

Operations Research (OR) in HEALTH CARE

- In both rich and poor countries public resources for health care are inadequate to meet the demand
- The policy makers must determine how to provide the most effective health care to citizens using the limited resources that are available
- OR models can play a significant role in solving health care delivery related problems

Health care planning

Health care planning

- Demand forecasting
- Location selection
- Capacity planning

Facility Location Problems in Health Care



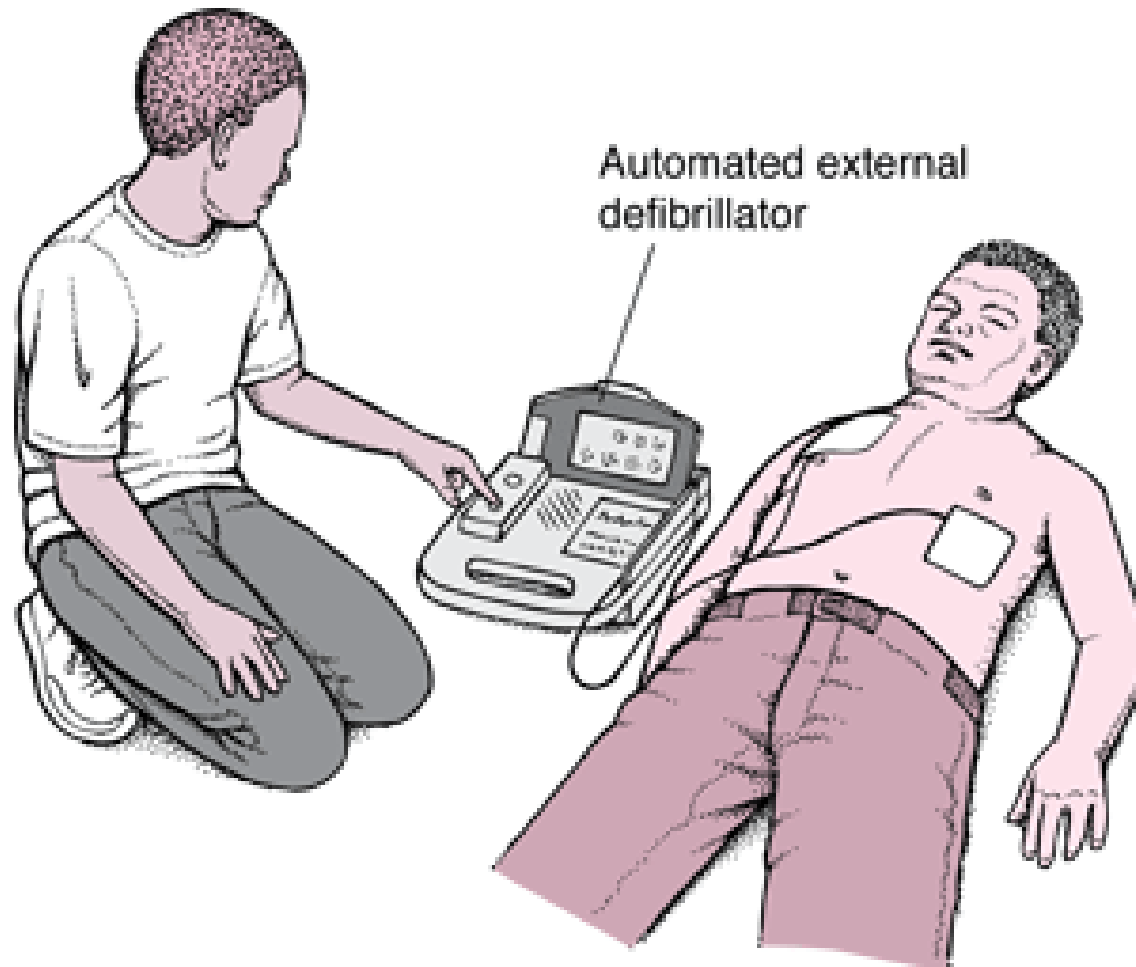
Locate hospitals:

Minimization of the maximum distance between a demand node and its closest facility

Minimization of the location cost of the facilities needed to cover the total demand

Maximization of the total covered demand

Locating AEDs



Source: <http://nursingcrib.com/demo-checklist/automated-external-defibrillation/>

Automated External Defibrillators (AEDs)

Can be used by bystanders to diagnose and treat a cardiac arrest victim

Place AEDs in public locations so that they can be used in case of emergency

- Identify a set of locations where placing AEDs would maximize the number of cardiac arrests that could be covered within a 100-m radius
- Decision: Locations of the AEDs to be deployed

Capacity Planning Example: Bed Management



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How much bed capacity to allocate to different hospital units?

