



# **Simulation Based Optimization Of A Pre-Surgical Screening Clinic**

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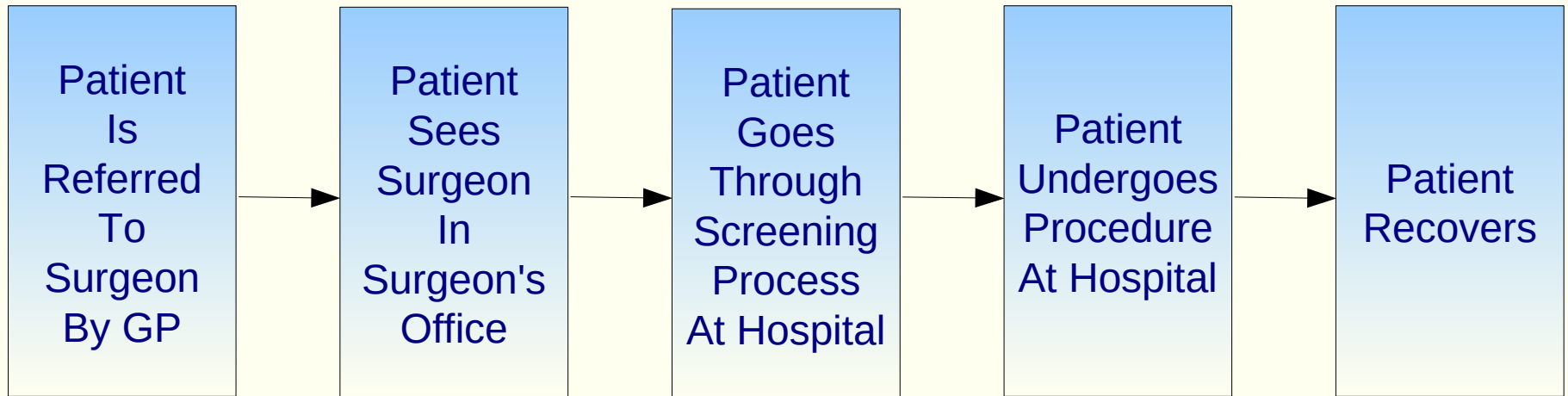
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# The Sir Mortimer B. Davis Jewish General Hospital

- **A full service university affiliated medical center**
  - Serves a large and diverse population in Montreal
  - Provides a broad range of inpatient and outpatient services
  - Has major tertiary & quaternary cardiovascular, neurosciences, oncology(including robotic surgery) and neo-natology programs
- **Approximately 15,000 operative procedures per year**
  - This number may grow 2% per year through 2015
  - Approximately 40% require overnight patient stays after the procedure



# A Simplified View Of The Peri-Operative Process



# Goals Of Pre-Surgical Screening Clinic

- **Medical**
  - Make sure patient is in good enough shape for procedure
  - Adjust medications
  - Give patient other medical directives
- **Patient logistical preparations**
  - When to arrive
  - Expected length of stay
  - Need for family help after stay is finished
- **Administrative - collect insurance information**

# Pre-Surgical Screening Clinic Tasks

- **Up to 35 patients/day will need to do some of the following:**
  - **Register for the clinic**
  - **Watch a DVD based video orientation at the start of visit**
  - **See pharmacist**
  - **Change into a gown**
  - **Have EKG taken**
  - **See GP or Internist**
  - **Get dressed**
  - **Give blood and urine samples**
  - **Receive group training**
  - **Receive individual training**
  - **Submit insurance information**



# Management Challenges

- **Different patient profiles**
- **Minimizing space requirements**
- **Minimizing staffing costs**
- **Minimizing physician idleness**
- **Minimizing excessive patient waiting**
- **Making sure that staff get breaks and lunch**



# Complicating Factors

- **Uncertainty of patient profile mix**
  - **Lack of knowledge about current mix**
  - **High likelihood of change in mix over the next few years**
- **Time needed for each task**
  - **Lack of knowledge about distribution of times**
  - **Randomness of time within distribution for individual patients**
- **A few patients need to see pharmacist before seeing physician**
- **Cost of overtime**
- **No shows and cancellations**



# Management Decisions

- **Capacity sizing**
- **Workforce sizing**
- **Staff scheduling**
- **Appointment scheduling**





# Possible Tools For Analyzing Management Decisions

- **Discrete Event Simulation**
- **Simulation based optimization**



# Simulation Model Challenges

- **Wished to carefully model entities (i.e. staff, resource and patient):**
  - **Activities**
    - **Patient**
    - **Staff**
  - **Interactions between patients and activities and staff and resources**
    - **Patients need to be in an exam room to change into their gown**
    - **Patients need to be in a gown before having their EKG taken**
    - . . .



