



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

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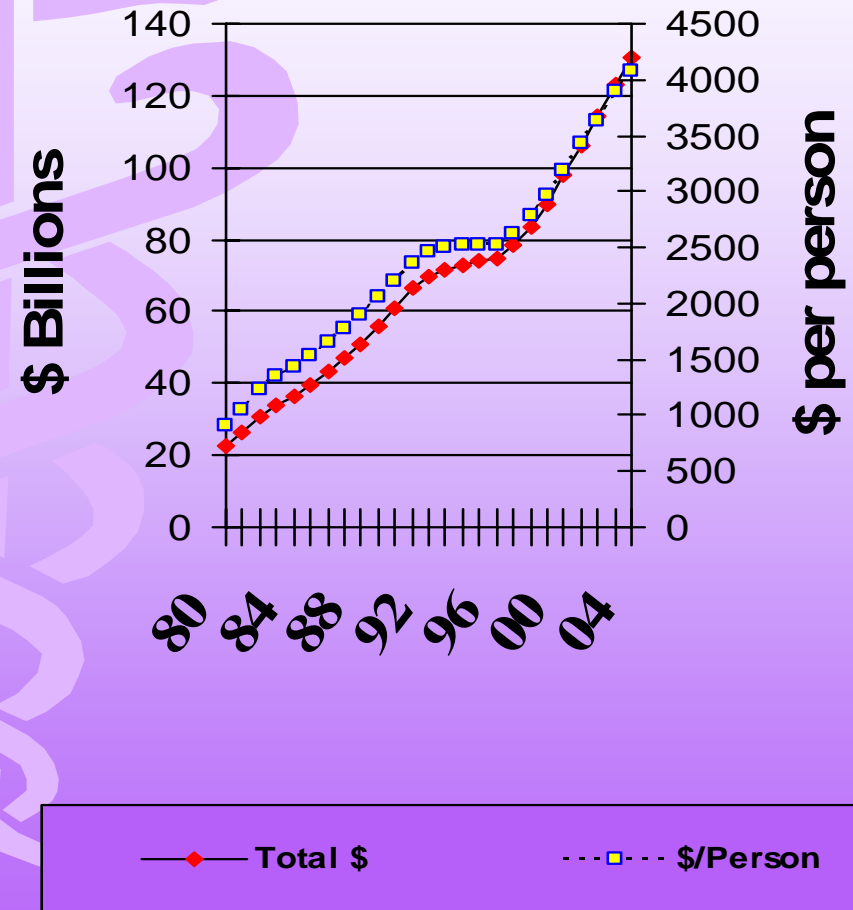
# Outline



- Intro to Health Industry
- Some application examples

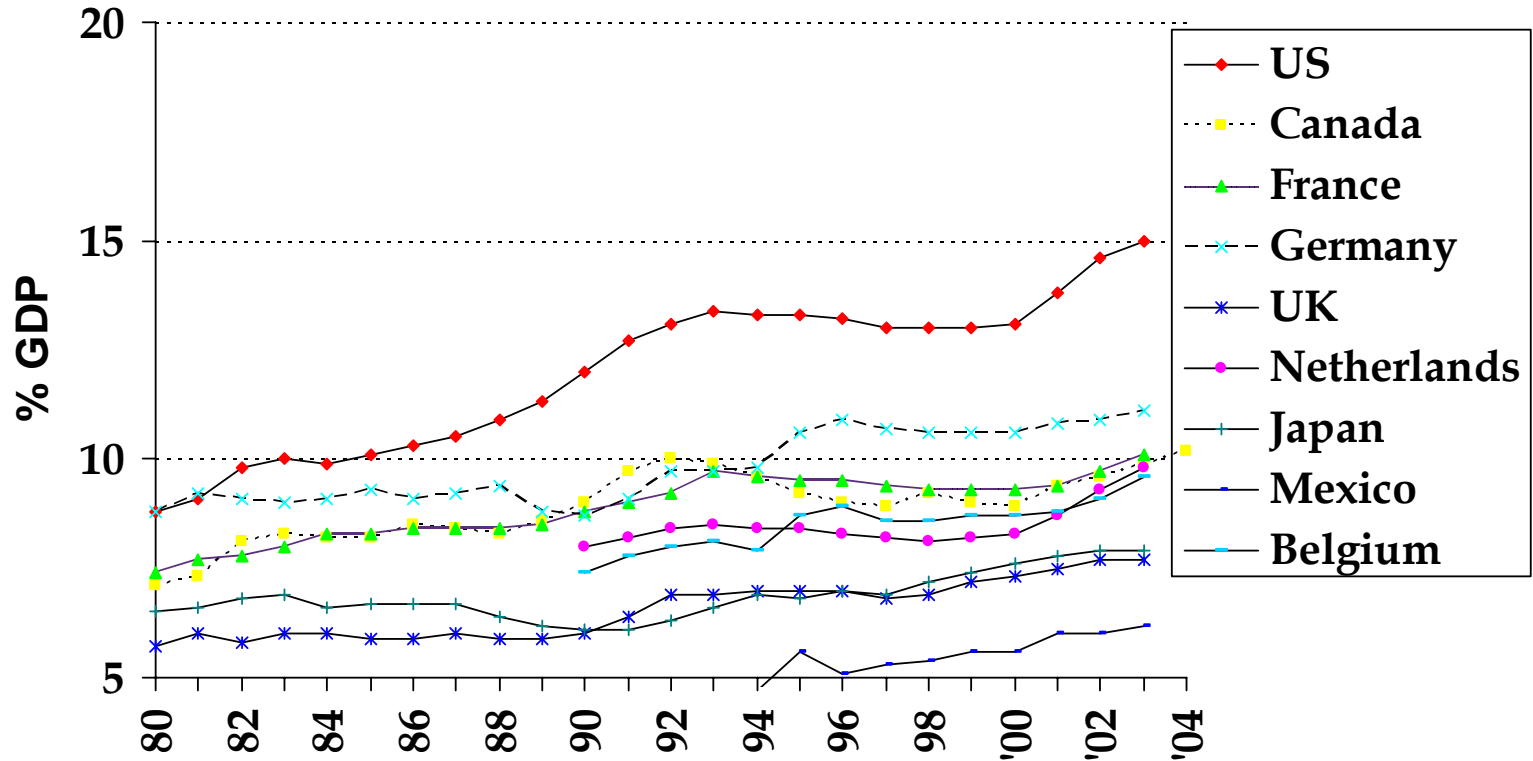
# The Importance of Health Care

- 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, \$3,001 US per person was spent on health care compared to \$5,635 in US)

