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

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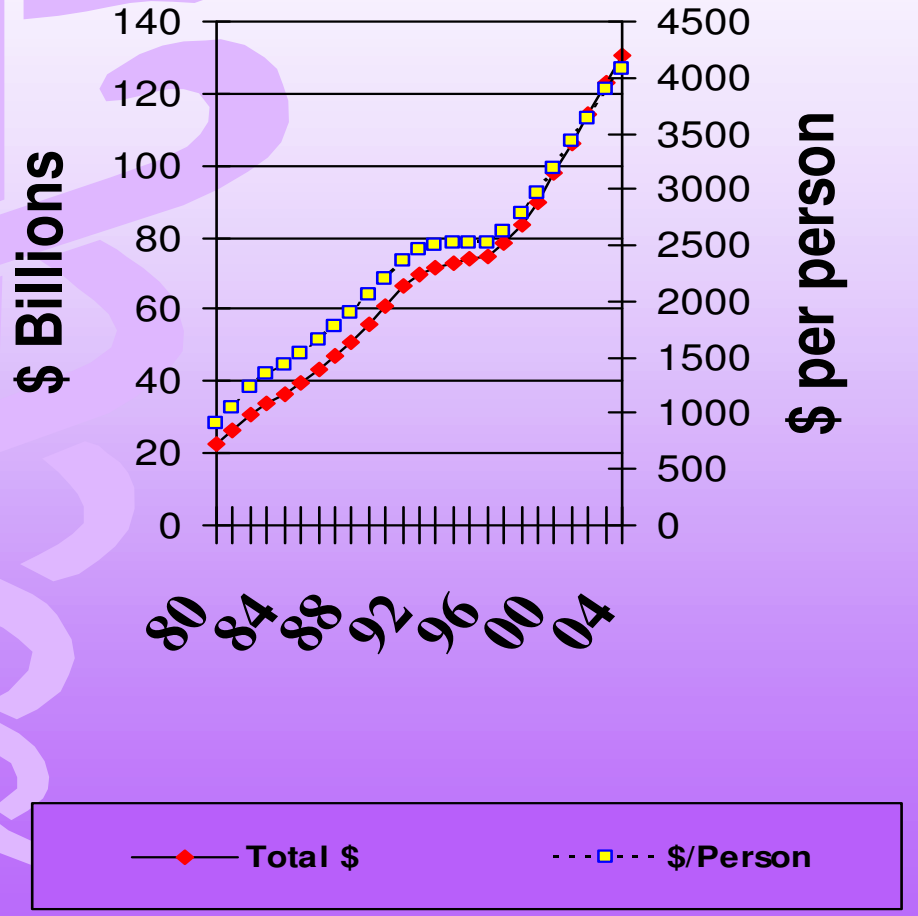
Outline

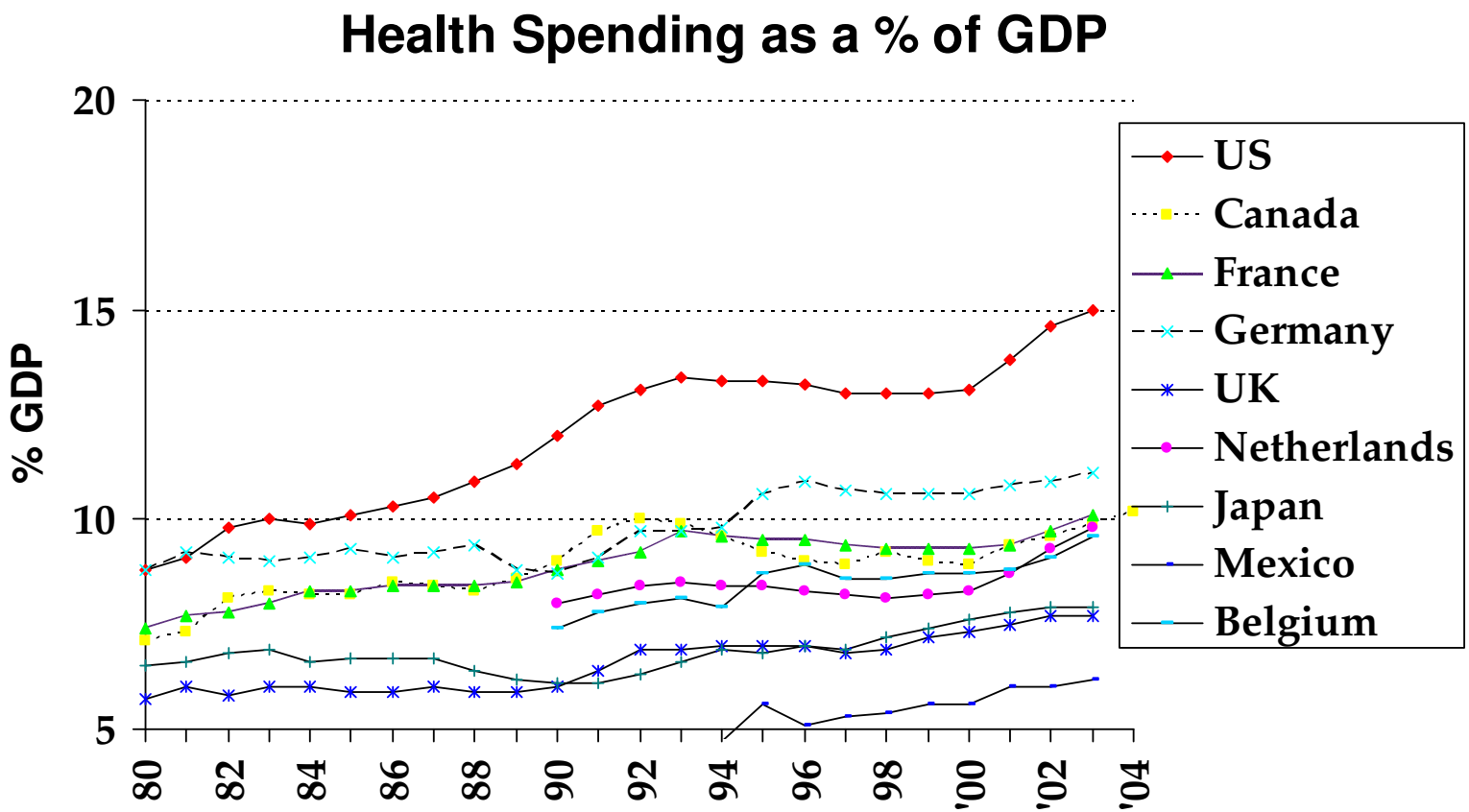
- Intro to Health Industry
- Some application examples

