UNIVERSITY OF TWENTE.

Operations Research and Health Care

introductory lecture

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Lecturers

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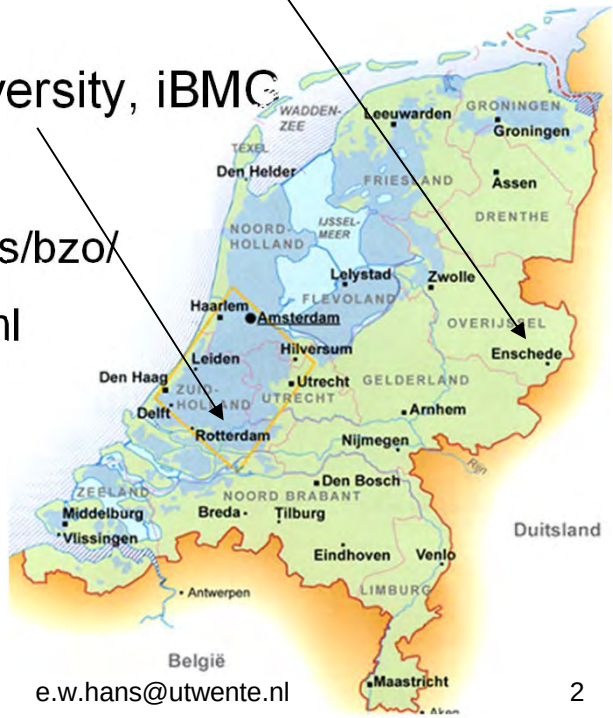

OR/OM in health care research at University of Twente:

CHOIR

Center for Healthcare Operations Improvement & Research

Our website:
http://www.utwente.nl/choir

Online bibliography:
http://www.utwente.nl/choir/orchestra

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Program
http://www.lnmb.nl/courses/ORHC.html

Dates 2012 (10:15-12:00)**:** 20/2, 27/2, 5/3, 12/3, 19/3, 26/3, 2/4, 16/4, 23/4

Lecture overview:

1. **Hans**: Introductory lecture
2. **Hans**: Operating room planning
3. **Hans**: Appointment scheduling, planning
4. **Klundert**: Human resource planning, crew rostering
5. **Klundert**: Health Services Research methodology & OR
6. **Klundert**: Health Modeling & Optimization
7. **Klundert**: Quality, Safety & Risk
8. **Hans**: Performance measurement and benchmarking (DEA)
9. **Hans**, **Klundert**: Reflection, synthesis, feedback on assignments

Program (cont.)

- Assignments are handed out (almost) every lecture
- Hand in your work to the lecturer that handed out the assignment
  - Preferably PDF
  - By email, subject: *LNMB Assignment X - name*
- Contact lecturer if you cannot meet a deadline
- There is no exam; the assignments will be graded and averaged

Objective of the course

To teach **advanced operations research techniques** and their **application in a complex environment** of high societal importance

Agenda for Lecture 1

- Introduction:
  - background Operations Research & Health Care
- Introductory case:
  - acute hip fracture
- Hand-out of first assignment:
  - strategic and tactical operating room planning

INTRODUCTION

Operations Research and Health Care

“OR/OM in healthcare is in its infancy”

“<2% from the OR/MS community actually focuses on healthcare”

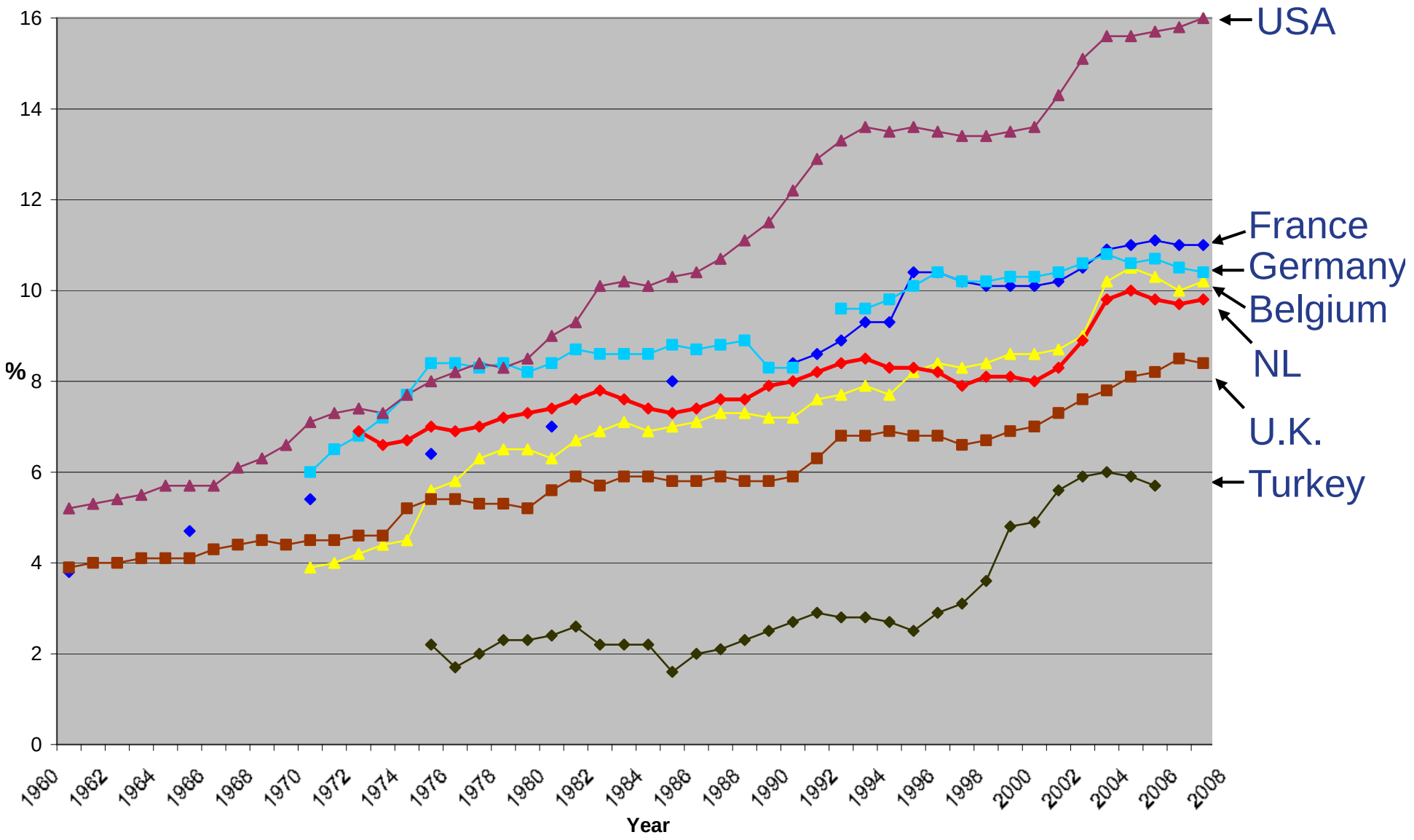
Michael W. Carter (OR/MS Today, 2002)

This number is rapidly rising in the last few years

Importance of healthcare

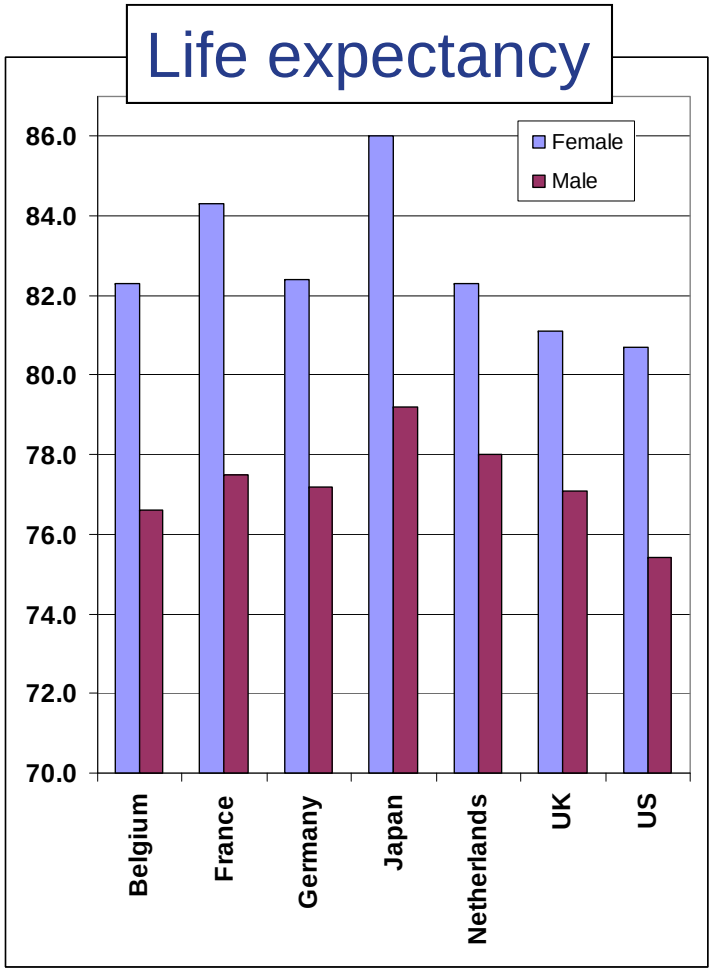
- Affects all in society
- Graying population
- More chronically ill, co-morbidity
- Increasingly advanced technology
- Expenditures growing rapidly
- Share of the GDP
  - In Netherlands: ±10% (80 billion €)
  - In the US: 16% (>1300 billion €)

Healthcare expenditure (% GDP)



“More $$ doesn’t mean better health”

- ± 40.000 people with age over 100 years in Japan (♀ 87%)
- In US best possible care
  - … if you can afford it
  - 4.5 million people without health insurance
- Publicly delivered, HC tends to be cheaper and more effective



In Netherlands very little attention for "OR/OM in healthcare" until 2003

Causes (*to name a few…*):

- Traditionally, "every hospital tries to provide everything"; long patient's LOS
- Hippocratic Oath
- Financial system did not reward efficiency
- Poor training in OM for healthcare managers
- Poor state of ICT (information systems)

Anno 2003…

“It’s not all bad…”

For the second year in a row, the Netherlands has been proclaimed as the country with the **most customer-friendly healthcare**

According to the **European Health Consumer Index** (EHCI), the Netherlands scores well in the areas of **medical results**, **patient rights** and **medicines**.