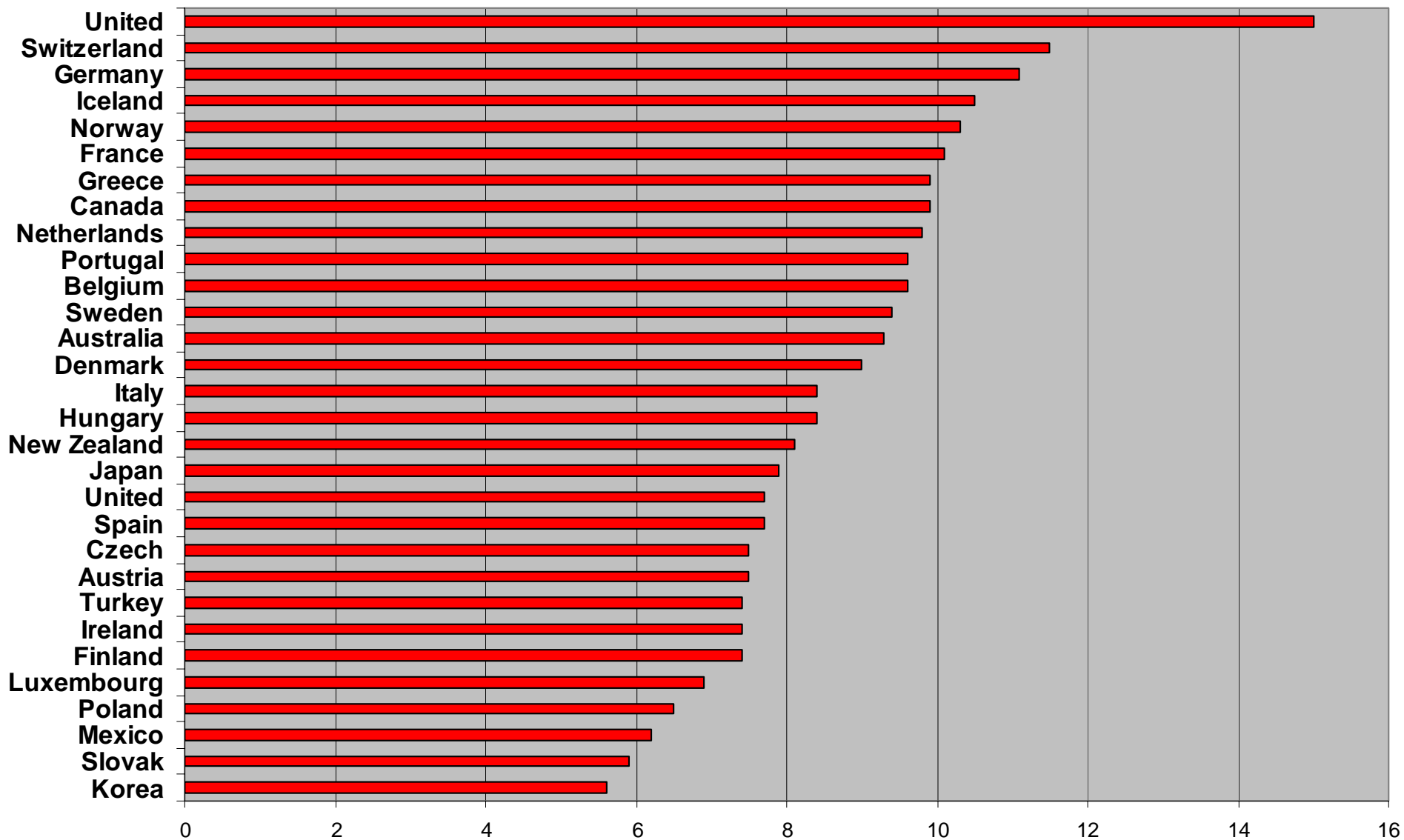


# International Trends

## Health Spending as a % of GDP



# % GDP 2003

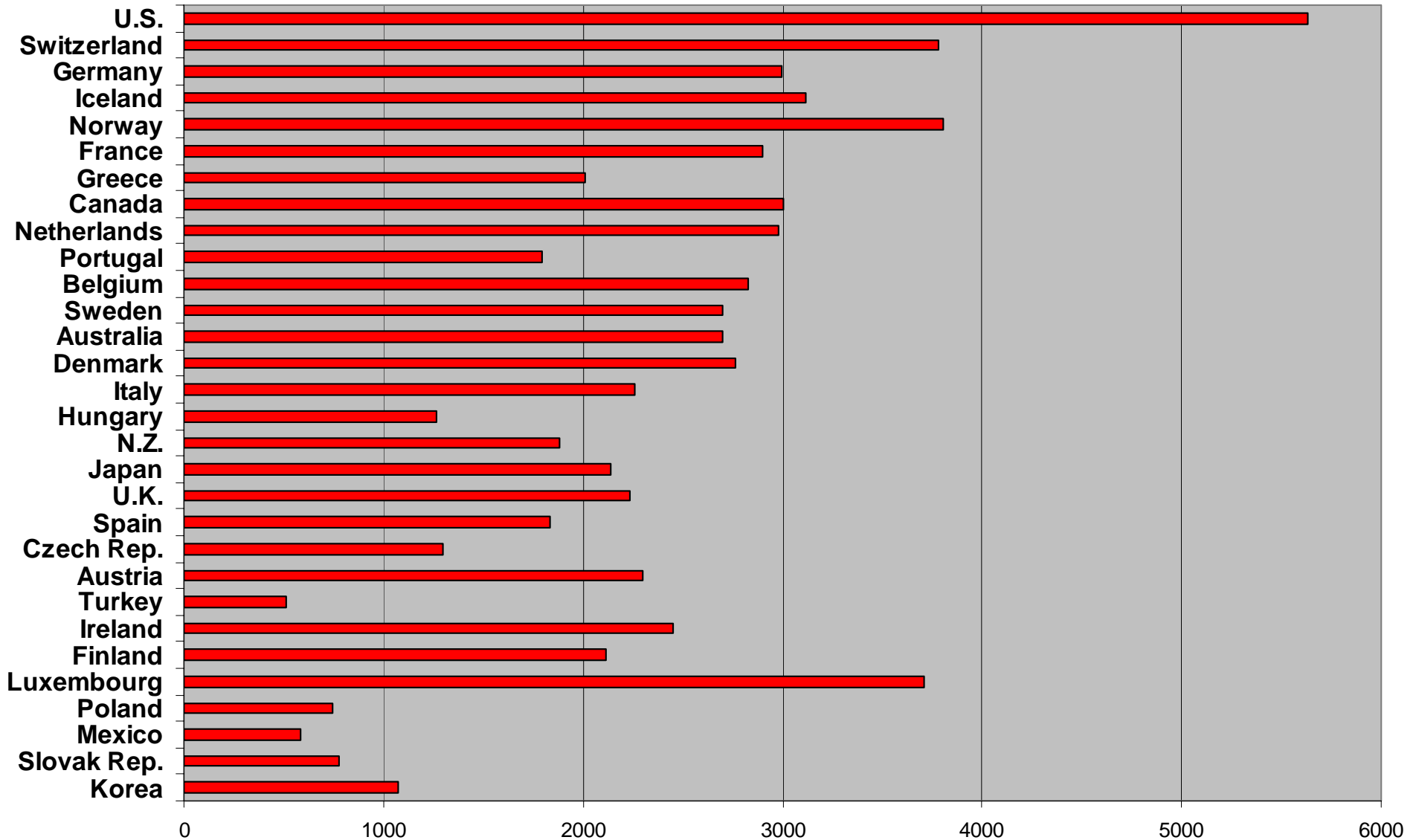


OECD web site: [www.oecd.org](http://www.oecd.org) Jan 2006

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# \$US Per Capita (PPP) 2003

