Operations Research in the Health Care or Who Let the Engineer Into the Hospital?

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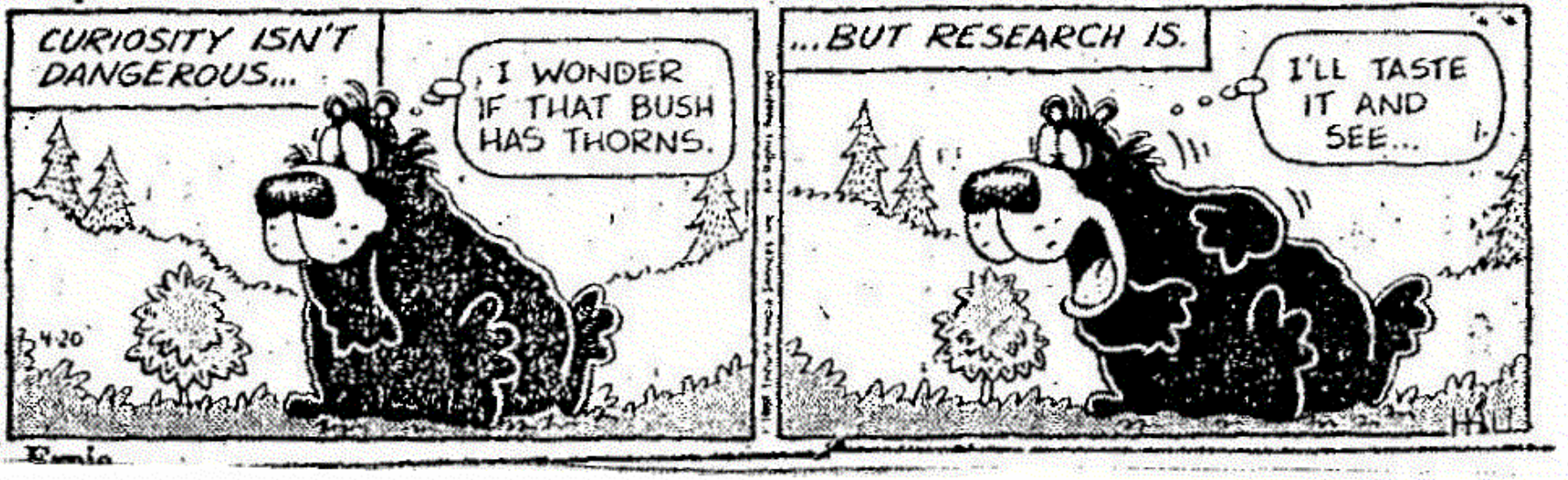
Outline

- Brief intro to Operations Research
- A few applications:
  - ED Simulation
  - Cardiac Bed Planning
  - Strategic Planning
- Future Directions

Simple Beasts



Brief Intro to O.R.

- Started during WWII in UK
- Quantitative analysis: math, physics, stats
- Canadians involved from the start

Optimisation in Health Care

- Two main criteria:
  - Minimize Cost
    - per visit/episode?
    - average annual cost?
  - Maximize Quality
    - for the particular episode?
    - quality of life?

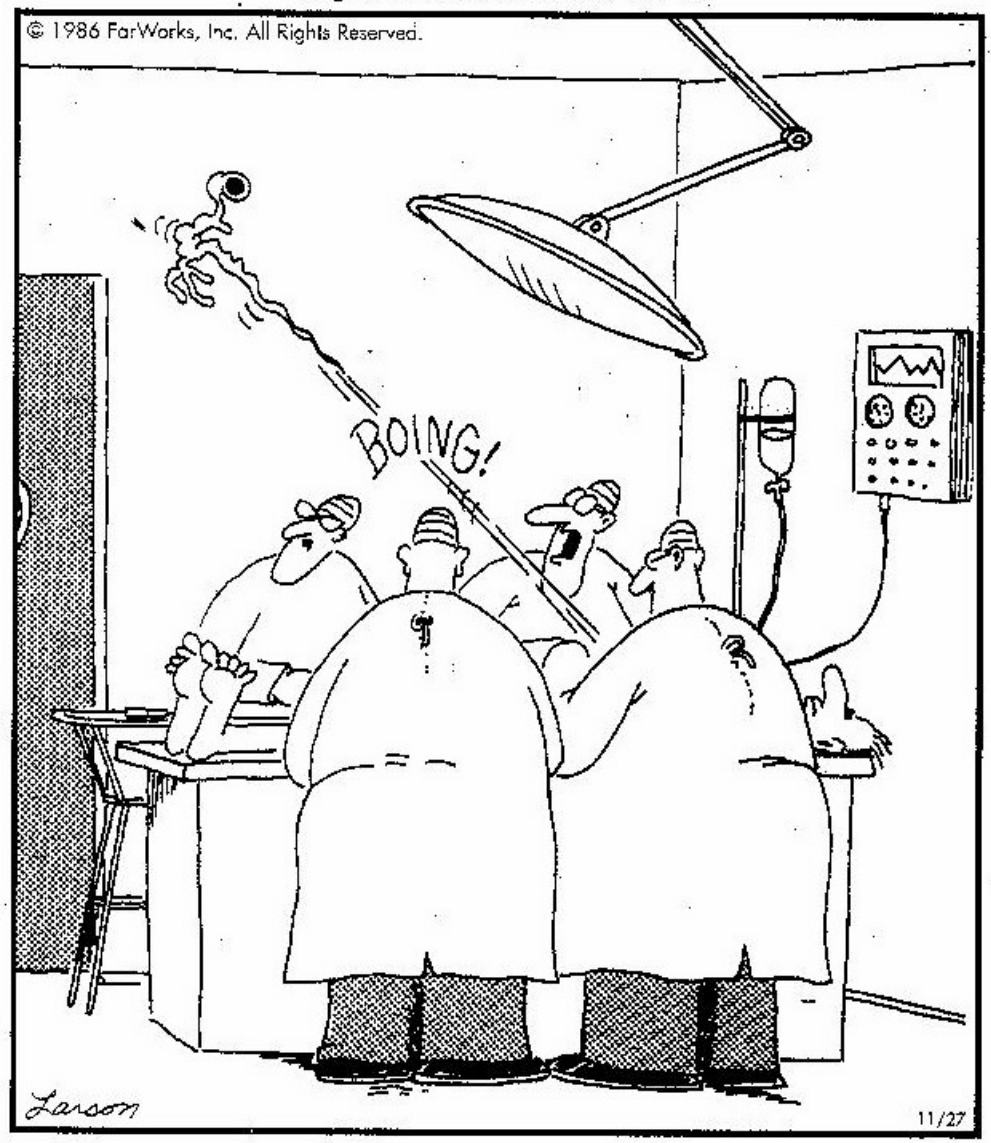
Have you ever counted them?

