Northeastern

Healthcare Systems Engineering as an Improvement Strategy

(Week 1)

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www.HSyE.org

Objectives

1. Overview of HSyE
2. Common types of problems and methods
3. Examples
   a. Simple through advanced
   b. Micro, meso, macro
4. Discussion and interests

About me / Healthcare Systems Engineering Institute

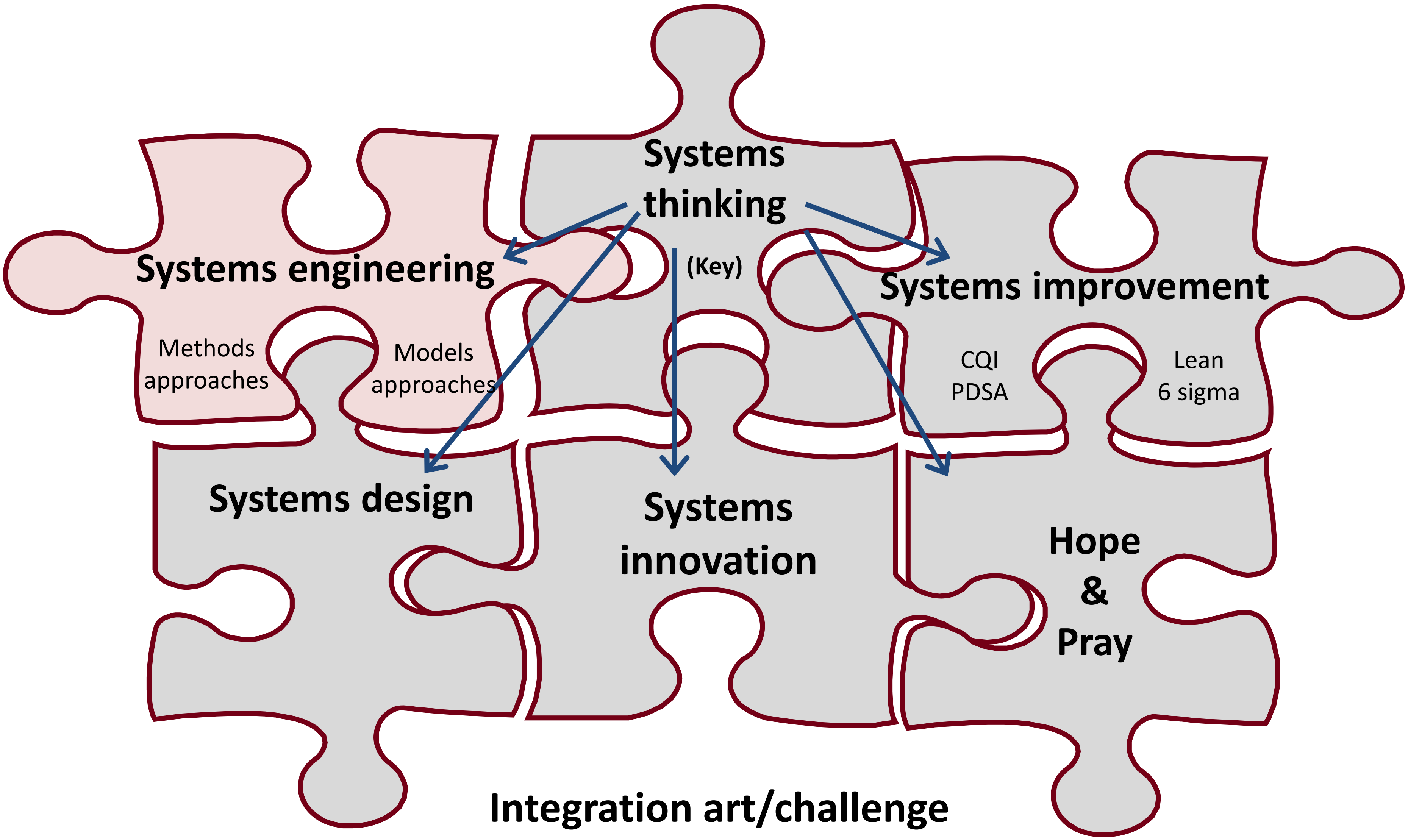
***Mission*: Broad measureable impact on health care, nationally, thru integration of research, education, and application of industrial and systems engineering**

Partnerships	Project Types	Criteria			Mechanisms
BWH, Dana-Farber, MGH, St. Luke's, Meadows Regional Medical Center, Texas Children's Hospital, Texas Health Resources, Seattle Children's, CHA Health, Northeastern University, Boston Medical Center, MD Anderson Cancer Center, Harvard Vanguard Medical Associates, Lahey Clinic, StuderGroup, Grady, Lone Star Circle of Care, Siemens, Georgia Trauma Commission, Highmark	**Research** – *Discover*	"Developing what we don't know"	1 - 2 years	1	CHOT – Center for Health Organization Transformation; NSF Research Center; AHRQ Safety Center; R01/other grants
	Applied – *Impact*	"Doing what we know"	3 - 9 months	2	Center for Medicare & Medicaid INNOVATION; CMS Regional Extension; VA Application Centers
	Experiential – *Education*	"Teaching others by doing"	2 - 6 months	3	Coops, Summer interns; Postdoc training program; Clinicians-in-residence

Systems Engineering

Introduction

Ways to improve systems



Process and system can be used mostly interchangeably

What is systems engineering?

- Set of methods to understand, model, improve, and optimize process / system performance
- Used in almost every other complex industry
- Underused in healthcare

Methods

(mathematical, computer, graphical)

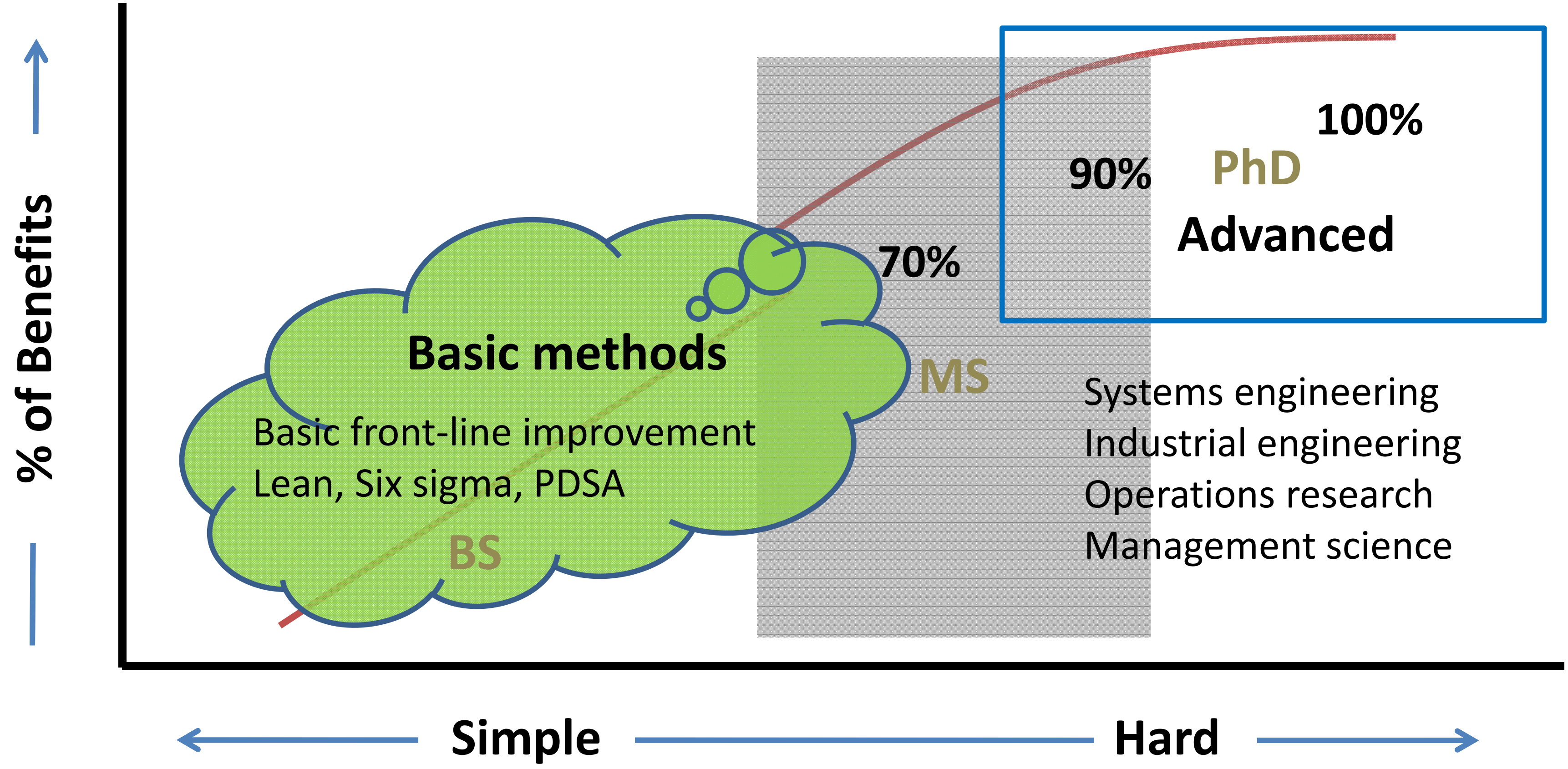
Uses

Improve, optimize, control

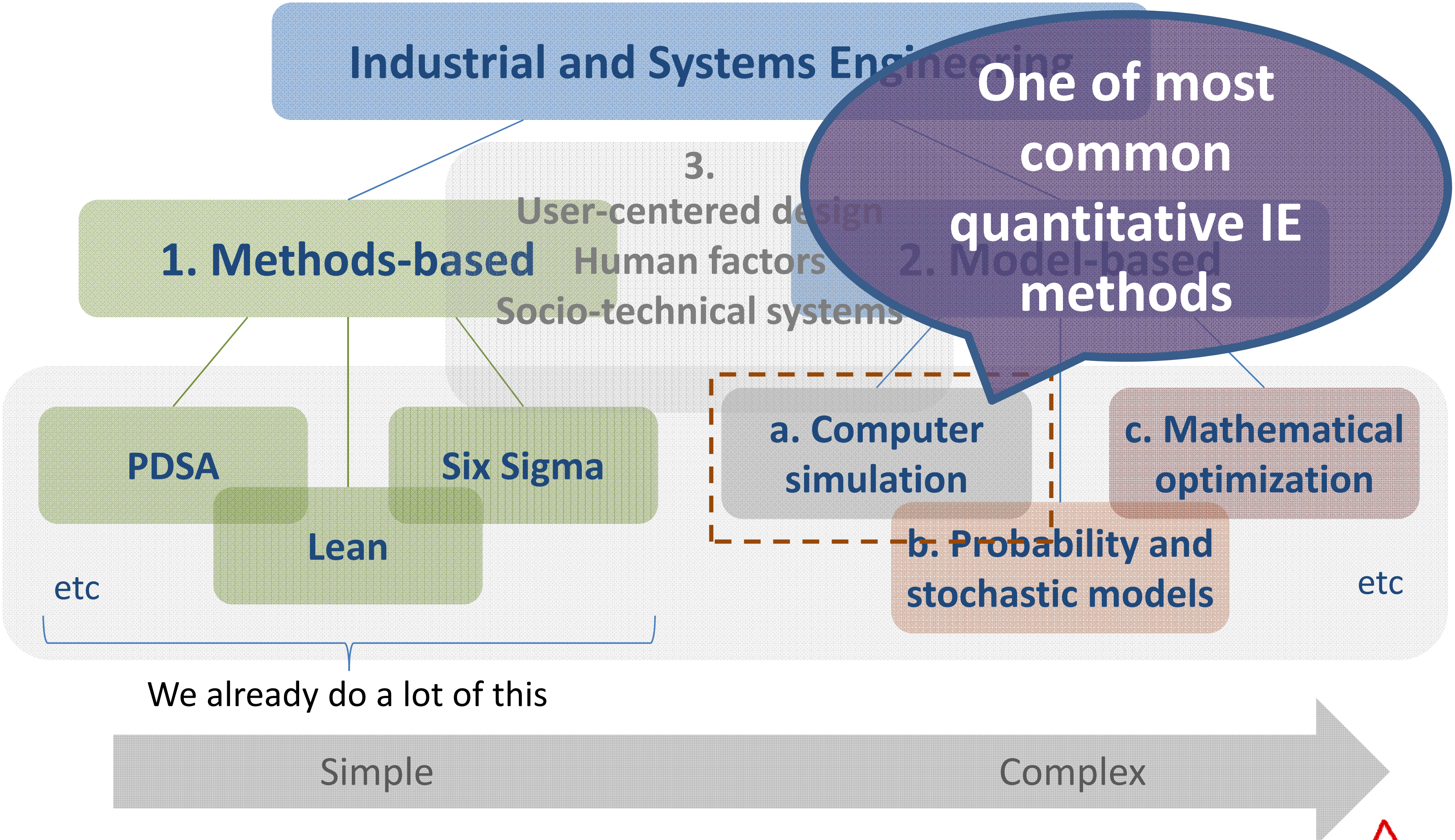
Foci

Better systems & processes

Range of methods



What is systems engineering?



Typical methods

Created by: Office of Performance Improvement, UT MD Anderson Cancer Center, with idea from the Standards and Practice Department, Mayo Clinic, 2010

Typical applications

Logistics & efficiency	Patient flow & Access
• Inventory and supply chains • OR scheduling and turn-around • Academic workforce logistics • Regional network design • Real time location systems	• Access, waits and delays • Patient flow simulation • Workflow smoothing • Capacity planning, scheduling, and demand management
Medical decision making	**Quality & patient safety**
• Treatment optimization • Screening and diagnostic tests • Radiation therapy optimization • Patient shared decision support • Palliative and hospice care • Medical alternative evaluation	• Reliable and consistent care • Adverse events reduction • Preventable readmissions • Care continuity • Human factors engineering • Quality/improvement science

Basic QI Methods

recap – more thursday

Process improvement methods

Variety of approaches

80%⁺ problems

Common concepts:

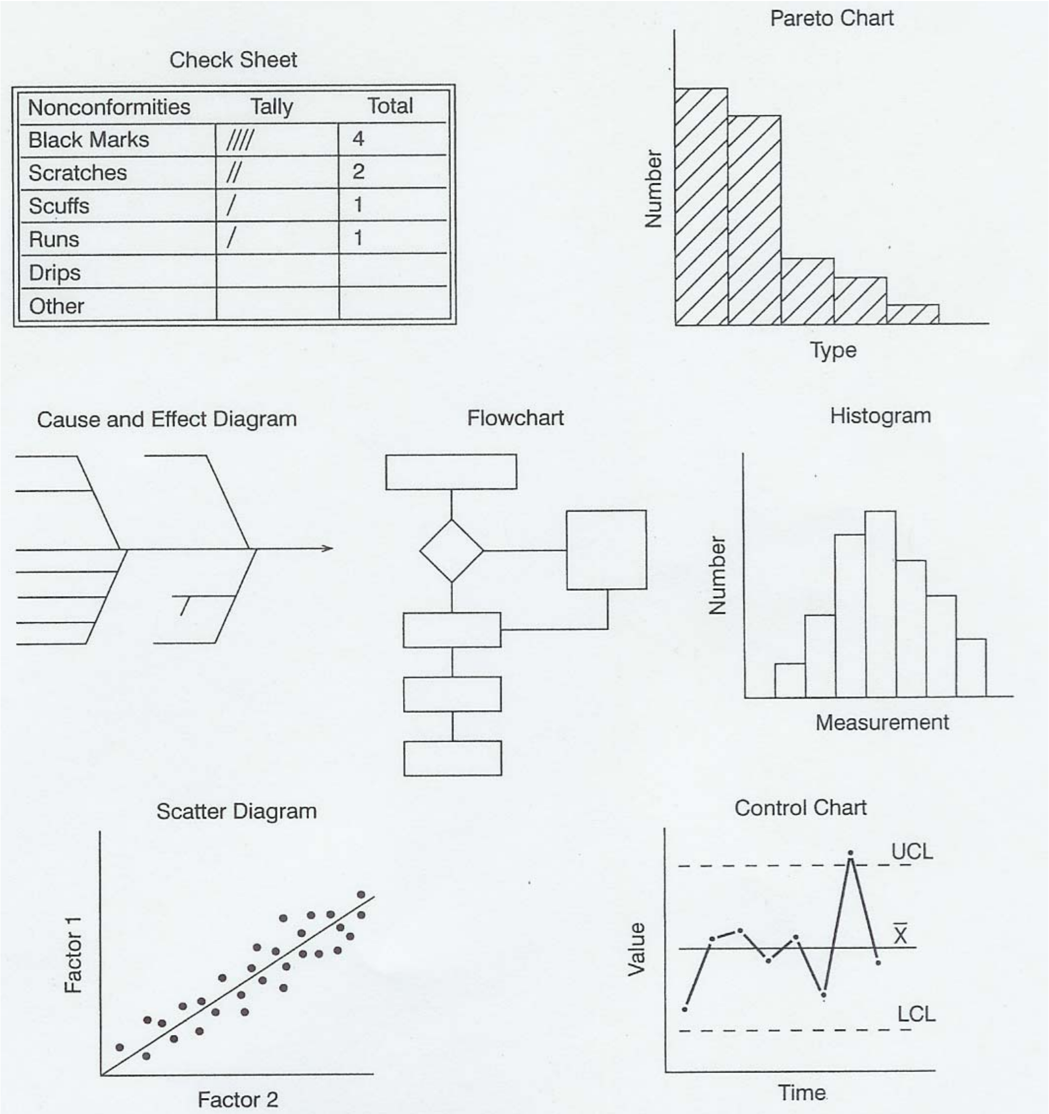
- **Understand** current process
- **Draw picture** of process logic
- **Use data** (before/after)
- **Test** improvement ideas