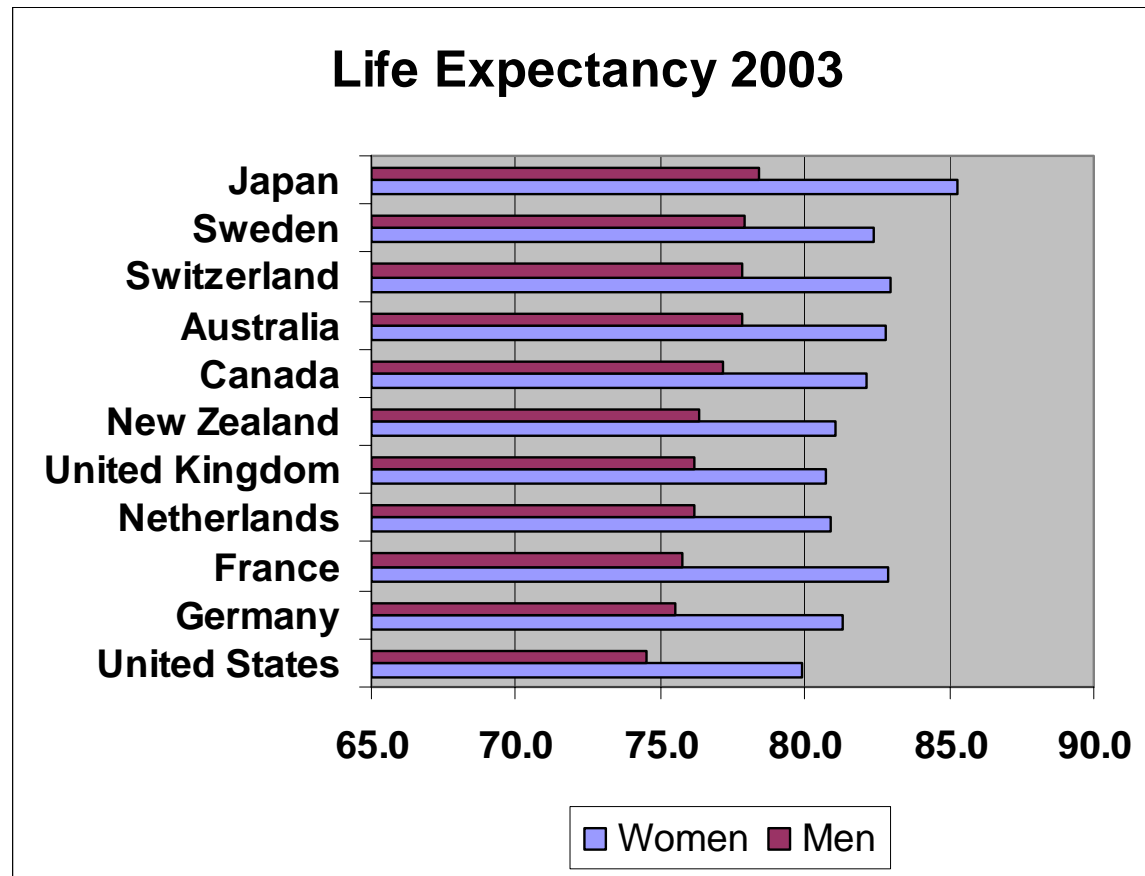


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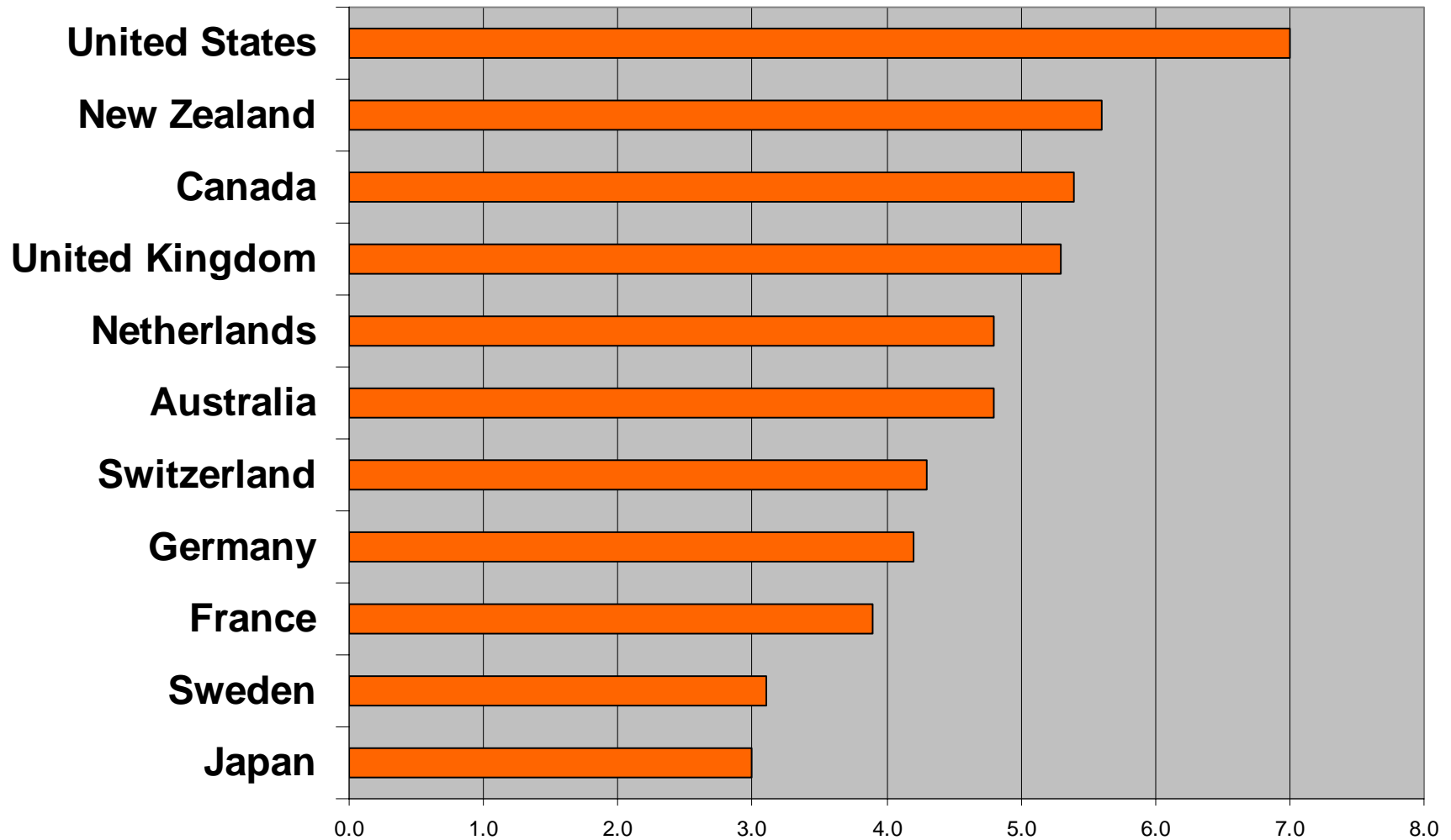
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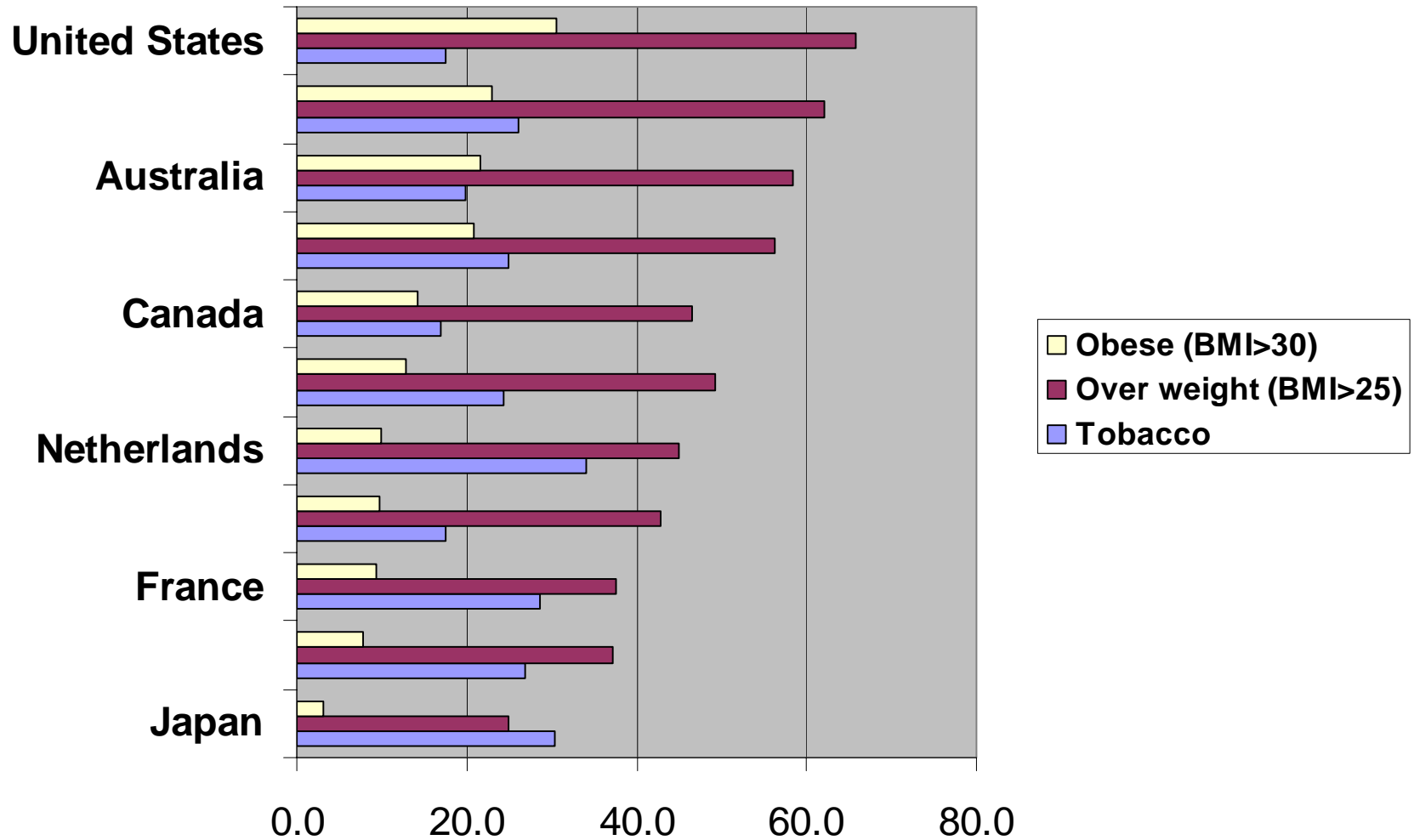
# Unfair Comparison: More \$ doesn't = better health?



## Infant Mortality per 1,000 live births 2003



# Health Risks (Percent of Population)



# Health Care Delivery (% Public Payor in 2003)

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

# Canadian Medicare (very brief)

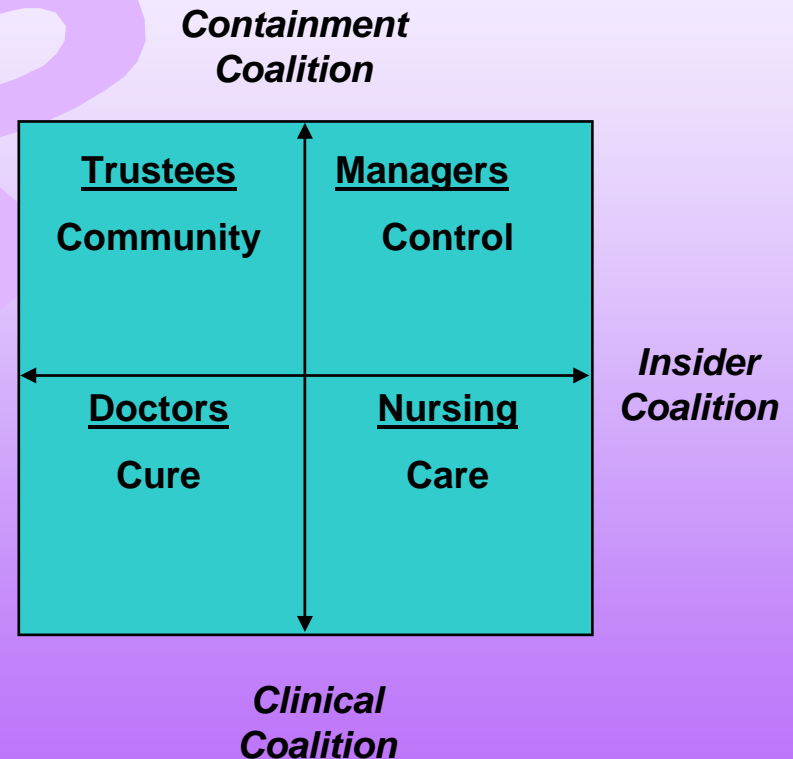


- Providers are private.
- Covered if:
  - “Medically necessary”
  - Done in a hospital
  - Done by a doctor
- 1990 - Internationally recognized leader
- 2000 - We had slipped significantly
- 2006? - Major funding increases - improving