- Nuclear Medicine at William Ostler
- Endocrinology at the Cleveland Clinc
- Medical Imaging at a large hospital

THE FAR SIDE

From ***The Complete Far Side***, available in bookstores

Original release date: 11/29/86



"Whoa! Watch where that thing lands—we'll probably need it."

OR Scheduling Delays

- Downtown acute care hospital OR suite
- Address issues causing delays in turnaround
- ORSOS data: two main factors
  - lack of recovery room beds
  - cleaners unavailable
- “Simple” solution

Hospital Patient Simulation

- 1989: Nursing Crisis in Ontario
- Ont. Min. of Health & Five Hospitals
- Linda O'Brien-Pallas & Linda McGillis-Hall (Nursing) plus John Blake (IE Dalhousie)
- 1995: Efficient Use of Resources!
- "What if?" Simulation tool
- However, some of the results were "simple"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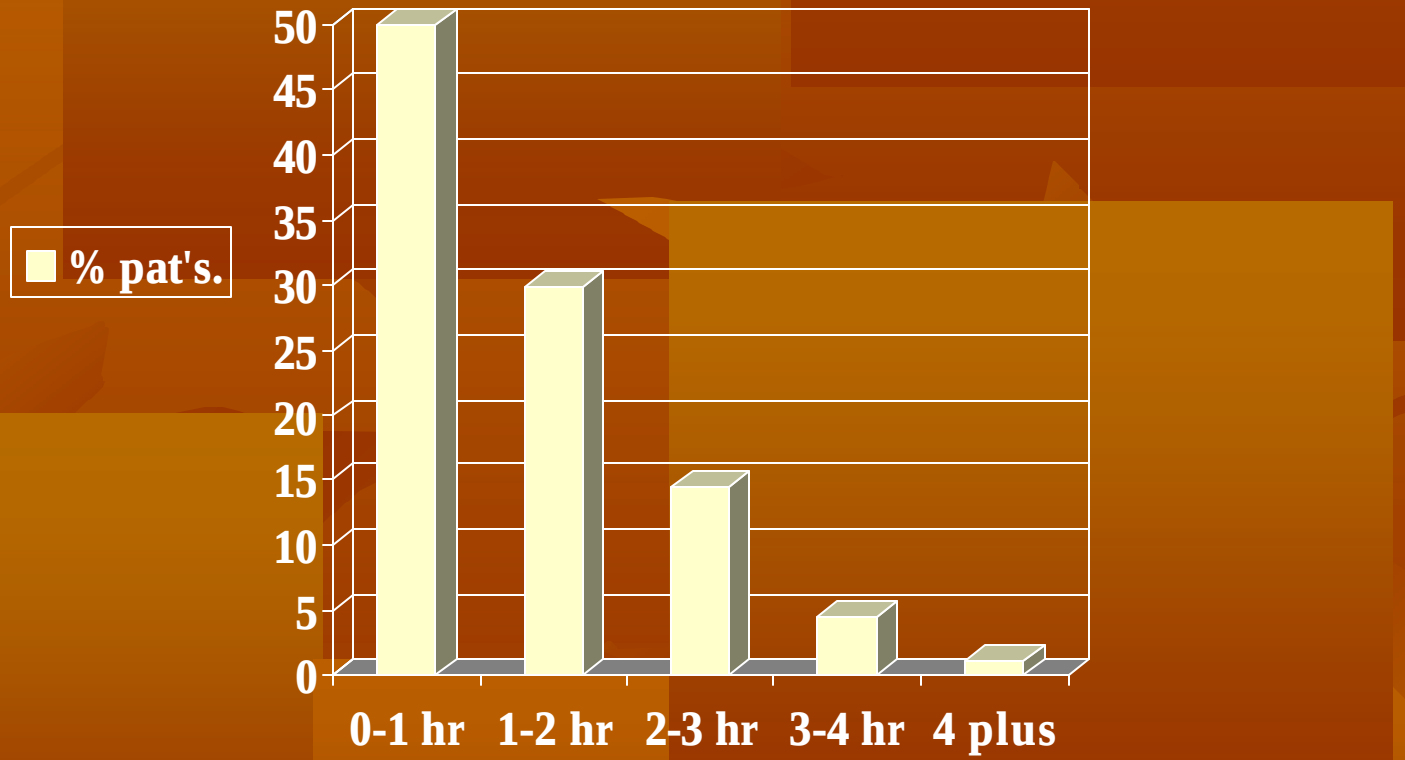
EMERGENCY
9-16
"You're on the waiting list to start waiting."

