Workflow Optimization in Interventional Radiology Using a Nonlinear Monte Carlo Simulation Model

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PURPOSE

The primary purpose of this study was to analyze a nonlinear Monte Carlo systems model that simulates the workflow of a modern Interventional Radiology (IR) practice in order to determine which variables are important in optimizing patient throughput and department efficiency.

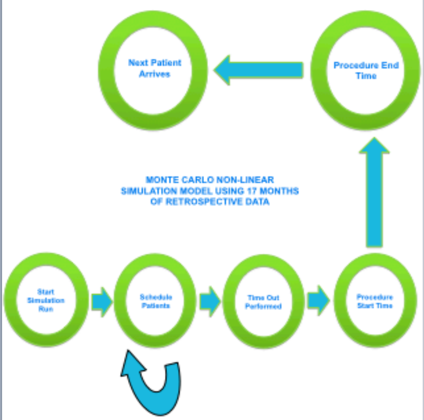
MATERIALS & METHODS

Interviews of the IR personnel at a Safety Net Level 1 Trauma Center were performed to define variables for use in a Monte Carlo nonlinear simulation model of department workflow. The parameters identified included Prep variables, Patient variables, RN availability, MD availability, Room availability, and Procedure time.

MATERIALS & METHODS (CONTINUED)

Iterations within the decision nodes of the model were based on a 95% confidence interval for the probability distribution of each variable and were based on 17 months of historical data. A sensitivity analysis was performed to determine which variables had the most significant effect on department workflow efficiency.

SUMMARY OF WORKFLOW LOOP



RESULTS

Numerous simulation loops were run using the Monte Carlo analysis. Based on the sensitivity analysis, the greatest increase in patient throughput resulted from a reduction in case procedure time. A reduction in case procedure time resulted in an improvement in patient throughput by a ratio of 1:1. However, reducing delays in the other system variables such as patient variables and prep variables by a factor of 10% yielded only a 1% increase in the number of new procedures. This 10:1 ratio persisted after running the simulation for 25% and 50% reductions in total system delay as well.

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CONCLUSIONS

Our study demonstrates that the workflow of an IR department can be analyzed using a nonlinear Monte Carlo simulation model. Using probability distributions for variables affecting workflow, our simulation model was also able to determine which variables have the greatest impact on throughput and department productivity. Department throughput was optimized by reducing individual case procedure time and standardizing case procedure times as well. These findings suggest that variability between different IR physicians in case time profoundly affect total department throughput to a degree greater than the simple time differences would account for. Variables previously conceived to be intuitively significant towards department throughput such as prep variables and patient variables are shown to be not as significant as underlying case time variability. This also supports the notion that an IR department is a nonlinear system in which variable change has a large impact on final outcome.