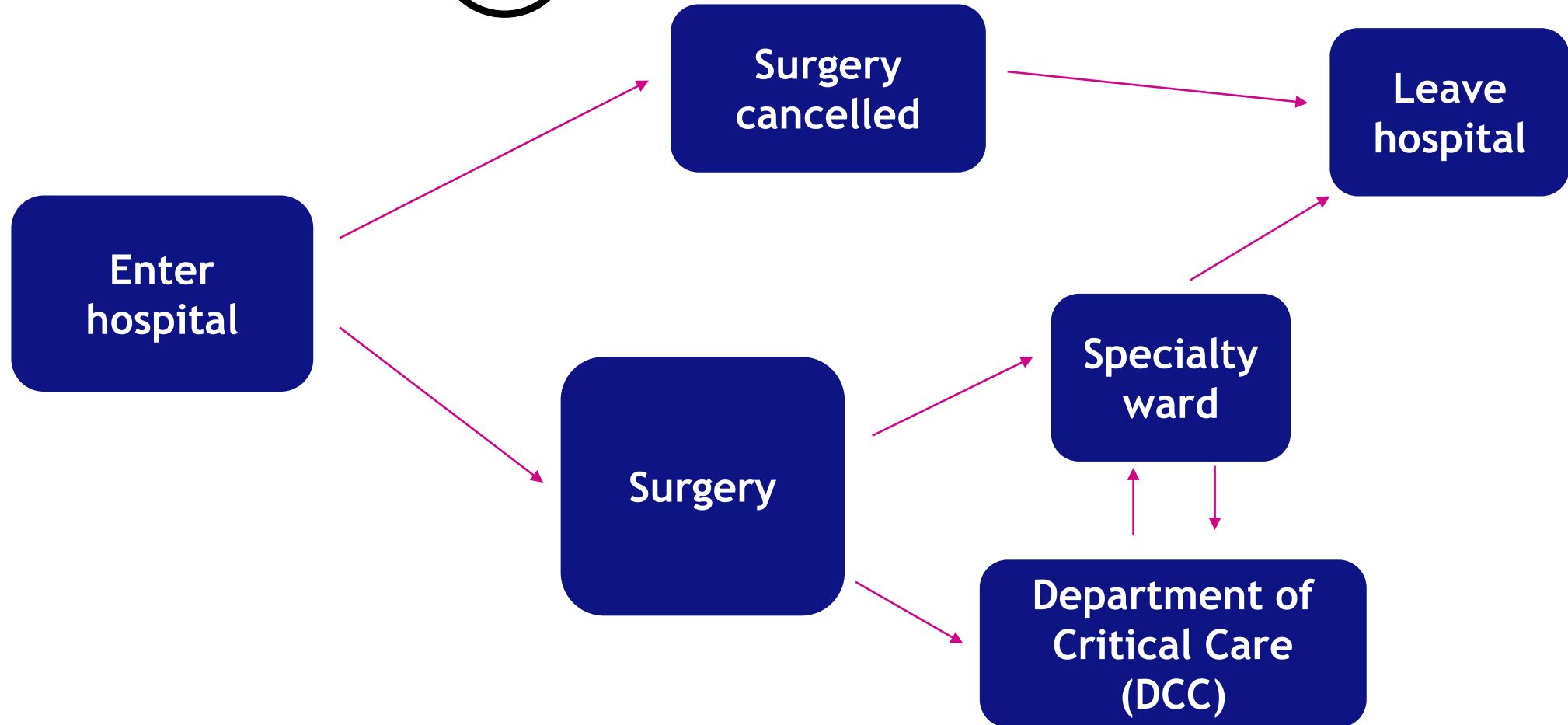
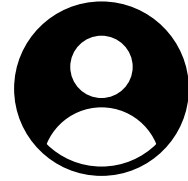