# Simulation Modeling Approach

- **Could have treated:**
  - **Patients as entities**
  - **Staff as resources**
  - **Exam rooms, dvd players, . . . as resources**
- **Wanted more flexibility for simulating staff**
- **Treated patients, staff and physical resources all as entities**
- **Visual display of model is as a console of states for each entity type**
- **Simulation logic is used to handle**
  - **Events**
  - **Logic of entity flow**



# Simulation Model Animation

EKG Technician	ET Not In PSS 1	ET Idle 0	ET In Bathroom 0	ET On Break 0	ET At Lunch 0	ET Taking EKG 0								
Blood Taker	BT Not In PSS 0	BT Idle 1	BT In Bathroom 0	BT On Break 0	BT At Lunch 0	BT Taking Blood 0								
General Practitioner	GP Not In PSS 2	GP Idle 0	GP In Bathroom 0	GP On Break 0	GP At Lunch 0	GP Seeing Patient 0								
Internist	IN Not In PSS 1	IN Idle 0	IN In Bathroom 0	IN On Break 0	IN At Lunch 0	IN Seeing Patient 0								
Lab						Lab Processes Urine 0	Lab Processes Blood 0							
Exam Room		Exam Room Idle 6				Exam Room In Use By GP 0	Exam Room In Use By IN 0							
DVD Player		DVD Player Idle 12				DVD Player In Use 0								
Patient	PA Needing Surgery 0 →	PA Waits RN Chart Review 1 0	PA RN Chart Review 1 0	PA Waits 1st PSS Visit 0 0	PA Sets 1st PSS Visit 0 0	PA Waits 1st PSS Visit 0 0	PA Waits Register 1 0	PA Register 1 0	PA Waits DVD Player 0 0	PA DVD Player 0 0	PA Waits PH 0 0	PA Pharmacist 0 0	PA Waits GP Exam Room 0 0	PA Into Exam Room 0 0
				PA Waits RN Call 0 0	PA RN Call 0 0								PA Waits IN Exam Room 0 0	

# Simulation Model Data Requirements

- **Patient profiles**
- **Service time distributions**
- **Count of tasks needing to be done each day**



# Actual Simulation Model Data

- **Patient profiles**
  - Guesstimates from subject matter experts in existing (PAT) clinic
- **Service time distributions**
  - Triangular distribution guesstimates from subject matter experts
  - Patient self-time studies (in progress)
- **Count of tasks needing to be done each day**
  - Use patient profiles and historical total non-emergent procedure count



# Simulation Model Miscellaneous Issues

- **Needed to determine rooms allocated to each type of physician**
  - **Can not pool rooms when GP and Internist worked at same time**
  - **For Internist**
    - **When alone allocate all of the rooms**
    - **When with GP, allocate 2 for each Internist**



# Validating The Simulation Model

- **Was difficult**
- **Received feedback from management**
  - **PSS Clinic Nursing Coordinator**
  - **Another analyst**
  - **The Chief Of Surgical Services**
  - **Associate Director Of Professional Services**
- **Tested against schedule with deterministic service times**
- **It was known that results were sensitive to service time distribution estimates which were at best guesstimates**





# Optimization Issues

- **Need to start day early to get everyone done by 21:00**
- **Certain staff had to arrive before other staff**
- **Breaks and lunches had to fit into 8 hour day**



# Static Optimization Of Management Decisions

- **Initial goal was to**
  - **Minimize physician idle time**
  - **Subject to:**
    - **Staff and patient availability constraints**
    - **Getting everyone out by 21:00**
- **Decision Variables**
  - **Number of each type of staff and resource**
  - **Staff and patient start times**
  - **Staff break and lunch times**



# Static Optimization Of Management Decisions - Cont'd.

- **Trials consisting of 10-20 one day runs with pre-defined patient profiles with random times for each patient task**
- **Optquest - for initial analysis and for generating initial schedules**
  - **Objective function including penalty for not seeing all patients by 21:00**
  - **Lower and upper bounds for each decision variable**
  - **Constraints on break and lunch times**



## Progress To date

- **Original model has been built and tested**
- **Optquest has been used to minimize physician idle time with respect to staff and patient start times**
  - **Moved one GP from morning to afternoon**
  - **Indicated need to control rooms allocated to each type of physician**
  - **Suggested that EKG technician break and lunch times are important**



# Best Decision Variable Values Found To Date

- **Depends on time distributions**
- **Using preliminary guesstimates (based on small study of existing PSS)**
  - **Space requirements**
  - **Scheduling of start times**
  - **Scheduling of breaks**
- **Using guesstimates from EKG machine salesrep, and slower dressing times**
  - **Space requirements**
  - **Scheduling of start times**
  - **Scheduling of breaks**



## To Do – Short Term

- **Revise model to:**
  - **Add other costs**
    - **Overtime**
    - **Excessive patient waiting**
    - **Cost of using rooms**
  - **Schedule screening so as to ensure that:**
    - **Screening doesn't expire (after 3 months) before procedure**
    - **It does not delay patient procedures**



## To Do – Medium Term

- **Improve quality of data:**
  - **Hope to use RFID to monitor patient and staff times**
  - **Plan to analyze data to try to identify correlation between task times for patients, possibly based on their age, preliminary surgeon evaluation, . . .**
  - **Plan on revising decision variables using updated data**



## To Do – Longer Term

- **Address changing patient profile mix**
- **Address no shows and cancellations**
- **Adapt for other clinics**
- **Adjust break and lunch schedule dynamically within day**