Approach
Total quality mgmt (TQM)
Continuous quality improvement
PDCA / "Model for Improvement"
Six Sigma
Lean Toyota Production System

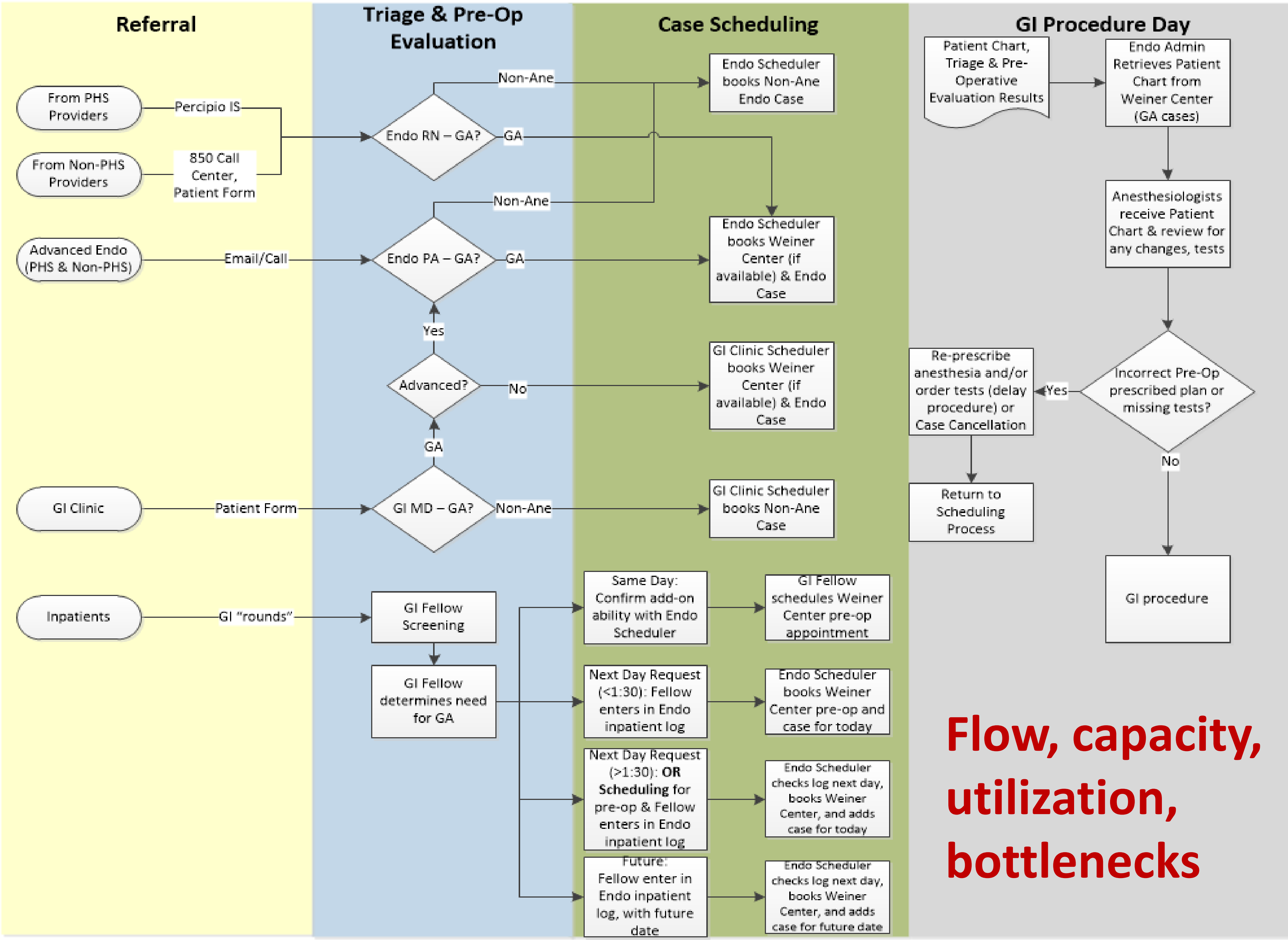
Common QI/6σ tools

"Basic 7 Tools"

- Check sheets
- Pareto charts
- Cause-and-effect "fishbone" diagrams
- Process flow charts
- Histograms
- Scatter diagrams
- Run and control charts



1. Process improvement examples

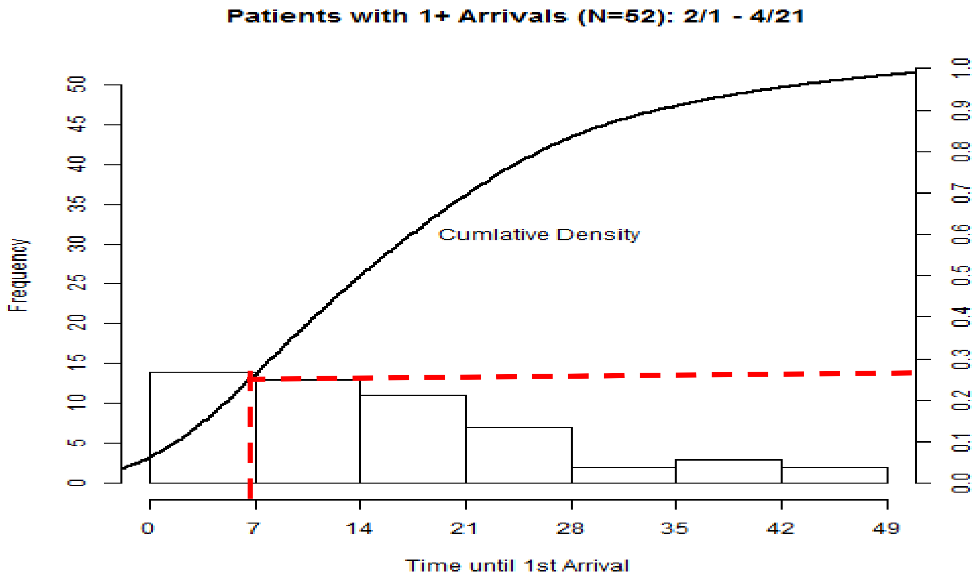


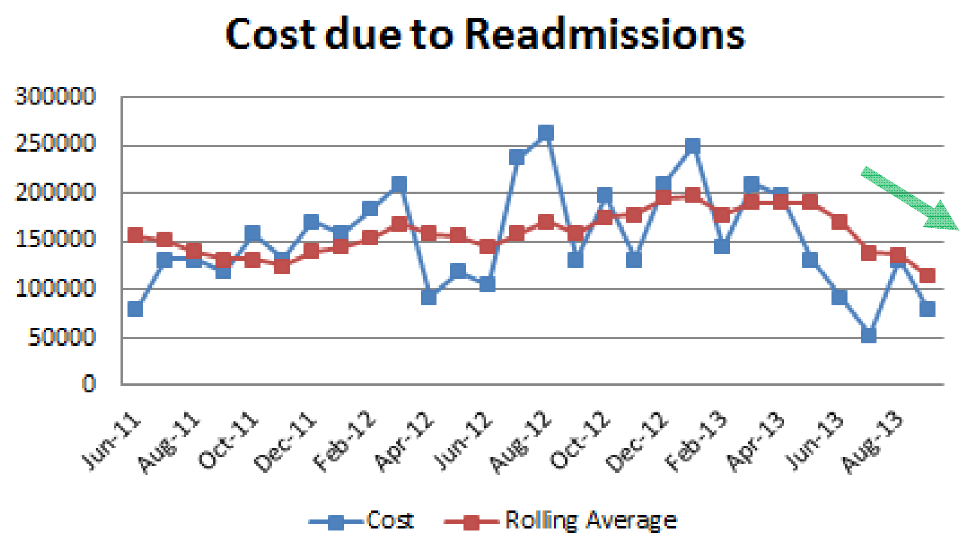
Flow, capacity, utilization, bottlenecks

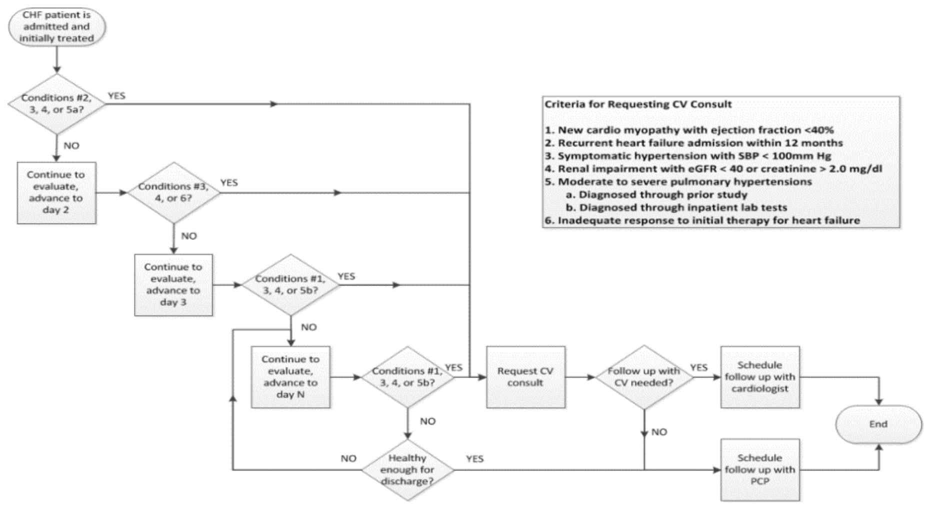
Congestive heart failure readmissions

Aim: Reduce CHF readmission costs 25% by increasing post-discharge follow-up appts ≤ 7 days

Approach: Basic process flow, data analysis, and CQI







Central line ICU infections

Aim

Reduce ICU CLABSI rate and associated costs by 50% within 9 months through implementation of "bundle"

Approach

- Process flow analysis
- Bundle implementation via reliability science and human factors models

CLABSI Bundle

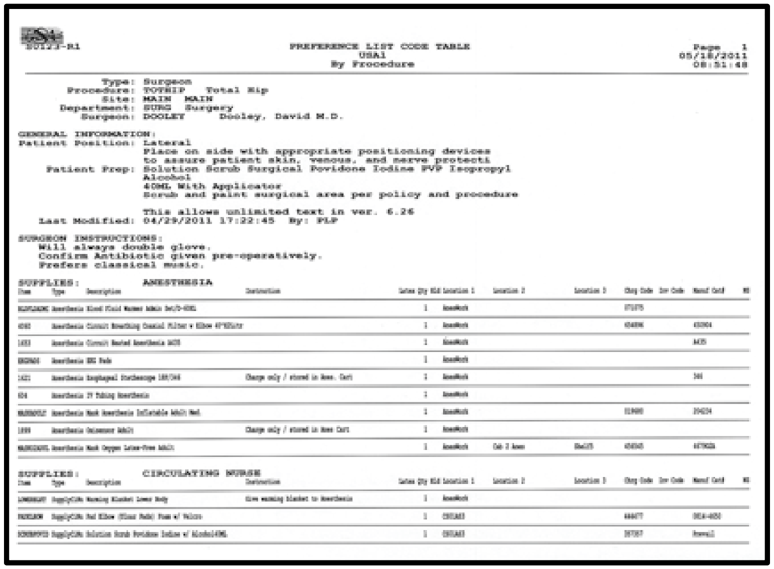
1. Insertion technique, hand hygiene
2. Low risk site selection
3. Maintenance (sterile)
4. Daily removal assessment

Reliability tier	Strategies	Measures	
		Process	Outcome
Prevent	• •	•	•
Detect	•	•	•
Mitigate	• •	•	•
Redesign	•	•	•

Peri-operative inventory

Aim

Reduce peri-operative supply costs by 20% via inventory methods, lean concepts, and preference card reduction



S0123-R1

PREFERENCE LIST CODE TABLE
USA1
By Procedure

Page 1
05/18/2011
08:31:48

Type: Surgeon
Procedure: TOTHIP Total Hip
Site: MAIN MAIN
Department: SURG Surgery
Surgeon: DOOLEY Dooley, David M.D.

GENERAL INFORMATION:
Patient Position: Lateral
Place on side with appropriate positioning devices
to assure patient skin, venous, and nerve protecti
Patient Prep: Solution Scrub Surgical Povidone Iodine PVP Isopropyl
Alcohol
40ML With Applicator
Scrub and paint surgical area per policy and procedure

This allows unlimited text in ver. 6.26
Last Modified: 04/29/2011 17:22:45 By: PLP

SURGEON INSTRUCTIONS:
Will always double glove.
Confirm Antibiotic given pre-operatively.
Prefers classical music.

SUPPLIES: ANESTHESIA

SUPPLIES: CIRCULATING NURSE

Approach

- Establish/revise PAR levels for 80% of “A” items
- Standardize & reduce preference cards
- 5S inventory areas

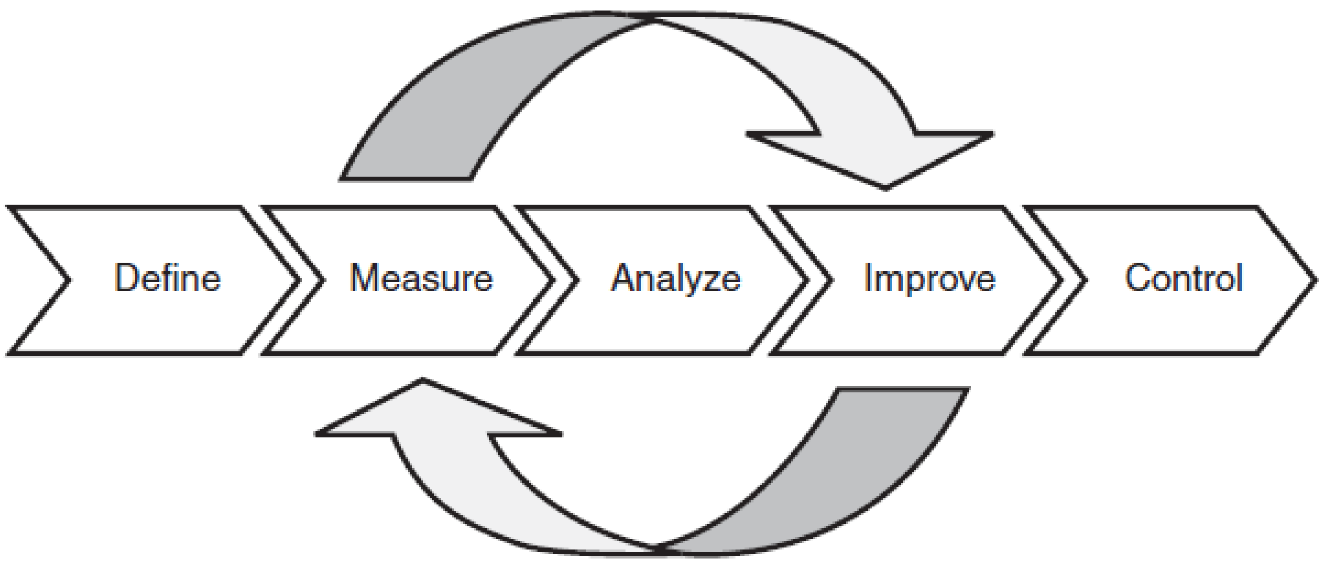
PAR STOCK LEVEL CHECKER

Supplier: Cash & Carry   Date: 12/1/2008

Item	Par Level	On Hand	To Order	
Baked Beans Tin	10	2	8	Order Needed
Rice 5kg	3	14	-11	No Order Needed
Soy Sauce Btl	34	12	22	Order Needed
			0	No Order Needed
			0	No Order Needed
			0	No Order Needed
			0	No Order Needed
			0	No Order Needed
			0	No Order Needed
			0	No Order Needed
			0	No Order Needed
			0	No Order Needed
			0	No Order Needed
			0	No Order Needed
			0	No Order Needed

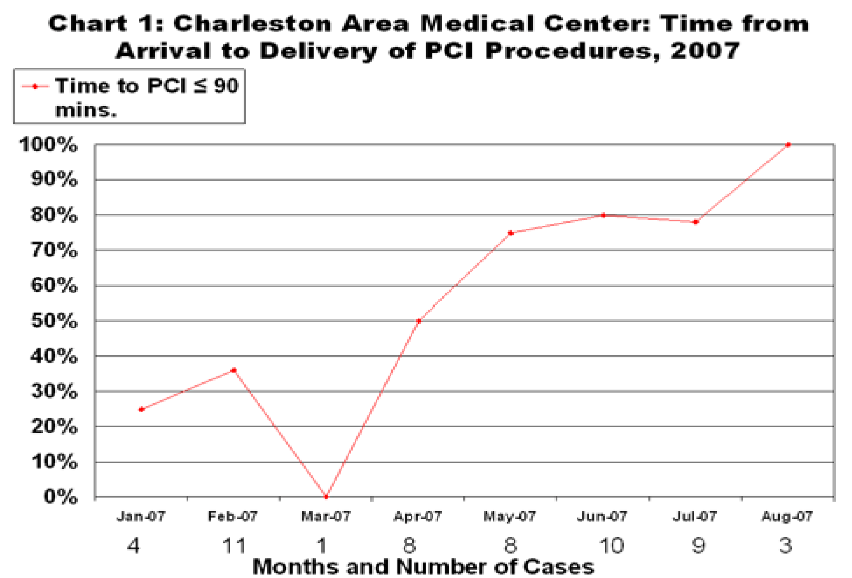
"Six Sigma" DMAIC basics

- Focus: Quality improvement
- Structured approaches, integrated measuring
  - **DMAIC: Improve existing process**
  - DFSS: Design for Six Sigma
  - DMADV: Define, Measure, Analyze, Design Verify