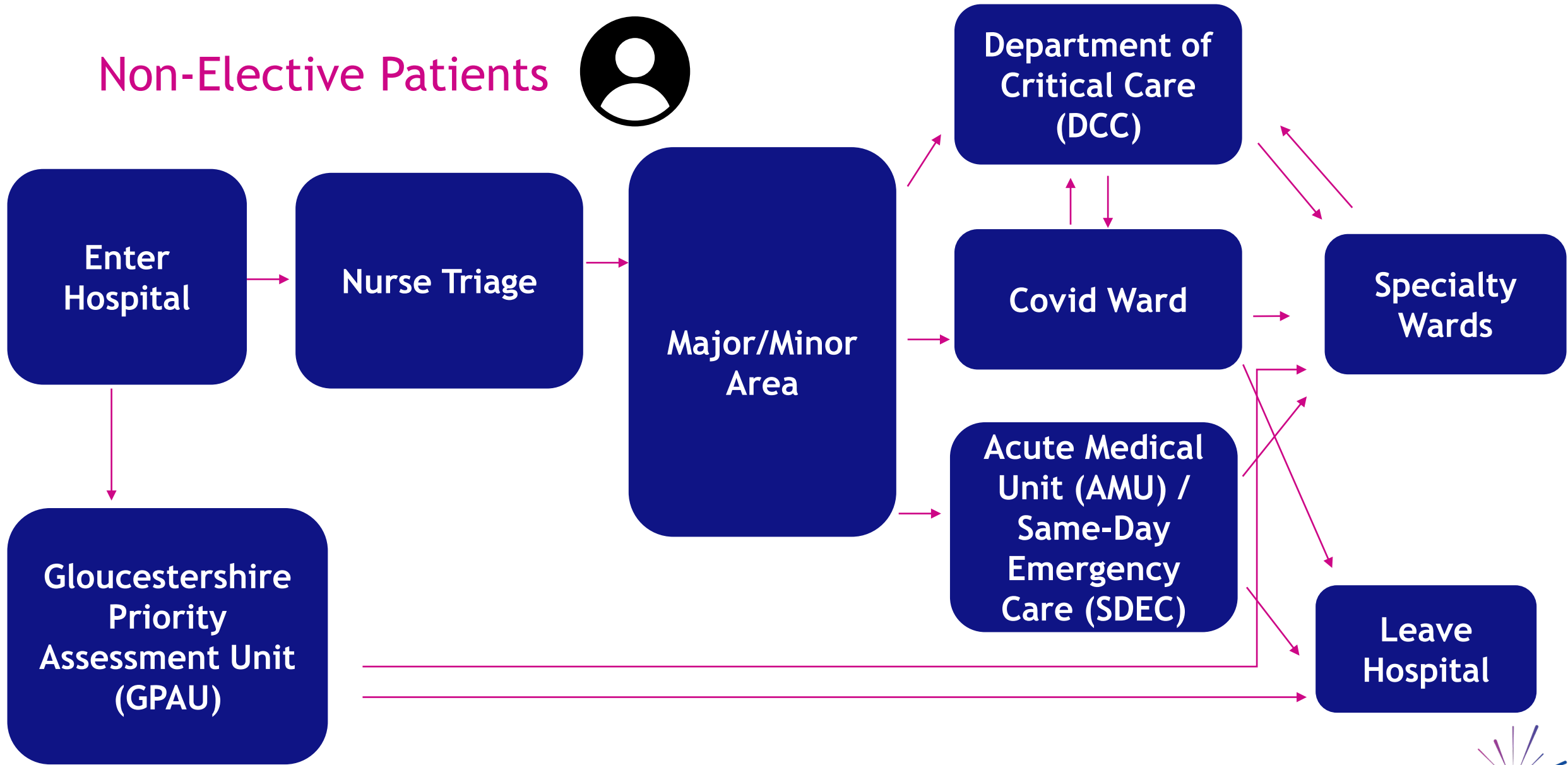
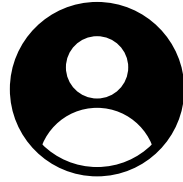
02

Logic

Elective Patients



Non-Elective Patients



Key Concepts

Specialties

- Different medical issues require different types of treatment. These are grouped into **specialties** such as cardiology, dermatology, orthopaedics, etc.
- Each ward has an ideal set of specialties.

Outliers

- Patients who get placed into wards that treat a different specialty than their own.
- E.g. a cardiology patient in a dermatology ward.
- Caused by limited capacity of wards.