Capacity Planning Example: Bed Management

- Problem: Overflow (i.e. Patients lodging at another specialty) of wards
- The **demand** of inpatient beds by medical specialties **changes over time**
- A periodic review of bed allocation by specialties is needed
- Assign the beds such that the specialties will end up with equitable bed occupancy rates subject to number of beds available

Health Care Management and Logistics

- Patient Scheduling
- Resource scheduling
 - Nurse
 - Operating room and physician
- Logistics
- Others

Outpatient Appointment Scheduling

Problem: Long waiting time at **outpatient** clinics before consultation



Possible methods:

Queuing theory

Discrete Event Simulation

The Science of Scheduling:

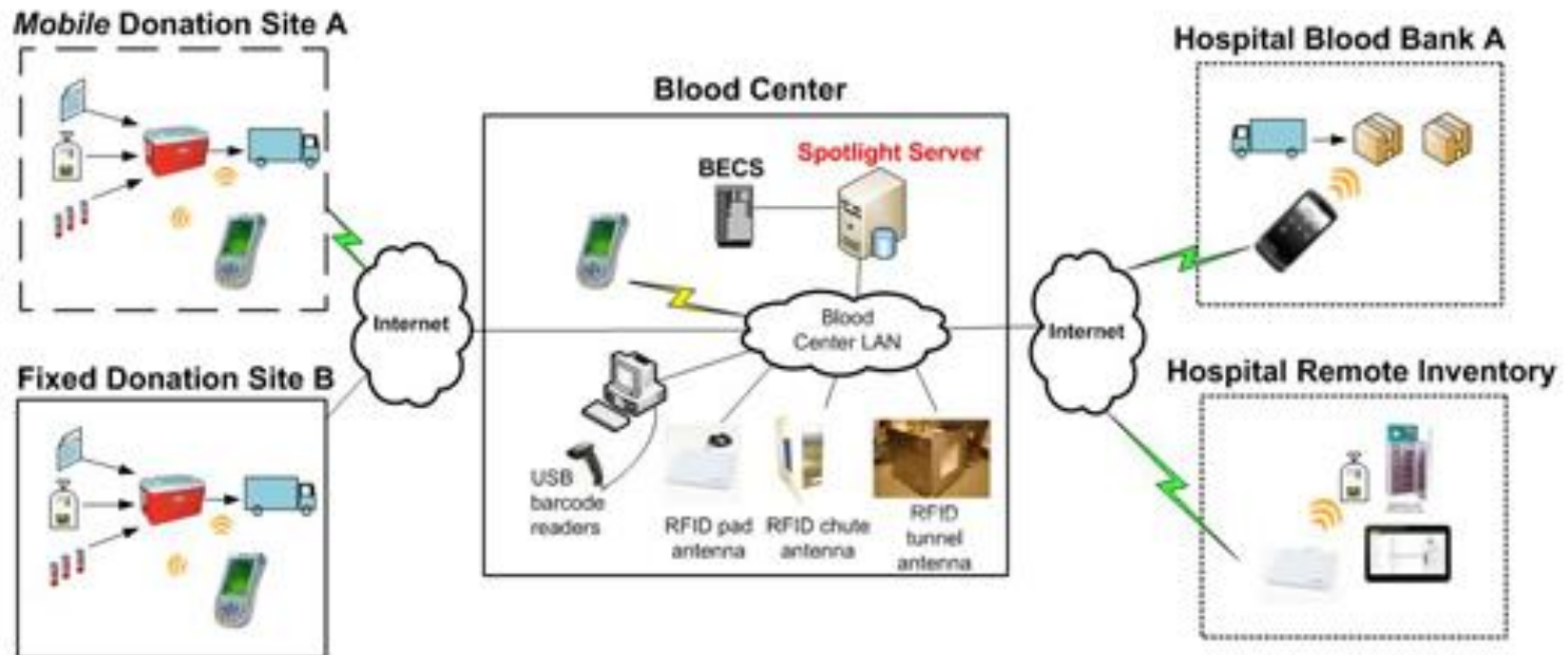
<https://www.youtube.com/watch?v=9MrL2BxKh1E>

Nurse scheduling

Employee	Wednesday 7/15/2009	Thursday 7/16/2009	Friday 7/17/2009	Saturday 7/18/2009
 Snyder, Molly Head Nurse Cardiac Care Unit	Swing Shift Cardiac Care U... 3:00 PM-11:00...	Swing Shift Cardiac Care U... 3:00 PM-11:00...	Night Shift Cardiac Care U... 11:00 PM-7:00...	Night Shift Cardiac Care 11:00 PM-7:0
 Garcia, Adam Registered Nurse Cardiac Care Unit	Swing Shift Cardiac Care U... 3:00 PM-11:00...	Vacation	Vacation	Night Shift Cardiac Care 11:00 PM-7:0
 Hawk, Danielle Registered Nurse Cardiac Care Unit	Swing Shift Cardiac Care U... 3:00 PM-11:00...	Swing Shift Cardiac Care U... 3:00 PM-11:00...	Night Shift Cardiac Care U... 11:00 PM-7:00...	Night Shift Cardiac Care 11:00 PM-7:0
 Kilroy, Trenton Registered Nurse Cardiac Care Unit	Swing Shift Cardiac Care U... 3:00 PM-11:00...	Swing Shift Cardiac Care U... 3:00 PM-11:00...	Day Shift Cardiac Care U... 7:00 AM-3:00 PM	Jury Duty
 Sampson, Peter Registered Nurse Cardiac Care Unit	Swing Shift Cardiac Care U... 3:00 PM-11:00...	Swing Shift Cardiac Care U...	Day Shift Cardiac Care U...	Day Shift Cardiac Care 7:00 AM-3:00
 Anderson, Lyndon LP/LV Nurse Cardiac Care Unit	Swing Shift Cardiac Care U... 3:00 PM-11:00...	7/15/2009 Sampson, Peter - Swing Shift (S) 3:00 PM - 11:00 PM - Cardiac Care Unit (CCU) - Break (BRK) 5:00 PM - 6:00 PM		
 Munoz, Crystal LP/LV Nurse Cardiac Care Unit	Swing Shift Cardiac Care U... 3:00 PM-11:00...	Swing Shift Cardiac Care U... 3:00 PM-11:00...		
 Anderson, Cory	Swing Shift	Swing Shift	Swing Shift	Swing Shift