At the same time… waiting lists amongst the worst in Europe

http://www.rnw.nl/english/article/dutch-healthcare-reaps-praise-and-criticism

Het kan écht:
betere zorg voor minder geld

Logistical improvements go hand-in-hand with quality improvements: patients that have to visit the hospital less often, have shorter waiting times, and may count on more attention from nurses and physicians.

Logistical quality improvements will yield some 3 to 3.5 billion EUR: almost a quarter of the entire hospital budget…

In other words:

improved care for less money!

Cultural change in Dutch healthcare

- Hiring OM experts from industry
- ICT innovation (e.g. EHR systems)
- OM education of healthcare managers
- Safety
- Copying logistical paradigms from industry
- Process reorganization (clinical pathways)
- Introduction of regulated market mechanisms

Example of where market competition can lead to…

Healthcare: a business unlike all others

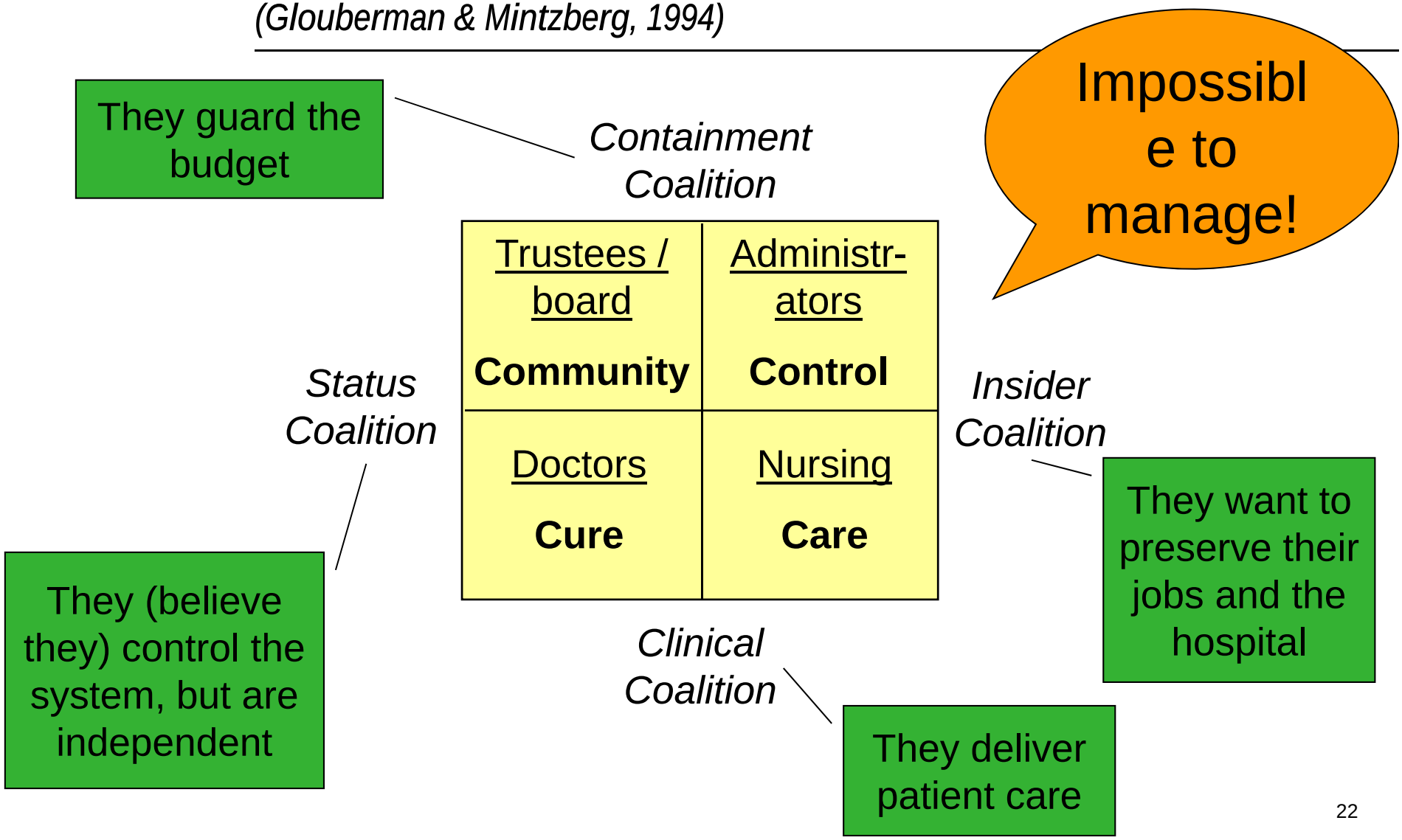
- Financial model does not reward efficiency
- Patients are *customer* and *product* at the same time
  - Patients cannot be refused
  - Interventions cannot be preempted
- More *variability* than in any other industry

Healthcare: a business unlike all others

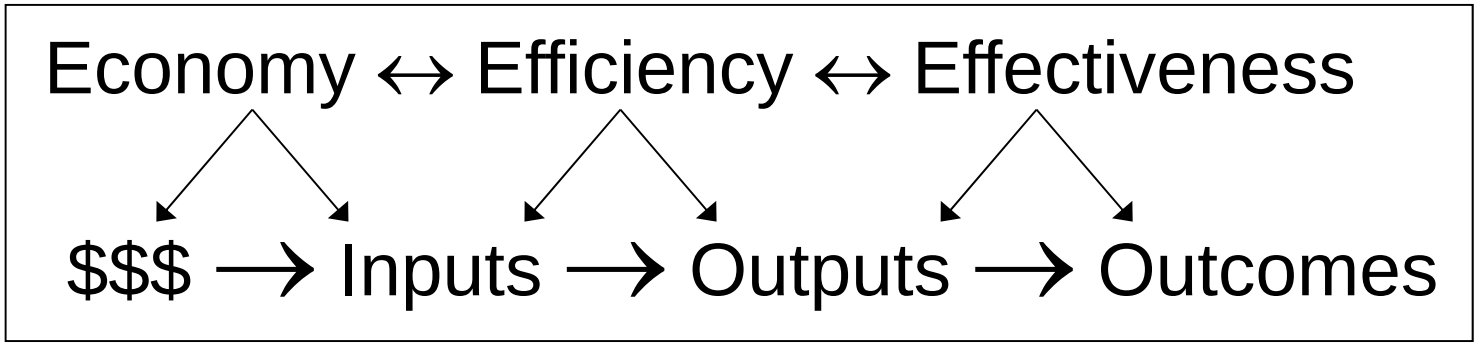
- Many different types of care providers
  - Different types of hospitals, different strategies
  - Academic hospitals do almost everything
  - Specialized clinics are often seen as “cream skimmers”
- Multiple decision makers (doctors ↔ managers)
  - Doctors are private entrepreneurs within hospital
    - They cheat the system to advance patients
- Stakeholders often have *conflicting goals*

The Four Faces of Health Care

(Glouberman & Mintzberg, 1994)