CHEO: Emergency Room

- Children's Hospital of Eastern Ontario: Ottawa 1993
- Paediatric Teaching Hospital
- 50,000 patient visits per year in the ER

CHEO: Waiting Times (1993)



CHEO: Emergency Room

- 20 % of patients wait over two hours
- Eleven suggestions by staff
- Simulation used to evaluate scenarios
- Fast track clinic
- New Casualty Officer
- Staggered start times

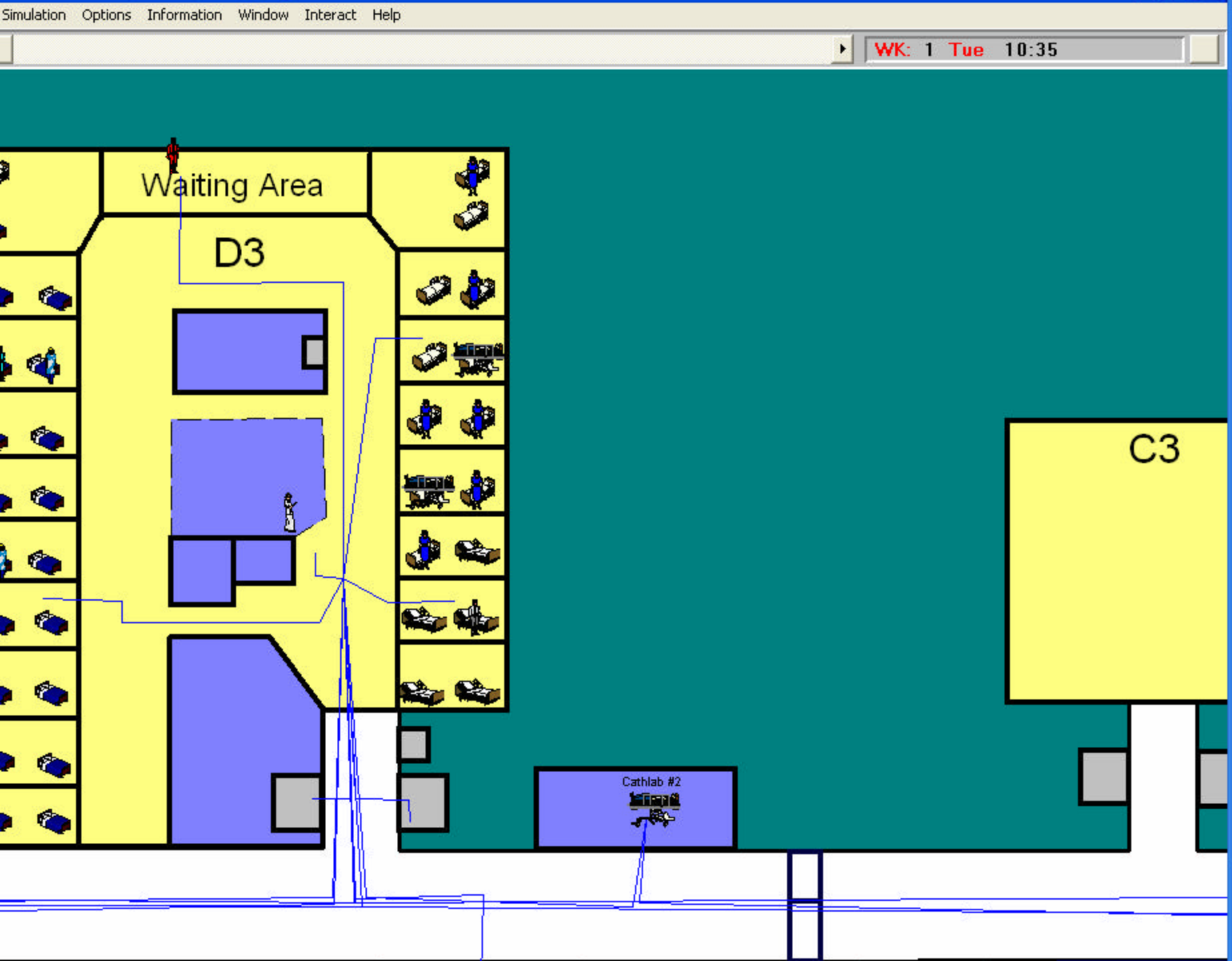
Cornered

by Mike Baldwin

The Angina Monologues

Cardiology at S&WCHSC

- Fourth year thesis topic
- Dr. Eric Cohen, Director, Cardiac Cath Lab
- Nadine Kerrigan & Maggie Le
- “What is the benefit of one more bed on the Cardiovascular ward?”