<http://www.bmscentral.com/products/schedule/industries/nurse-scheduling-software.aspx>

Logistics: Blood Supply Chain



Healthcare Practice

- Disease diagnosis
- Treatment planning

Intensity-modulated radiation therapy (IMRT)

<https://www.youtube.com/watch?v= moypMx05Fw>

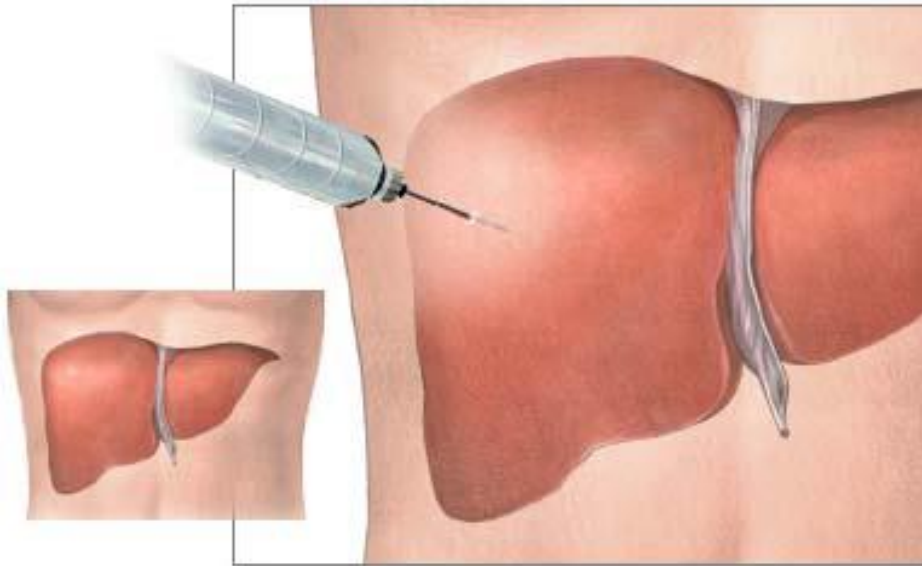
- You want to target the tumor
- You want to minimize the harm to healthy tissue

IMRT

- **Challenge:** As a patient breathes during treatment, a tumor in the lung will be moving (possibly irregularly)
- Build a model of motion uncertainty using probability density functions that describe breathing motion
- Optimizing intensity modulated radiation therapy
- Find a method that reliably delivers a sufficient amount of dose to the tumor, while sparing the healthy tissue as much as possible.

Biopsy

- Determine the zones to be biopsied in order to maximize the probability of cancer detection



Biopsy needle is inserted and a sample of the liver is removed

 ADAM.

<http://www.okclipart.com/Biopsy-Clip-Art30rofhkibn/>

Specialised and Preventive Healthcare

- Organ donation and transplant
- Prevention of diseases

Organ Transplant

There are patients waiting

A kidney becomes available

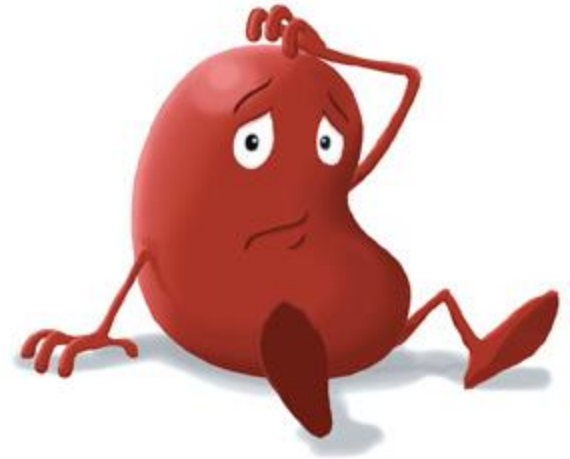
Decision: Whom to offer the kidney?

-Challenges: Patients' conditions are different

The system should be efficient

The system should be fair

The system should be transparent



Prevention of Diseases: Determining Screening Policy

Mammography:

- Too frequent : early detection but high cost
- Not frequent: less cost, late detection

TRADEOFF

- Find the optimal policy that balances cost and detection