DMAIC example

- <u>Define</u>: Process maps for EBM delivery (AMI, SSI, CHF)
- <u>Measure</u>: Baseline element and composite measures
- <u>Analyze</u>: Weekly review of 10 random patient charts by change agents and case coordinators. Root cause analysis
- <u>Improve</u>: Staff education, order sets, Protocols, check lists
- <u>Control</u>: Standardize processes Compliance monitoring

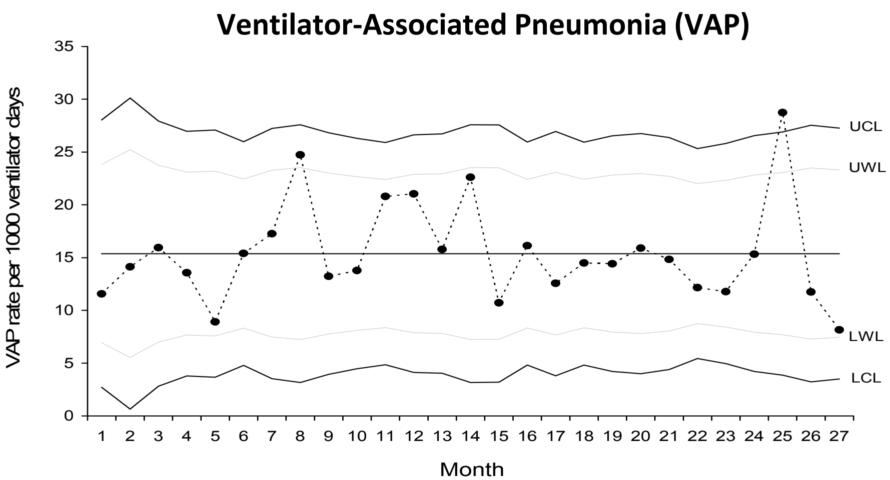


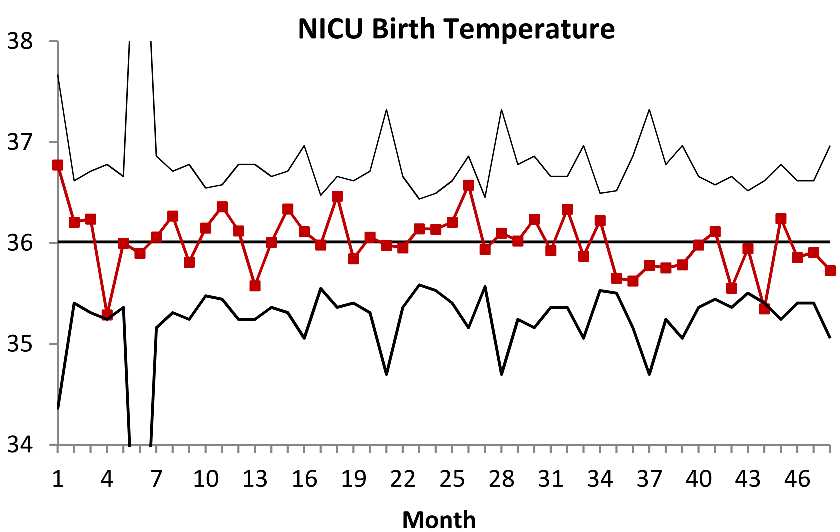
HQA Indicator: Time from arrival to percutaneous coronary intervention ≤ 90 minutes. Data: Charleston Area Medical Center, November 2007.

http://www.commonwealthfund.org/Content/Innovations/Case-Studies/2007/Nov/Case-Study--Improving-Performance-at-Charleston-Area-Medical-Center.aspx

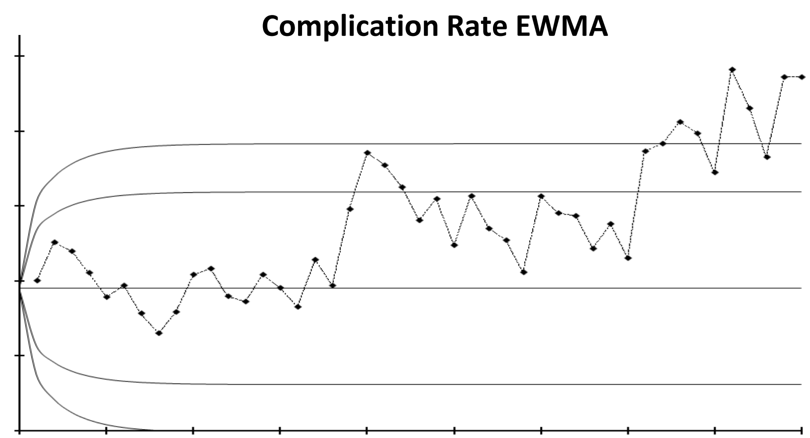
SPC methods

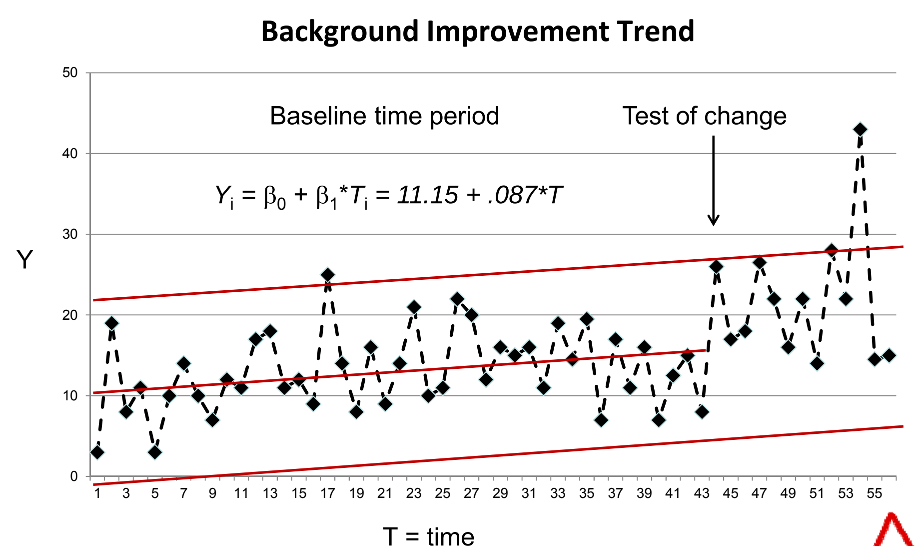
'Simple' Methods





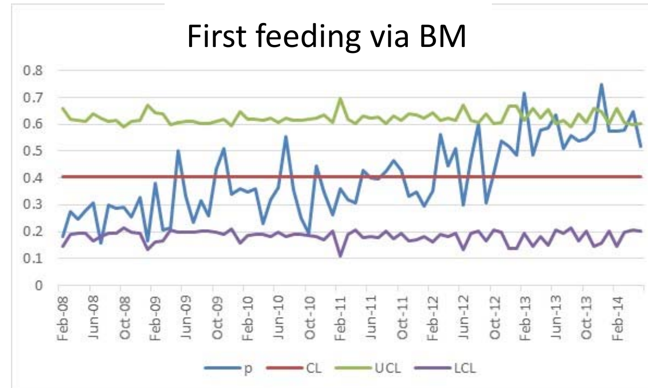
Advanced Methods

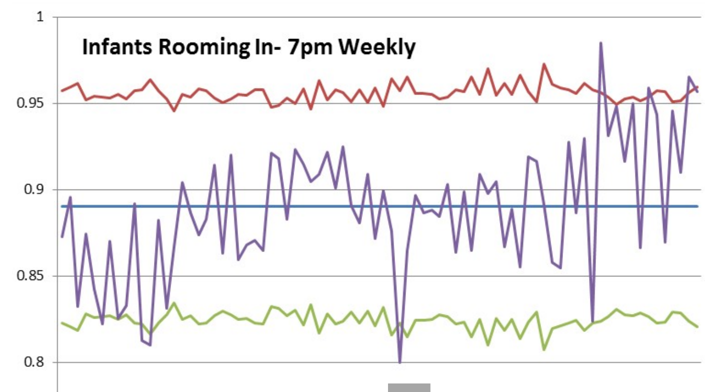


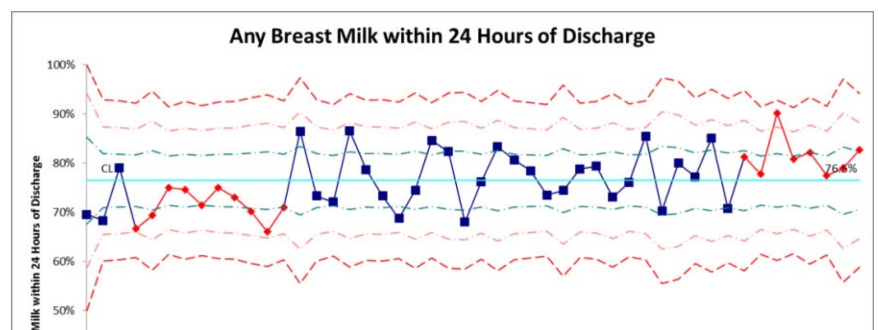


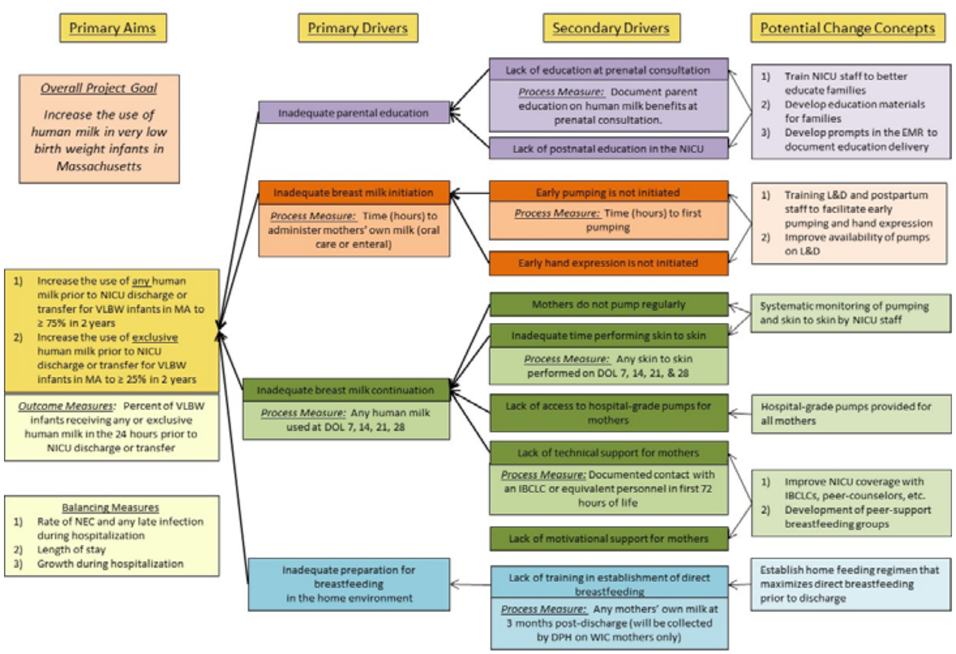
2. Breast milk feeding

- Aim: BMF during/after (↑)
- Full or low birth weight babies (NICU)
- Better for baby, mom
- Complications, LOS, $ (↓)





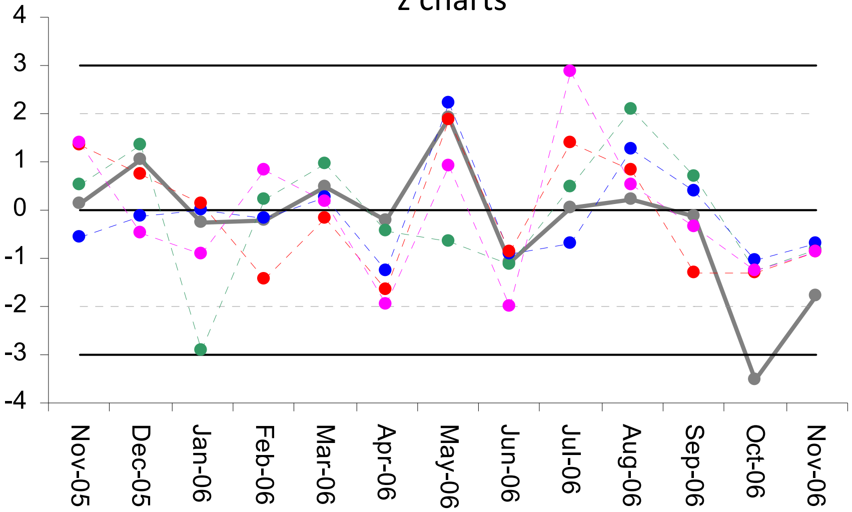




Simple tool support

Comparing multiple system or measures

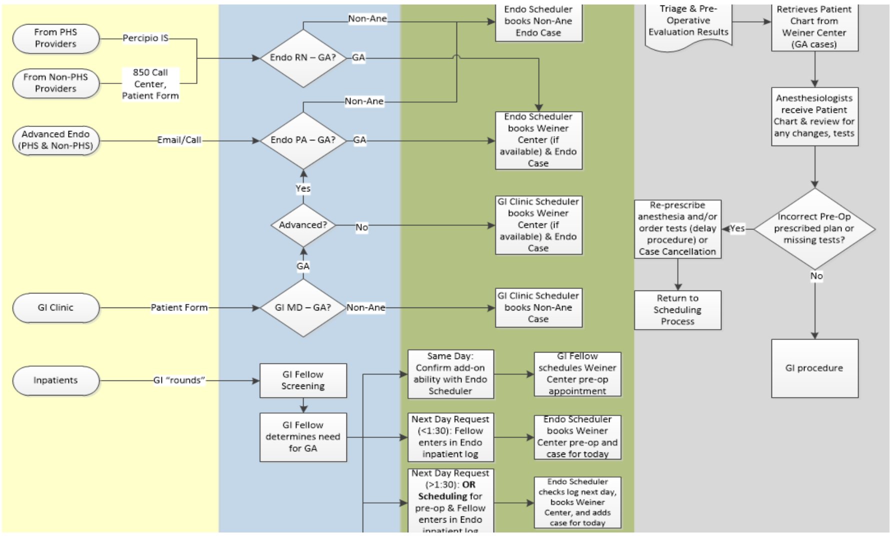
z charts



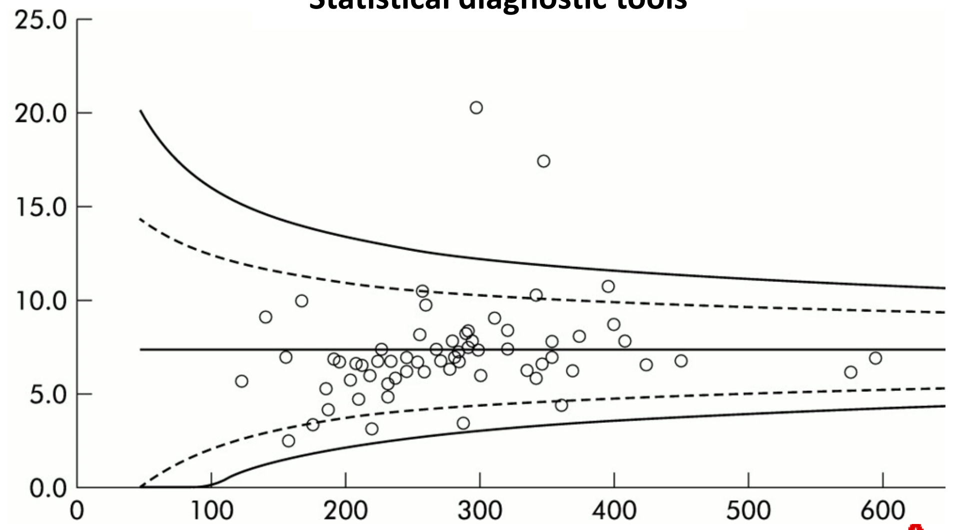
Reliability process design

Reliability tier	Strategies	Measures	
		Process	Outcome
Prevent	• •	•	•
Detect	•	•	•
Mitigate	• •	•	•
Redesign	•	•	•