The Importance of Health Care

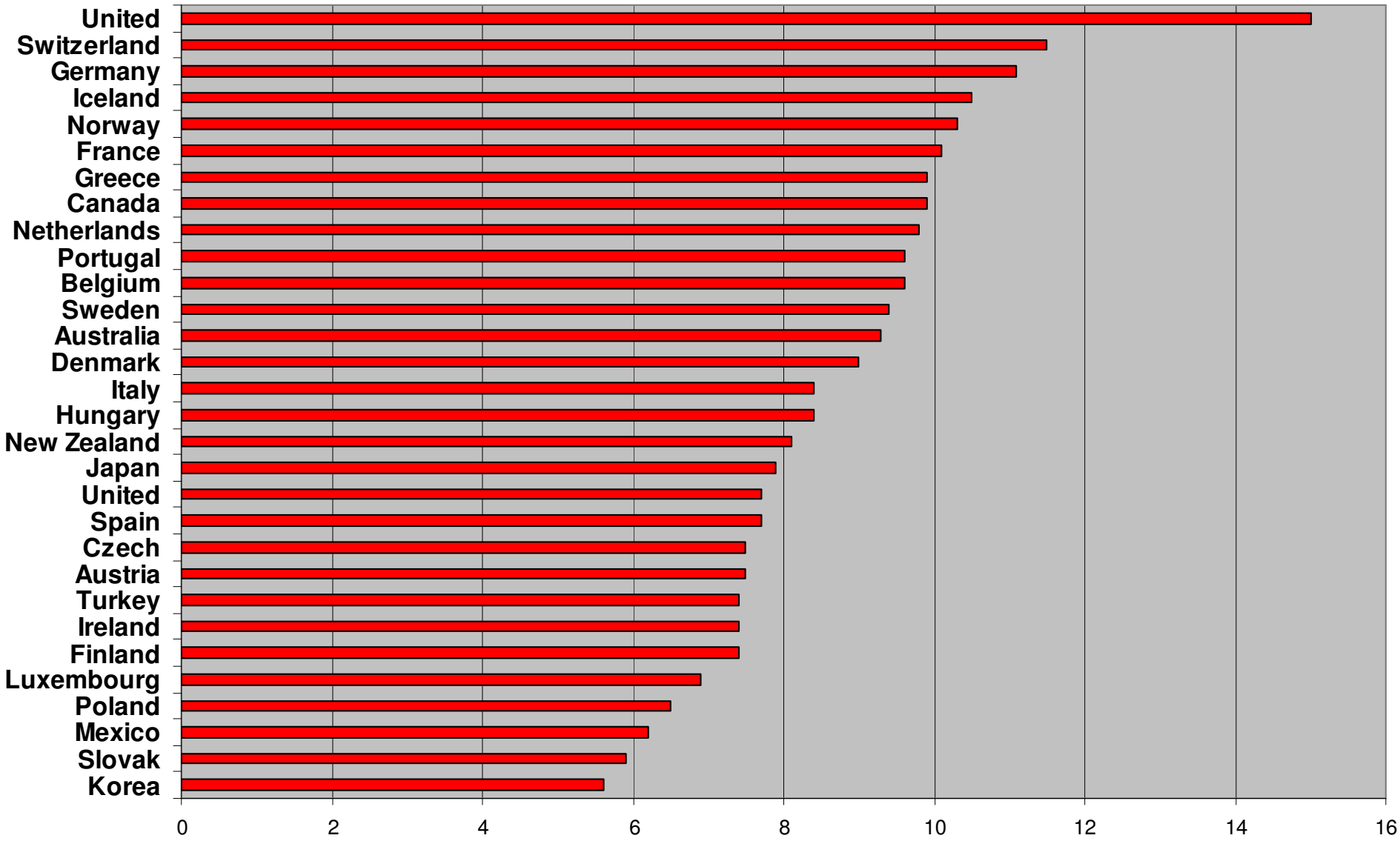
- Health care is North America's largest single industry.
- Total spending in Canada was $123 billion (CN) in 2003. ($1.6 trillion in the US)
- In Canada, in 2003, $3,635 per person was spent on health care (or approx. $3003 US compared to $5,635 in US)