# 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.

*Status  
Coalition*



\*Glouberman & Mintzberg, 2001

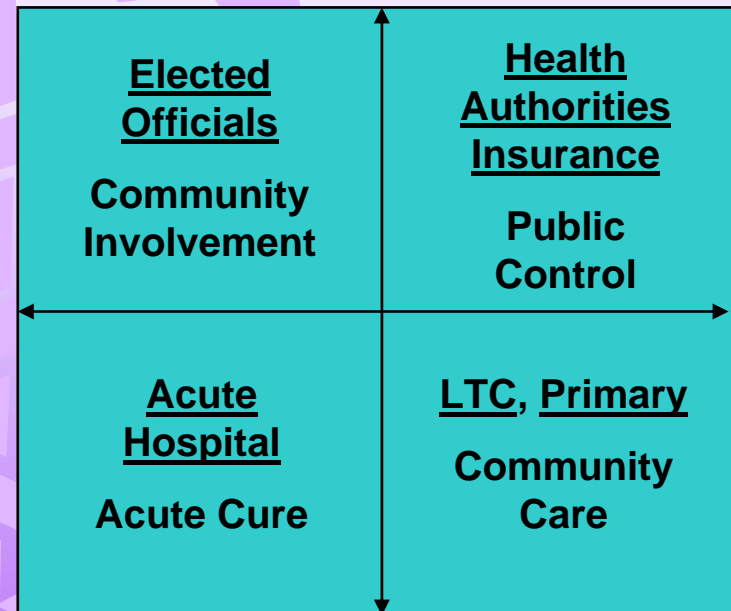
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# The Four Faces of Health Care\*

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



\*Glouberman & Mintzberg, 2001

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## 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

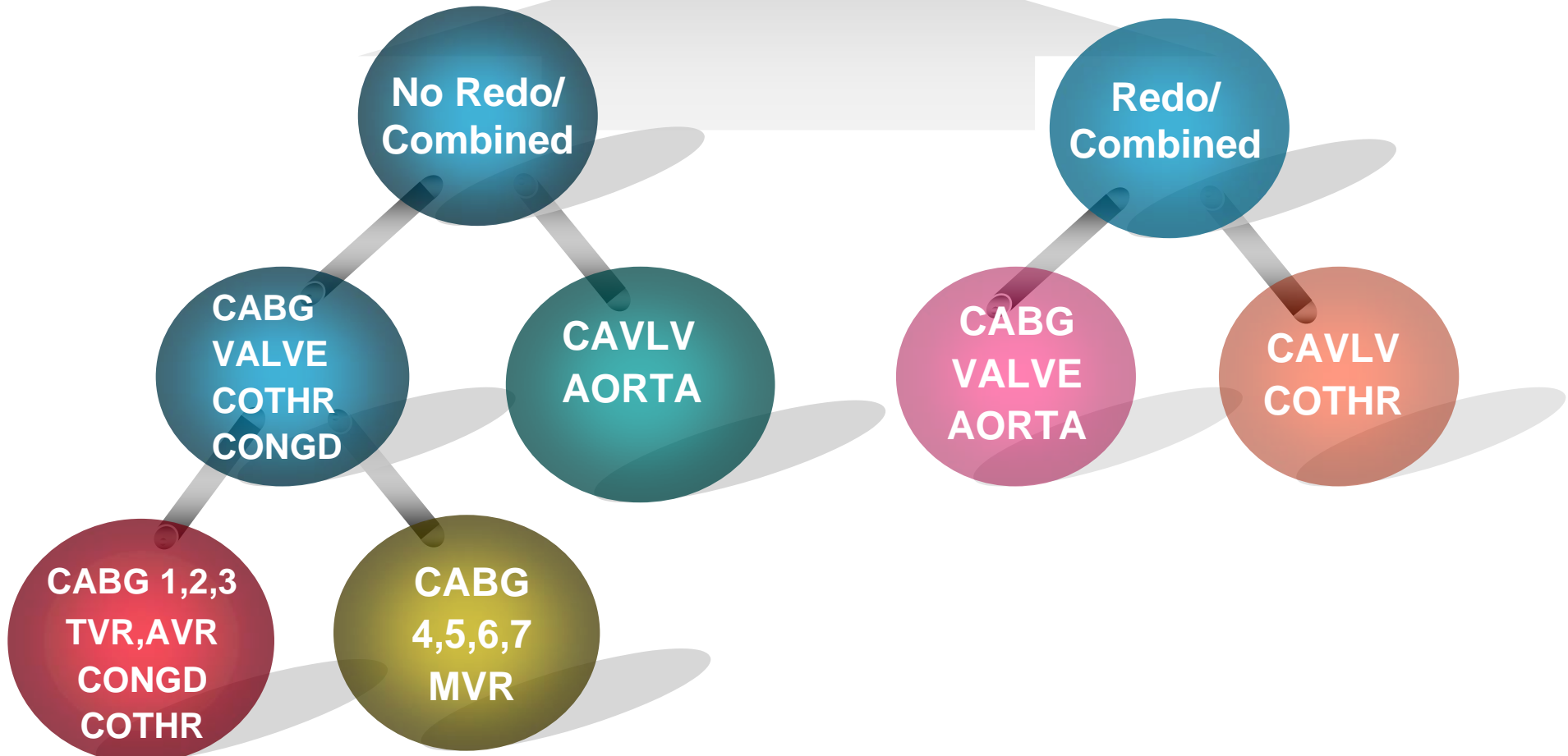


- Hamilton Health Sciences
- Opening fourth cardiac OR in Spring 2006
- How should OR time be allocated?
- How many beds are required in ICU/ward?
- “What if?” Simulation tool