Process mapping

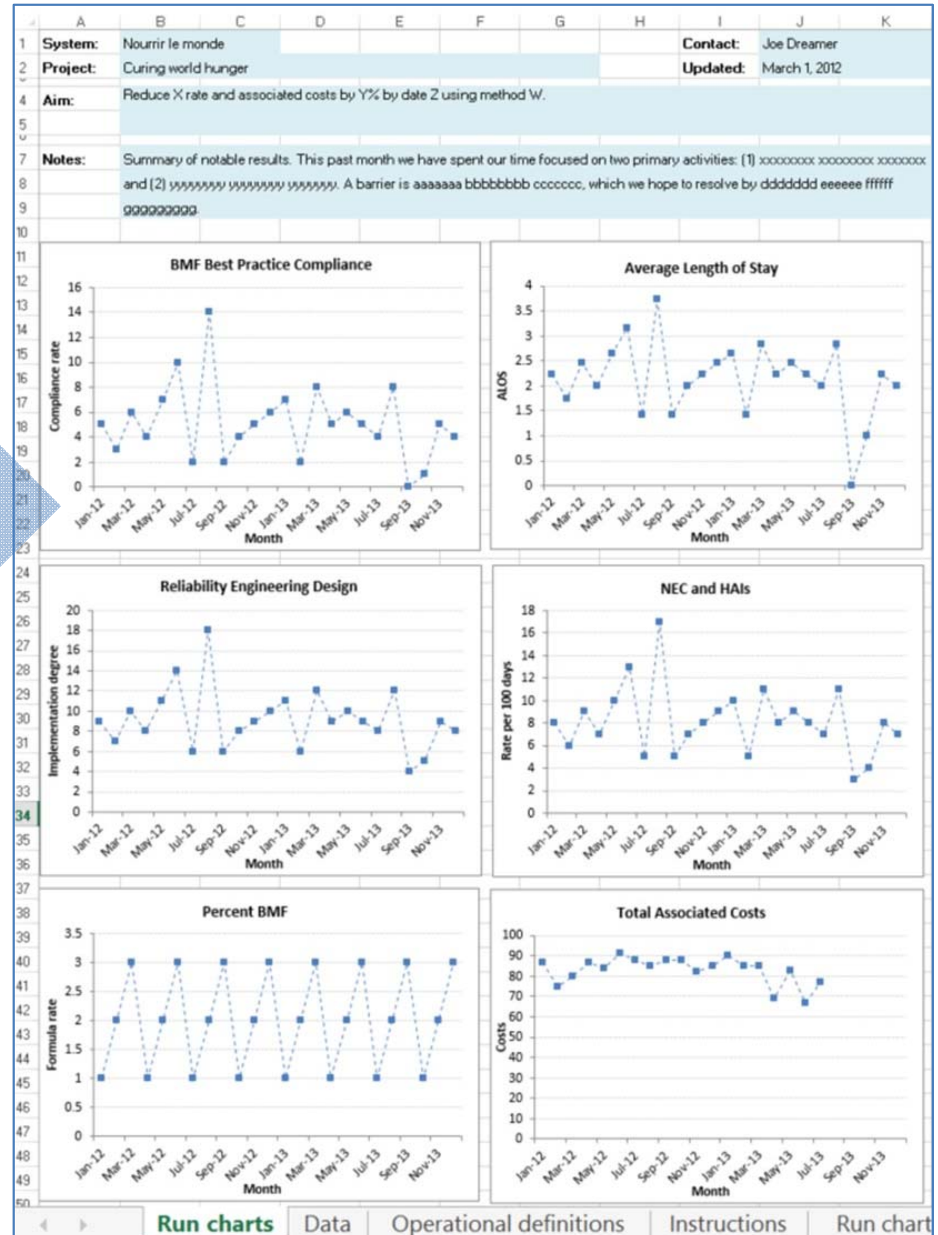


Statistical diagnostic tools



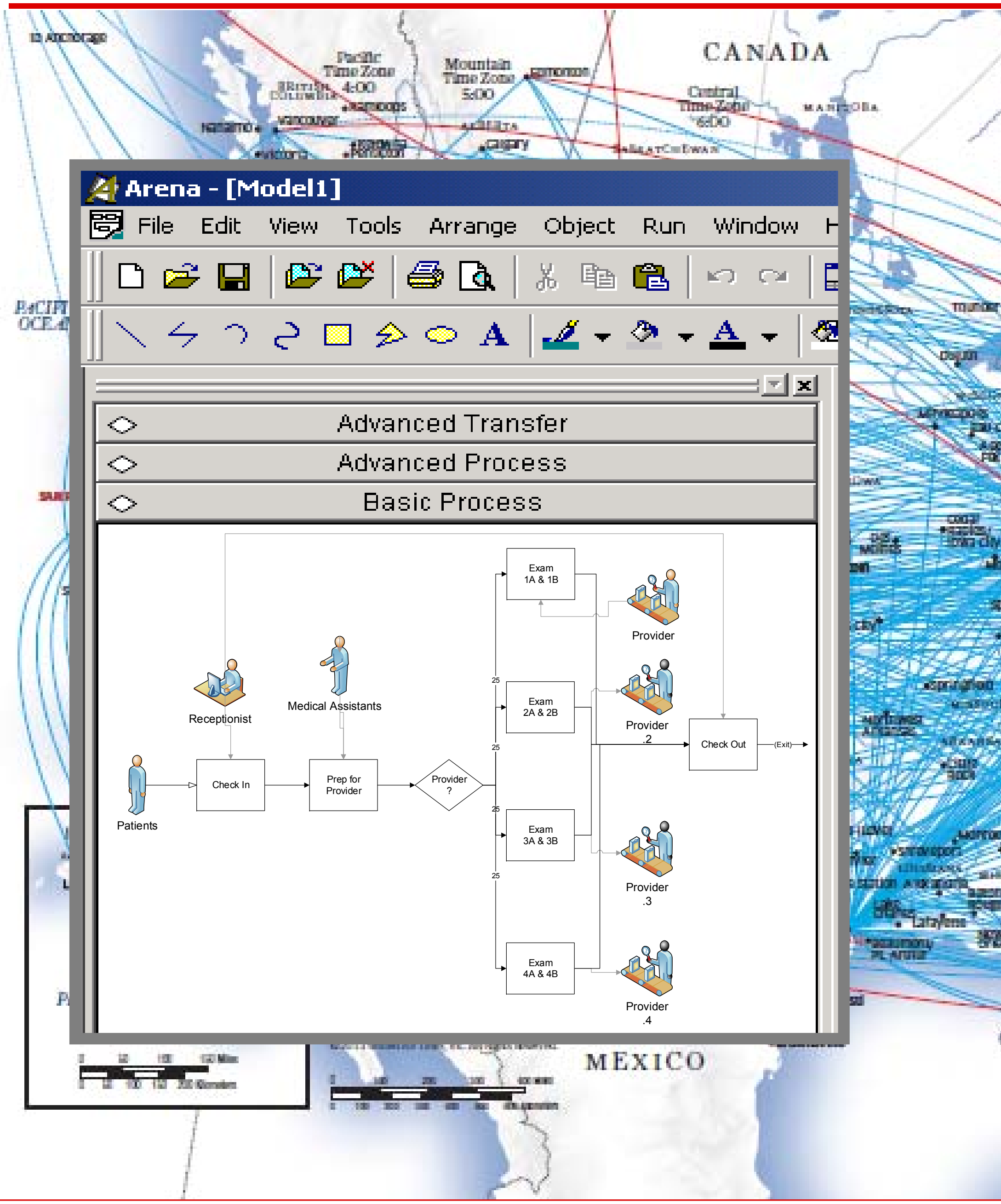
Automated/Excel tools, dashboards

A	B	C	D	E	F	G
Chart	BMF Best Practice Compliance		Reliability Engineering Design		Percent BMF	
titles:		Average Length of Stay		NEC and HAIs		Total Associated Cost
Y-axis	Compliance rate		Implementation degree		Formula rate	
labels:		ALOS		Rate per 100 days		Costs
Month	Data 1	Data 2	Data 3	Data 4	Data 5	Data 6
Jan-12	5	2.236067977	9	8	1	87
Feb-12	3	1.732050808	7	6	2	75
Mar-12	6	2.449489743	10	9	3	80
Apr-12	4	2	8	7	1	87
May-12	7	2.645751311	11	10	2	84
Jun-12	10	3.16227766	14	13	3	91
Jul-12	2	1.414213562	6	5	1	88
Aug-12	14	3.741657387	18	17	2	85
Sep-12	2	1.414213562	6	5	3	88
Oct-12	4	2	8	7	1	88
Nov-12	5	2.236067977	9	8	2	82
Dec-12	6	2.449489743	10	9	3	85
Jan-13	7	2.645751311	11	10	1	90
Feb-13	2	1.414213562	6	5	2	85
Mar-13	8	2.828427125	12	11	3	85
Apr-13	5	2.236067977	9	8	1	69
May-13	6	2.449489743	10	9	2	83
Jun-13	5	2.236067977	9	8	3	67
Jul-13	4	2	8	7	1	77
Aug-13	8	2.828427125	12	11	2	
Sep-13	0	0	4	3	3	
Oct-13	1	1	5	4	1	
Nov-13	5	2.236067977	9	8	2	
Dec-13	4	2	8	7	3	



- Option for initial baselines
- Tabs: Data input, run charts, definitions, instructions
- Automatically plots run charts

Model-based improvement – beyond basic QI

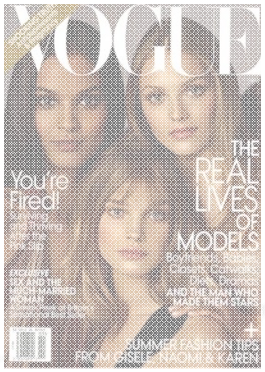


Max Z= $\sum_k \sum_t \sum_r \sum_s w_{kt} * p_{ktrs}$

$\sum_t A_{mts} \le 1$	$\forall\, i, s \text{ and } \forall\, m \in G_i$
$\sum_s A_{mts} = R_{mt}$	$\forall\, i, t \text{ and } \forall\, m \in G_i$
$A_{mts} = 1$	$\forall\, (m, t, s) \in O_i$
$\sum_{n \in D_{imt}} A_{nts} \ge A_{mts}$	$\forall\, i, t, s \text{ and } \forall\, m \in G_i, D_{imt} \ne \emptyset$
$A_{nts} + A_{mts} \le 1$	$\forall\, i, t, s \text{ and } \forall\, m \in G_i, \forall\, n \in U_{imt}$
$\sum_m A_{mts} \ge C_{it}$	$\forall\, i, t, s \text{ where } m \in G_i$
$\sum_m A_{mts} \ge \sum_k k * p_{ktrs}$	$\forall\, t, r, s \text{ where } m \in Q_r^t$
$\sum_r p_{k_{tr}trs} \ge Goal_t$	$\forall\, t, s$
$A_{mts} \in \{0,1\}$	$\forall\, m, t, s$
$p_{ktrs} \in \{0,1\}$	$\forall\, k, t, r, s$

What is a model…?

a.

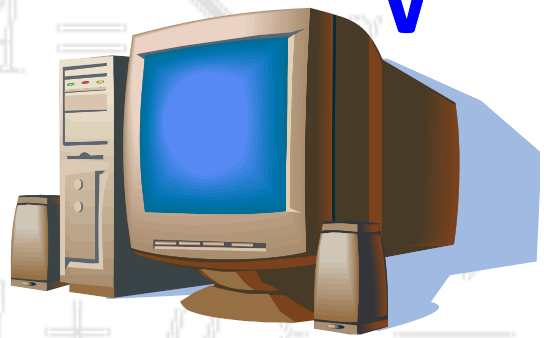


X

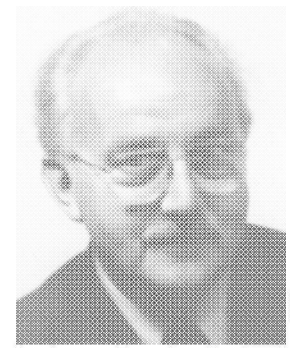
b.

X

c. √



d.



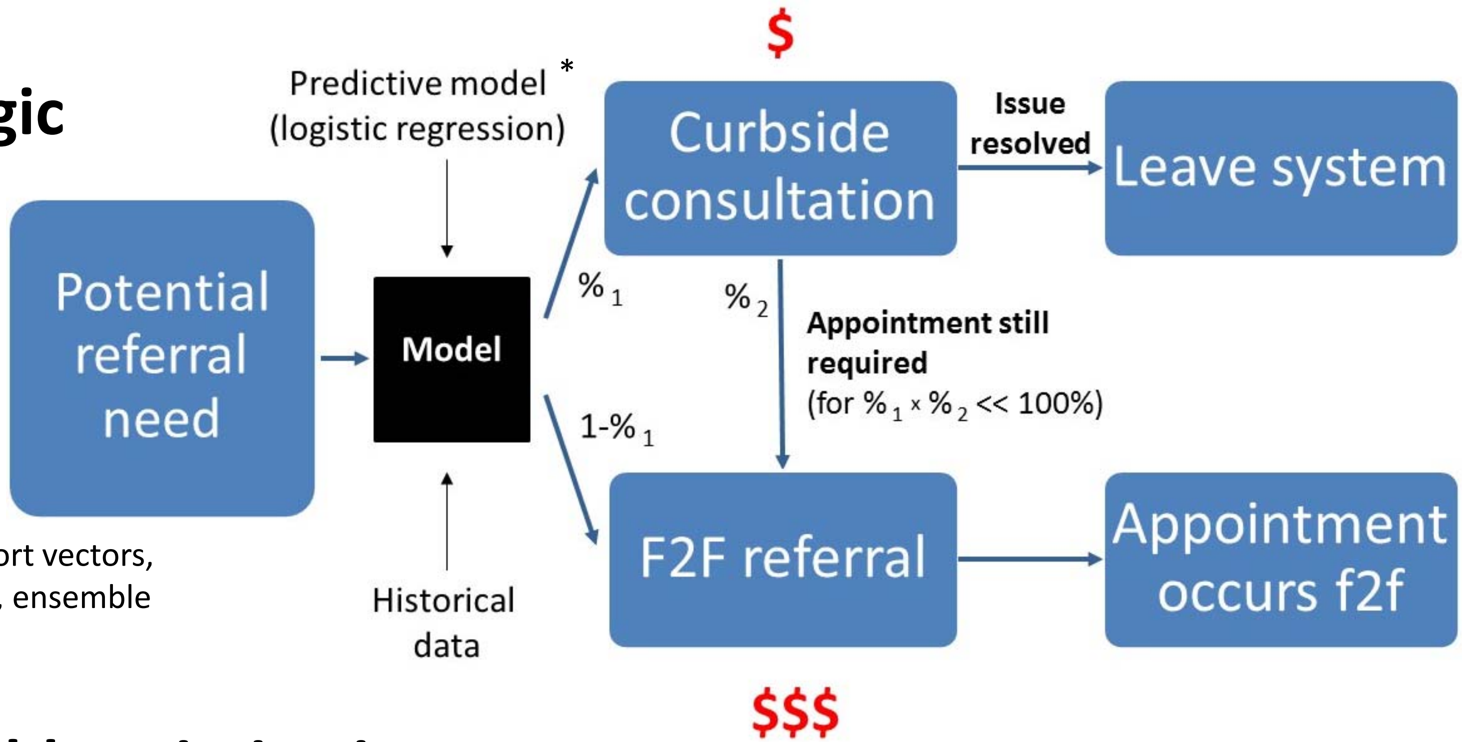
- An artificial representation of the real world
- Perhaps idealized, simplified; hopefully useful

"All models are wrong, some are useful"

- G.E.P. Box

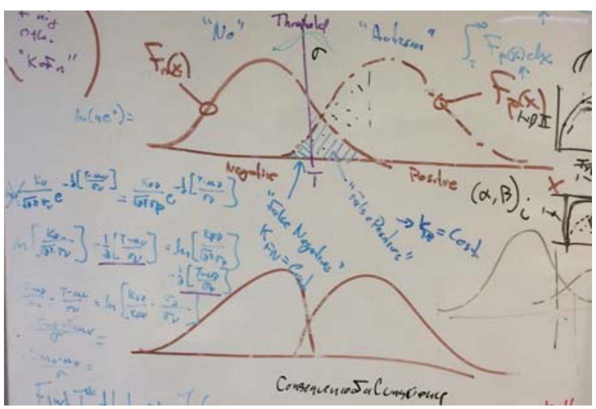
3. Unnecessary referrals or consults

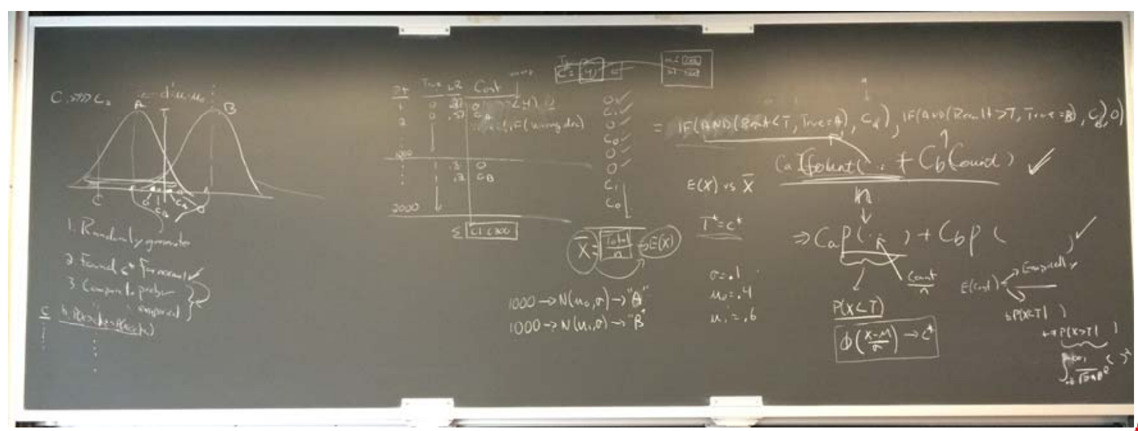
Flow logic



* regression, support vectors, classification trees, ensemble methods, etc

Threshold optimization





Results

Application

- One neurology sub-specialty
- One month off-line testing
- Retrospective review as gold standard

Results

- 23% reduction in F2F consults
- 3% remaining F2F's unnecessary
- Corresponding improved access
- $223K/month estimated savings