Simulation
Options
Information
Window
Interact
Help
WK: 1 Tue 10:35
Waiting Area
D3
C3
Cathlab #2

Causes and Relationships of Overcrowding and Waiting in Different Emergency Departments: The CROWDED study

MW Carter[1], DJT Fernandes[1,2], MJ Schull[2], GS Zaric[3], G Geiger[4]

[1] Healthcare Productivity Laboratory, Mechanical & Industrial Engineering, U of Toronto;
[2] Institute for Clinical Evaluative Sciences;
[3] Richard Ivey School of Business, University of Western Ontario
[4]Sunnybrook and Women's College Health Sciences Centre

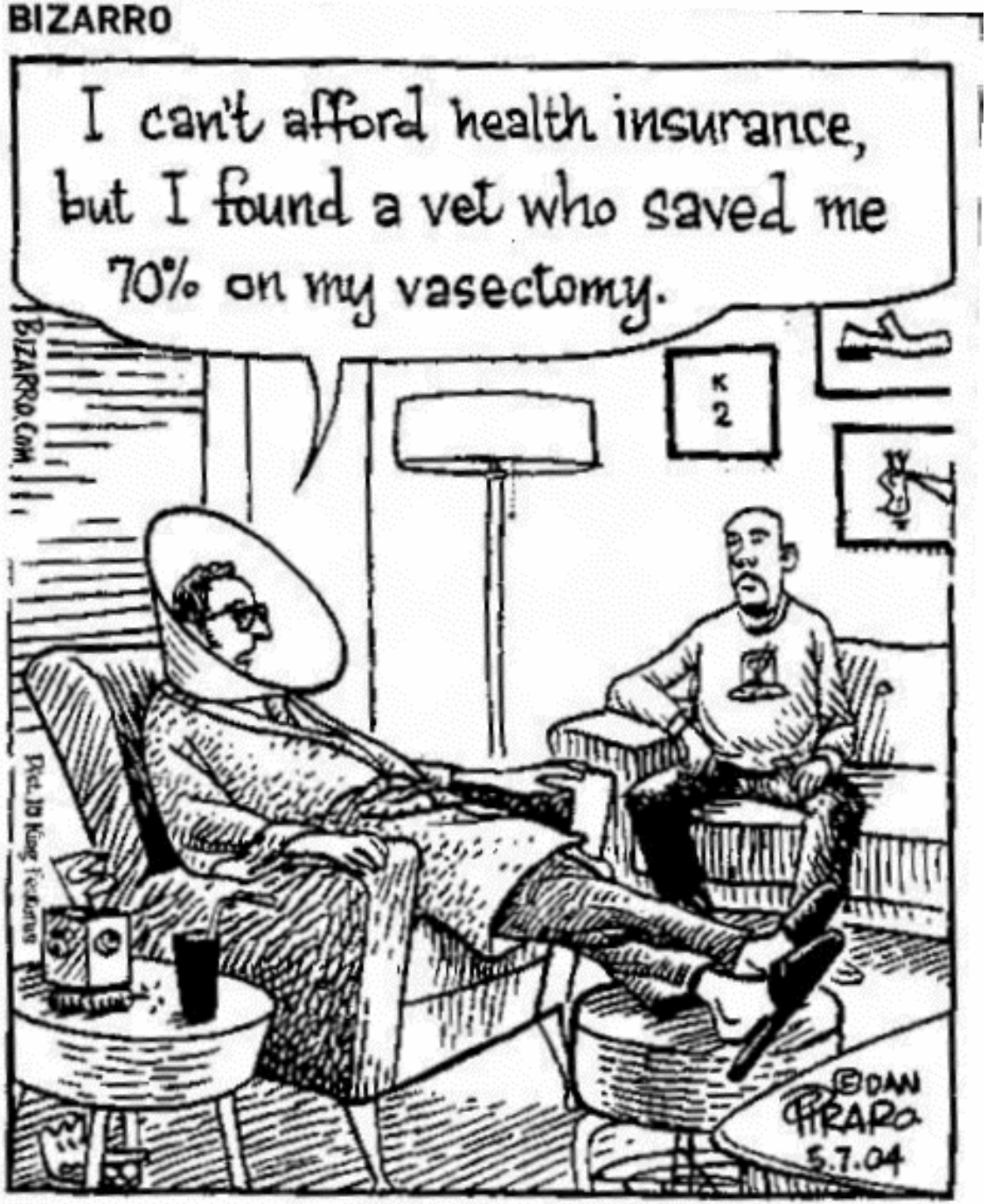
Background

- ED overcrowding and waiting - major problem
- Most analysis based on LOS data
- Statistical models extrapolate the past
- A few simulation models - typically model LOS
- Does not help us analyze improvements
- Wanted to understand what happens in an ED