Queueing

- Customisable **priority** for queueing for bed spaces. E.g. patients coming from Critical Care have highest priority.
- Key target is to reduce queue times.



03

The Model

Model Video 1 - Results



Model Video 2 - Locations

nhs_gloucester_runner: Simulation - AnyLogic Professional

NHS Gloucester Sim Logic Results Patients **Locations** Day: 7 06:38
02/08/2022

Select up to FOUR locations to display:

Location	Site	Type
<input type="checkbox"/> Acute Care Unit C CGH	CGH	AMU
<input type="checkbox"/> Alstone Ward CGH	CGH	Elective Specialty
<input type="checkbox"/> Acute Medical Unit 2 GRH	GRH	AMU
<input type="checkbox"/> Avening Ward CGH	CGH	Elective Specialty
<input type="checkbox"/> Bibury Ward CGH	CGH	Elective Specialty
<input type="checkbox"/> Cardiac Ward CGH	CGH	Non-Elective Specialty
<input type="checkbox"/> Cardiology GRH	GRH	Non-Elective Specialty
<input type="checkbox"/> Dept of Critical Care CGH	CGH	DCC
<input type="checkbox"/> Dept of Critical Care GRH	GRH	DCC
<input type="checkbox"/> Dixton Ward CGH	CGH	Elective Specialty
<input type="checkbox"/> Frailty Assessment Unit GRH	GRH	Non-Elective Specialty
<input type="checkbox"/> Gloucestershire Priority Admission Unit GRH	GRH	GPAU

Display

Previous

Next

Running

Model Video 3 - Patient journey 1

nhs_gloucester_runner: Simulation - AnyLogic Professional

NHS Gloucester Sim Logic Results **Patients** Locations

Day: 8 10:54
03/08/2022

Input patient ID number: [View Patient](#)

Or: [Search for Patient](#)

Patient KPIs -

Patient Statistics	Patient Location Durations	Patient time in groups
Current Reporting Group: N/A		
Current Specialty: N/A		
Current Activity: N/A		
Current Location: N/A		
Total Time in Hospital: N/A		
Total Time Spent Queueing: N/A		

Ward KPIs -

Location Data	Beds & Queues
Results	
Avg. Occupancy Level	N/A
Avg. Stay (hours)	N/A
Total Ward Admissions	N/A
Perc. Time Above Optimal	N/A
General Queue Length	N/A
Information	
ID	
Desc.	
Site	
Capacity	
Treats:	

Running

Model Video 3 - Patient journey 2

nhs_gloucester_runner: Simulation - AnyLogic Professional

NHS Gloucester Sim Day: 9 15:00
04/08/2022

Input patient ID number: View Patient

Or: Search for Patient Stop

Patient KPIs - Patient#1003

Ward KPIs - 5A/SAU Chairs Tower Block G...

Patient Statistics	Patient Location Durations	Patient time in groups	Location Data	Beds & Queues
<p>KEY (Location ID)</p> <ul style="list-style-type: none"> EDGRHA W5ASAUGRHA 				
<p>Duration (hours)</p>				
<p>Results</p> <ul style="list-style-type: none"> Avg. Occupancy Level: N/A Avg. Stay (hours): 9.0 Total Ward Admissions: 94 % Perc. Time Above Optimal: N/A 				
<p>Information</p> <ul style="list-style-type: none"> ID: W5ASAUGRHA Desc: 5A/SAU Chairs Tower Block G... Site: GRH Capacity: N/A Treats: Surgical SDEC 				

Simulation controls: Pause Stop Zoom x1 Refresh Speed x0.04 Reset Next Settings Running Fullscreen Help

Why Use AnyLogic?