# Surgery Grouping

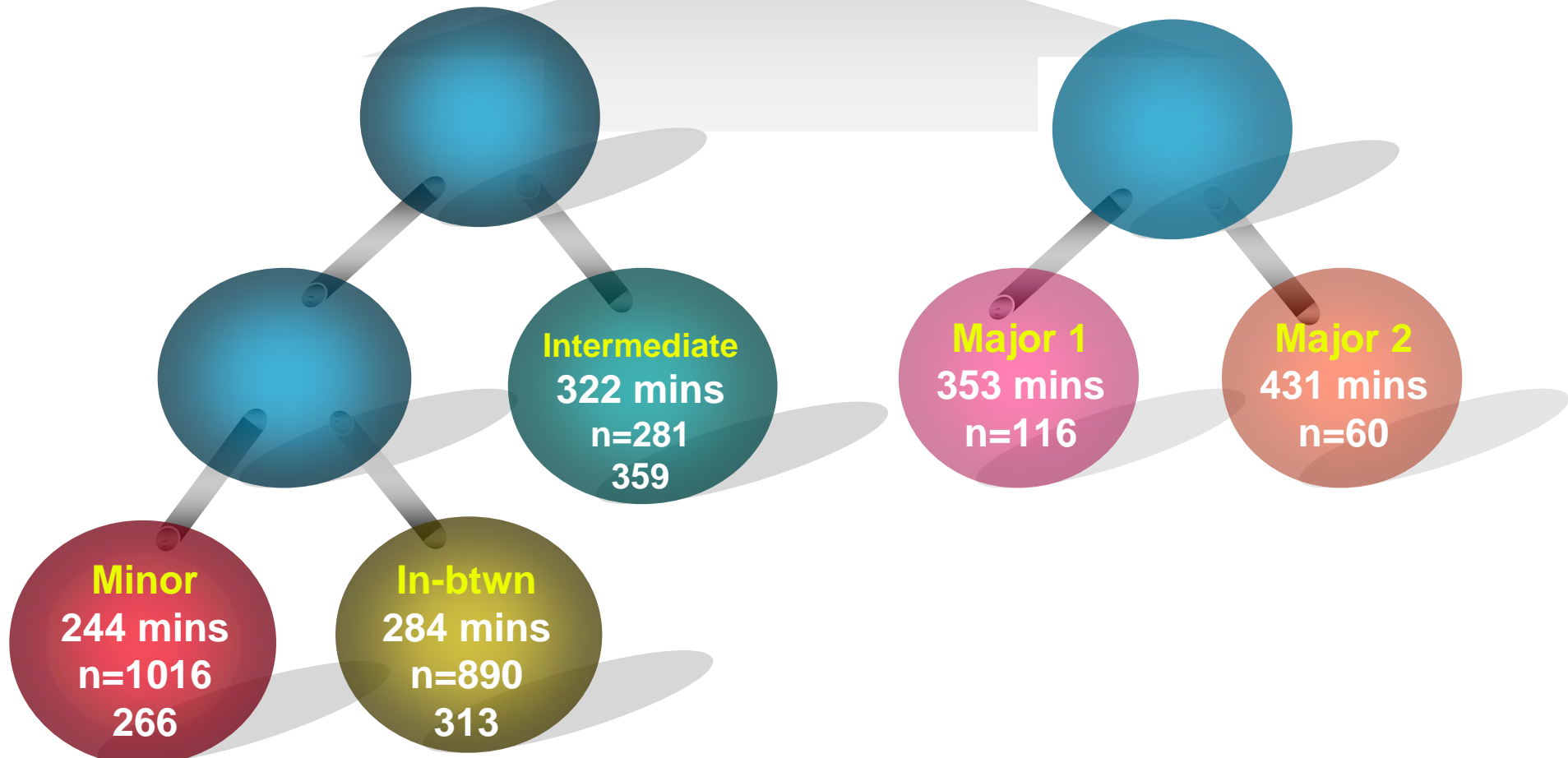
Cardiac Surgery 2002-2004  
N>4000





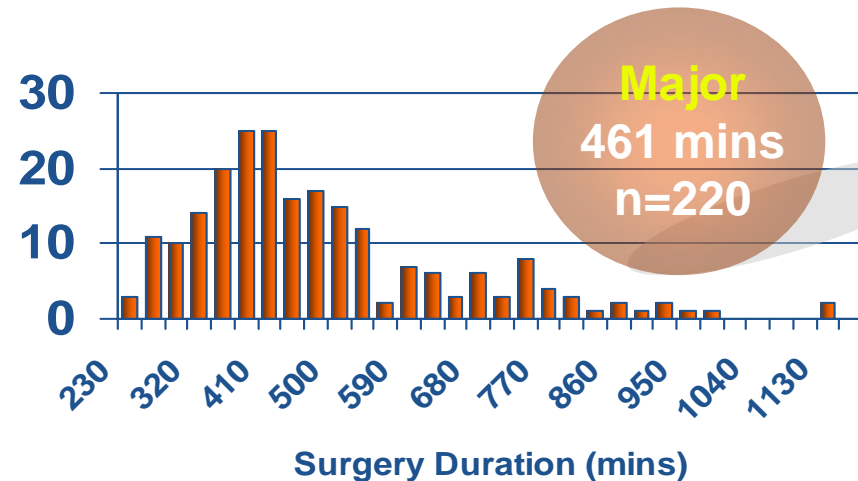
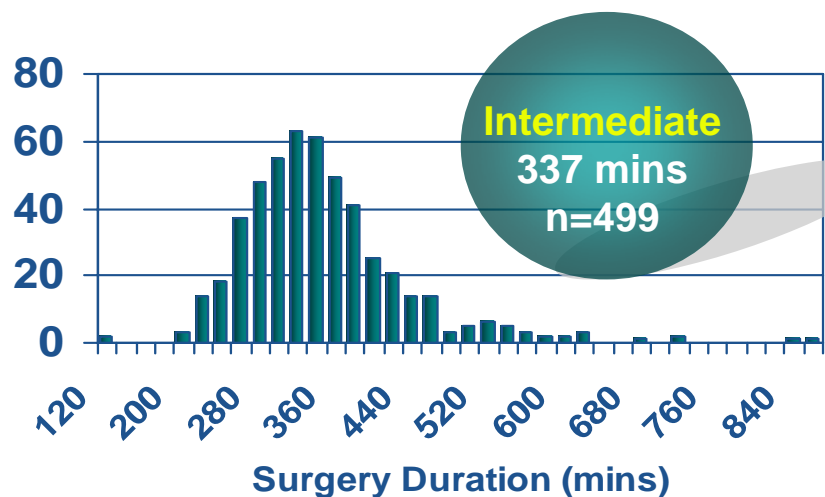
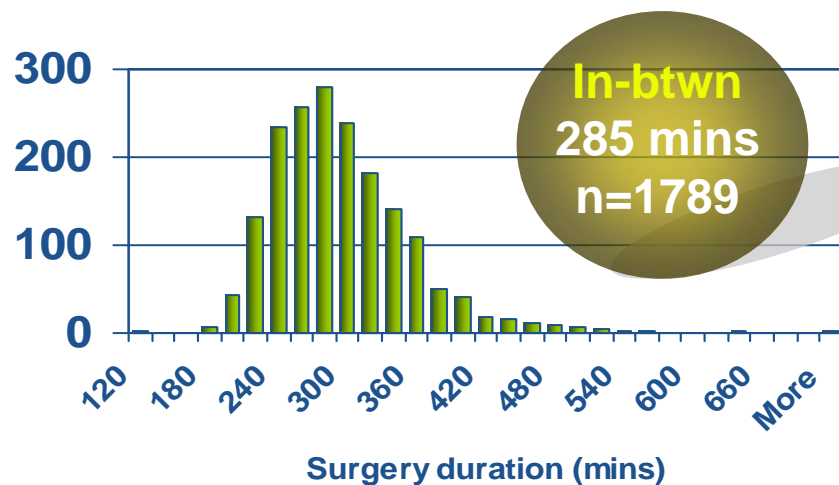
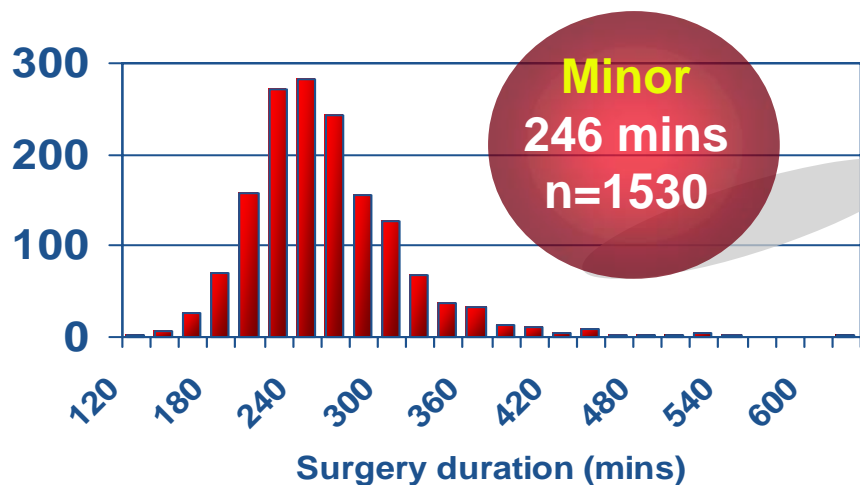
# Surgery Grouping