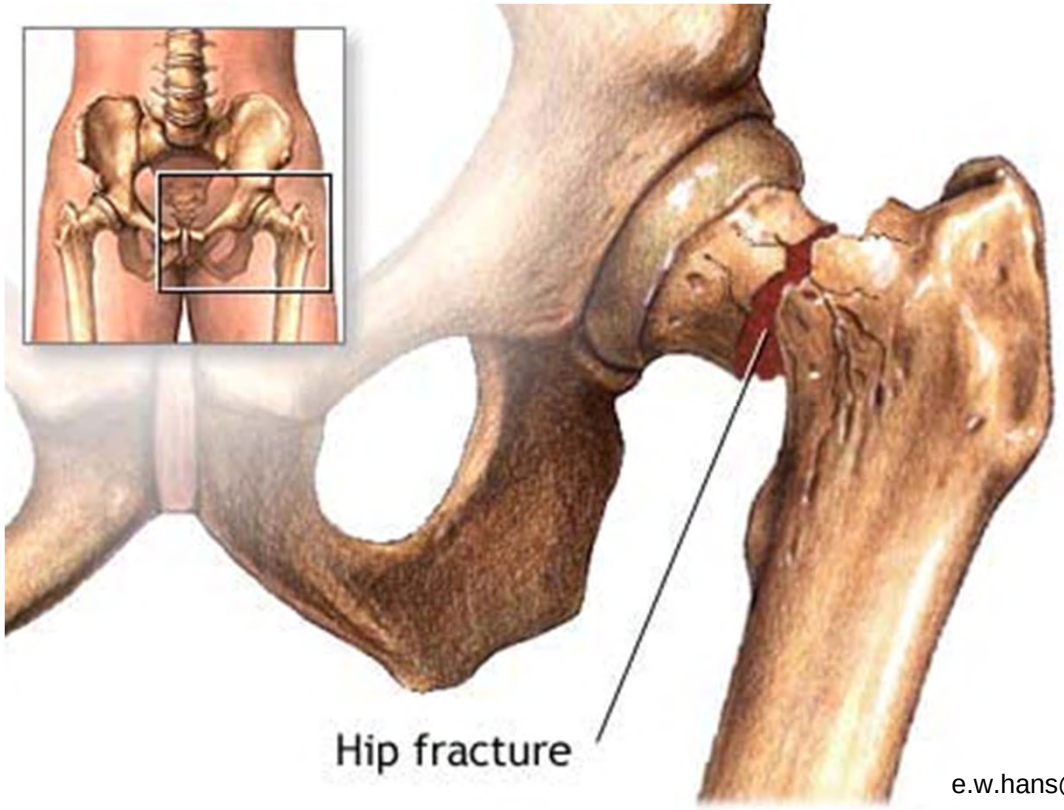


Healthcare delivery objectives: The four Es



- The fourth E: Equity!
- Productivity ↔ Quality of care ↔ Quality of labor

Introductory case:
acute hip fracture patient

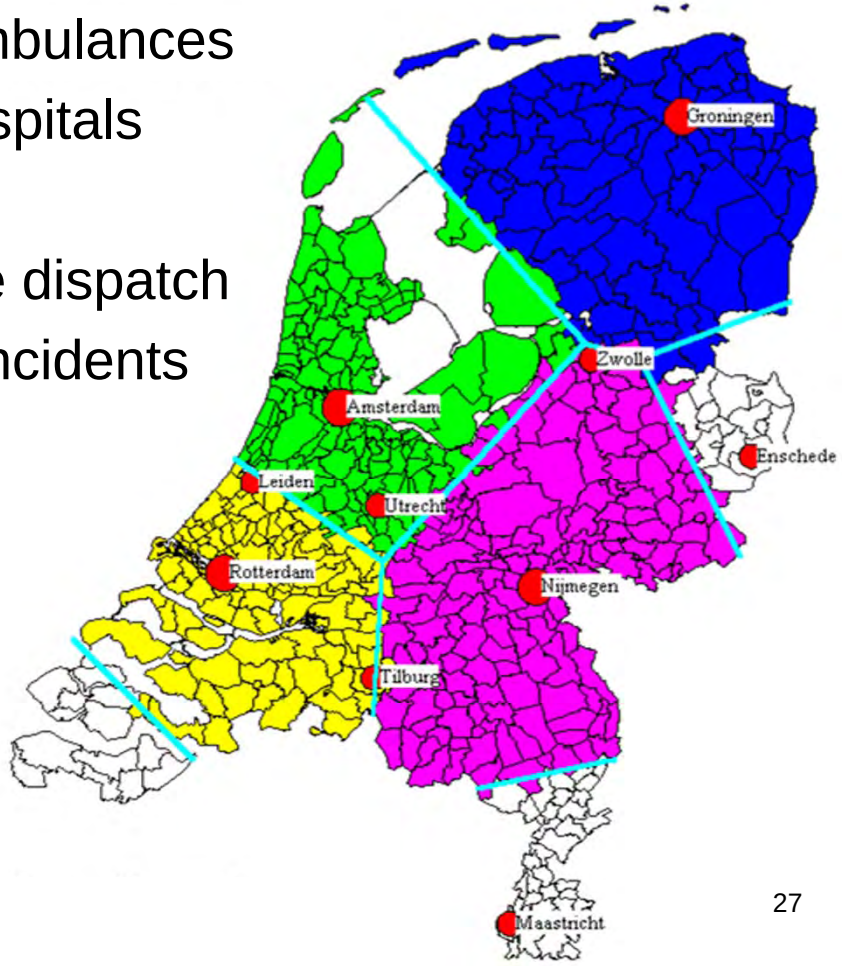


The acute hip fracture patient

Patient is brought into the hospital's Emergency Department by ambulance

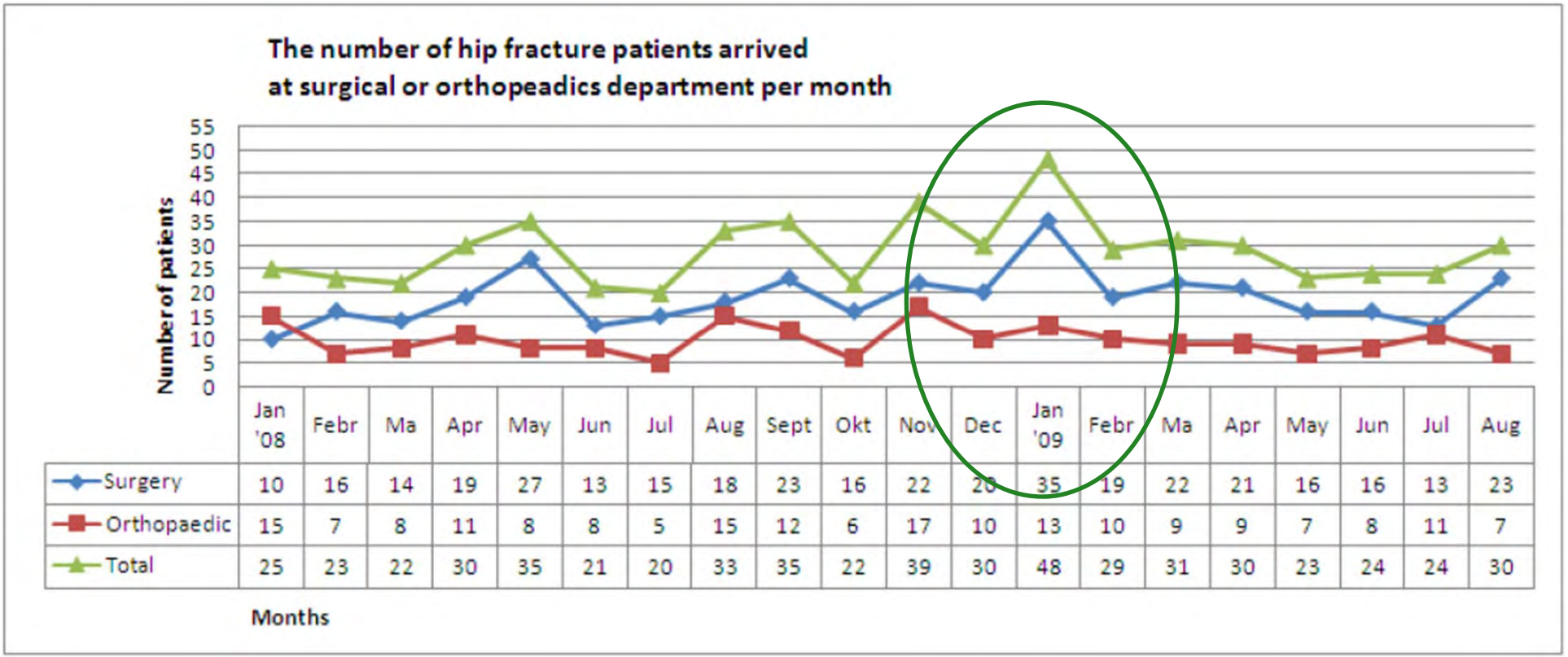
Ambulances: applications of OR

- Selection of ambulance for (emergency & elective) transports
- Tactical geographic positioning of ambulances
- Assignment of trauma function to hospitals
- Shift planning
- Forming trauma teams for immediate dispatch
- Assignment of trauma helicopter to incidents
  and to regions & hospitals



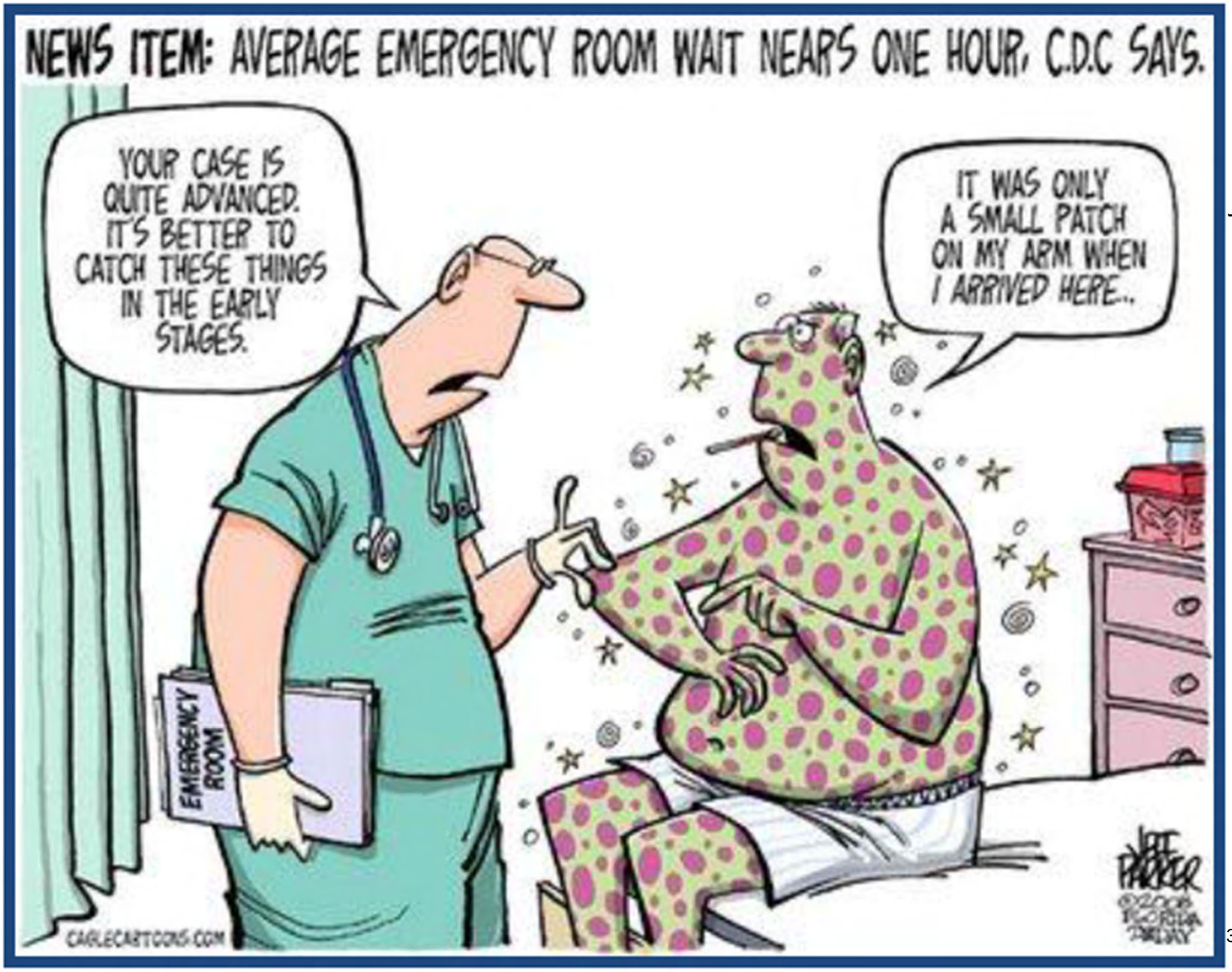
Patient arrives at the Emergency Department (ED)

