Scheduling Challenges in Healthcare

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Outline

- Nurse Scheduling
- Nurse Planning
- Chemotherapy
- Surgical Planning & Scheduling
- Waitlist Management
- Diagnostic Imaging
- Ambulatory Clinic Scheduling/ Fracture Clinic

Nurse Scheduling

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Nurse Scheduling

- 7 days per week, 24 hours per day
- 2 or 3 shifts per day (8 or 12 hours)
- 40 hours per week average
- Workload higher on day shift (weekdays?)

Scheduling Challenges

- Complex Union rules
  - Weekends off; shift change restrictions;
- Schedule typically produced 6 weeks in advance
  - E.g., Schedule posted on June 28 covers August 9 to Sept 19
  - Forecast patient demand 6-12 weeks in advance
- Nurse preferences (day shifts; weekdays; seniority)
- Patient complexity varies widely
  - Workload higher during initial days in hospital
- Hand-offs: Overlap between shifts for information exchange

Potential Solutions

- Column Generation
  - Construct feasible shift patterns
  - Typically, 80 hours over 2 weeks
- Construct cyclic shift rotation patterns
- Fill gaps with part-time staff

Example:

Mental health support call centre

- Staff wanted to move from 5 days/week to 4 days
- Management: Great idea!
  - Plus, add evenings and Saturday coverage
- Problem: Staff was thinking Monday – Thursday or Tuesday to Friday
  - But someone has to get Wed/Thurs off!
  - Imagine the potential shift rotation patterns that would be required.
  - Three-day work week … 13-hour days … might work

Nurse Planning

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Nurse Planning

- Tactical: workforce hiring problem
- How many nurses do you need in each hospital unit in the future?
- Nurses have different levels of training
  - University (4 year)
  - College (2 year)
  - Master's (Nurse Practitioner)
  - Specialty (ED, critical care, etc.)

Scheduling Challenges

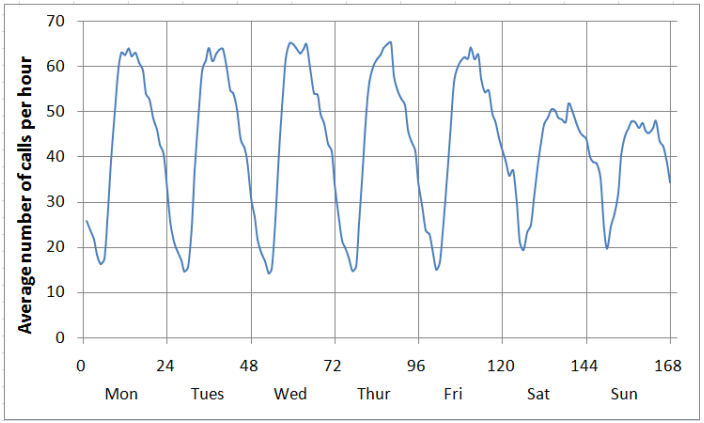
- Turnover rates (retirement, termination, transfer)
- When a nurse leaves, give two weeks notice?
  - Takes 2 months to hire a replacement
  - Meanwhile, units are short staffed
  - Hiring capacity constrained by nursing school graduation cycles
- Absentee levels
  - Need to plan for covering shortages

Potential Solutions

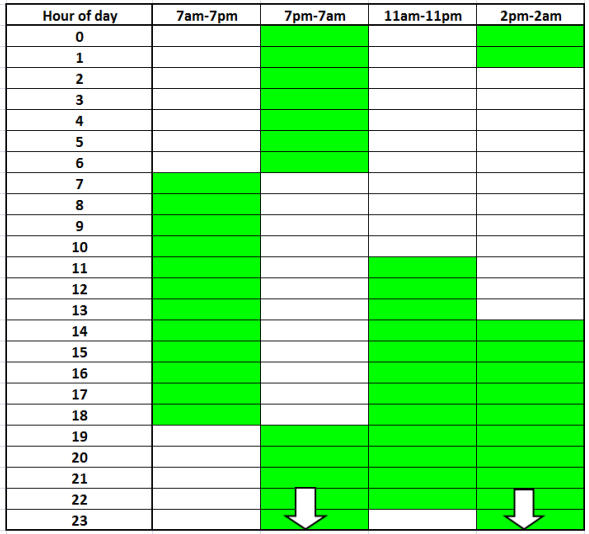
- Temporary staffing challenges
  - Part time nurses
  - Overtime
  - Use of agency nurses
- Nurse Resource Team
  - Full time pool of nurses who can fill in if/when required
- Hospitals typically do not know or manage the relative costs!
  - Often cheaper to have idle NRT nurses than paying agency or overtime when short

Example:

911 EMS call takers



- Hourly call volume variable/predictable
  - Average duration 67 seconds
- Metric: *"Answer calls on 1st or 2nd ring (90%?)"*
- Shifts fixed types: 7AM-7PM; 7PM-7AM; 11AM-11PM; 2PM to 2AM.
- How many call takers on each shift?