The Hospital Partners

- Academic
  - Kingston General
  - Sunnybrook & Women's
  - London HSC
- Rural
  - Quinte Health Corp
  - Stevenson Memorial
  - South Muskoka
- Community
  - Royal Victoria - Barrie
  - Sudbury Regional
  - Markham-Stouffville
  - Windsor Regional

BIZARRO


I can't afford health insurance, but I found a vet who saved me 70% on my vasectomy.
BIZARRO.COM
K 2
DAN PIRARO 5.7.04

Strategic Hospital Planning Model

- Mid 1990's – 3 year cuts of 18%
- John Blake Ph.D. thesis - Mt. Sinai Hosp
- Understand relationship between revenues, costs, resources.
- Mathematical model
- Goal Programming formulation

Problem Statement

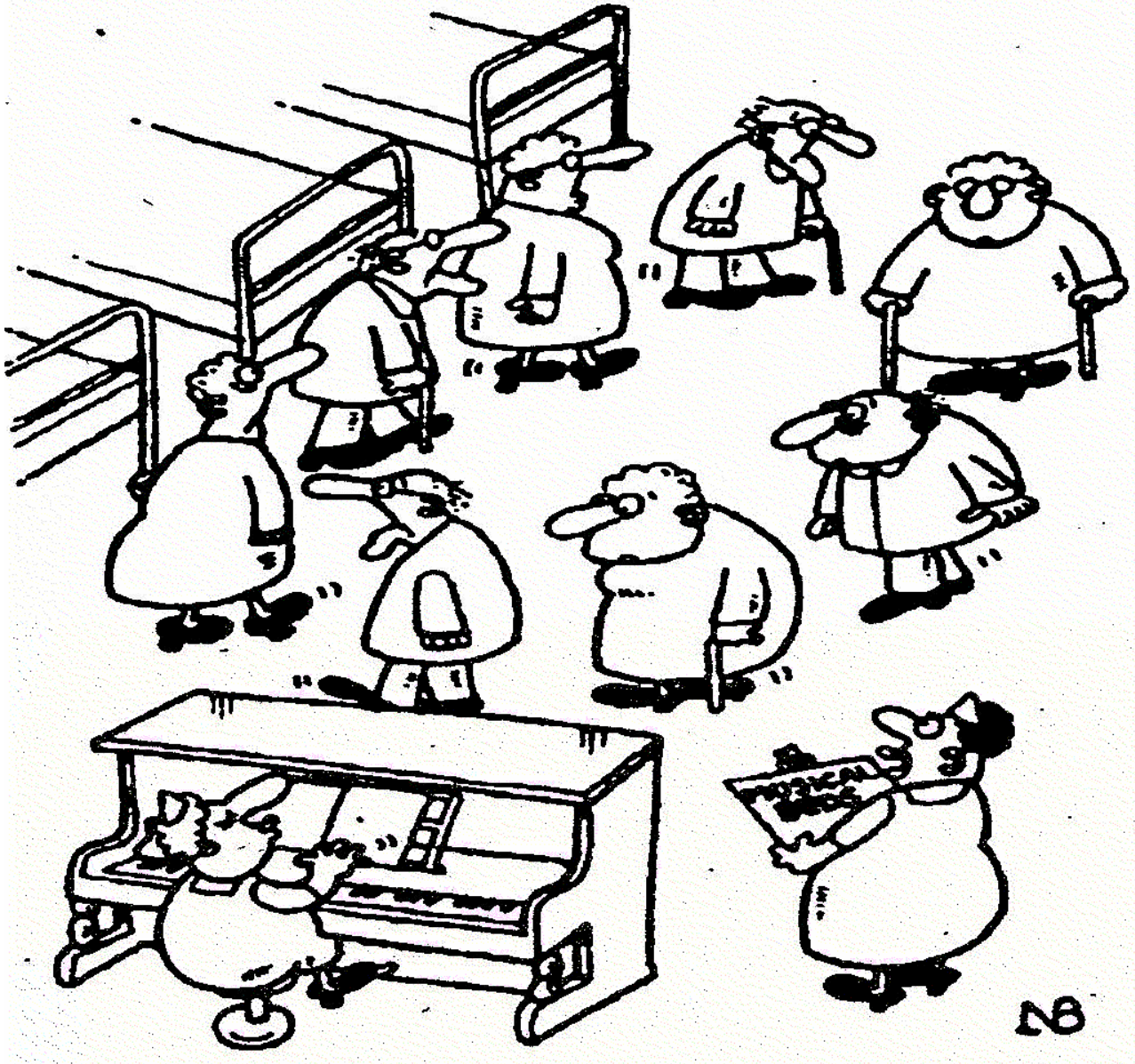
- Identify a case mix for physicians that:
  - Enables the hospital to break even.
  - Provides physicians with a stable income.
  - Allows physicians, as much as is possible, to perform their target mix of cases.