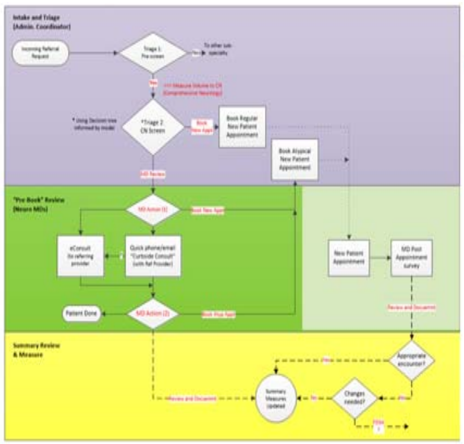
Request Total	Tool: CS	Tool: F2F	MD: CS	MD: F2F	Tool Correct	Cost w/o Tool	CS Cost w/ Tool	F2F Cost w/ Tool	Total Cost w/ Tool	Total Savings w/ Tool
90	33% (30/90)	67% (60/90)	10% (9/90)	90% (81/90)	78% CS (7/9) 72% F2F (52/81)	**$672,840**	$1,200	$620,508 $448,560 (60 or 89?)	**$621,708** $449,760 (if 60)	**$51,132** $223,080 monthly (if 60)

Off-line test of accuracy and savings

Patient Request	Tool B1 Prediction		"Gold Standard" (MD Feedback)		Tool B1 Correct?	Cost Without Tool B1 [1]	Impact Using Tool			
	CS	F2F Appt	CS	F2F Appt			CS Cost[1]	F2F Appt Cost[1]	Total Cost using Tool	Savings using Tool
1	✓		✓		Yes	**$7,476**	$40		**$40**	$7,436
2	✓			✓	No	**$7,476**	$40	$7,476	**$7,516**	- $40
3		✓	✓		No	**$7,476**		$7,476	**$7,476**	
4		✓		✓	Yes	**$7,476**		$7,476	**$7,476**	
5	✓		✓		Yes	**$7,476**	$40		**$40**	$7,436
⋮					⋮	⋮				⋮
89	✓		✓		Yes	**$7,476**	$40		**$40**	$7,436
90	✓			✓	No	**$7,476**	$40	$7,476	**$7,516**	- $40

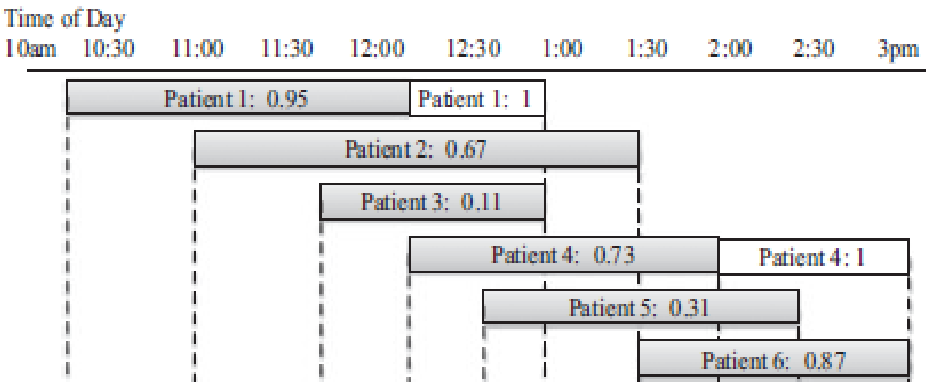
Simpler decision tree tool

Referral workflow logic



4. Predictive modeling

Same day forecast (1-4 hours)



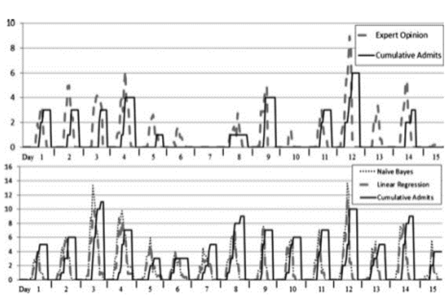
E(T)	0.95	1.62	1.73	2.51	2.82	1.71	1.91	2.18	1.87
σ(T)	0.05	0.27	0.37	0.52	0.73	0.63	0.52	0.33	0.11

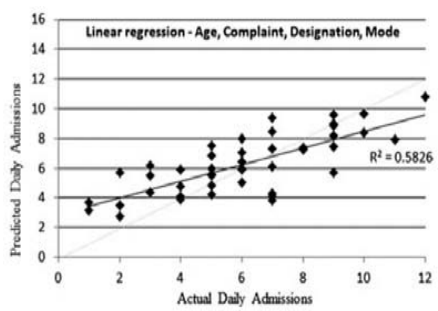
Academic Emergency Medicine
Official Journal of the Society for Academic Emergency Medicine

ORIGINAL RESEARCH CONTRIBUTION

Predicting Emergency Department Inpatient Admissions to Improve Same-day Patient Flow

Jordan S. Peck, MS, James C. Benneyan, PhD, Deborah J. Nightingale, PhD, and Stephan A. Gaehde, MD, MPH

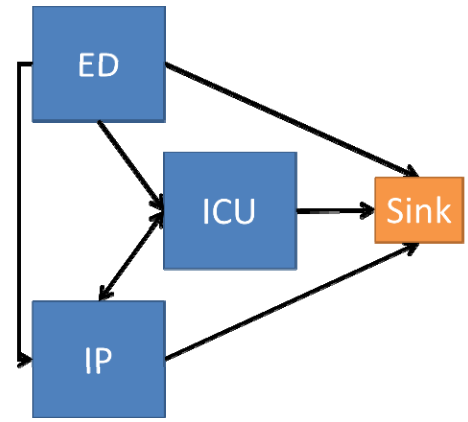


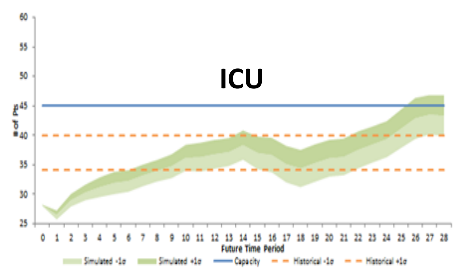


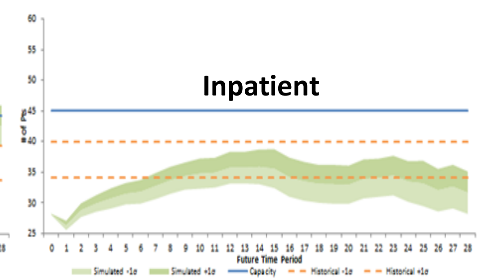
Long term forecast (1-30 days)

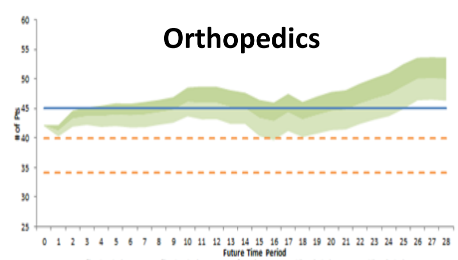
Inputs:

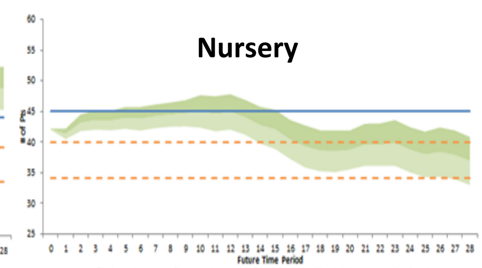
1. Starting conditions
   - Beds occupied
   - How long
2. Probabilistic
   - Flow paths
   - Lengths of stay
3. Arrivals
   - Scheduled
   - Emergent



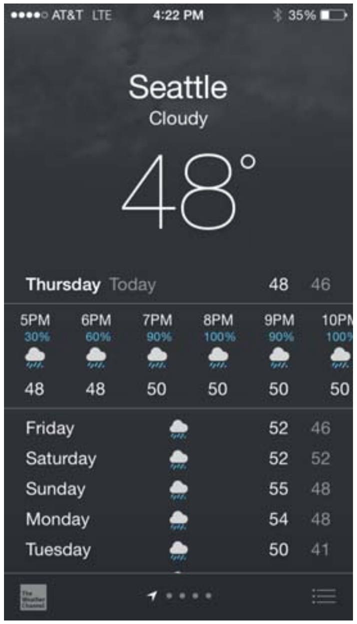






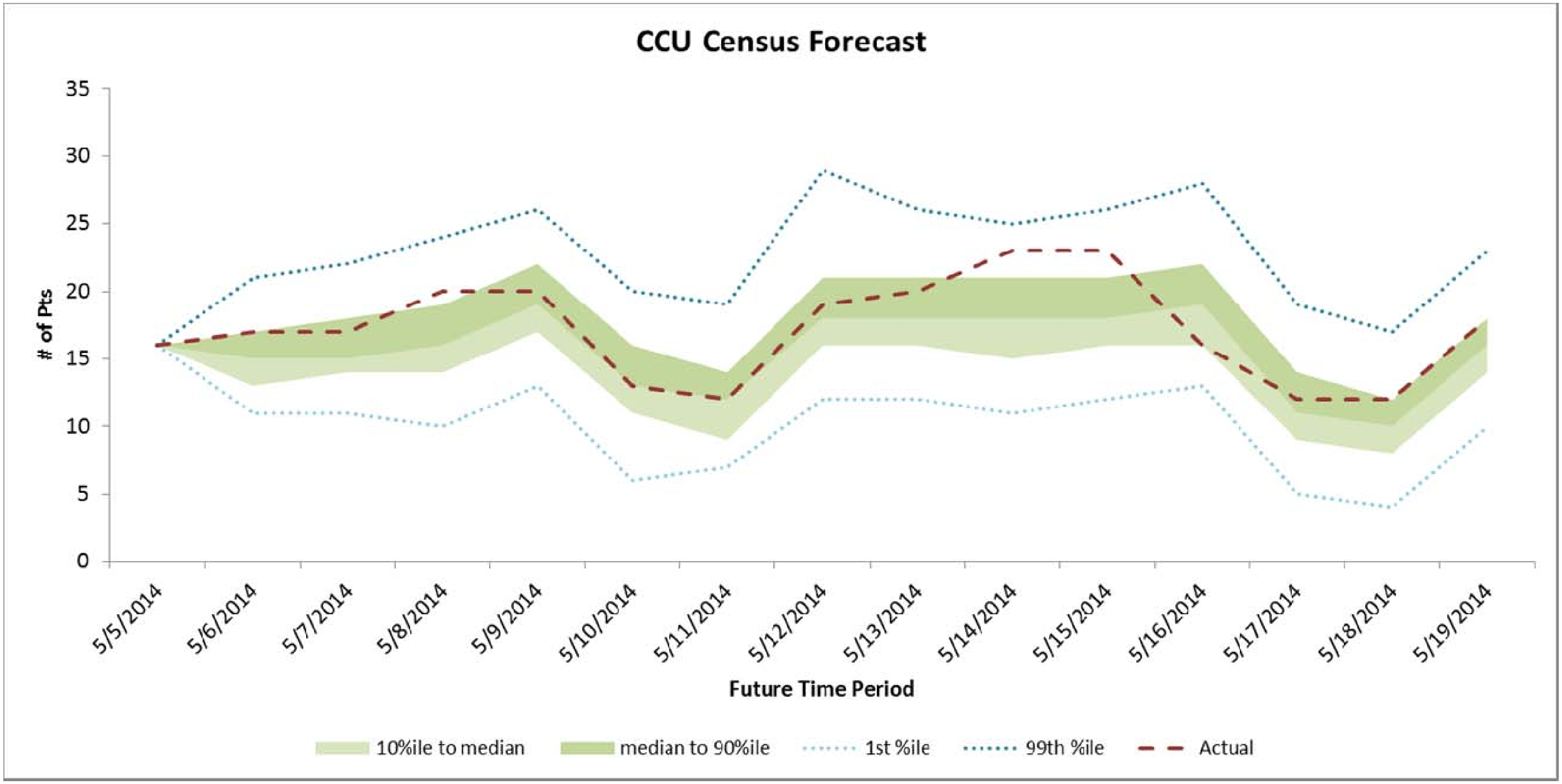


Weather forecast metaphor

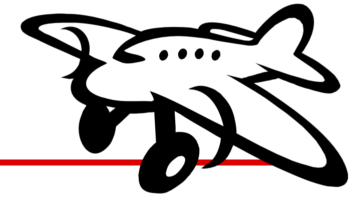


Example of CCU bed demand model accuracy

CCU 2-week look-ahead forecast – Retrospective study

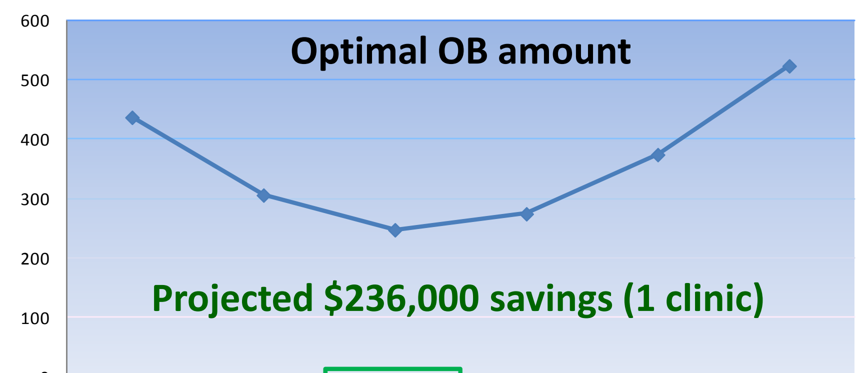


Patient no-shows



Approach

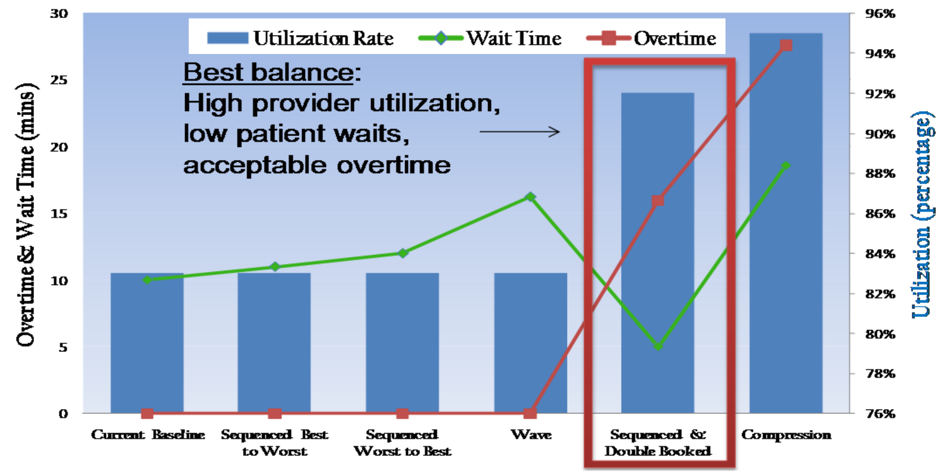
1. Reduce no shows (CQI)
2. Predict no-shows (regression)
3. Optimal over-book amount (probability cost model)
4. Decide when overbook (simulate)
5. Test/refine in practice (DOE)

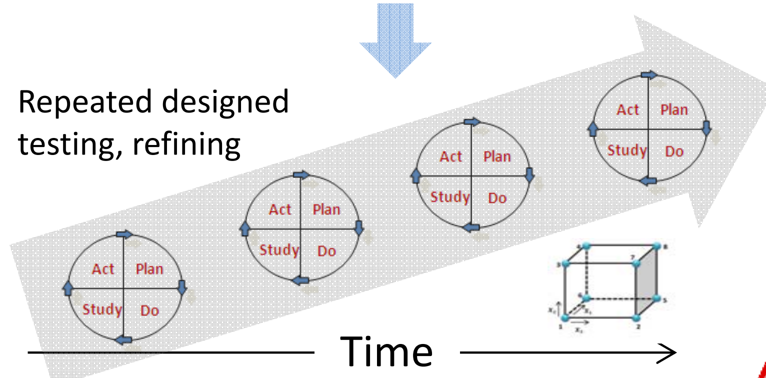


	12	13	14	15	16	17
ing Cost	436.80	306.24	247.83	274.78	374.22	523.15

$$E(TC) = \sum_{x=0}^{N-1} C_u * (N - x) * P(X = x) + \sum_{x=N+1}^{M} C_o * (x - N) * P(X = x)$$

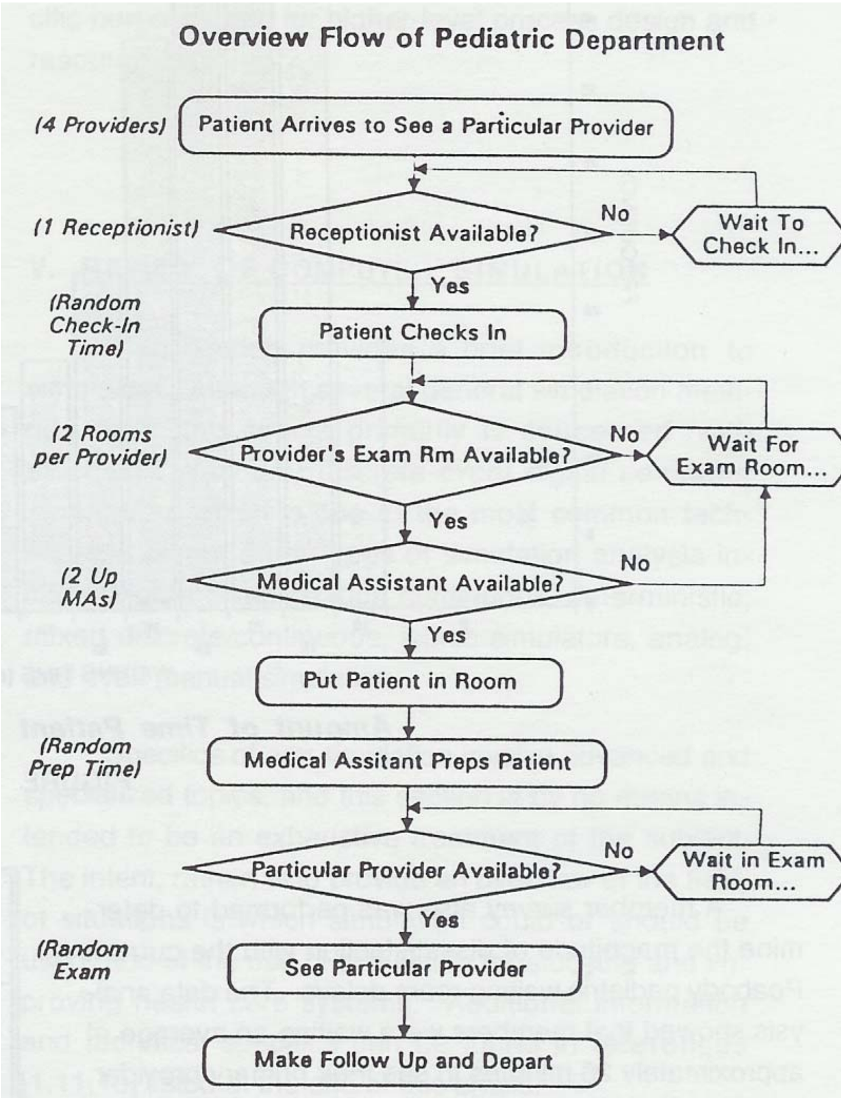
$$\text{where } P(X = x) = \binom{M}{x} (1-p)^x p^{M-x}$$