Monthly hip fracture arrivals at the ED

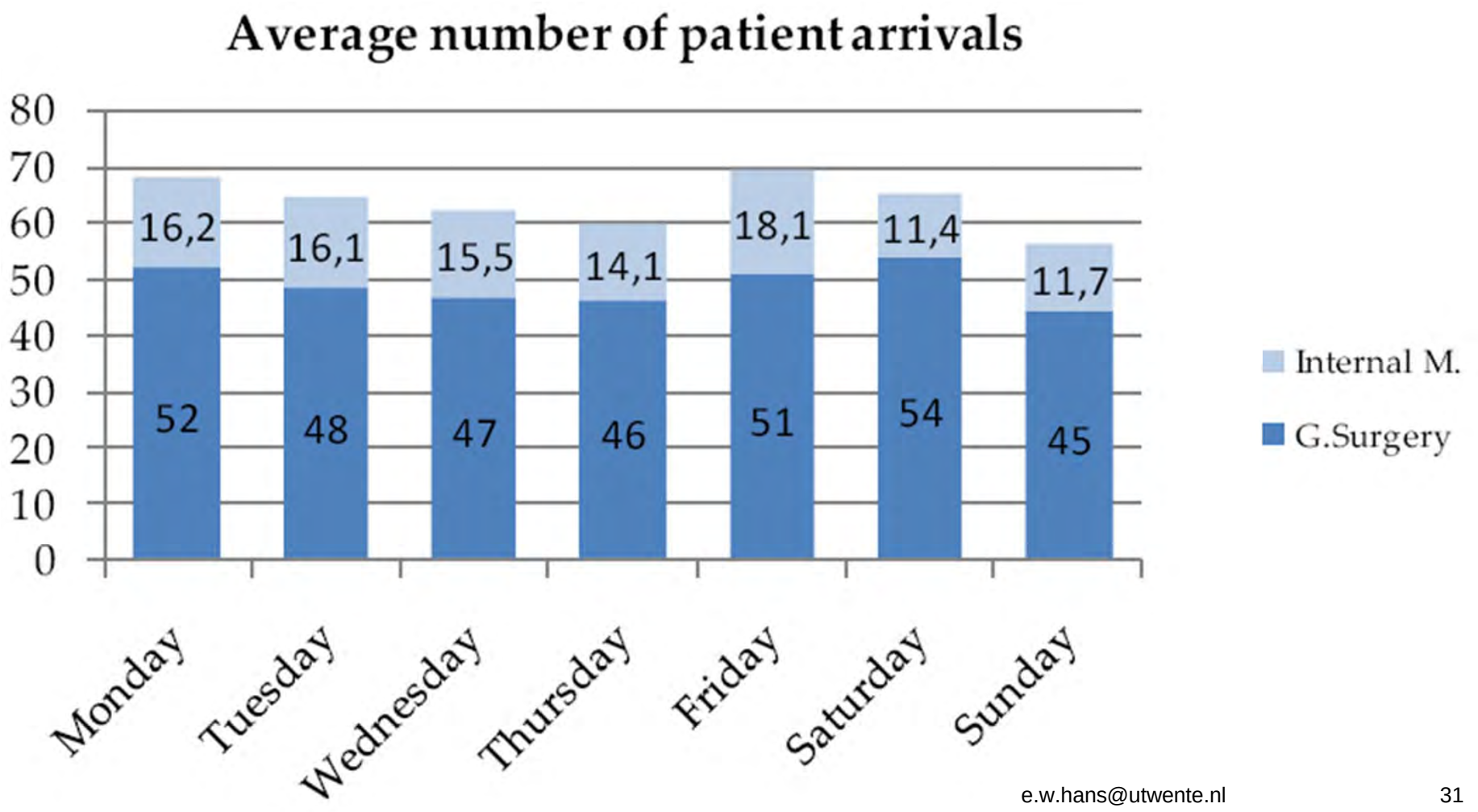


	Jan '08	Febr	Ma	Apr	May	Jun	Jul	Aug	Sept	Okt	Nov	Dec	Jan '09	Febr	Ma	Apr	May	Jun	Jul	Aug
Surgery	10	16	14	19	27	13	15	18	23	16	22	20	35	19	22	21	16	16	13	23
Orthopaedic	15	7	8	11	8	8	5	15	12	6	17	10	13	10	9	9	7	8	11	7
Total	25	23	22	30	35	21	20	33	35	22	39	30	48	29	31	30	23	24	24	30

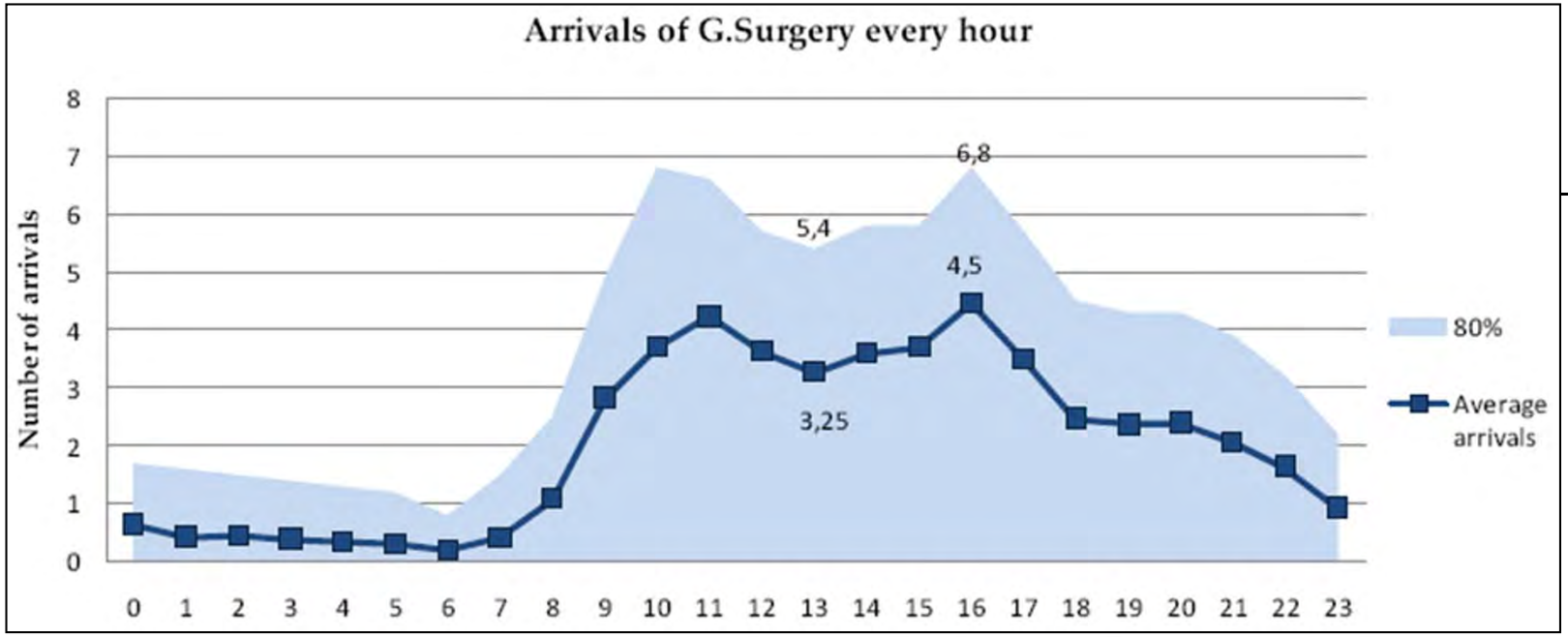
Months

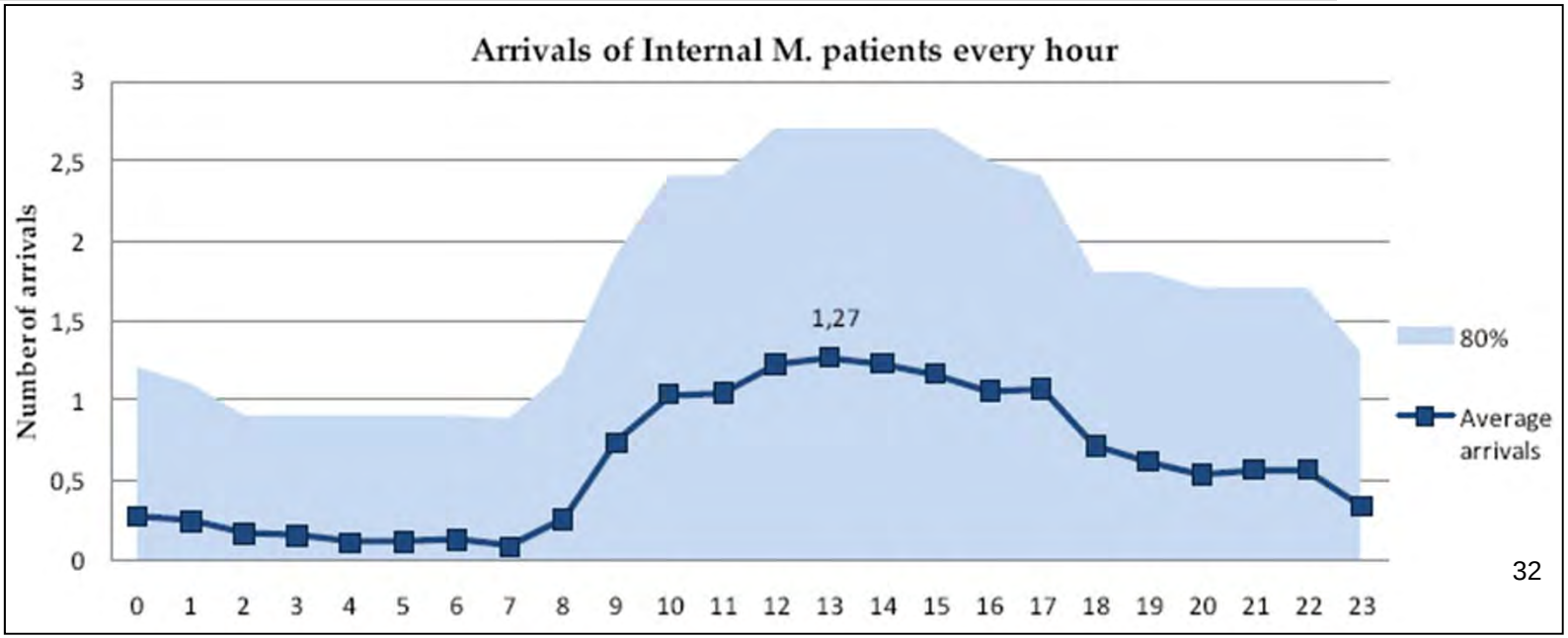

NEWS ITEM: AVERAGE EMERGENCY ROOM WAIT NEARS ONE HOUR, C.D.C SAYS.
YOUR CASE IS QUITE ADVANCED. IT'S BETTER TO CATCH THESE THINGS IN THE EARLY STAGES.
IT WAS ONLY A SMALL PATCH ON MY ARM WHEN I ARRIVED HERE..
EMERGENCY ROOM
CABLECARTOONS.COM