Customisable discrete event modelling

- Treatment duration (delay) can depend on specialty
- Priority queueing based on patient classification



Pedestrian modelling

- Visualise patient journey



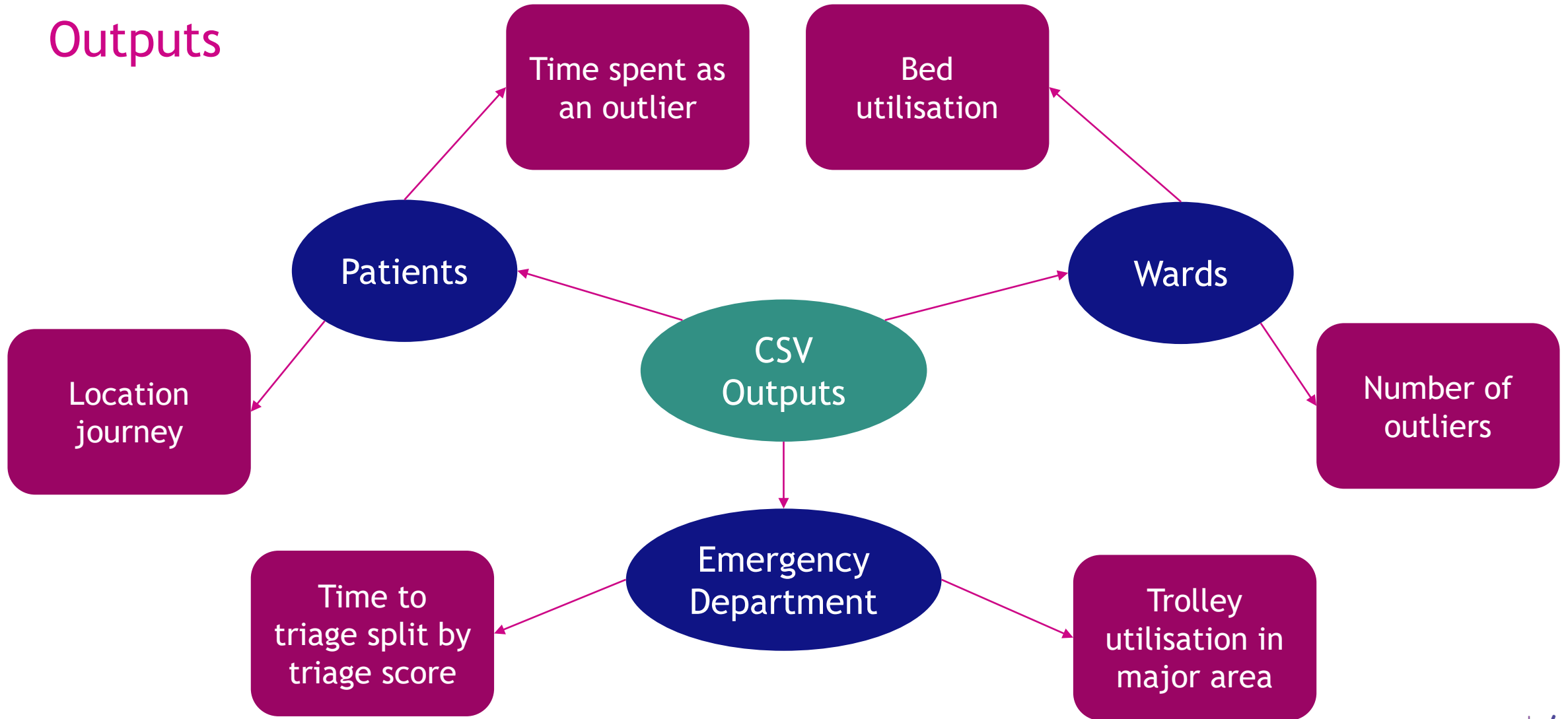
Navigable and interactive UI

- Intuitively move between different views
- On-click action to select locations / patients of interest

04

Benefits and Applications

Outputs



What can the tool be used for?

- Scenario planning to reduce outliers, queueing and Length of Stay
- Winter planning to stress-test capacity to explore effects of increase in demand
- Understand how bed capacity impacts hospital performance
- Investigate how much time patients spend queueing in different areas of hospital
- Planning for building a new ward
- If Length of Stay was reduced, how does it impact bed surplus / deficit?

Possible Extensions

- More detailed staff modelling, such as for shift patterns and to optimise workforce allocation
- Scenario comparison window with charts
- Enhanced UI for input parameters
- Cost model
- Develop optimal logic for outlier management

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THANK YOU