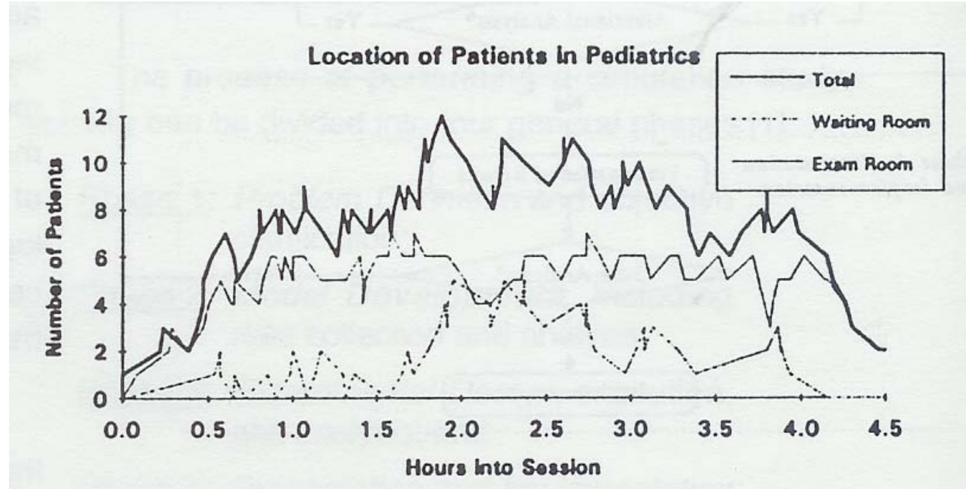
5. Computer simulation: Flow example

Process Logic

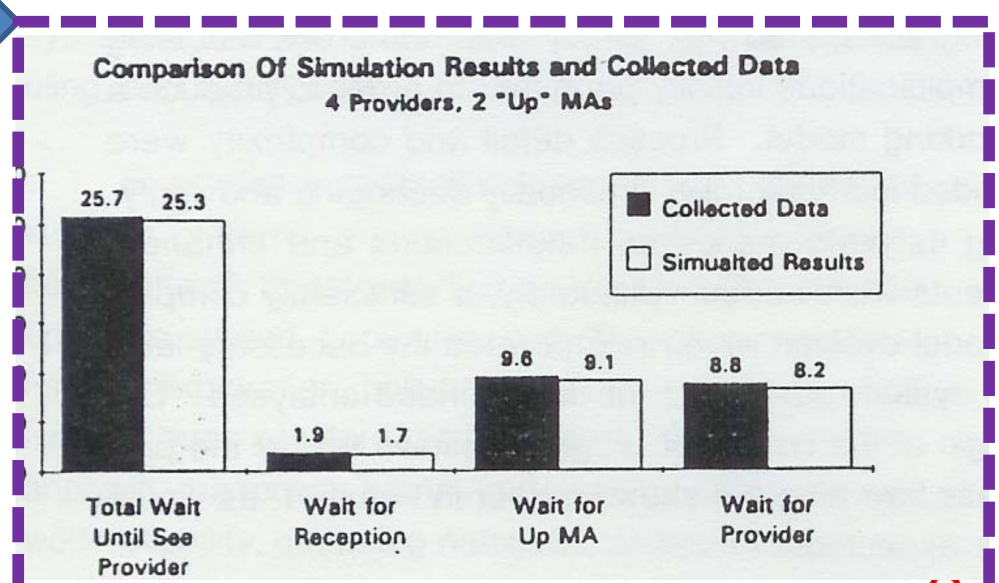


Patient Flow Through a Pediatric Department

Analysis Results & Accuracy



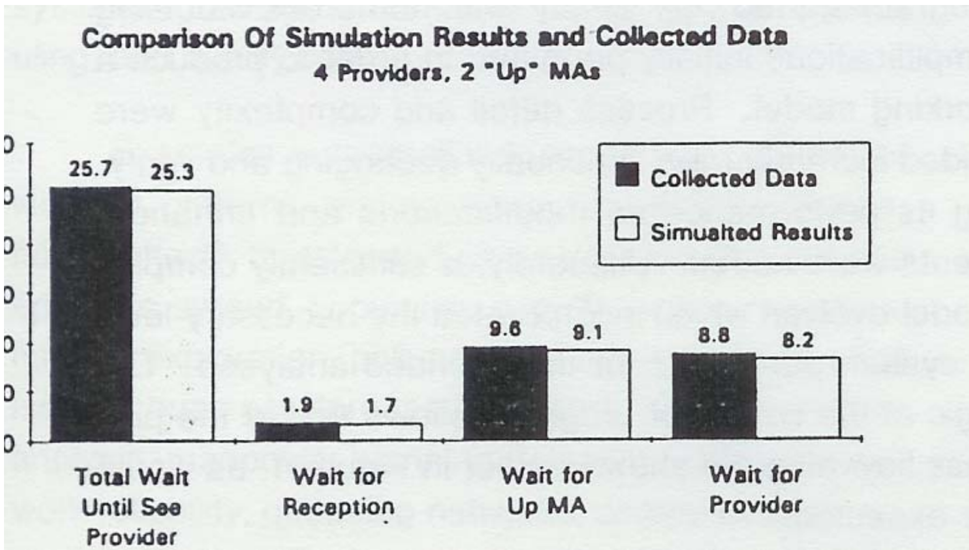
Location of Patients in Pediatrics



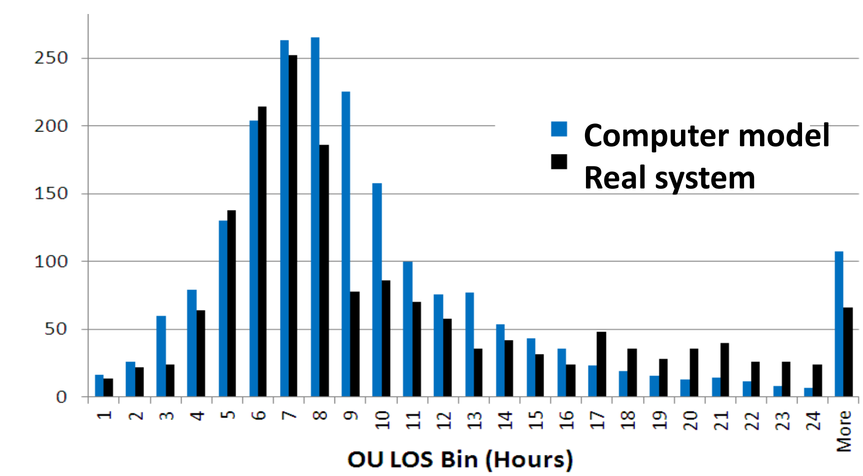
Benneyan, 1997, An introduction to using computer simulation in healthcare, *Jrl Society Health Systems*, 5(3):1-15.

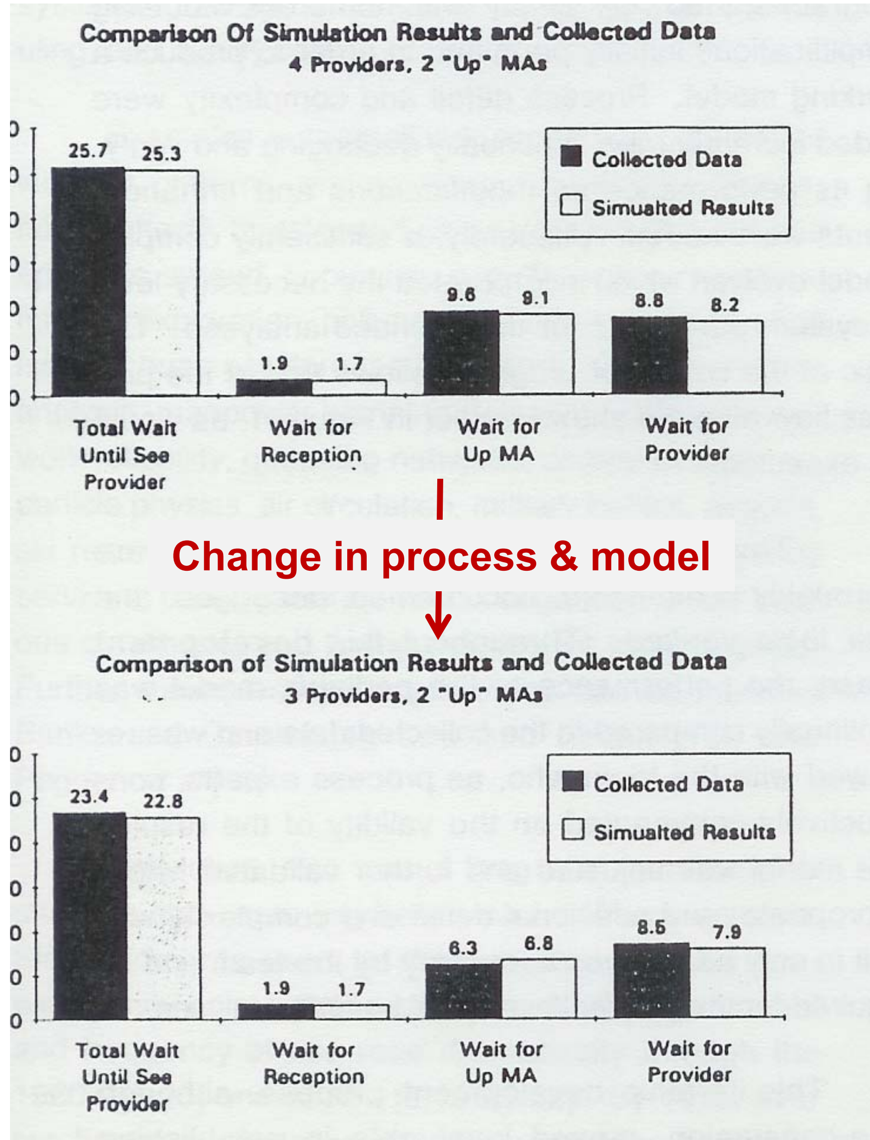
Model accuracy - Simulation vs real data

Pediatric clinic simulation



Observation unit simulation





Validation Output: Comparison of Simulation Results to Real Process

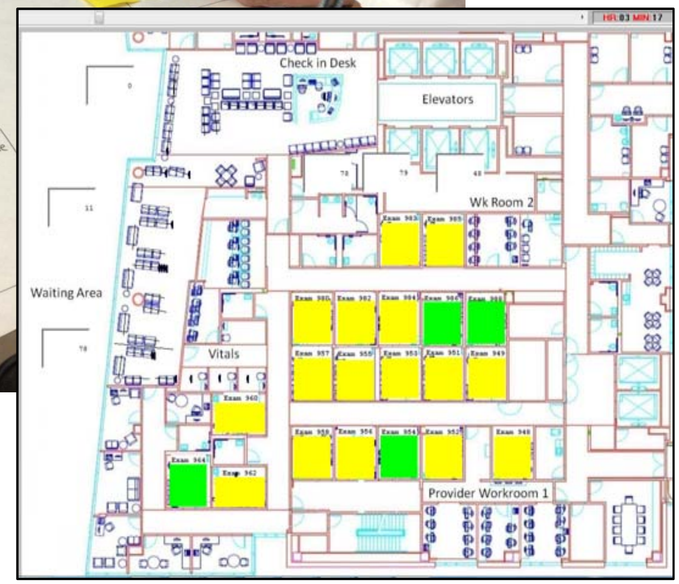
Room utilization logic

Aim

Consolidate low utilized patient rooms to eliminate ~$2m/yr overflow space costs by hybrid room pooling

Approach

- Room sharing simulation
- Open availability real-time RTLS tool
- Pareto/CQI of reasons new process not followed

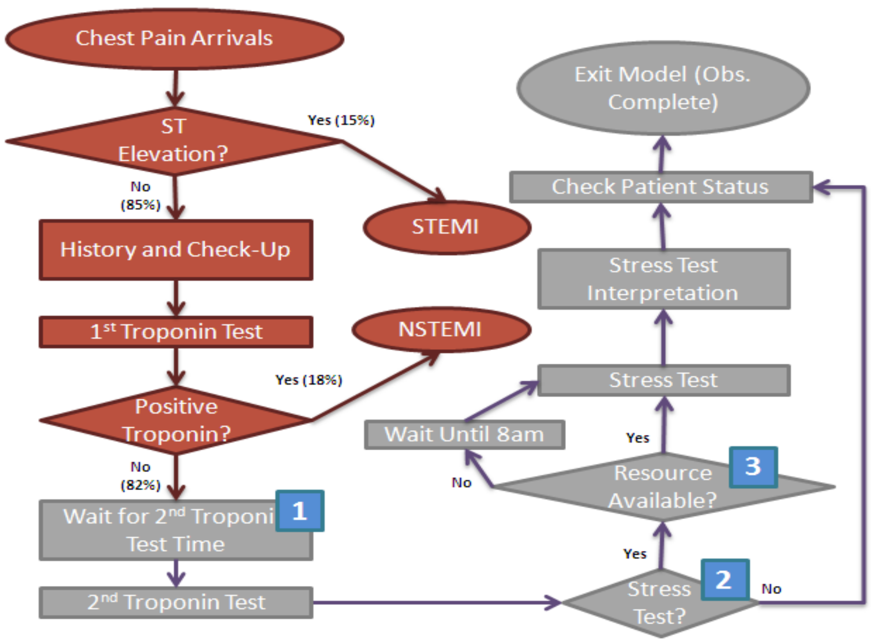


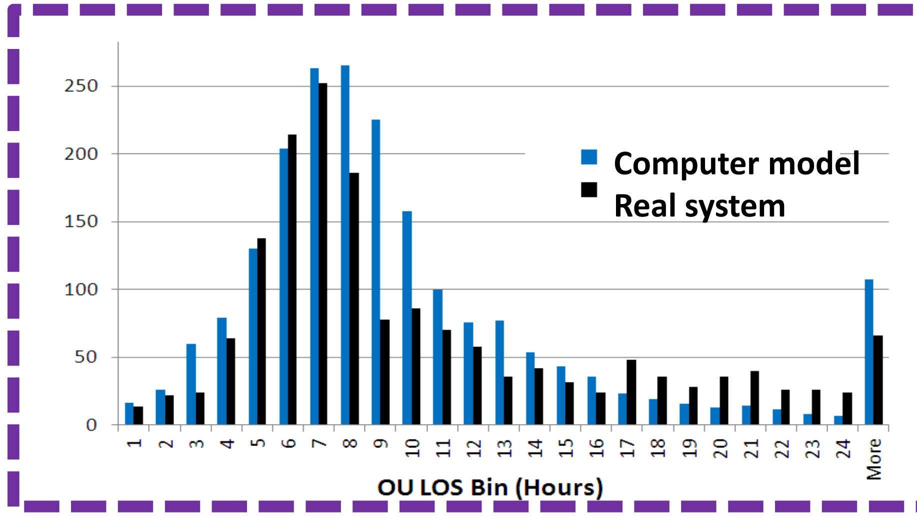
Dept	D Indicator	Apt Time	Arrival Time	Pt Name	Provider	P Indicator	P Count
BOC		10:30 AM	10:29 AM	AAA	NAKHLIS		0
		10:30 AM	10:31 AM	BBB	OVERMOYER		2
		10:30 AM	10:36 AM	CCC	BURSTEIN		2
		11:00 AM	10:33 AM	DDD	GOLSHAN		1
		11:15 AM	10:34 AM	EEE	OVERMOYER		2
SAC		10:30 AM	10:38 AM	FFF	MORGAN		1
		11:00 AM	10:44 AM	GGG	RAUT		1