International Trends



OECD web site: www.oecd.org Jan 2006



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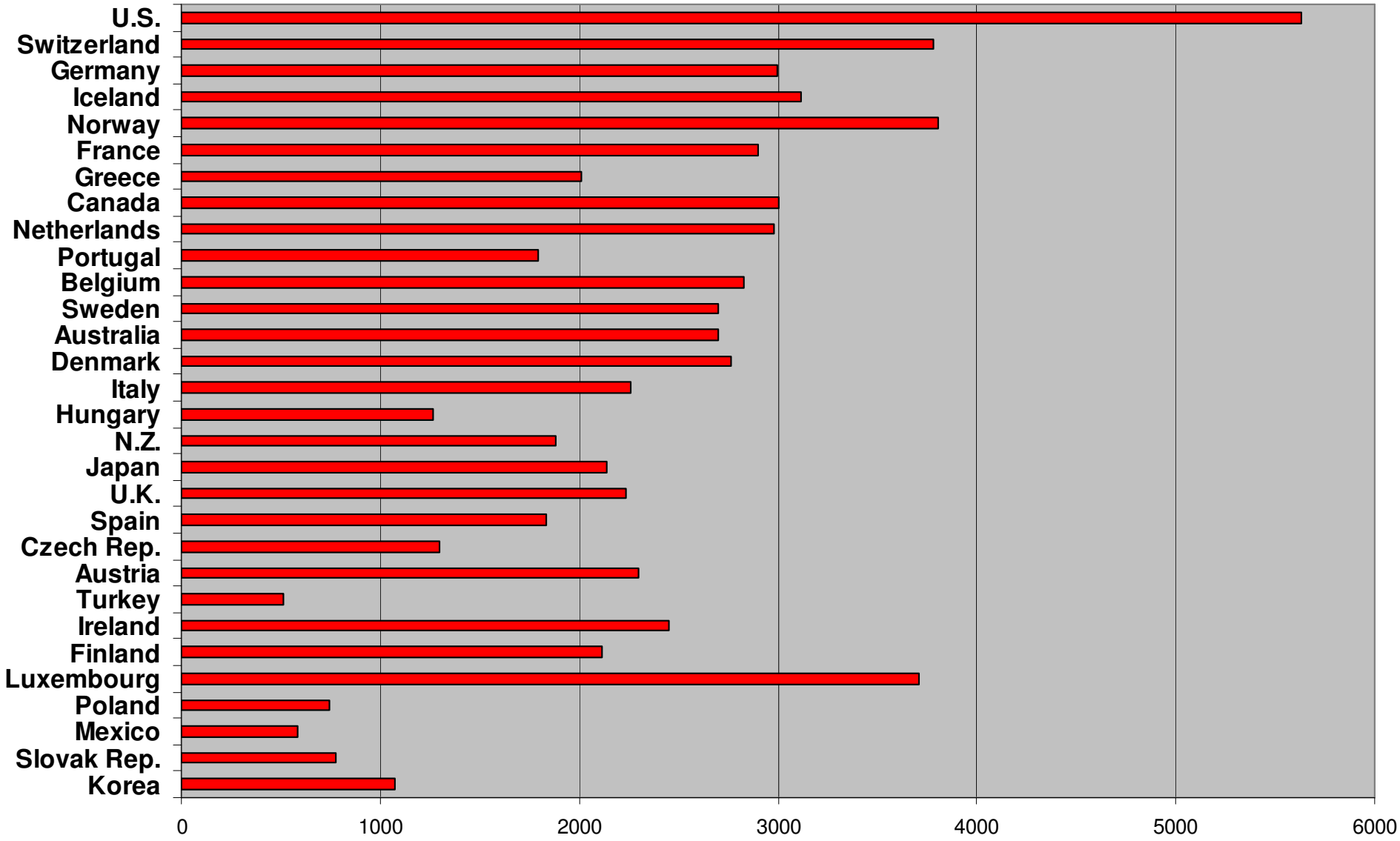
$US Per Capita (PPP) 2003



