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

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April 20, 2006
RCHE Pioneers in Healthcare Engineering Colloquium
Outline

- Intro to Health Industry
- Some application examples
The Importance of Health Care

- Health care is North America’s largest single industry.
- Total spending in Canada was $123 billion (CN) in 2003. ($1.6 trillion in the US)
- In Canada, in 2003, $3,001 US per person was spent on health care compared to $5,635 in US)

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International Trends

Health Spending as a % of GDP

OECD web site: www.oecd.org Apr 2006
Unfair Comparison:
More $ doesn’t = better health?

Life Expectancy 2003

- Japan
- Sweden
- Switzerland
- Australia
- Canada
- New Zealand
- United Kingdom
- Netherlands
- France
- Germany
- United States

Women
Men

[Graph showing life expectancy by country and gender]
Infant Mortality per 1,000 live births 2003

- United States
- New Zealand
- Canada
- United Kingdom
- Netherlands
- Australia
- Switzerland
- Germany
- France
- Sweden
- Japan

United States has the highest infant mortality rate among the listed countries.
Health Risks (Percent of Population)

United States

Australia

Canada

Netherlands

France

Japan

Obese (BMI>30)
Over weight (BMI>25)
Tobacco
# Health Care Delivery (% Public Payor in 2003)

<table>
<thead>
<tr>
<th>Public Provider</th>
<th>Private Payor</th>
<th>Mix</th>
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<tr>
<td>Public Payor</td>
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<tr>
<td>UK (83), Japan (81)</td>
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<td>Sweden (85), Holland (62)</td>
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<tr>
<td>Private Payor</td>
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<tr>
<td>Canada (70%), Germany (78), France (76)</td>
<td>United States (44)</td>
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<td>Mix</td>
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<td>** Most OECD states allow wealthy to opt out of public system **</td>
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Canadian Medicare (very brief)

- Providers are private.
- Covered if:
  - “Medically necessary”
  - Done in a hospital
  - Done by a doctor
- 1990 – Internationally recognized leader
- 2000 – We had slipped significantly
- 2006? – Major funding increases - improving
Systemic Hospital Issues: The Four Faces of Health Care*

- Health care is a business, but...
- It is a business unlike all others.
  - Multiple decision makers.
  - Conflicting goals, incentives.
  - Social “good”.
  - No market, no manager.

*Glouberman & Mintzberg, 2001
The Four Faces of Health Care*

- The same divisions apply to the overall social health system!

*Glouberman & Mintzberg, 2001
Toddler’s Creed

If I want it, it’s mine.
If I give it to you and change my mind later, it’s mine.
If I can take it away from you, it’s mine.
If I had it a little while ago, it’s mine.
If it’s mine, it will never belong to anybody else, no matter what.
If we are building something together, all the pieces are mine.
If it looks just like mine, it is mine.

Source: Parenting Department, Toronto Board Of Education
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 Osler
- Endocrinology at the Cleveland Clinic
Cardiac Surgery Simulation

- Hamilton Health Sciences
- Opening fourth cardiac OR in Spring 2006
- How should OR time be allocated?
- How many beds are required in ICU/ward?
- “What if?” Simulation tool
Surgery Grouping

Cardiac Surgery 2002-2004
N>4000

No Redo/Combined

CABG VALVE COTHR CONGD

CABG 1,2,3 TVR,AVR CONGD COTHR

CABG VALVE AORTA

CABG 4,5,6,7 MVR

Redo/Combined

CABG VALVE AORTA

CABG COTHR

CAVLV COTHR
Surgery Duration Distribution

- **Minor**
  - Duration: 246 mins
  - Count: n=1530

- **In-btwn**
  - Duration: 285 mins
  - Count: n=1789

- **Intermediate**
  - Duration: 337 mins
  - Count: n=499

- **Major**
  - Duration: 461 mins
  - Count: n=220
Performance Indicators

- Number of cases completed/year
- Cancellation rates
  - Lack of ICU/ward bed
  - Out of scheduled time
  - More urgent case took precedent
- Operating room utilization
  - Under-utilization (hours/week)
  - Overtime (hours/week)
- Ward bed utilization (ICU & CSU)
Can we book surgery differently?

11 hour OR

Undertime & Overtime (hour/day)

Total Cancellations (Cases/year)

Combinations

- 1 major + 1 minor
- 1 intermediate + 1 in-between
- 1 intermediate + 1 minor
- 2 in-between
- 1 in-between + 1 minor
Planning ICU and Ward Capacity

- ICU cancel (# cancellations)
- CSUover (# days exceeded 30 beds)
Strategic Hospital Planning Model

- Mid 1990’s – 3 year cuts of 18%
- 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
System Dynamics Simulation for Cardiac Resource Allocation at Trillium Health Center

Somayeh Sadat, Caroline Chan, Michael Carter
Cardiology at Trillium

- Community Hospital which also serves as the regional cardiac care centre for communities west of Toronto, Ontario
- Conducts 10% of all cardiac procedures in Ontario
- Performs more than 7,000 cardiac surgeries annually
- Performs unique procedure: beating heart surgery
Cardiac Patient Flow at Trillium
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.
Some Current Projects

- ED Simulation (10 Ontario hospitals)
- Patient Centred Care – Princess Margaret
- Queueing model for CBS blood inventory
- CPOE evaluation
- Clinical Managers workload measurement
- OR scheduling & peri-operative simulation
- Fracture clinic scheduling
Some Current Projects (cont)

• Diagnostic imaging scheduling
• HIV/AIDS funding allocation in Africa
• Bed allocation
• Ambulance drop-off delays
• Early speech & language therapy
• Surgical equipment processing
Conclusions

- Health Care is major industry
- There are plenty of Operations Research problems in this field
- There are very few people who devote their major research effort to O.R. in health care
Readings

  Brandeau, Margaret L.; Sainfort, Francois; Pierskalla, William P. (Eds.) 2004, 872 p.