Two Goal Programming Models

- Volume model:
  - Fix the cost of each CMG
  - Determine the case mix that meets targets
- Cost model:
  - Fix the case mix (volume) for each CMG (at current levels)
  - Determine the cost reductions necessary to meet targets

Project Results

- Used during 1996 (plan for 11% cut)
- Intuition at hospital:
  - Retain clinically important services (oncology)
  - Eliminate “unimportant” services (dental, ENT, ophthalmology)
- Model recommendations:
  - ***increase*** dental/eye/ENT
  - ***decrease*** thoracic, oncology
- Thoracic surgery was eliminated in 1997



"And when the music stops, grab a bed . . ."

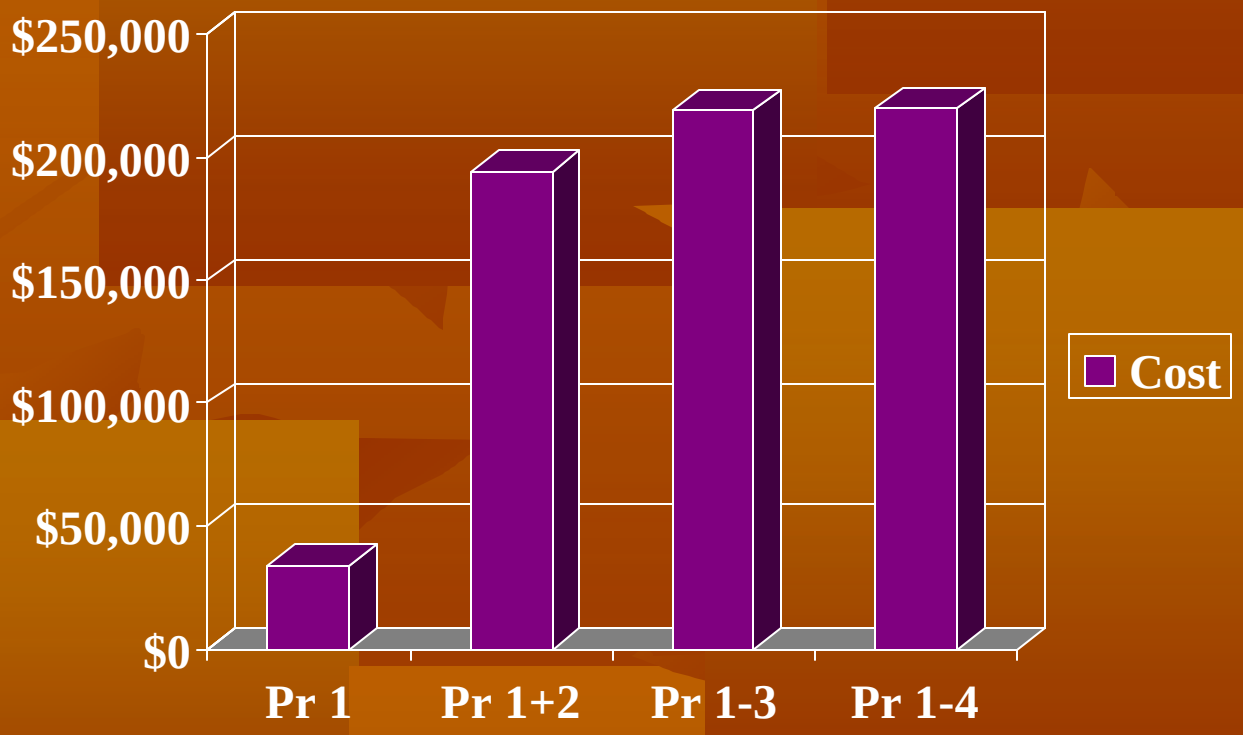
Simcoe County CCAC

- Services
  - Nursing
  - Therapies
  - Personal Support
    - Meals, bathing, dressing, cleaning, living skills ...
  - Placement Services
    - 21 Long term care facilities – 1,763 beds