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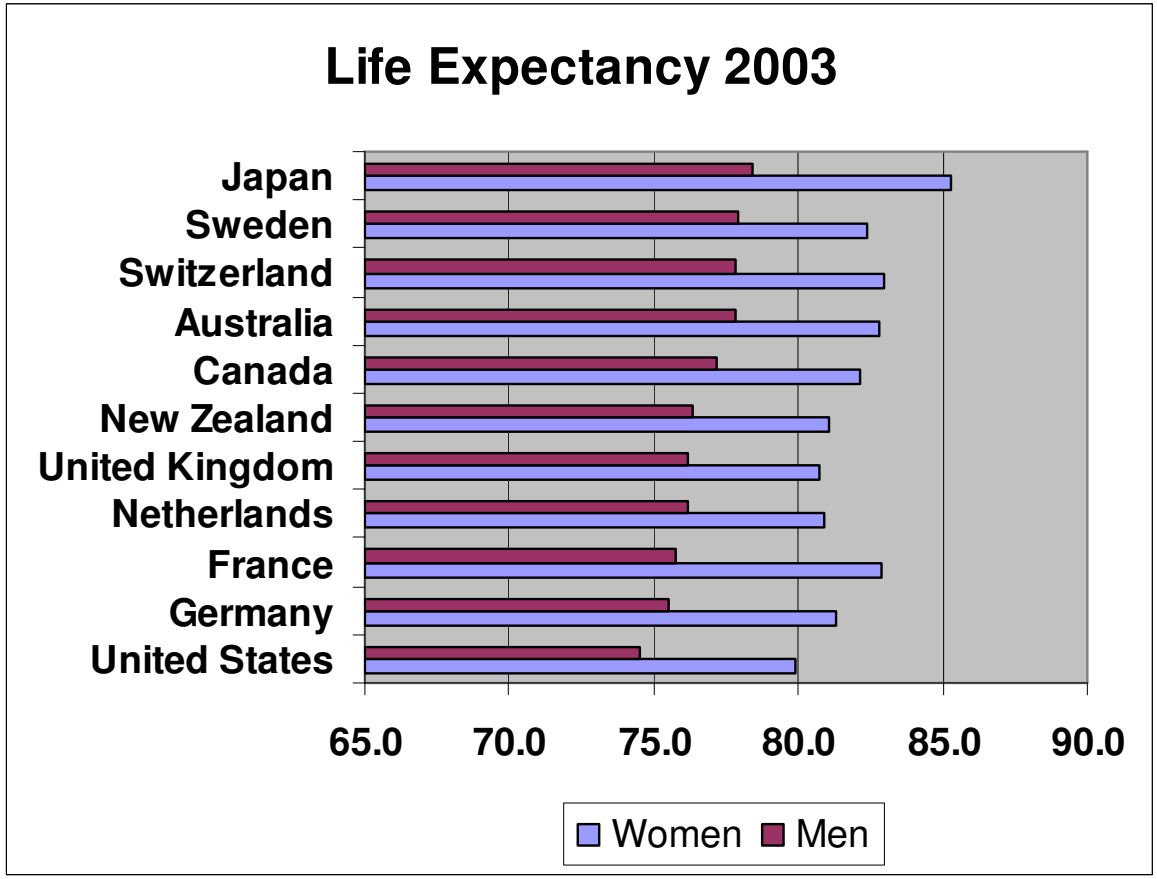
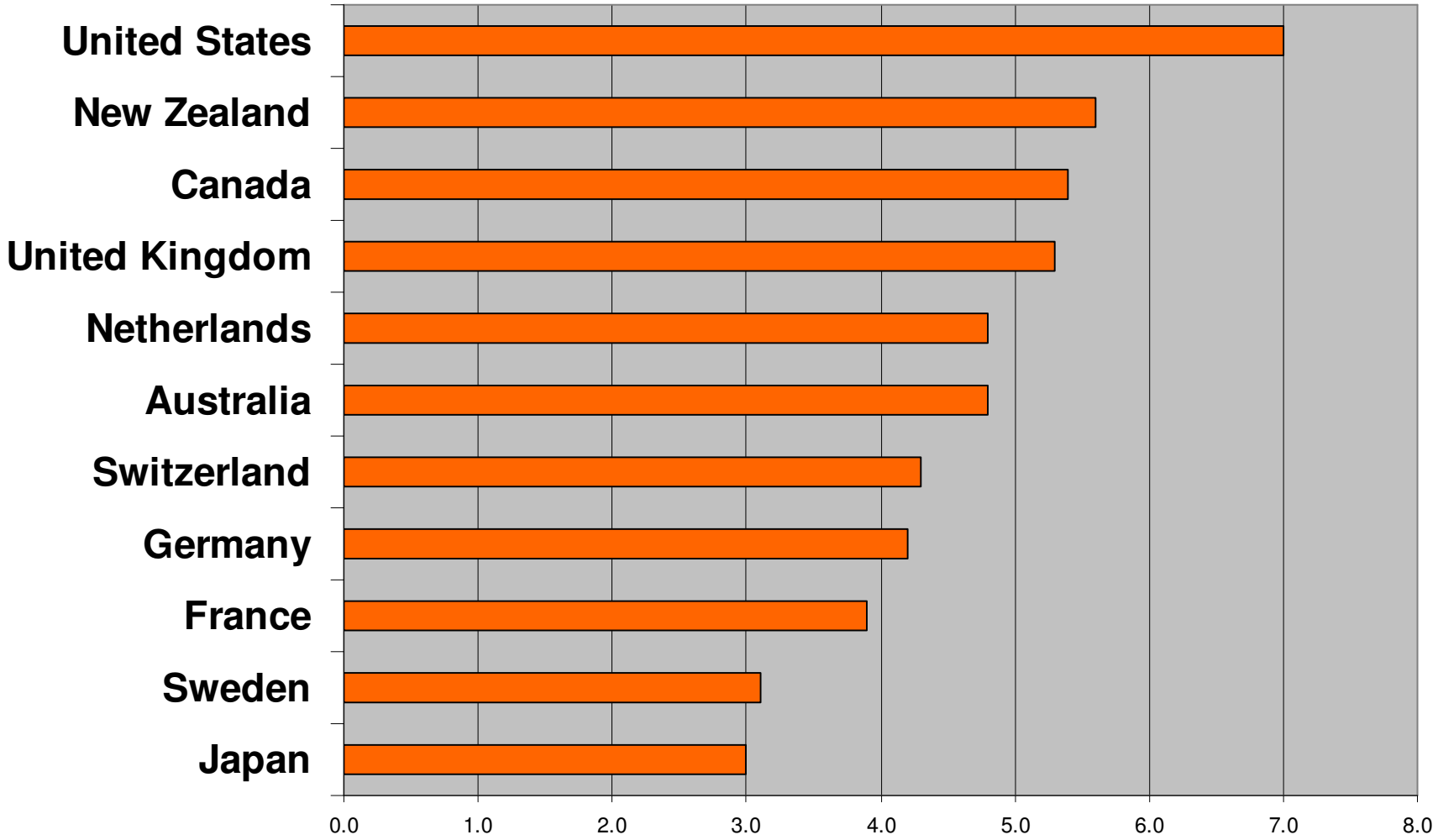