## Cardiac Surgery 2002-2004





# Surgery Duration Distribution



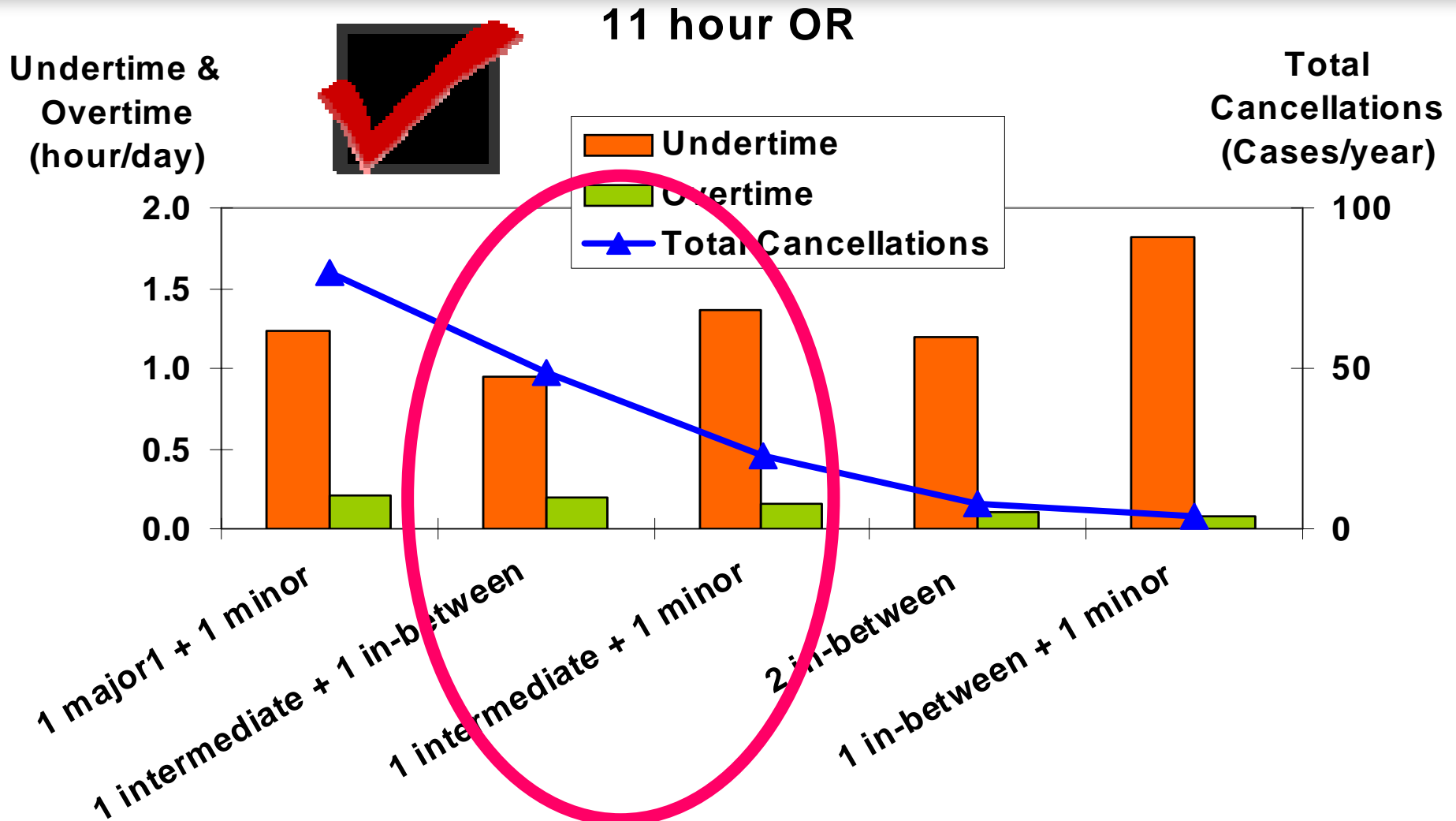


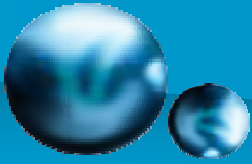
# Performance Indicators

- 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)

