

Background

Implementing ideas to produce measurable change requires a rigorous understanding of how a system or process behaves. This requires understanding if a change implemented to one area may lead to unintended impacts to other elements of a system. Furthermore, significant costs may be associated with the implementation of unsuccessful changes to a system.

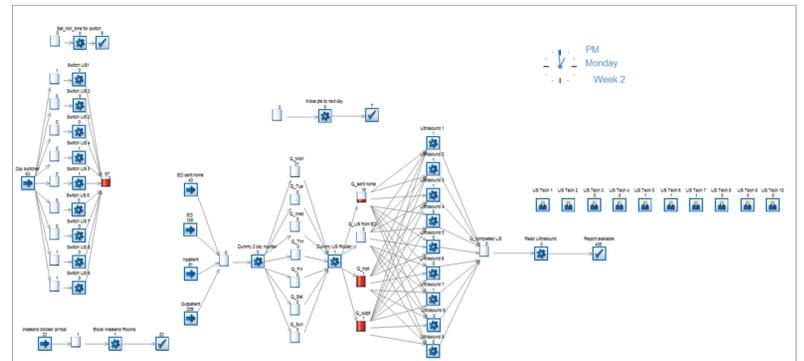
In early 2018, North York General Hospital (NYGH) employed specialized software to produce a Discrete Event Simulation (DES) which modeled the processes for ultrasound imaging services at the hospital. The model was built using advanced statistical analyses and methods and was refined with numerous iterative input sessions with leaders and subject matter experts.

The model was used to analyze multiple potential change ideas in a low-risk environment, and determine if the changes would be expected to produce unintended impacts to other areas of the system. Following this analysis, a specific recommendation was tested with a live-trial. All changes implemented were resource neutral for the Medical Imaging (MI) department, and the total number of ultrasound rooms and technologists were kept stable. As a result, NYGH was able to see a reduction in wait times for patients visiting the Charlotte and Lewis Steinberg Emergency who required ultrasound imaging.

Discrete Event Simulation

Building a DES starts with creating a digital representation of workflows for a system. Data analysis is performed to create a mathematical description of how each system element behaves. Major elements of the workflows include:

- **Patient Types:** Including Emergency Department (ED) patients, inpatients and outpatients.
 - **Processing Tasks:** Task time may be highly variable given multiple factors.
 - **Queues:** Patients are prioritized by many factors, including acuity and exam reason.
- DES model for NYGH ultrasound service:



Strategies for Success

Developing a DES is a highly iterative process that requires expertise in process modeling and analysis as well as expert clinical knowledge and judgment. A simulation model is effective when it can accurately re-create historical data, within acceptable confidence intervals. Strategies for effective DES development include:



Compiling at least two years of historic data:

- Process data for a minimum of two years is required to accurately create mathematical descriptions of processes, while accounting for seasonality and process variation.



Leveraging expert clinical knowledge:

- Expert knowledge will help revise the model and clarify process workflows. When required, expert clinical knowledge will help create robust assumptions for modeling processes where there is a high degree of variation or uncertainty.



Testing frequently:

- Development of a robust DES requires multiple testing cycles to determine if the model can accurately re-create historic data. At the end of each testing cycle, a systematic analysis must be completed to determine where the refinements must be made.

Summary of Results

Simulation development:

- 9 revisions made during DES development
- 5 process evaluation metrics identified
- 11 improvement suggestions evaluated by the DES model

All changes implemented were resource neutral for the MI department.

Recommendations generated:

1. Ultrasound technologist schedules optimized to meet ED demand
2. Two rooms dedicated for during daytimes for ED patients
3. One Team Attendant resource was added in the ED to support flow.

Given the changes above, no negative impact was estimated by the DES for inpatient & outpatient exam turnaround times.

A trial of the recommendations was conducted between June and August 2018. During this period, the 90th percentile for the exam turnaround time was observed.

Metric	Baseline	Trial Period
90th percentile turnaround time (H:MM):	2:39	1:55
Average weekly exam volume	100	110

Measured from exam request to exam completion by the technologist
Exams completed during weekdays only

Baseline

2:39

100

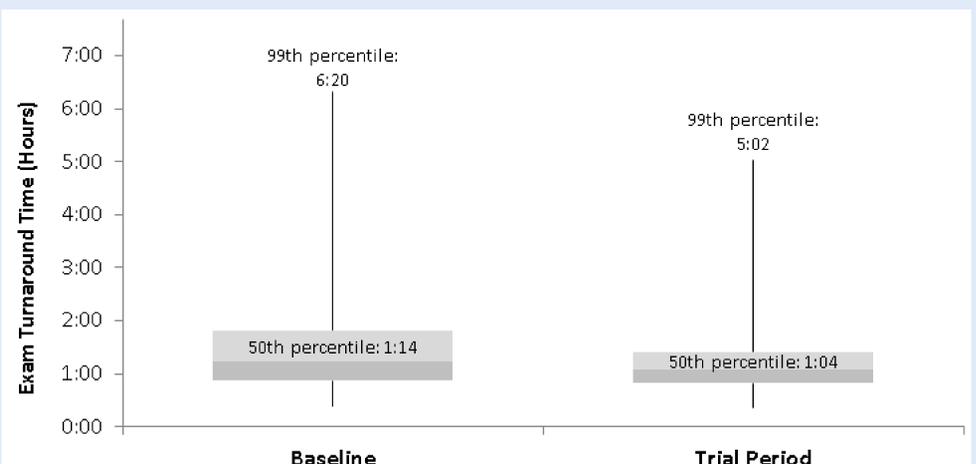
Trial Period

1:55

110

Measurable changes observed during the trial period:

- A reduction in the variation in exam completion turnaround times, as shown in the boxplot to the right.
- The turnaround time during the trial period represents an improvement of over **20%** compared to the baseline.



Lessons Learned

DES can be an effective tool to evaluate potential changes in quality improvement projects, particularly for operational processes where large amounts of data are available for analysis. Combined with expert clinical knowledge, a DES serves as a low-cost and low-risk technique for understanding the impacts of changes in a system.

As the trial continues, NYGH will continue to monitor turnaround times for ultrasound exams for all patient types. During the initial six weeks of the trial, no negative impact was noted for inpatients, however recent data indicates an opportunity to expand the simulation model to identify service adjustments to improve turnaround times for this patient group.