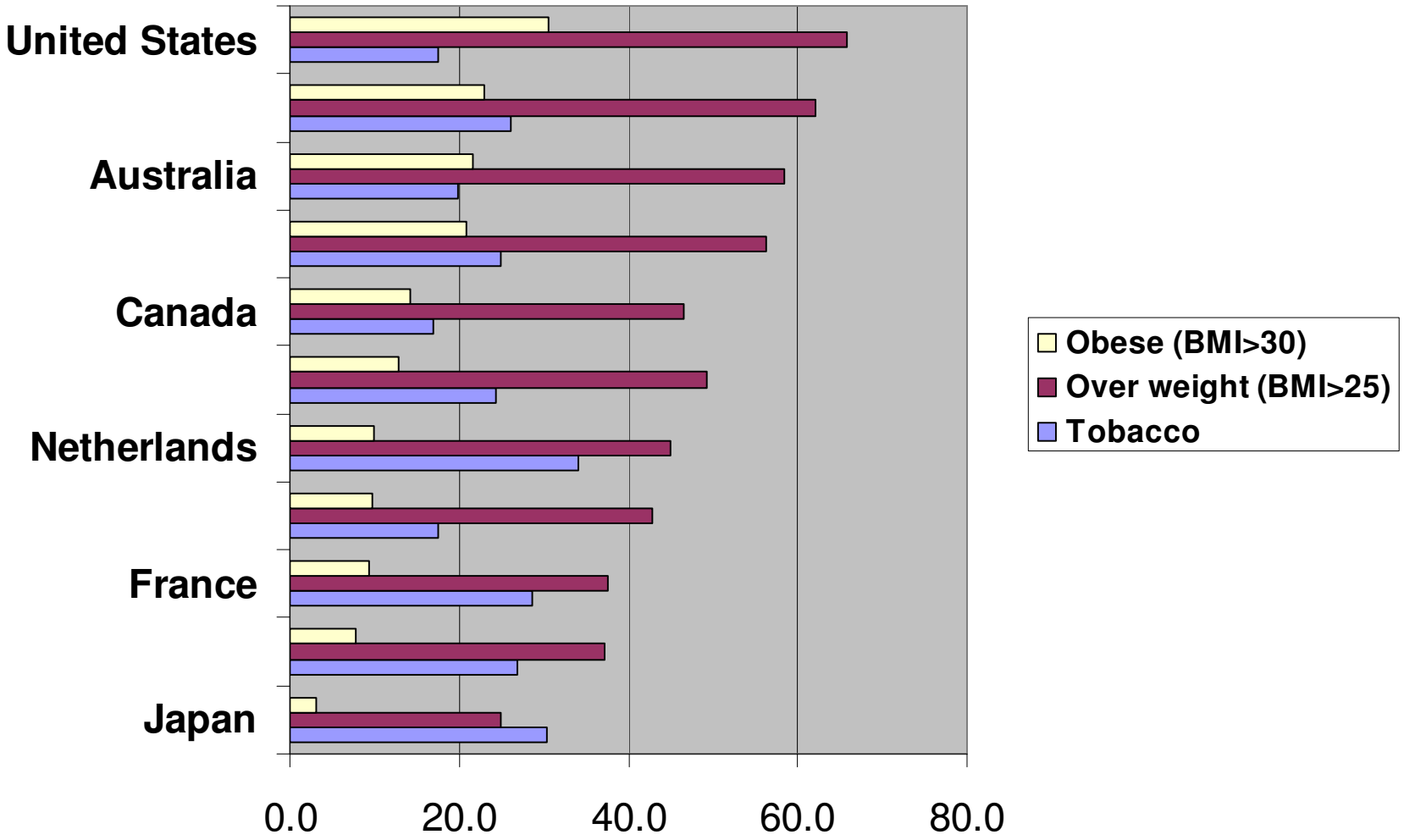
Unfair Comparison:
More $ doesn't = better health?