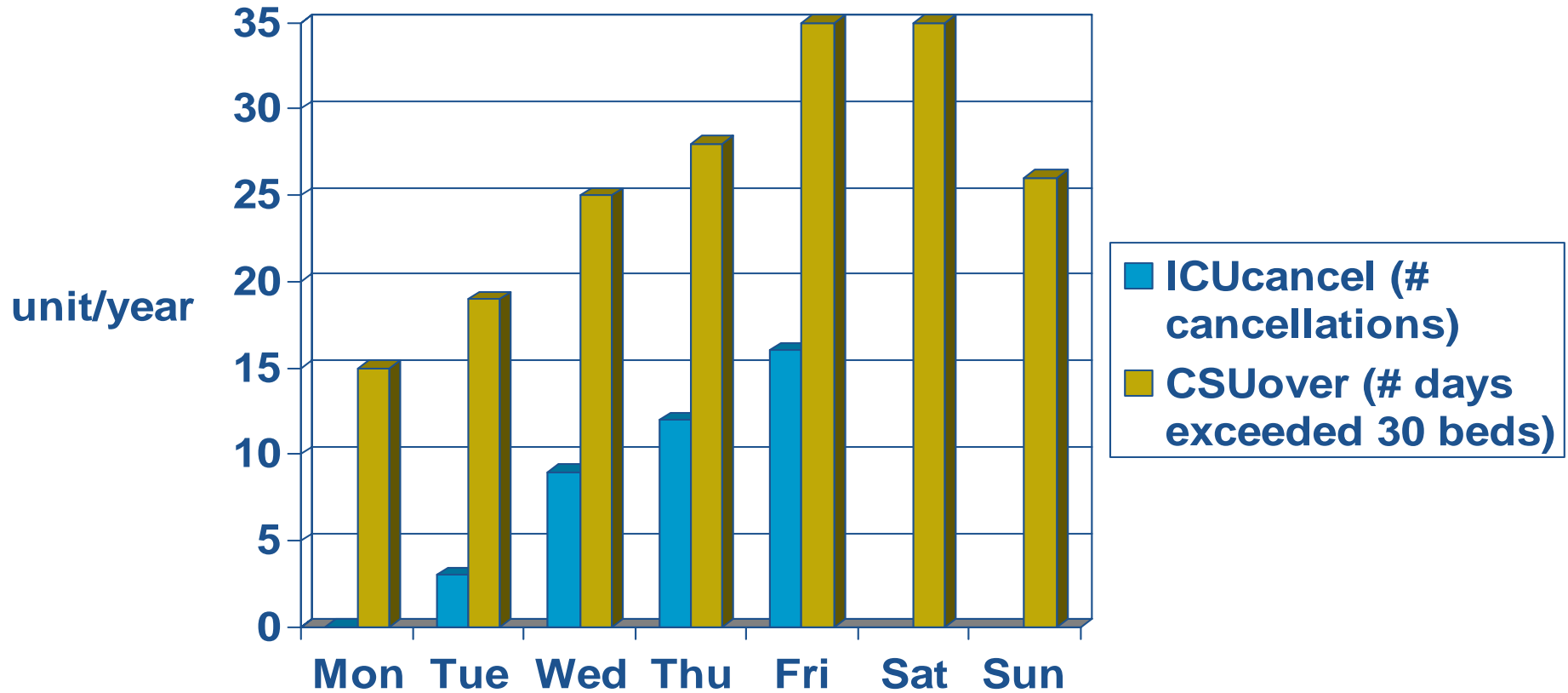


# Can we book surgery differently?





# Planning ICU and Ward Capacity



# 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



# **System Dynamics Simulation for Cardiac Resource Allocation at Trillium Health Center**

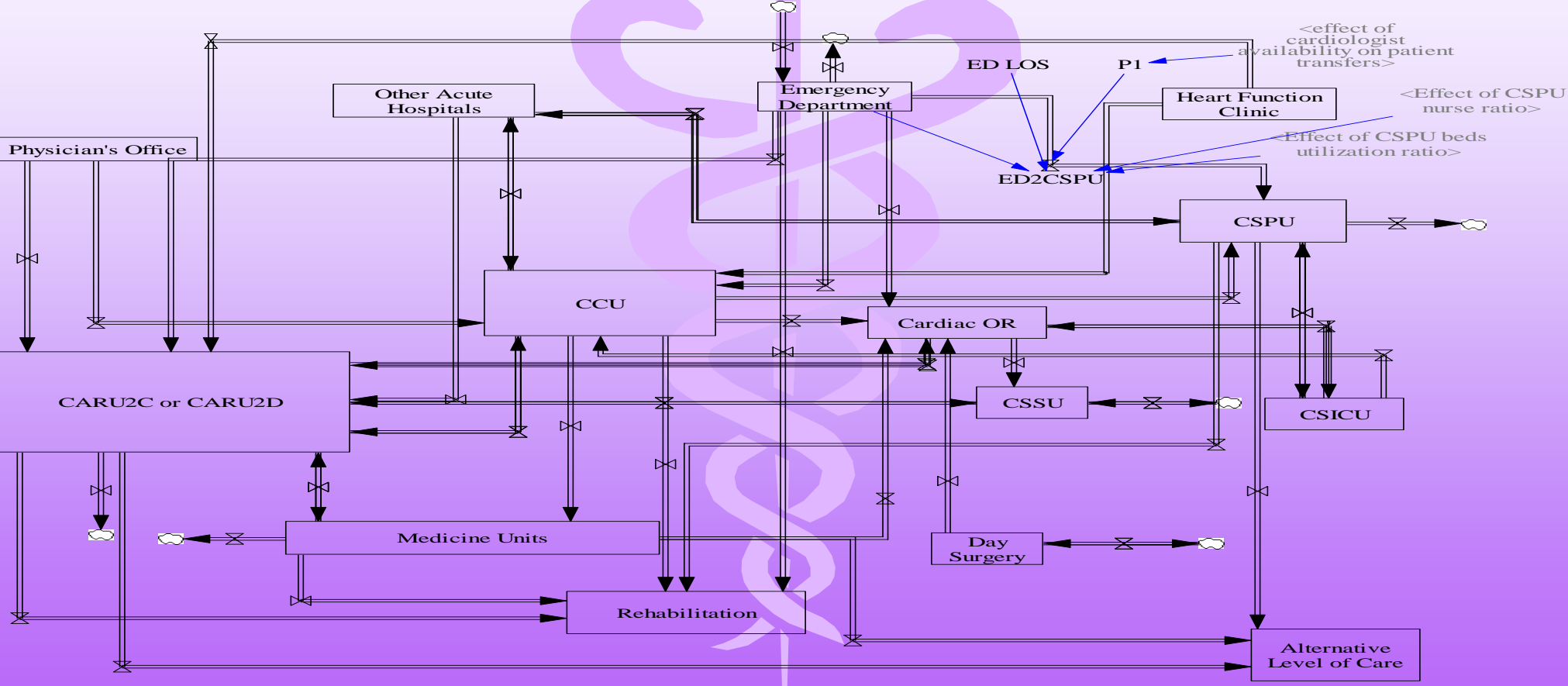
**Somayeh Sadat, Caroline Chan, Michael Carter**

# 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.