ED Observation Unit

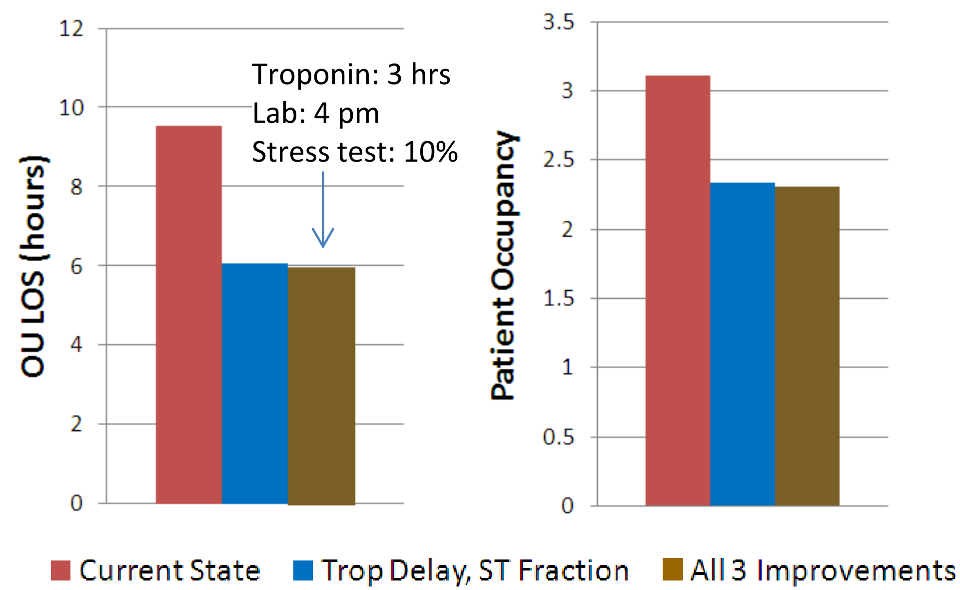
Standard Process Improvement

Computer Simulation Analysis





	CTA	ETT Stress	PET/ CT	SPECT	SPECT/ CT	Stress echo gram
Average wait time	0:09	0:48	11:21	0:31	0:16	2:42
Process ave time	1:35	1:13	1:06	1:31	2:25	1:59
% of all tests	1%	51%	22%	19%	3%	3%

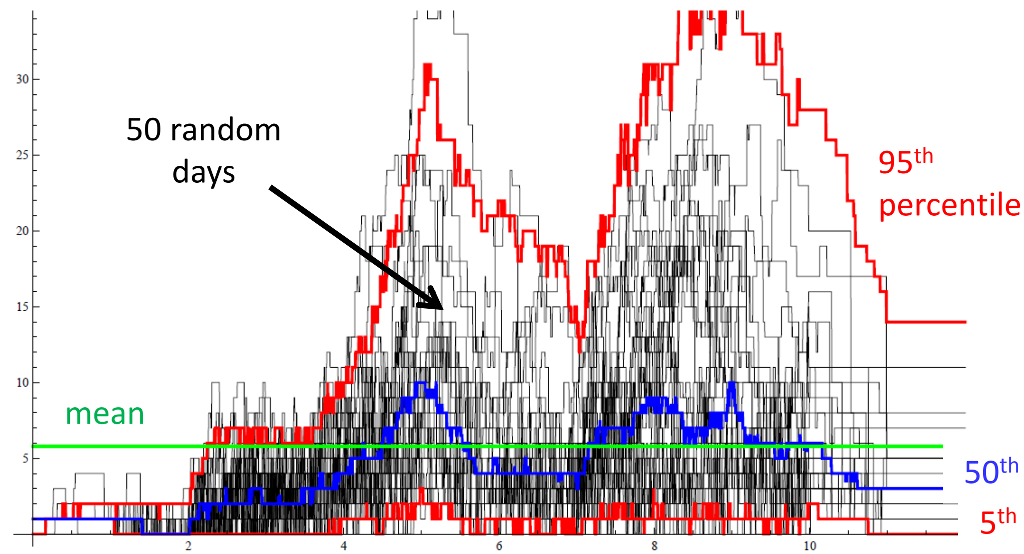


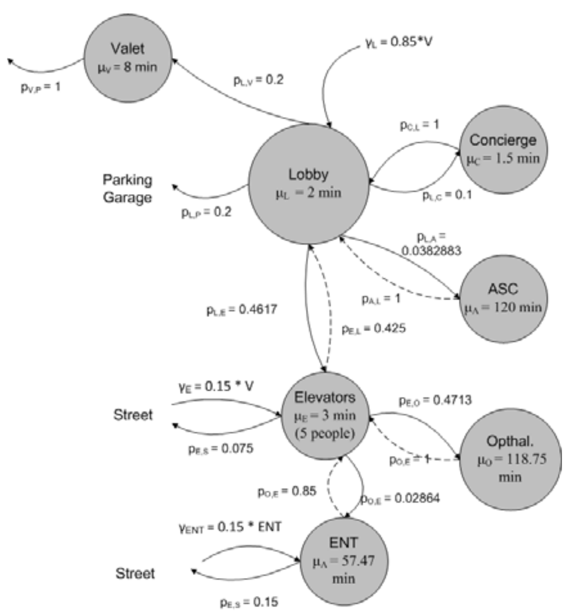
Macro system example

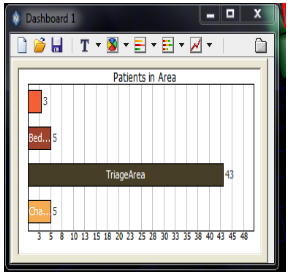
- New facility master space planning
- Queuing flow simulation

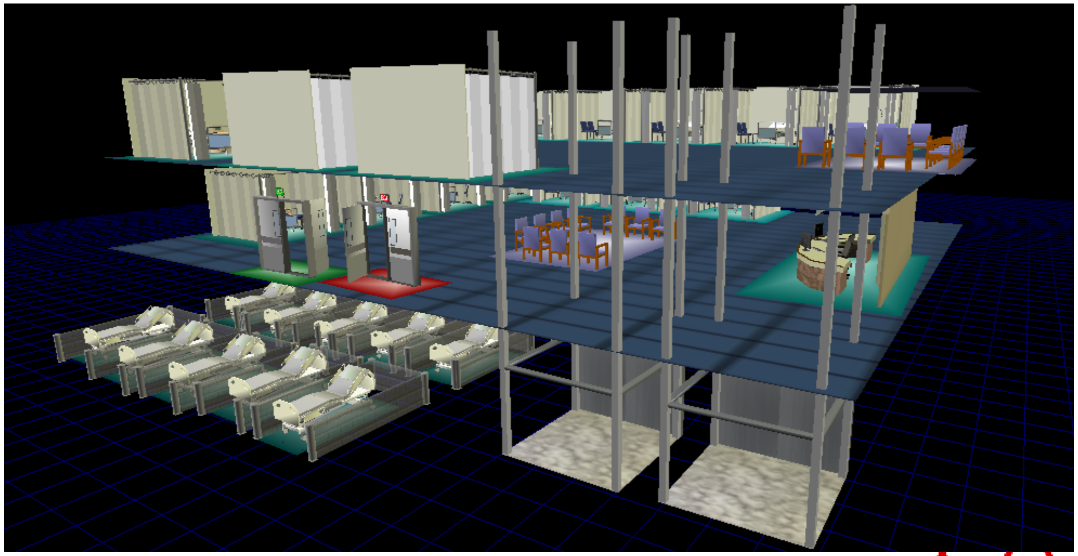
Massachusetts Eye and Ear
experience. life.

Number people in Lobby by time of day



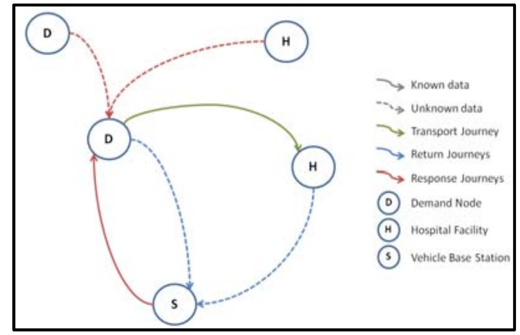






Regional EMS example

- Ambulance location and routing
- Maximize survival probabilities



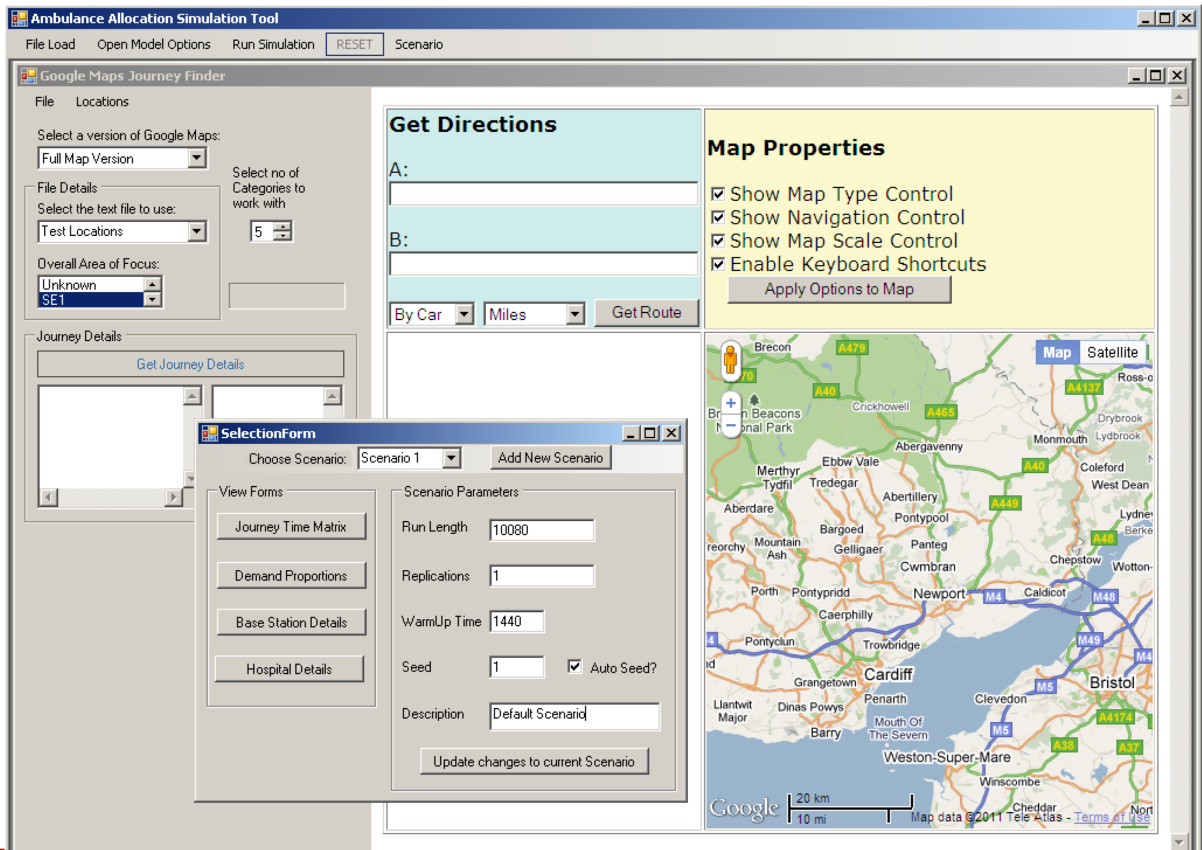

GWENT NEWS

Welsh ambulance review urges end to 8-minute 999 target

By Andy Rutherford - Health correspondent

5:46pm Monday 29th April 2013 in Gwent news

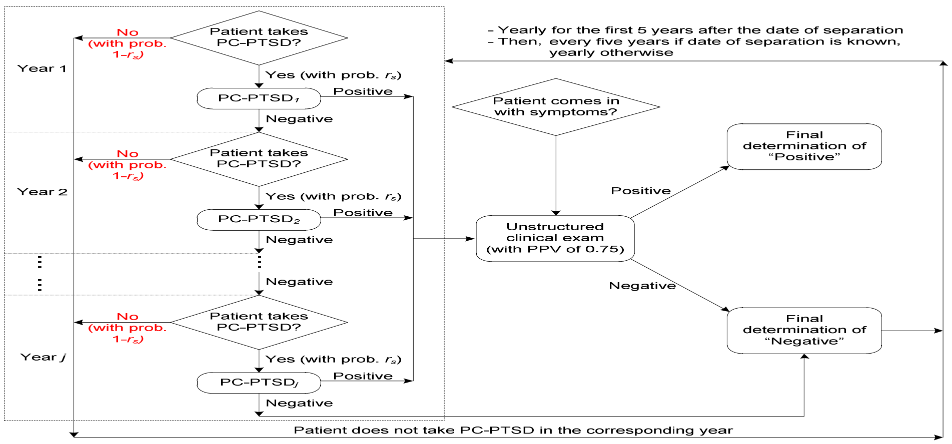
Welsh ambulance review urges end to 8-minute 999 target

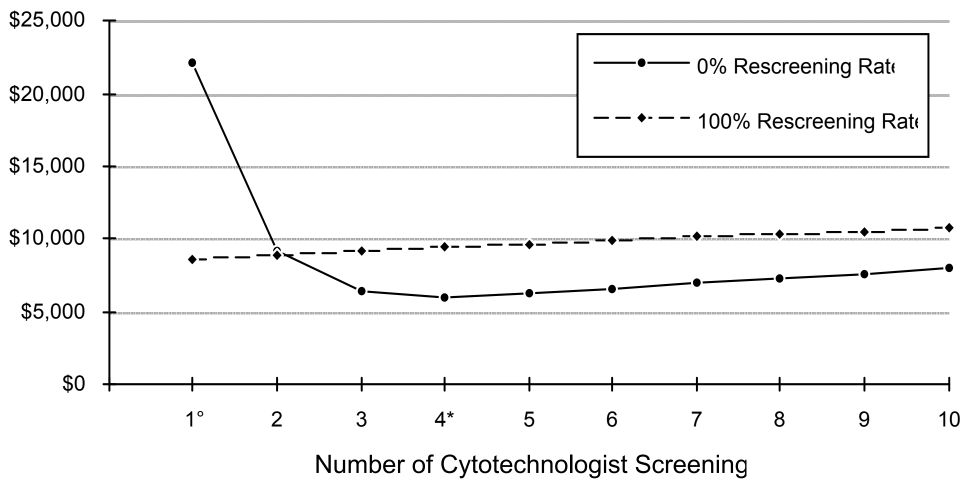


Policy examples (Monte Carlo)

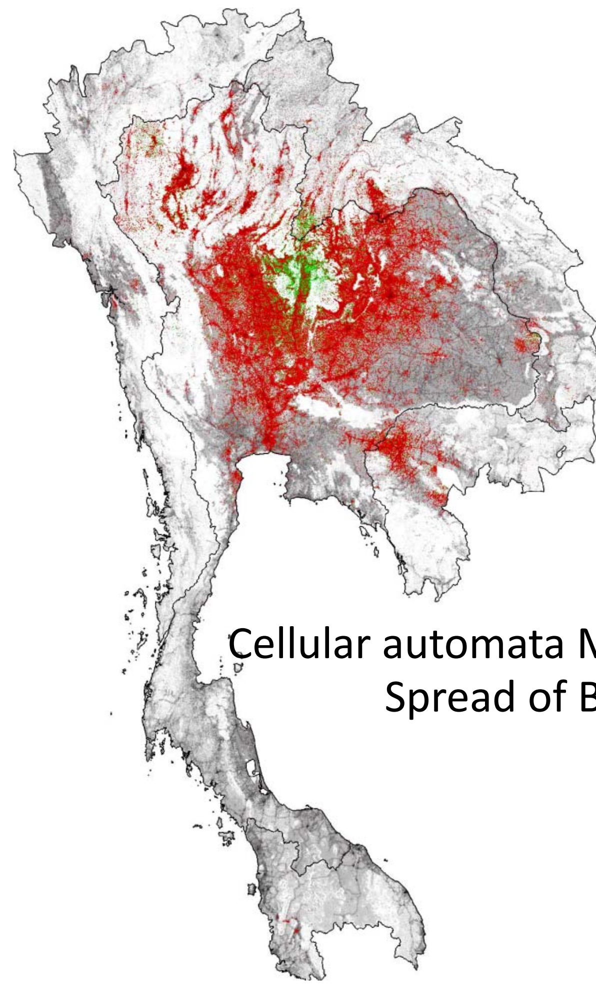
Cancer Screening Policies

Comparison of alternate policies





Spread of Epidemics (or improvements)