Infant Mortality per 1,000 live births 2003



Health Risks (Percent of Population)

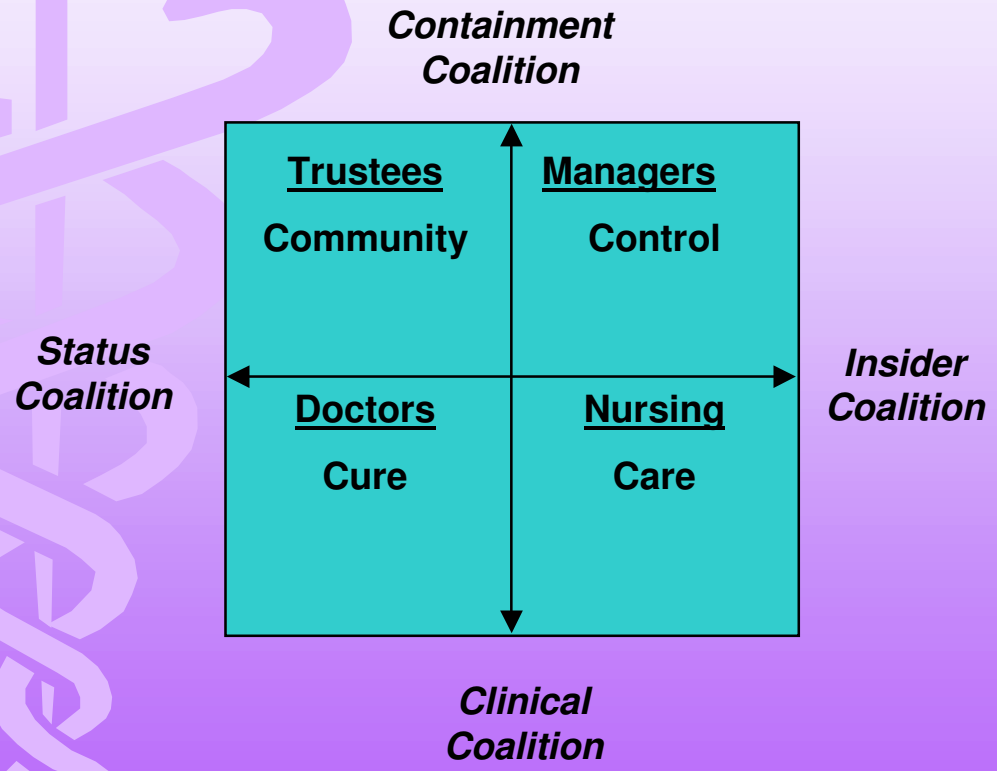


Health Care Delivery
(% Public Payor in 2003)

	Public Payor	**Private Payor**	**Mix**
Public Provider	UK (83), Japan (81)		Sweden (85) Holland (62)
Private Provider	Canada (70%), Germany (78) France (76)	United States (44)	
Mix	** Most OECD states allow wealthy to opt out. of public system **		