Chemotherapy Scheduling

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Chemotherapy

- Registration (100 per day)
- Blood test (wait for lab results)
- Review by physician? If ok (white blood cell recovery)
- Order drugs from pharmacy
  - no pre-mixing cocktails, 350 different regimes
  - wait for drugs
- Bed (11) or chair (22) (1 – 8 hours) 13-15 nurses
  - Nurse set up 10-20 min. (one patient)
  - Chemo (monitoring 4 patients)
  - Nurse disconnect 10 min. (one patient)

Scheduling Challenges

- Patients booked for a sequence of days (e.g., 3 days per week for 4 weeks)
- Scheduling is “real-time” (in batches?)
- Emergencies/ no-shows/ cancellations on day of treatment
- It’s a Tetris game! Except you also need to balance nurses
  - Maximize resource utilization
  - Minimize patient wait times

Potential Approaches

- Assign days real time; optimize batch sequencing day before
- Template scheduling based on usual distribution
- Dynamic template

Example:

Sunnybrook Cancer Centre in Toronto

- Very difficult to arrange patients to all finish around 5:00 PM
- Always a few patients left over, and staff would have to stay until everyone was done.

Surgical Planning and Scheduling

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Master Surgical Scheduling Process

- Hospital allocates OR time to surgeons
  - E.g., “Every Monday and Wednesday in OR #4”
  - Typically allocates time to a “service”, and doctors divide the time
  - Allocation reviewed/revised every 6 months maybe.
- Surgeon schedules their own patients into blocks
  - Informs hospital 1-2 weeks in advance
  - Surgeons typically fee-for-service; not salary

Scheduling Challenges

- Balancing use of downstream resources (recovery room, ward beds, nurses)
- Politics; surgeons have other priorities (clinics, teaching, research)
- Wait list priorities and throughput
- Overtime and undertime
- Urgent/emergent patients
- Estimated vs Actual time
- Cancellation policies

Potential Approaches

- Simulation modelling
- Statistical evaluation of historical surgery times

Example:

Saskatchewan Wait Times

- "No wait longer than 3 months by 2014"
- One of the hospitals
  - Ortho wait times avg. 8 months; 90th % 18 months
  - Added a new Ortho surgeon plus OR time
  - Used surgical model: average weekly throughput
  - Used current wait list and predicted arrivals
  - Ortho will be fine in 2014!
  - But, Gen. Surg. wait will grow!
  - And, serious bed capacity issues (they knew that)

Wait List Management

- Hip & Knee Replacement

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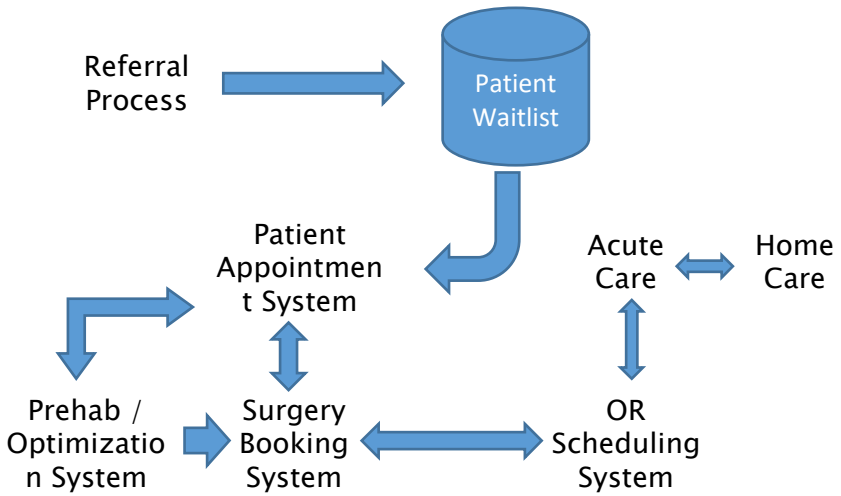
Orthopedic Wait List Process

- Referral from Family Physician
- Consult with surgeon; Decision to Treat?
  - Value-Add Wait for Functional and/or Medical Optimization
  - Personal preference wait time
  - System delays …
- Extensive rehab



Scheduling Challenges

- Every surgeon has their own wait list!
- Perceptions of quality often measured by wait time!
- Surgeons reluctant to schedule patients in advance!
  - Urgent/emergent patients take priority
- Queueing theory fails
  - We actually ***want*** arrival rate = service rate!