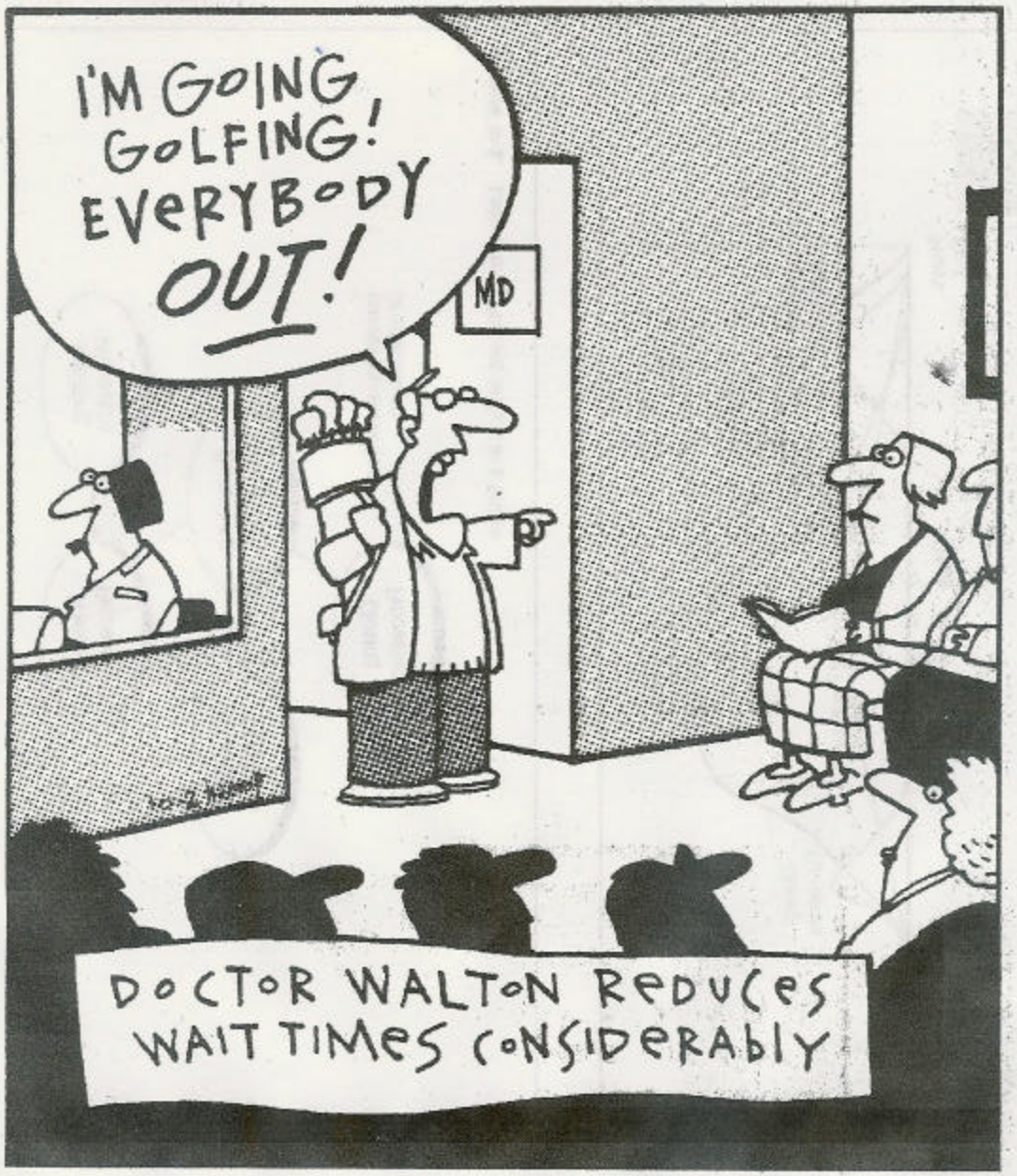
Simcoe County CCAC

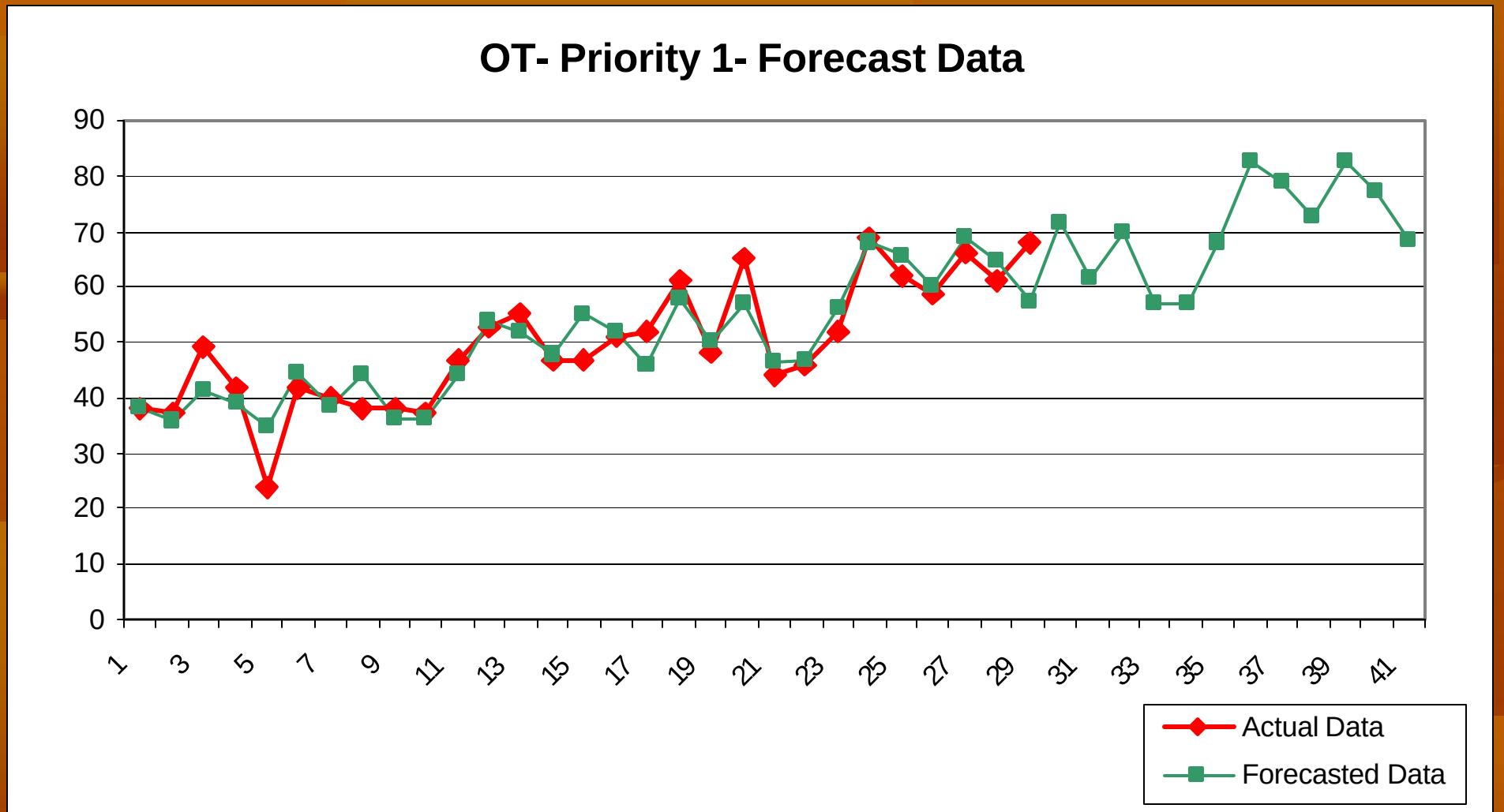
- Therapies
  - Occupational therapy (OT)
  - Physiotherapy (PT)
  - Diet/Nutrition (NUT)
  - Speech pathology (SP)
  - Social work (SW)

