Optimal Scheduling Policy for Elective and Emergency Surgeries

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Challenge

Major hospitals are equipped with dozens of operating rooms to accommodate elective as well as emergency surgical cases. Elective cases are scheduled months in advance, but often get cancelled at the last minute when multiple emergency cases are directed to an operating room that has been assigned to elective cases. This can cause inconvenience and anxiety among patients and their family members. Therefore, the objective of the research project is to schedule both elective and emergency cases so that utilization of operating rooms is maximal while limiting or minimizing the disturbance to pre-scheduled elective surgeries.

Methodology

The research involves two scheduling approaches: traditional static scheduling and dynamic scheduling under uncertainty. The former will be tackled by using combinatorial optimization theory, whereas the latter will be by Markov decision processes. To integrate the two scheduling problems is not a trivial problem; hence, iterative heuristic algorithm will be used. In each iteration, the two scheduling problems will be solved independently to optimality. The iterative algorithm will try to estimate dual variables at optimality of the Markov decision process and utilize the information in the static scheduling optimization.

Results and Impact

The optimization model enables hospitals to maximize the utilization of operating rooms while minimizing the disturbance in the schedule of elective surgeries. This will also lead to the reduction in overtime utilization after regular hours and over weekends, resulting in significant cost savings. Preliminary numerical studies indicate that an effective scheduling policy may reduce overnight stay among surgical patients by 26% (3,884 vs. 5,288 cases).

Performance comparison for several alternative scenarios handling ca. 54,000 cases

| Scenario | Elective Surgery | | | Emergency Surgery | | | | | OR Performance | | | Over-nights | Over-time |
| | On-time | Delayed | Canceled | On-time | Delay for Emergency Level* | | | | Utilization | | | | |
					A	B	C	D	Day	Evening	Night		
1	50%	38%	12%	92%	322	378	185	0	74%	80%	27%	5,288	6,861
2	50%	38%	12%	92%	312	346	179	0	73%	73%	27%	5,090	6,941
3	50%	38%	12%	92%	316	355	164	0	74%	78%	26%	4,957	7,840
4	50%	38%	12%	93%	309	326	164	0	74%	78%	25%	3,884	6,666
5	50%	38%	12%	93%	307	326	128	0	74%	78%	25%	3,884	6,664
6	50%	38%	12%	93%	307	333	138	0	74%	77%	25%	4,109	6,618
7	50%	38%	12%	93%	310	344	163	0	74%	78%	25%	4,633	6,674

* Priority time frame: A = within 2 hours; B = within 8 hours; C = within 48 hours; D = within 7 days

Partner Profile

St. Michael's Hospital (SMH) is a teaching and research hospital located in the downtown core of Toronto, and has 24 operating rooms to accommodate over 50 thousand surgical cases annually.

9 September 2015