(General daily) arrivals at the ED



(General hourly) arrivals at the ED

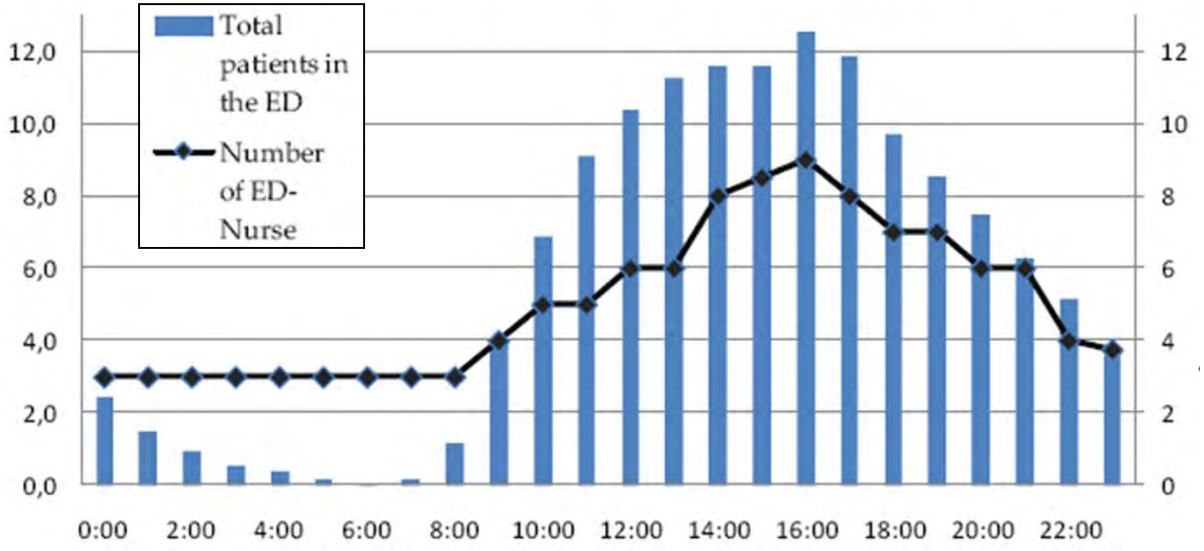




ED: applications of OR

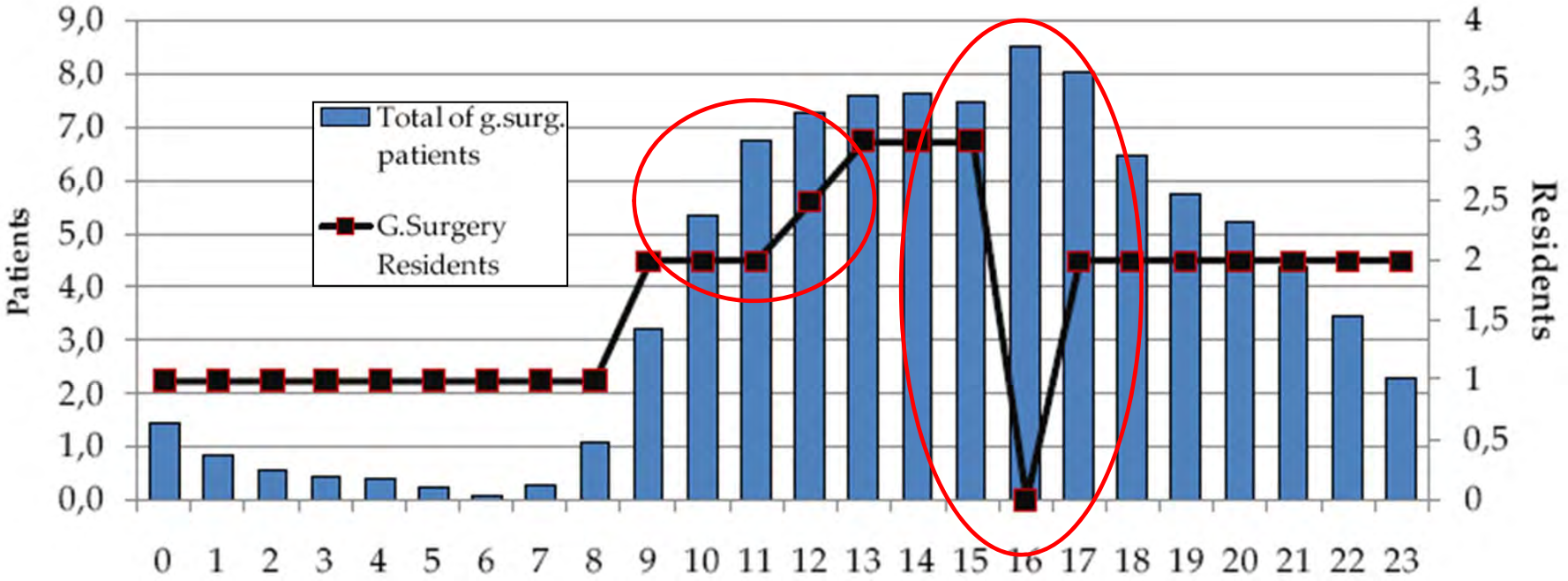
- Determination of staffing levels in relation with service level
- 24/7 shift scheduling
  - Various skills
  - Demand prediction (arrivals, LOS)
  - Levels of presence during nights:
    - At hospital, awake
    - At hospital, asleep
    - At home, on call

Capacity of nurses vs. total patients in the ED



ED: applications of OR

Capacity of residents vs the number of patients



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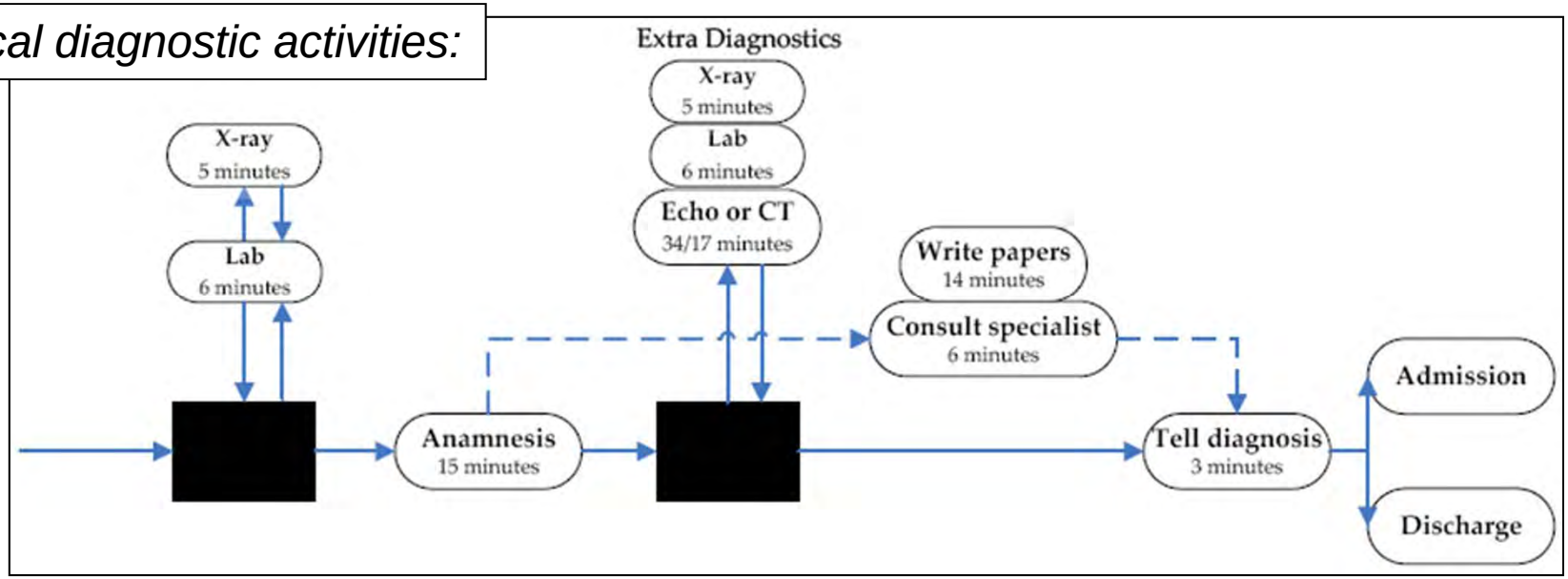
ED: applications of OR

Activity prioritization after triage:

Urgency level of patient

Colour	Number of patients	
	G. Surgery	Internal M.
Blue	0,2%	0,1%
Green	59%	27%
Yellow	35%	62%
Orange	4%	9%
Red	0,5%	0,5%

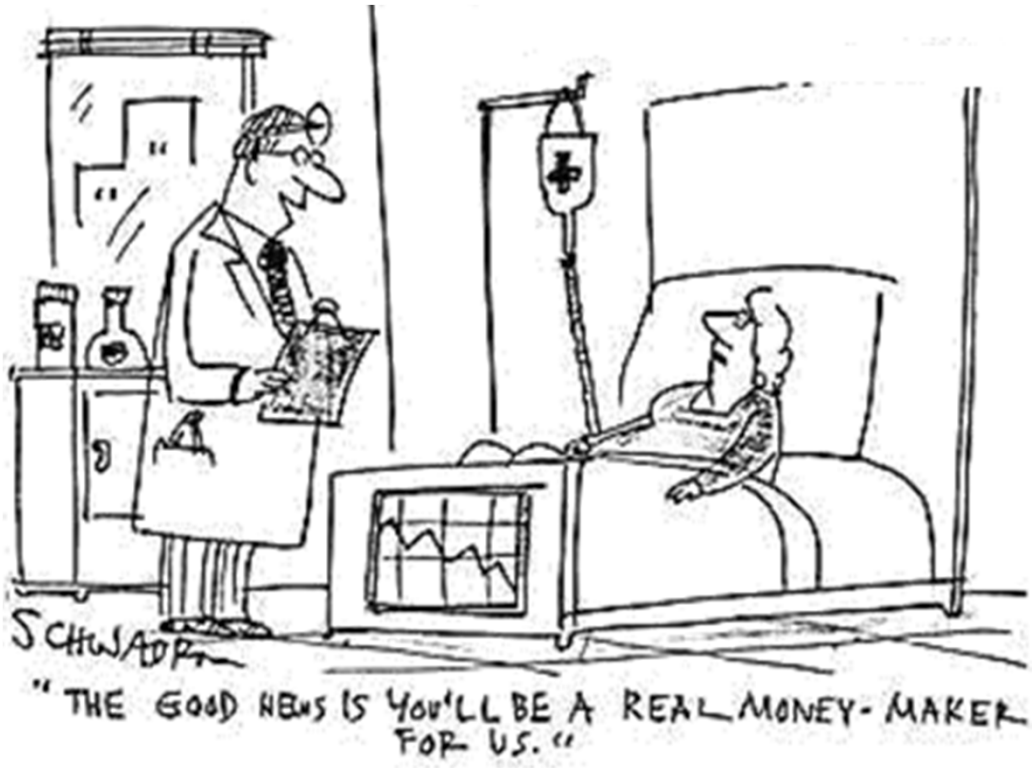
Typical diagnostic activities:



Patient arrives at the ward

….and waits there for surgery

Wards: applications of OR



- Nurse rostering, staffing
- Determination of required number of staffed beds
- Pool or un-pool wards?
- Bed transportation in hospital
- Planning of bed cleaning
- Positioning of nurses, supplies

Patient arrives at operating room

Operating rooms: applications of OR

- Pre-operative screening by anesthesiologist
  - Walk-in or appointment based?
- Surgery sequencing, scheduling, planning
  - Elective, add-on, emergency
  - Inpatient, outpatient
  - With movable resources (e.g. X-rays)
  - Integrated with bed planning (ICU, wards)
- Capacity dimensioning of operating rooms
- Staffing, rostering
  - Determination of staffing levels during the night for dealing with emergencies

Operating rooms: applications of OR

- Instrument tray optimization

Example base instrument tray, which contains 107 instruments

Big Basis Tray

Required instruments for
Laparoscopic small surgery

Required instruments for
Abdominal surgery

Operating rooms: applications of OR

- Instrument tray optimization
  - Instrument tray composition
    - Tray per surgery type ←→ 1 tray for all surgery types ←→ multiple trays per surgery
    - Incrementally, or integrally?
  - Inventory levels

Operating rooms: applications of OR

>logistiek<
Nieuws, kennis en carrière

Nieuwsbericht - Voorraadbeheer / Forecasting

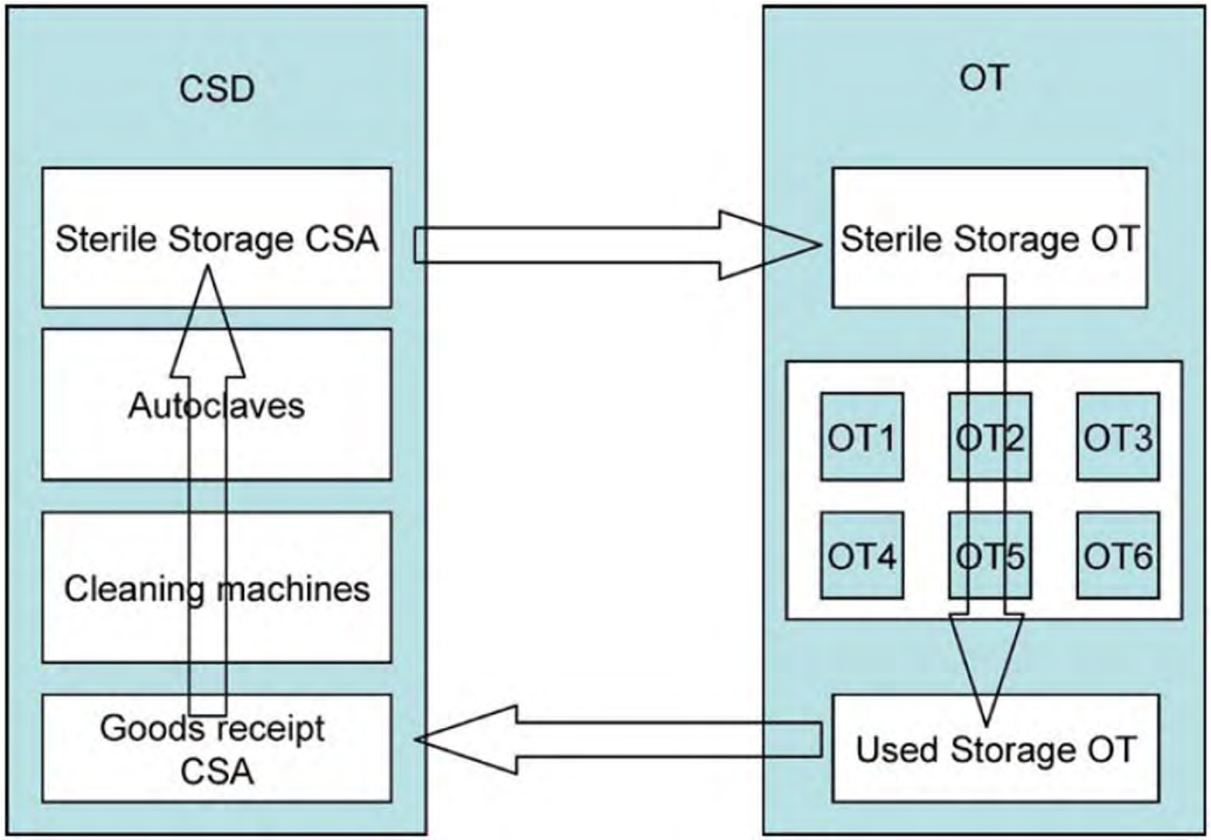
UMCG-ziekenhuis zet voorraadbeheer op de kaart

Auteur: Harm Beerens
Geplaatst: 9 jun 2009

Een voorraadanalyse bij het Universitair Medisch Centrum Groningen wees uit dat de voorraad 40% omlaag kan. Om dit bereiken moet het voorraadbeheer ingrijpend worden geprofessionaliseered. Logistek manager Jonnie Mooi legt uit hoe hij dit gaat doen.

Operating rooms: applications of OR

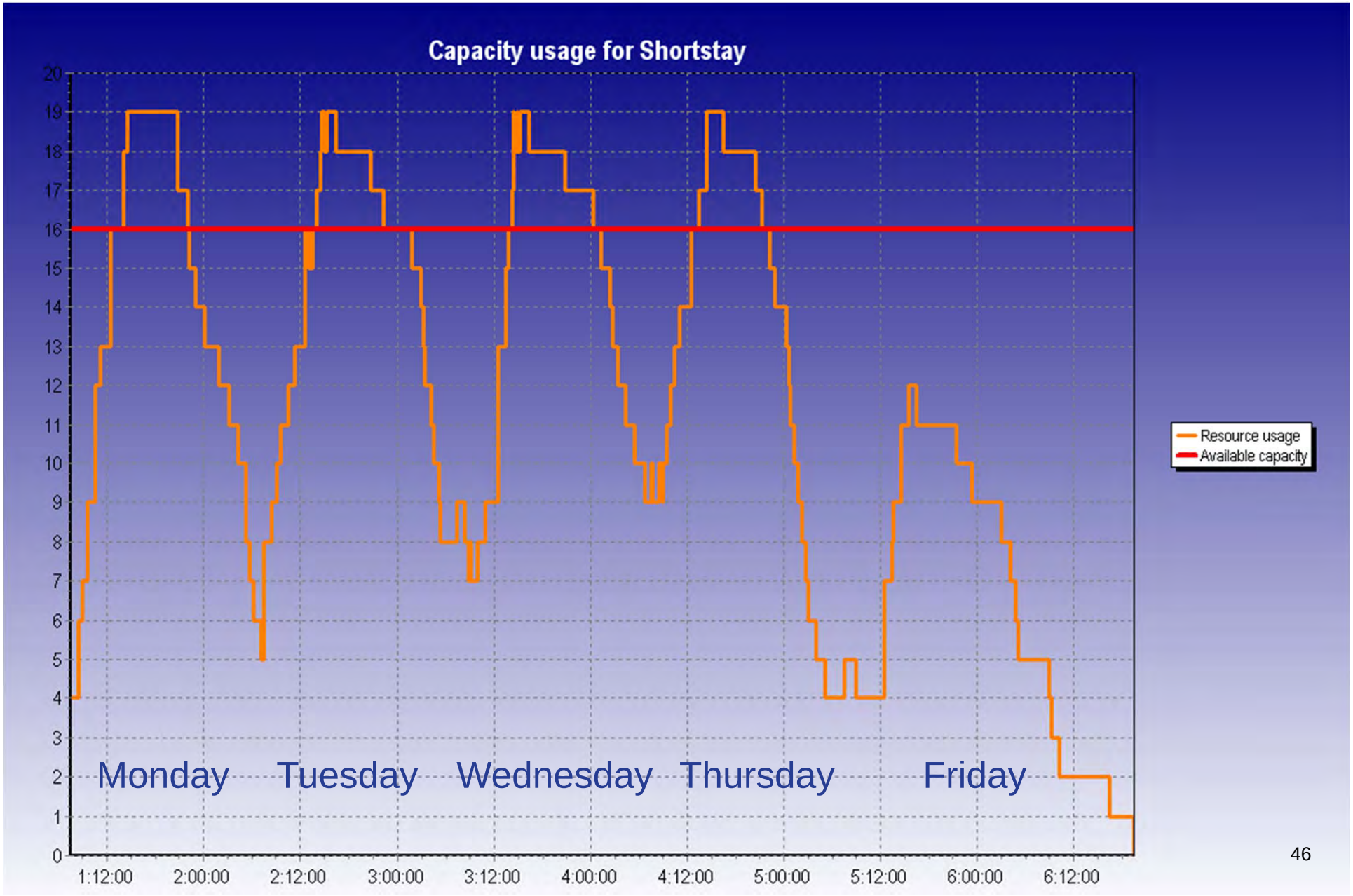
- Optimization of the reverse logistics chain of instrument sterilization (inventory locations)



Source: Health Care Mgmt Science, 11:23-33

Patient returns to the ward for recovery

On average, there are sufficient beds…



After recovery, patient may return home

Or… go to a nursing home

If the nursing homes are full, the patient will stay in the hospital → bed blocking!