Systemic Hospital Issues: The Four Faces of Health Care*

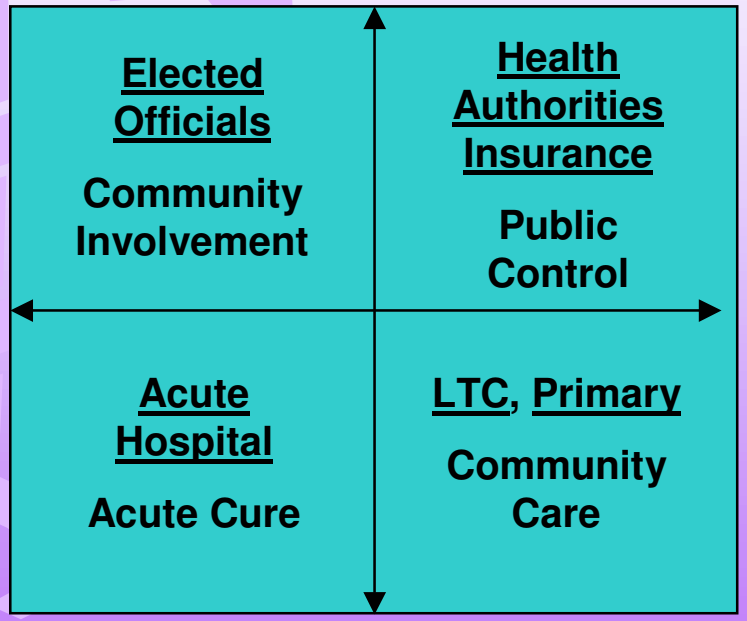
- Ø Health care is a business, but...
- Ø It is a business unlike all others.
  - ØMultiple decision makers.
  - ØConflicting goals, incentives.
  - ØSocial “good”.
  - ØNo market, no manager.



*Glouberman & Mintzberg, 2001

The Four Faces of Health Care*

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



*Glouberman & Mintzberg, 2001

1980's: "The Good Old Days"

- 10% funding increases annually
- Overbudget? No problem!
- Industrial Engineering virtually disappeared from hospitals!
- Ended in 1991

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 Clinc

Hospital Patient Simulation

- 1989: Nursing Crisis in Ontario
- Ont. Min. of Health & Five Hospitals
- Prof. Linda O'Brien-Pallas (Nursing)
- 1995: Efficient Use of Resources!
- "What if?" Simulation tool

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

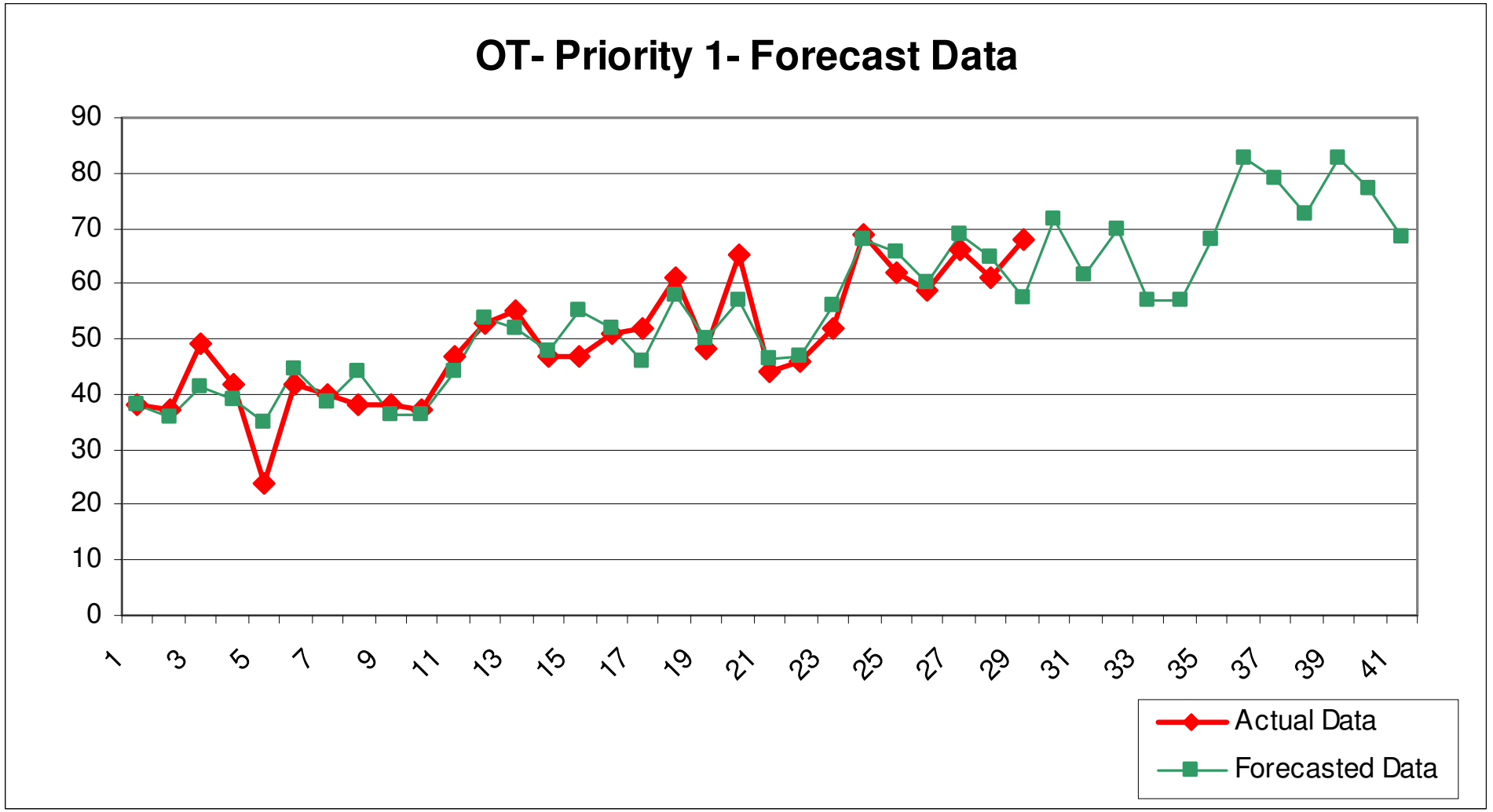
- Used during 1996 (plan for 11% cut)
- Intuition at hospital:
  - Retain clinically important services (oncology)
  - Eliminate “unimportant” services (dental, ENT, ophthalmology)
- Model recommendations:
  - ***increase*** dental/eye/ENT
  - ***decrease*** thoracic, oncology
- Thoracic surgery was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