Potential Solutions

- Urgent/emergent patients ***can*** be modelled using queueing
- Elective patient list starts out 6 months long
- Surgeon has “fixed” O.R. time per week
- Can tell patients a range of possible surgery dates that shrinks over time

Example:

Winnipeg, Manitoba Orthopedic Centre

- Six orthopedic surgeons
- Central Waitlist
- Pilot project implementing system
  - Worried about reaction from the docs.
  - But, main pushback came from the scheduling assistants!
  - Worried about extra workload!
  - Could have reduced dozens of daily phone calls from worried patients

Diagnostic Imaging

- MRI, CT

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MRI Scheduling Process

- Magnetic Resonance Imaging
- Ordered by Family Physician
  - Referred to a hospital
- Ontario priority levels have target wait times
  - P1 1 day (emergent)
  - P2 2 days (urgent)
  - P3 10 days
  - P4 28 days
- Divided by body part

Scheduling Challenges

- Family doctor who orders test picks a hospital.
  - Based on estimated wait time?
- Significant “inappropriate” requests
- Supply driven demand
- High “No show” rates
- Scan times 20 minutes to 1 hour
- Booked in clusters by body part
- Difficulty meeting target wait times!

Potential Solutions

- Central intake
  - Assessment of appropriateness
  - Advice on allocation to hospital
  - Involves patient preference. “How far will you travel to reduce wait time?”
- Published guidelines on appropriateness
- E-booking systems with updates, reminders and confirmation
- Near-optimal booking heuristic
  - Book P2, P3 and P4 at the last available slot within their target
  - Book P1 at earliest spot
  - No time available? Work overtime!

Example:

Ontario MRI Waittimes

- Target for P4: 28 days
  - Current average wait 55 days!
- Target for P3 10 days
  - Current average 15 days
- Covid-19 has made things worse.

Ambulatory Clinic Scheduling

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Master Clinic Scheduling

- Each day (typically) morning and afternoon clinic times
  - Doctors get assigned to regular clinic time(s) in shared space
  - Each doctor has “preferred” days/times
  - Each doctor has unavailability
  - Each doctor has a preferred number of examination rooms
- Some rooms may have special equipment
- Some clinics use ancillary facilities
  - E.g., Cancer hospital clinics may require blood work prior to appointment

Scheduling Challenges

- No one wants Friday afternoon
- Mondays are also less popular due to statutory holidays
- Doctors like lots of exam rooms
  - Patient goes in room
  - Nurse, Fellow and Doctor rotate
- Patients have preferences!
  - All their clinics on the same day
- Congestion created by schedule
  - Pile of patients require blood work at beginning of day

Potential Solutions

- All of these can be handled as straight forward ILP
- Initial solution is “never” feasible!
  - How do you modify ILP to provide hints for resolving issues?
  - Not just “No feasible solution”
  - Need to modify the formulation to “soften” hard constraints
  - Allow for infeasibility to be “measured”
- Typically, solution is iterative
- Solution uses “weights” on soft constraints, but meaningless to the user

Example

Women's College Hospital in Toronto

- Converted from in-patient to ambulatory hospital in 2012
- Clinics had expanded using former patient rooms
- Then squished into 3 floor clinic, hoteling style
- Went through 11 iterations over 2 years
- Major concessions from docs.

Fracture Clinic

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Fracture Clinic Scheduling

- Scheduled vs urgent patients (referrals from ED)
- Some people need X-ray prior to appointment
- Simple vs complex patients
- Ortho techs and orthopedic surgeons

Scheduling Challenges

- Doctors fee-for-service; always want patients ready
  - No shows
  - Wait for x-rays; done in different department – drop-in
  - Ortho techs apply and remove casts
- So … docs like to front load schedule:
  - Double booking early slots
  - Some clinics tell everyone to come at 8:00 AM!
  - First-come: first-served

Potential Solutions

- Minimize uncertainty
  - Scheduler should know who needs x-ray
  - Schedule x-rays; equipment in-house
  - Schedule complex patients at the end (reduces schedule variation)
- Optimize overbooking strategy
  - Maximize surgeon utilization
  - Minimize patient wait time
  - Using simulation
  - Need to convince surgeons that their utilization will not be adversely affected

Example:

Limited clinic capacity

- One hospital we worked on
  - Assumed 2 patients/ 15-minute slot
  - Clinic ran 8:00 AM to noon.
  - When scheduler got to noon, no slots left
  - So, went back and put 3 at 8:00, 8:15 … etc.
  - Clinic always ran late!

Many other scheduling problems

- Physician scheduling
- Resident scheduling
- Home care routing (PSW example)
- Primary care / Advanced Access