ZORGVISIE
De site voor beleid en management

Home Nieuws Kwaliteit Huisvesting Personeel Financ

Home > Nieuws > Artikel > Atrium MC sluit ok's wegens tekort verpleeghuisbedden

Atrium MC sluit ok's wegens tekort verpleeghuisbedden

22 januari 2009

Het Atrium Medisch Centrum in Heerlen sluit tijdelijk de helft van zijn operatiekamers omdat verpleeghuizen in de regio geen nazorg kunnen bieden.

Atrium MC heeft deze week **de helft van de planbare operaties afgezegd**. 's Winters zijn er meer acute long- en hartklachten en botbreuken. Atrium MC heeft voor zulke gevallen geen ruimte als daarnaast de geplande operaties doorgaan. Het is ruim vijftig bedden kwijt door een verkeerdebeddenprobleem: mensen het verpleeghuis.

Tienduizenden euro's schade

"We moeten aan het personeel denk

Nieuwsbericht

woensdag 21 januari 2009

Opnamestop voor planbare patiënten (VIDEO)

Atrium MC heeft het aantal planbare operaties deze week met de helft gereduceerd. Dit om aan de vraag naar dringende acute zorg te kunnen blijven voldoen. De Raad van Bestuur heeft tot deze ingreep besloten om de gewenste acute zorg te kunnen verlenen en een te grote werkdruk en onveilige situaties te voorkomen.

Het ziekenhuis ligt al weken overvol. Dit geldt eveneens voor de overige ziekenhuizen in Zuid-Limburg en in het aangrenzende Duitse grensgebied. Het ziekenhuis ligt vol vanwege seizoensinvloeden met longpatiënten en orthopedie-

Nursing homes: applications of OR

- Transmural care pathways
  - Capacity dimensioning of:
    - Intermediate care wards
    - Nursing homes
- Analysis of care networks
- Contracting between hospitals and nursing homes
  - How many beds?
  - Of which type?
  - When?
- Temporal scheduling of care pathways
- Relation between flexibility in building design and logistical performance


NIN
SUCCESSFUL
HIP REPLACEMENT

Logistical paradigms

LEAN

Six Sigma

Total access

What they all have in common

Benchmarking

3 basic principles of Operations Management:

- Reduction of waste
  eliminate non-value-adding activities
- Reduction of variability
  eliminate disturbances, errors, fluctuations
- Reduction of complexity
  easiest effective solution is the best

TOC

BPR

ConWip

Continuous Improvement

Strengths

- Focus on performance measurement
- Analyzing performance
- Simple principles
- Organization-wide involvement
- Organization-wide improvement

Weaknesses

- Selection of paradigm generally not based on effectiveness, but on enthusiastic consultant
- Paradigm = “Philosophy” / “strive”

  How to attain objective?
- Focus on operational level
  - “Low hanging fruit”…

LEAN

Six Sigma

Total access

What is missing?

Benchmarking

TOC

What performance levels can theoretically be attained?

"10% improvement of a lousy performance is still a lousy performance!"

BPR

ConWip

Continuous Improvement

Research is required

- To develop new concepts
- To test these concepts prospectively
  - Using mathematical (simulation) models
  - Under various scenarios, and a long horizon
  - For different types of hospitals

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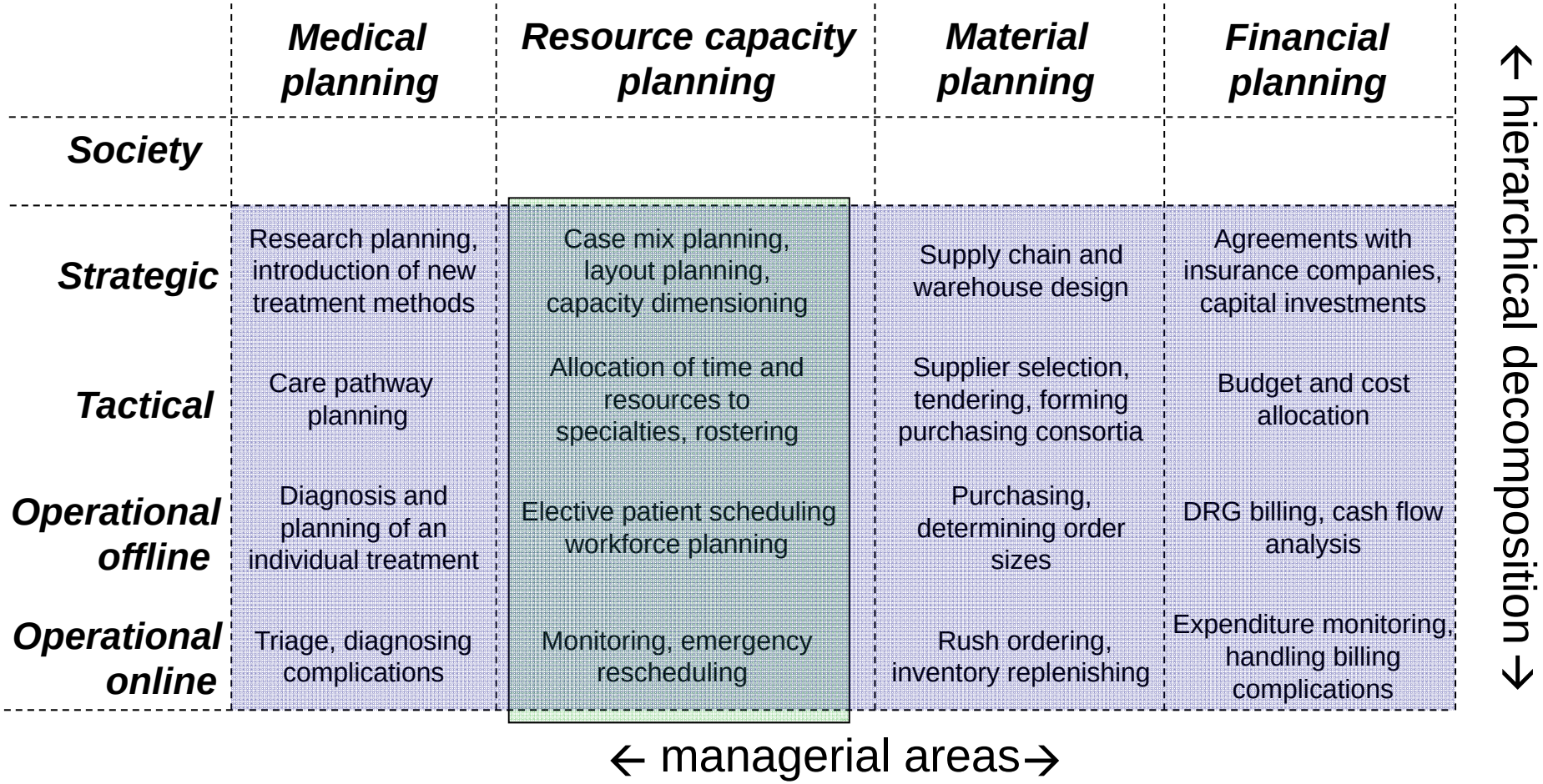
Hierarchical positioning framework for hospital planning & control



Assignment 1: “OR in the OR”

Introduction operating room planning

- **Strategic level** (year, quarter)
  - Allocation of OR capacity to surgical specialties
- **Tactical level** (month)
  - Weekly allocation of “OR-days” to specialties
- **Operational (offline) level** (weeks)
  - Semi-urgent & elective surgery scheduling
- **Operational (online) level** (days)
  - Emergency surgery scheduling

Assignment 1:
strategic and tactical operating room planning

Situation:

- A hospital is going to build a new operating room department

Strategic problem:

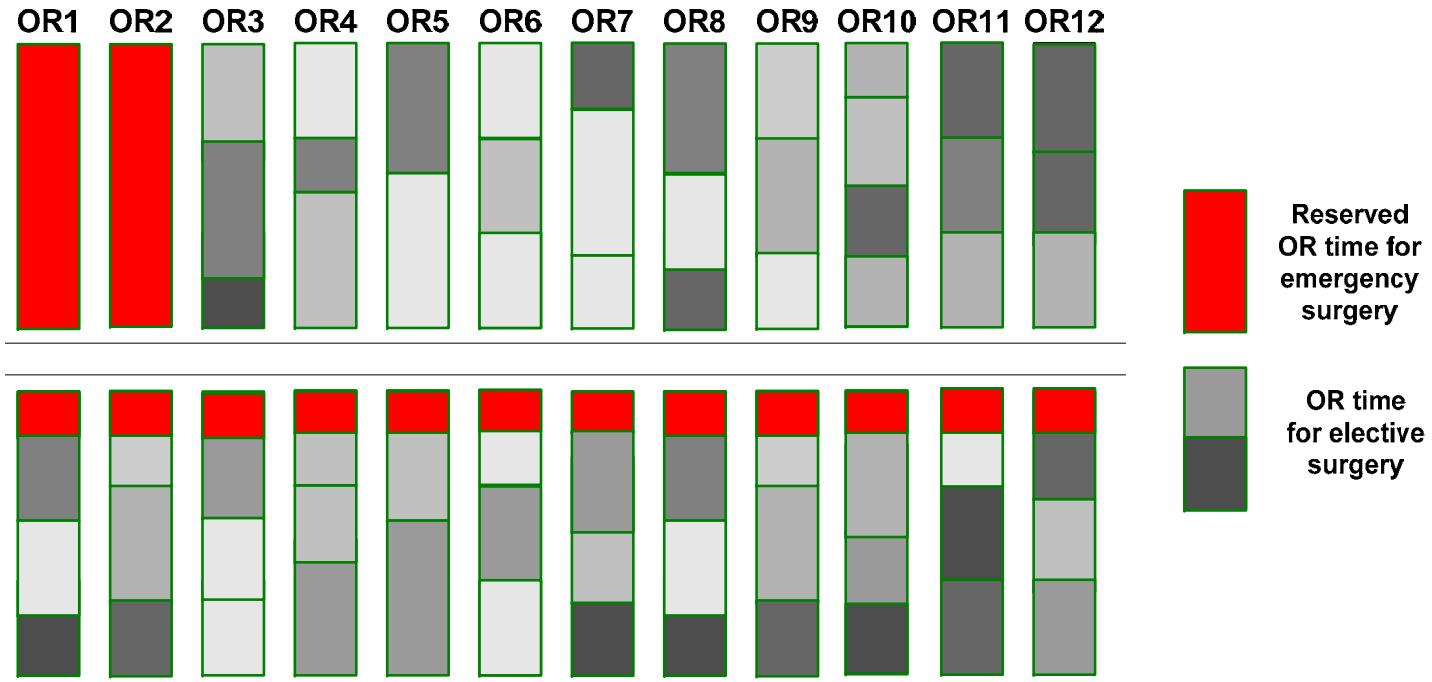
- We will investigate how many operating rooms (ORs) to build, and of which type
  - Inpatient ORs (“dedicated” or “generic”)
  - Outpatient ORs
  - Emergency ORs
- Inpatient ORs can be made “dedicated” to one specialty, or can be made “generic” to serve all specialty

Assignment 1:
strategic and tactical operating room planning

- Emergency operating rooms or not?