Total Cost to Clear Wait List



BACKBENCH


I'M GOING GOLFING! EVERYBODY OUT!
MD
DOCTOR WALTON REDUCES WAIT TIMES CONSIDERABLY


OT- Priority 1- Forecast Data
90
80
70
60
50
40
30
20
10
0
1
3
5
7
9
11
13
15
17
19
21
23
25
27
29
31
33
35
37
39
41
Actual Data
Forecasted Data

Estimating Waiting Time

- Queueing Theory: Given the customer arrival rate 8, and the system service rate :, we can analytically compute a number of statistics (expected wait time, expected number of patients waiting, etc.) for each service.
- This can be extended to multiple priority queues

Monthly Arrival & Service Rates

Service	Priority 1 (λ_1)	Priority 2 (λ_2)	Priority 3 (λ_3)	Total (λ)	Service Rate (μ)
NUT	33.58	11.29	2.97	47.84	42.06
OT	40.42	33.00	9.25	82.67	89.38
PT	139.75	55.78	5.92	201.45	169.31
SP	4.25	4.33	0.81	9.39	15.68
SW	16.5	18.29	7.5	42.29	36.06

Decision Support Tools

- Model 1: Given limits on the queue for each priority (in a service) compute the minimum service level.
- Model 2: Given a fixed service level, compute the expected wait times.

Some Current and Future Projects

- System Dynamics model of a hospital:
  - Trillium
  - Toronto Western
  - Mount Sinai
  - Ottawa Hospital (General & Civic)
- Where are the resource bottlenecks?
- How many resources do we need?

Resource allocation for HIV prevention in a multi-level decision making framework

- Arielle Lasry (UofT) and Greg Zaric (UWO)
- Economic model for intervention funding in Africa
- Analysis of current methods

Canadian Blood Services

- Queueing model for blood products
- Stochastic demand and supply!
- Perishable products
- Cost of shortage?
- Product substitution
- Decentralized decision making

Western Canada Wait List Project

- Wait lists are anecdotal!
- Plus, every doc has his/her own priority
- WCWL has developed standard priority instruments
- But, how will that help reduce wait times?
- Need to develop models of resources to predict impact on wait times.

Cardiac Patient Flow in Vancouver

- Simulation models of patient flow
- Clinical flow (between providers)
- Physical movement (between resources)

Cardiac Care Network of Ontario

- Currently fund 110 surgeries per 100,000 pop.
- What would happen to wait lists if they funded 120? 130?
- Developing simulation model with CCNO and ICES (Jack Tu)

Patient Centered Care

- Princess Margaret Hospital
- Improve the patient “experience”
- Involves process improvement
- Requires culture change

Centre for Addiction & Mental Health

- CAMH - significant bed blocker problem
  1. Placement difficulties
  2. Internal transfers
  3) Issues around internal culture.

Readings

- Operations Research and Health Care: A Handbook of Methods and Applications Series : International Series in Operations Research and Management Science , Vol. 70 Brandeau, Margaret L.; Sainfort, Francois; Pierskalla, William P. (Eds.) 2004, 872 p.