

# USING DISCRETE-EVENT SIMULATION TO REPLICATE A FOUR-ZONE CANADIAN EMERGENCY DEPARTMENT

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## DESCRIPTION

Emergency departments (EDs) have been faced with increased patient volumes without changes in the supply of resources, leading to overcrowding, with negative ramifications for patients and staff. Using discrete-event simulation (DES), a digital representation of the ED is created by simulating the various entities and processes. This allows decision makers to explore how the ED would hypothetically perform under different scenarios and predict the potential impacts of various changes prior to implementation. Through a collaborative effort between the research and ED team, we created a DES model of our four-zone ED to explore what would happen to 90<sup>th</sup> percentile time to physician initial assessment (PIA) and length of stay (LOS) when changing physician schedules and room allocations.

## OBJECTIVE

To find scenarios resulting in lower time to PIA and LOS for potential pilot implementation.

## ACTIONS TAKEN

In collaboration with the ED team, the goals of the model were discussed, and a simplified flowchart of the four-zone (Fast Track, Ozone, Sub-Acute, Acute) ED was created. ED visit data between September 2023–August 2024 were used to calculate the input probabilities and distributions for the model. The DES model was created using Python and JaamSim. The ED team validated the inputs, and statistical validation was conducted to compare simulated outputs to reality. Lastly, “what-if” scenarios chosen by the ED team were tested using the simulation to evaluate resultant changes in PIA and LOS.

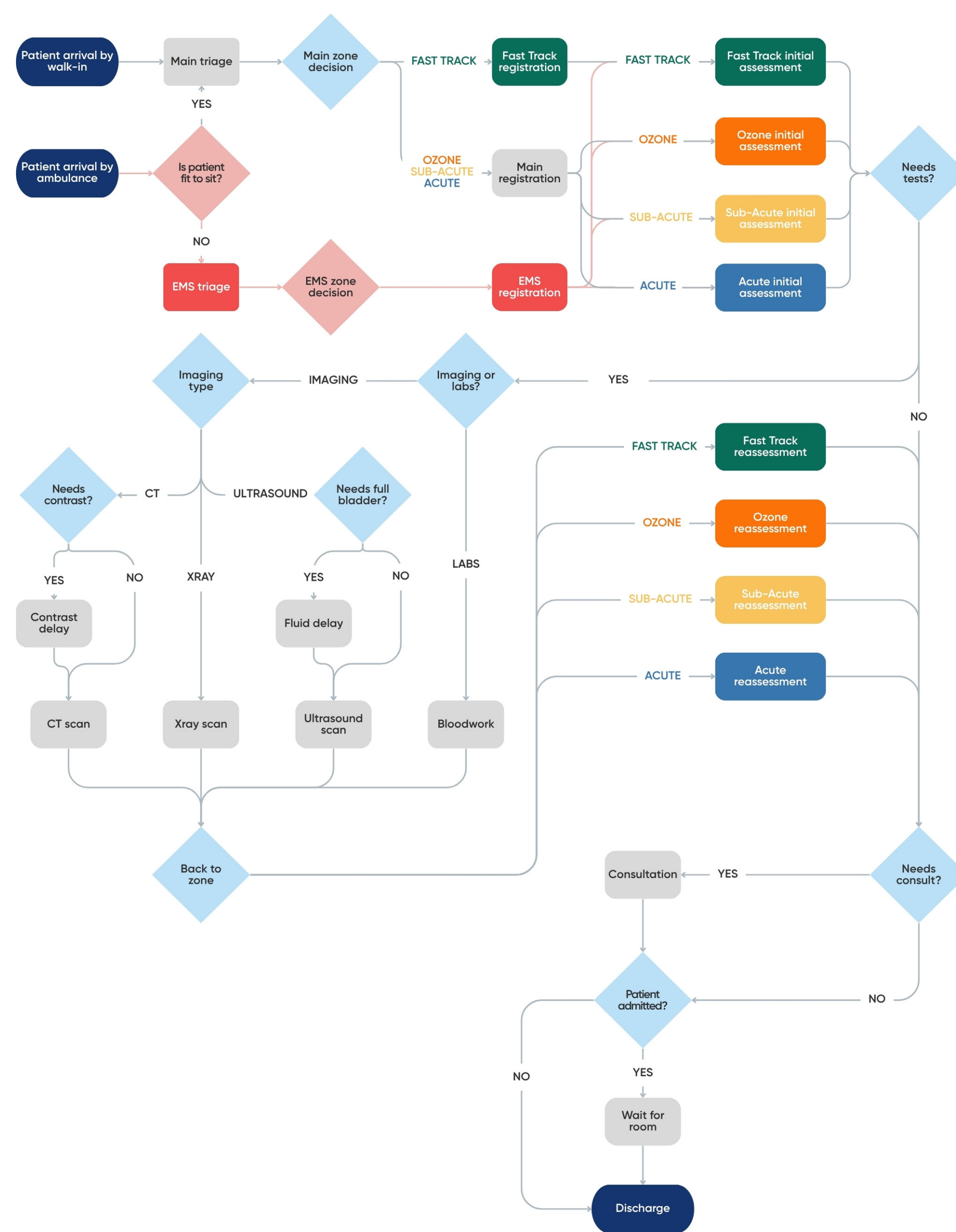


Figure 1. Flowchart of simplified patient journey in the Emergency Department.

|                     | 90 <sup>th</sup> Percentile Time to PIA | 90 <sup>th</sup> Percentile LOS |
|---------------------|---|---------------------------------|
| EMR Data            | 4.31 hours                              | 10.20 hours                     |
| Baseline Simulation | 4.44 ± 0.10 hours                       | 11.15 ± 0.19 hours              |
| Percentage Error    | 3.0%                                    | 9.3%                            |

Table 1. Baseline comparison of the simulation model to the EMR data.

|   | 90 <sup>th</sup> Percentile Time to PIA in hours (change from baseline) | 90 <sup>th</sup> Percentile LOS in hours (change from baseline) |
|---|---|---|
| 1. Moving one Sub-Acute/Acute physician shift 6 hours earlier       | 3.42 (-23%)   | 9.25 (-17%)   |
| 2. Changing 4 Fast Track rooms to Ozone                             | 3.39 (-24%)   | 9.15 (-18%)   |
| 3. Adding four rooms to Sub-Acute                                   | 4.46 (0%)   | 11.18 (0%)  |
| 4. Adding a new Sub-Acute/Acute physician shift starting at 5:00 am | 2.72 (-39%)   | 7.91 (-29%)   |
| 5. Combining 1 + 2 + 4  | 2.16 (-51%)   | 6.99 (-37%)   |

Table 2. Results of the scenarios, comparing 90<sup>th</sup> percentile time to PIA and LOS.

## SUMMARY OF RESULTS

Simulated 90<sup>th</sup> percentile time to PIA (error: 3.0%) and LOS (error: 9.3%) were within a 10% error rate and thus deemed statistically acceptable. All scenarios except for one showed a decrease in time to PIA and LOS. A combination of moving a physician shift earlier, allocating Fast Track rooms to Ozone, and adding one Sub-Acute/Acute physician shift in the early morning lowered time to PIA by 51%, and decreased LOS by 37%.

## LESSONS LEARNED

Large decreases to time to PIA and LOS could be achieved from small changes, and this gives the ED team confidence to pilot these scenarios.