Concept: "emergency ORs"

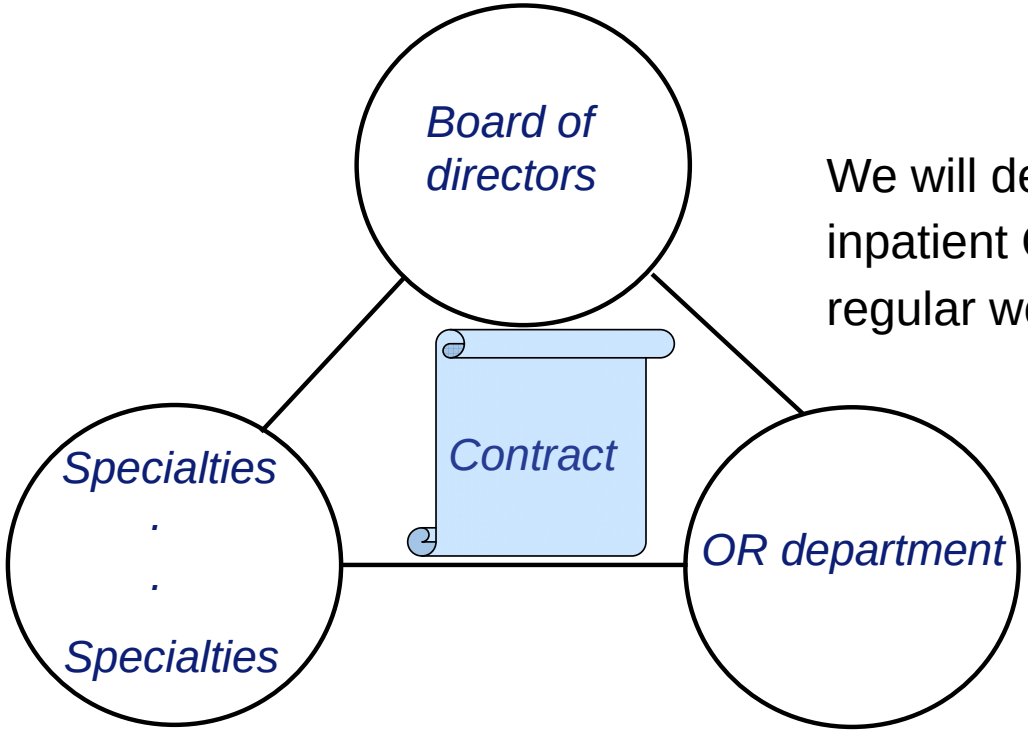
Concept: "No emergency ORs"



Assignment 1:
strategic and tactical operating room planning

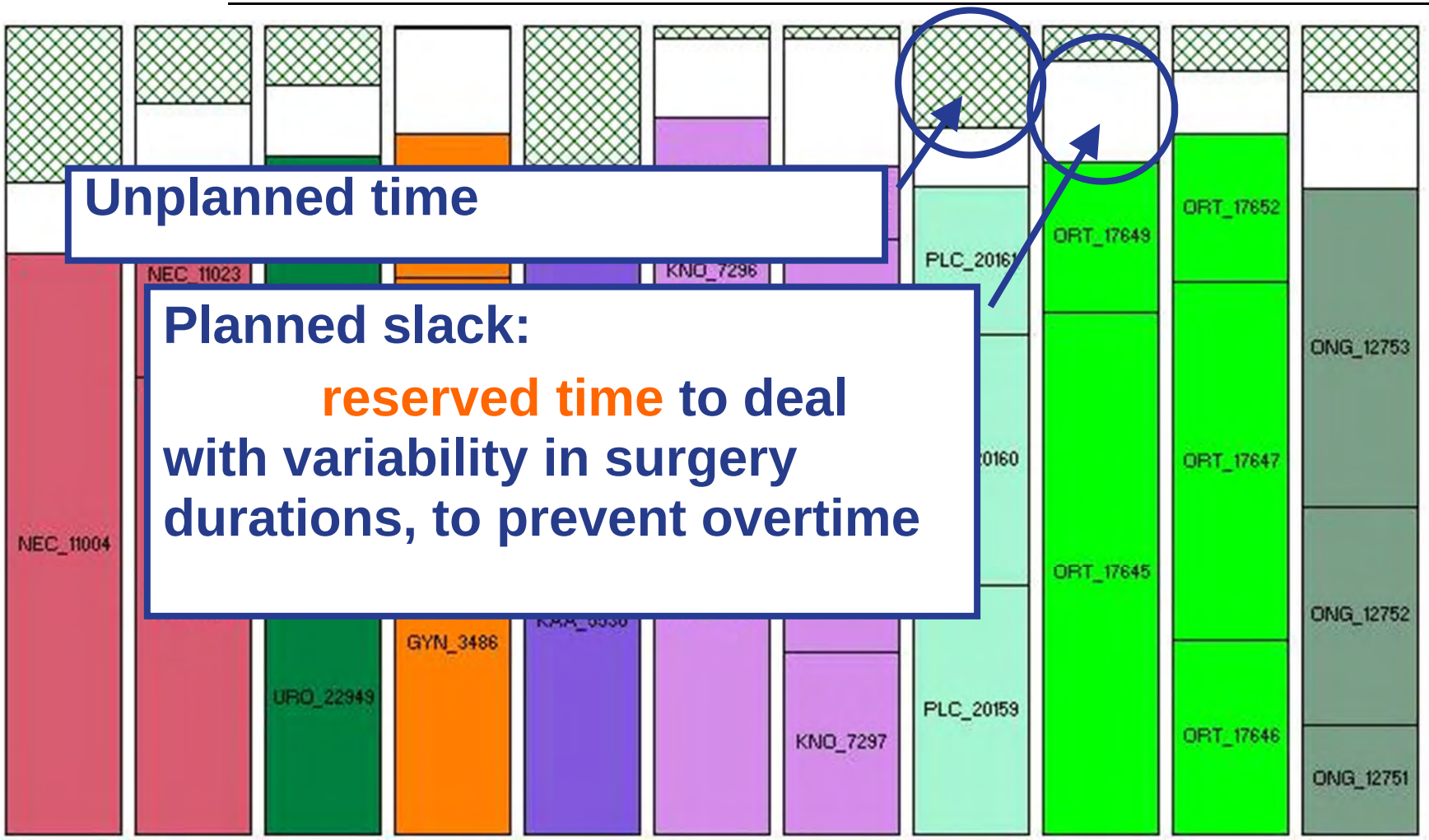
Tactical problem:

- Annually, the board of the hospital, the operating room management and the surgical services draw a contract regarding the division of the “capacity pie”



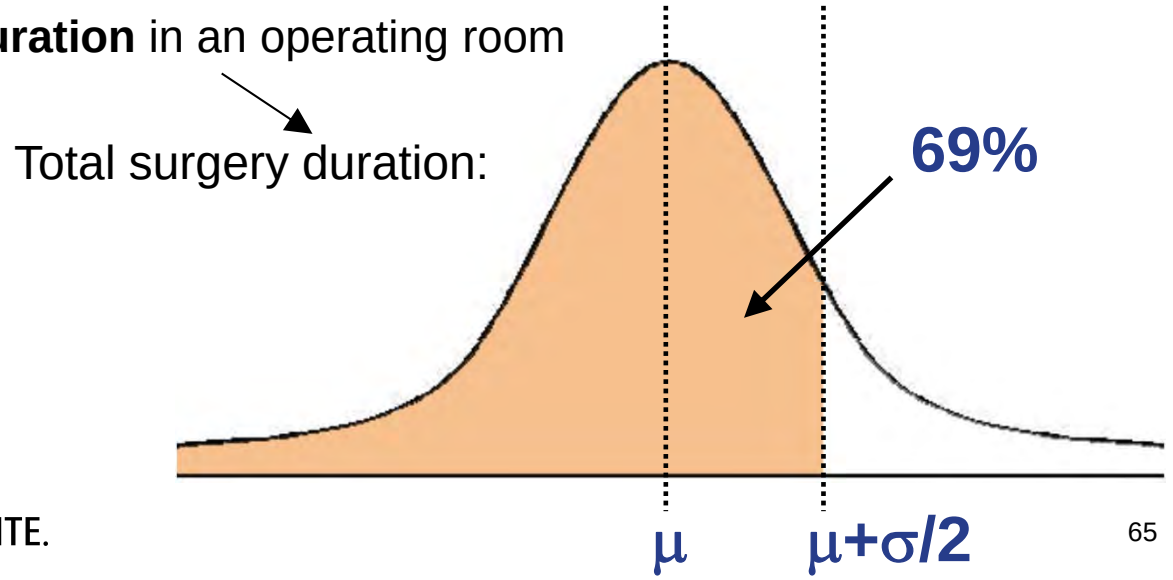
We will determine how to divide the dedicated inpatient ORs over the specialties, for every regular working day

Example elective schedule(11 ORs)



Assignment 1:
strategic and tactical operating room planning

- At the strategic and tactical level, you must account for the planned slack at the operational level.
- This planned slack is dimensioned in such a way, that the probability of overtime is less than 30%
- We will assume that surgery durations are lognormal distributed
  - At Erasmus MC, planners assume a normal distribution **of the total surgery duration** in an operating room



Assignment 1:
strategic and tactical operating room planning

Input for the assignment:

- Given: 10 years of historical process data
  - Surgery durations per surgery type
  - Emergency arrival frequencies per day

ASSIGNMENT: formulate an advice for the hospital's board, and support this advice with sound, convincing calculations

Download assignment 1 here:

http://www.filedropper.com/lnmb1

Good luck!