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)


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

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

Network of Queues

- Many queues involve a sequence of wait lists:
  - ED ► ICU ► Ward ► ALC ► LTC
  - GP ► Surgeon ► Lab ► Surgeon ► OR ► etc
- Each one is a queue – each has an arrival rate and service rate/LOS
- We typically don't know arrival or service rate for many parts
- Analysis is more complex (computer simulation)

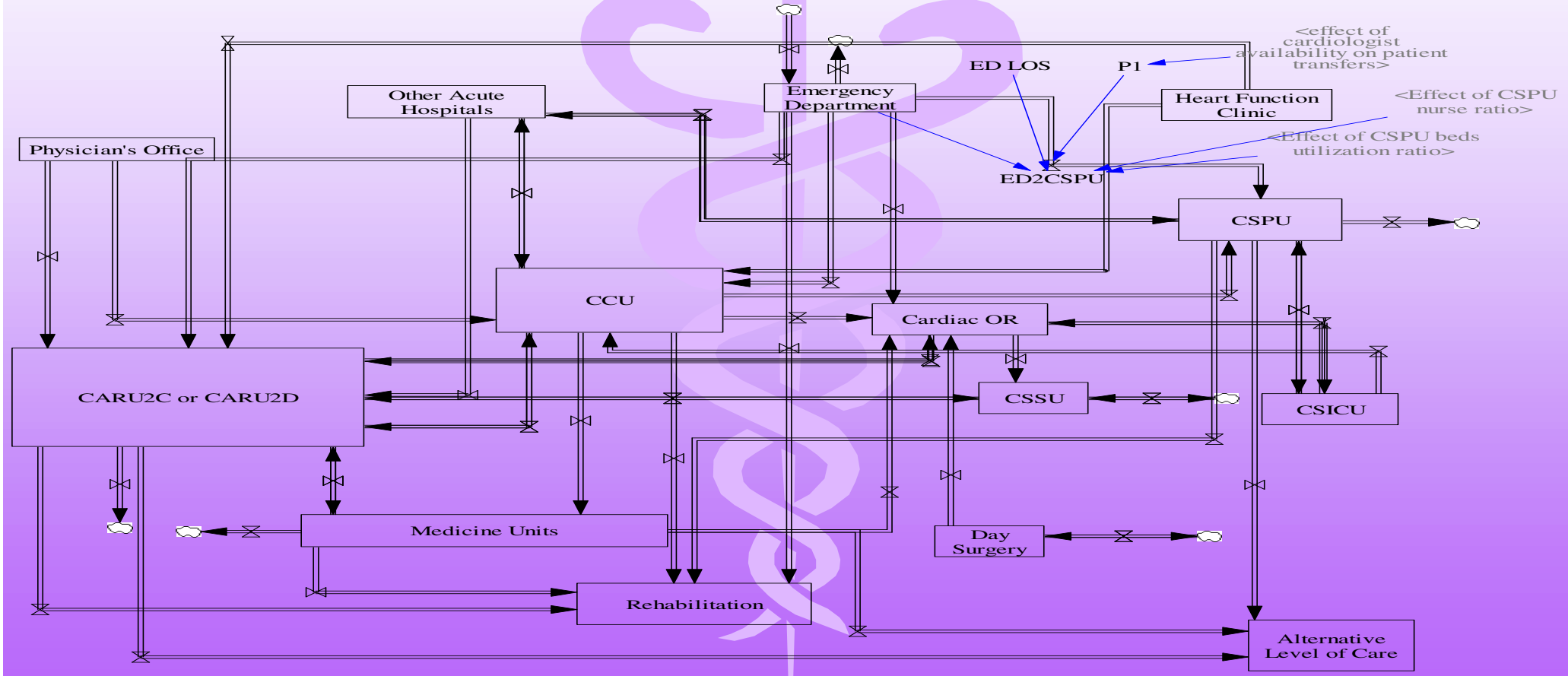
System Dynamics Simulation for Cardiac Resource Allocation at Trillium Health Center

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

- 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.