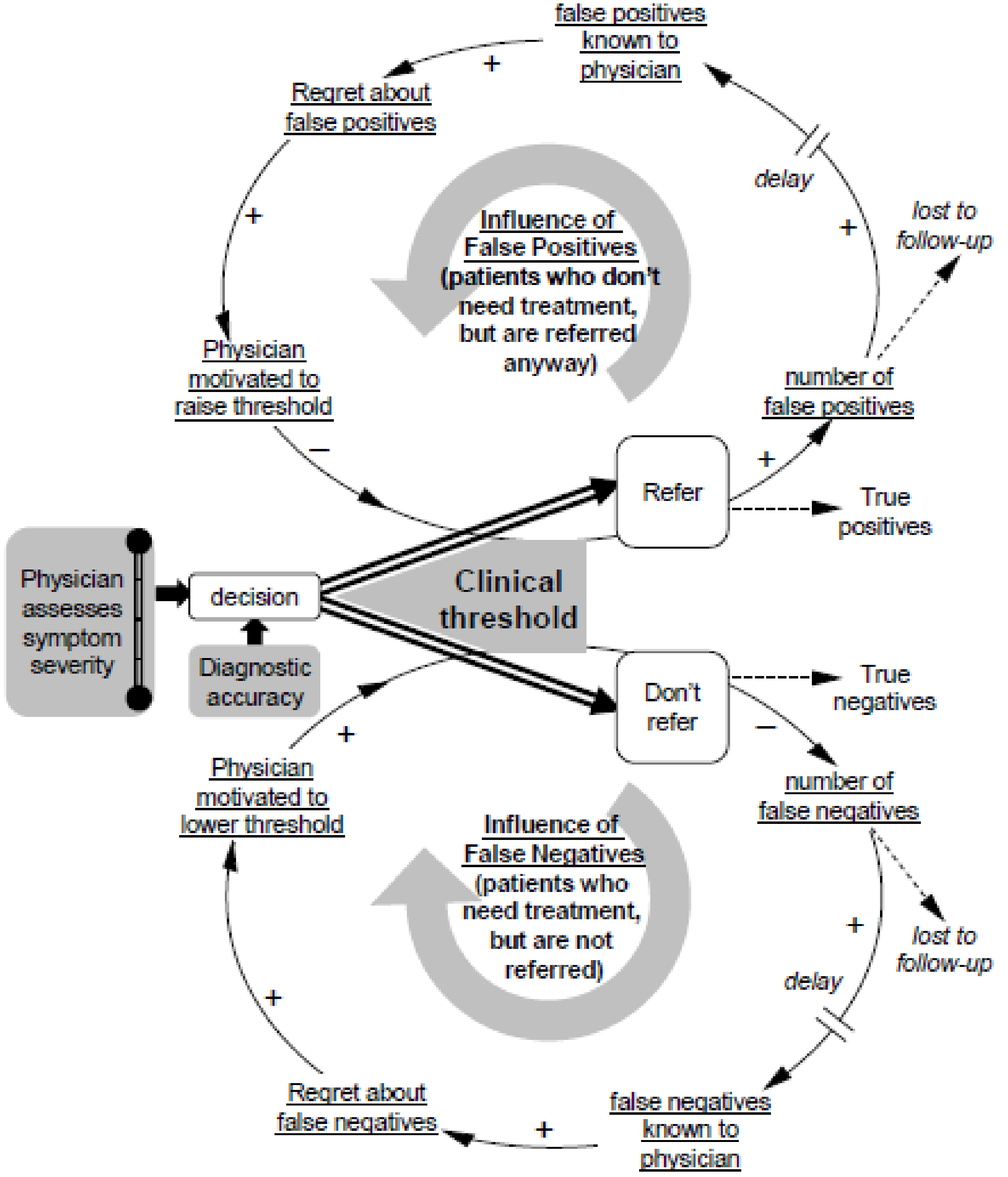


Cellular automata Monte Carlo Spread of Bird Flu

System dynamics example

- Typically macro level or policy analysis
- Concepts of 'flows', 'stocks', 'rates', feedback loops
- Based in differential equations
- Also very useful thinking exercise

Figure 1. Trade-offs between higher and lower clinical thresholds



6. Optimization models

Basic elements

- Objective function
  - Cost, quality, safety…
- Constraints
  - Resources, capacity, time, sequences, etc
- Decision variables
  - Staff level, start time, locations, capacity…

Types of methods

- Math programs
  - Linear programming
  - Nonlinear, integer
- Search optimization methods
  - Genetic algorithms
  - Random searches
- Calculus-based methods

3. Optimization models

	Description	**Example:** Inventory Purchasing
Objective function	*What are trying to achieve?* (Maximize / minimize some thing of interest)	Minimize total purchasing cost of all inventory
Decision variables	*What can we change?* (What model solves for)	How much of each item to buy from each potential vendor
Constraints	*What can't we change?* (Logistical givens)	• Must buy ≥ N_i quantity of Item *i* • Can not buy more from Vendor *K* than they produce

Supply contract example

- J types of items
- Need to buy n_j of each
- K vendors
- Complex purchasing contracts based on total volume bought from each vendor annually
- $m_{j,k}$ = Maximum item j available from vender k
- $x_{j,k}$ = Number item j bought from vender k

Minimize: Total cost of all items from all vendors

Subject to:

$$x_{1,1} + x_{1,2} + \ldots + x_{1,k} = n_1$$

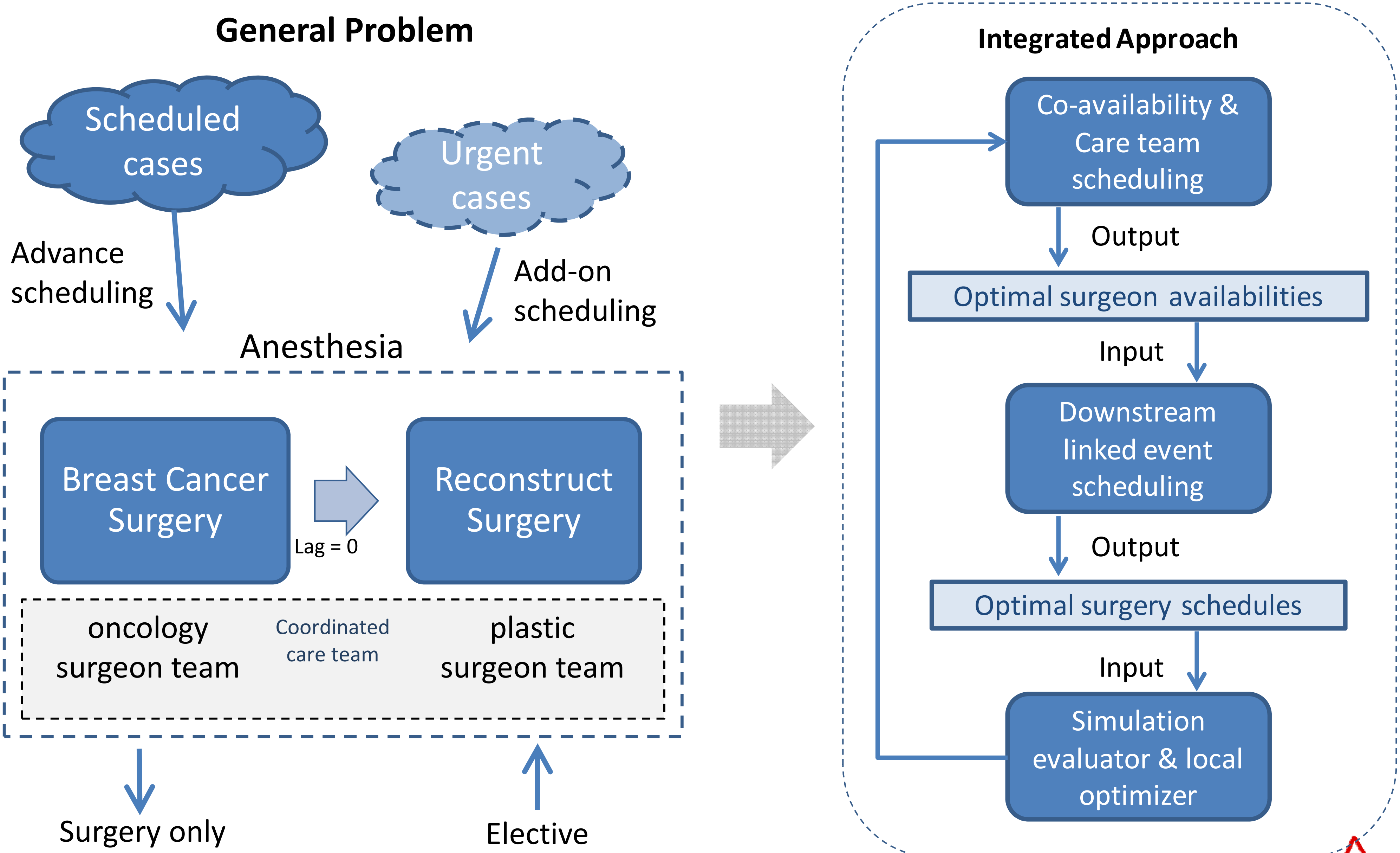
$$x_{2,1} + x_{2,2} + \ldots + x_{2,k} = n_2$$

$$\vdots$$

$$x_{j,1} + x_{j,2} + \ldots + x_{j,k} = n_j$$

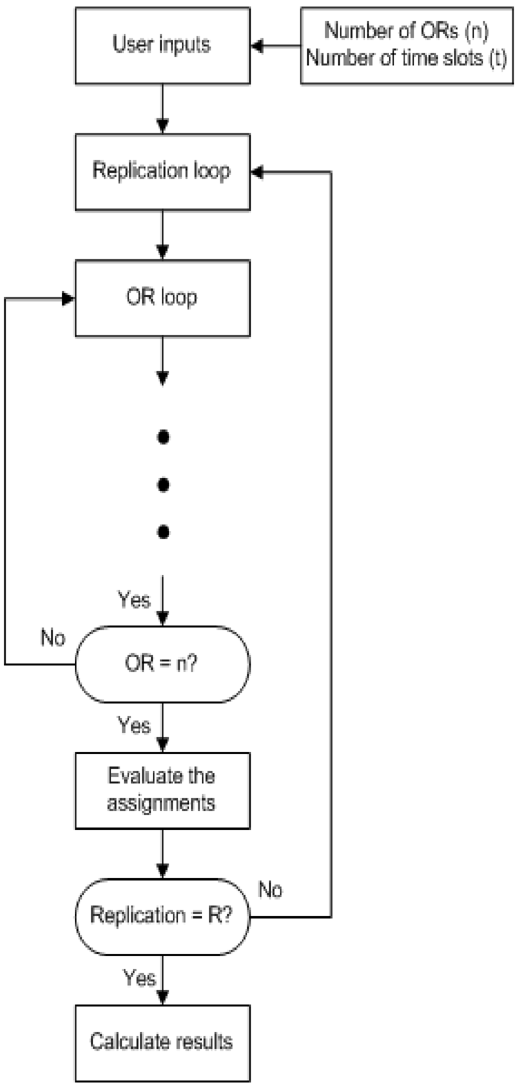
$$0 \le x_{j,k} \le m_{j,k} \text{ for all } (j,k)$$

Scheduling examples



Models

Monte Carlo Simulation



Integer Programming

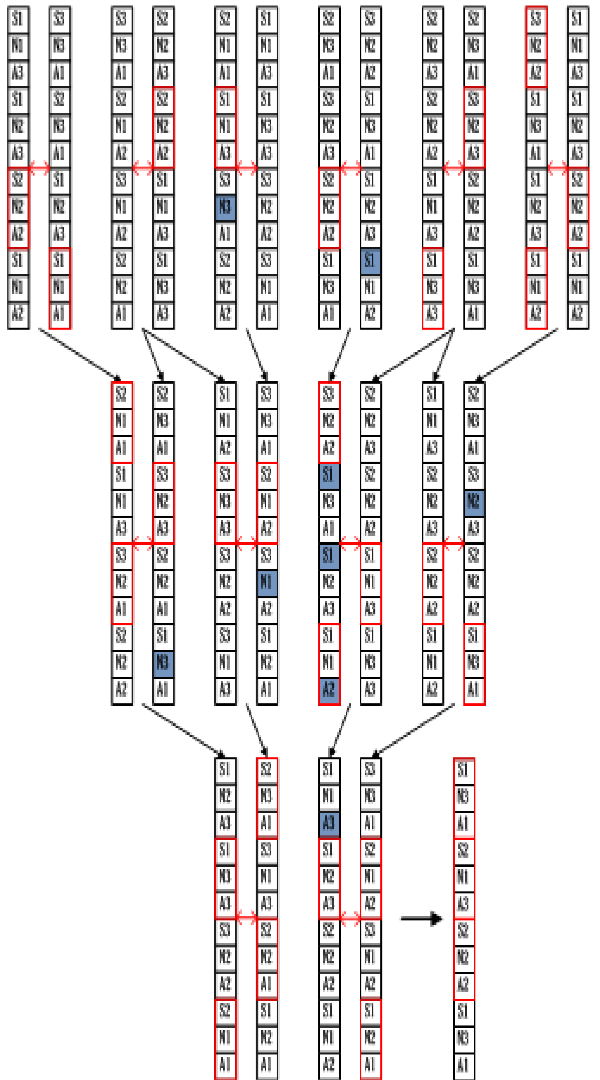
$$\text{Maximize } \sum_{\Phi}\sum_{j}\sum_{k} R_{\Phi jk}$$

subject to,

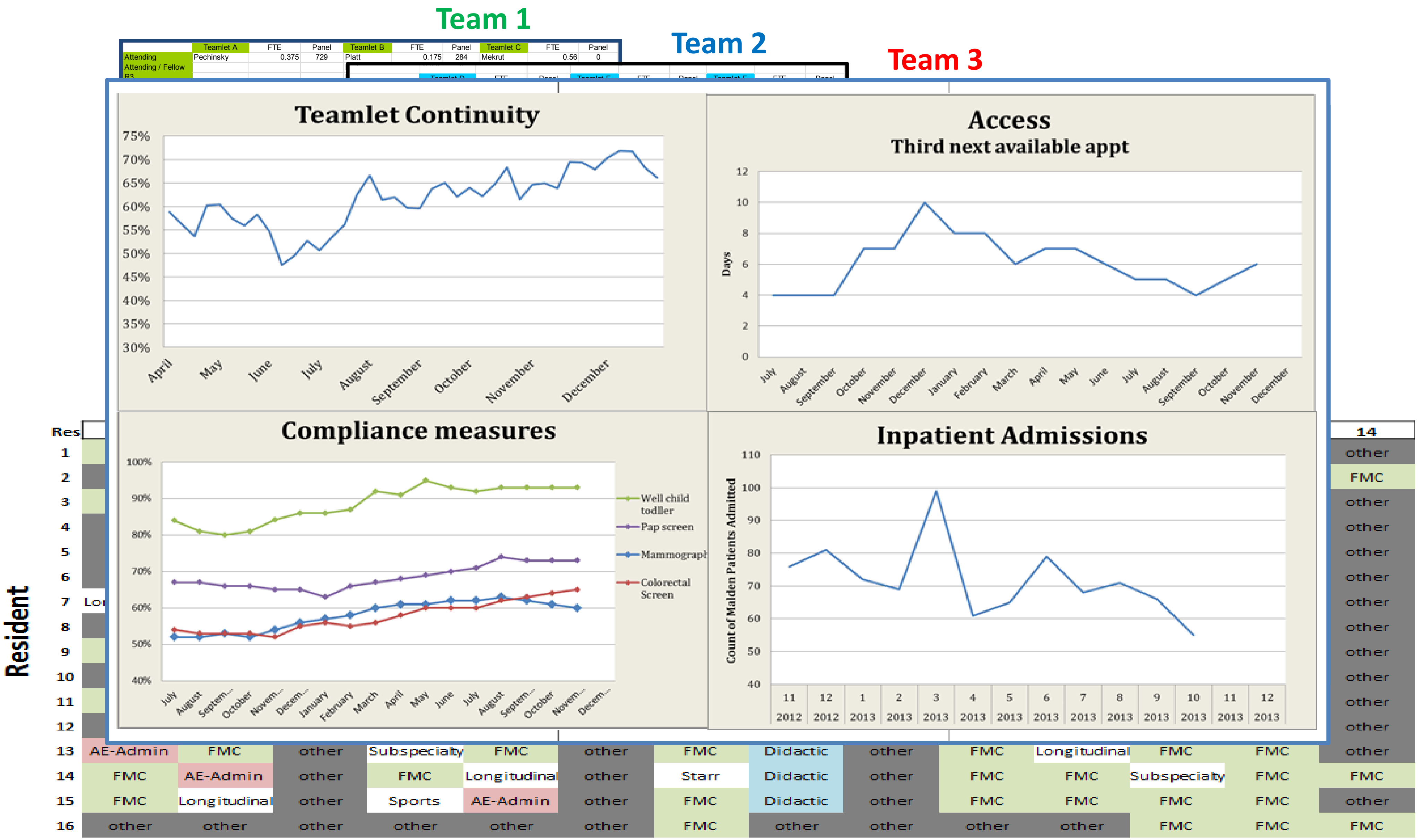
$$\sum_j s_{ijk} \leq 1 \qquad \forall\, i, k$$
$$\sum_j n_{ljk} \leq 1 \qquad \forall\, l, k$$
$$\sum_j a_{mjk} \leq 1 \qquad \forall\, m, k$$
$$\sum_i s_{ijk} = 1 \qquad \forall\, j, k$$
$$\sum_l n_{ljk} = 1 \qquad \forall\, j, k$$
$$\sum_m a_{mjk} = 1 \qquad \forall\, j, k$$
$$\sum_j \sum_k s_{ijk} \leq K \qquad \forall\, i$$
$$\sum_j \sum_k n_{ljk} \leq K \qquad \forall\, l$$
$$\sum_j \sum_k a_{mjk} \leq K \qquad \forall\, m$$
$$s_{\alpha jk} + n_{\beta jk} + a_{\gamma jk} = B_{\Phi jk} \qquad \forall\, \Phi, j, k$$
$$B_{\Phi jk} - 3 * x_{\Phi jk} - 2 * y_{\Phi jk} - 1 * u_{\Phi jk} = 0 \qquad \forall\, \Phi, j, k$$
$$r_3 * x_{\Phi jk} + r_2 * y_{\Phi jk} = R_{\Phi jk} \qquad \forall\, \Phi, j, k$$
$$x_{\Phi jk} + y_{\Phi jk} + u_{\Phi jk} + v_{\Phi jk} = 1 \qquad \forall\, \Phi, j, k$$

$$x_{\Phi jk}, y_{\Phi jk}, u_{\Phi jk}, v_{\Phi jk} \in \{0,1\} \qquad \forall\, \Phi, j, k$$
$$R_{\Phi jk}, B_{\Phi jk} \geq 0 \text{ and integer} \qquad \forall\, \Phi, j, k$$
$$s_{ijk} \in \{0,1\} \qquad \forall\, i, j, k$$
$$n_{ljk} \in \{0,1\} \qquad \forall\, l, j, k$$
$$a_{mjk} \in \{0,1\} \qquad \forall\, m, j, k$$

Genetic Algorithm

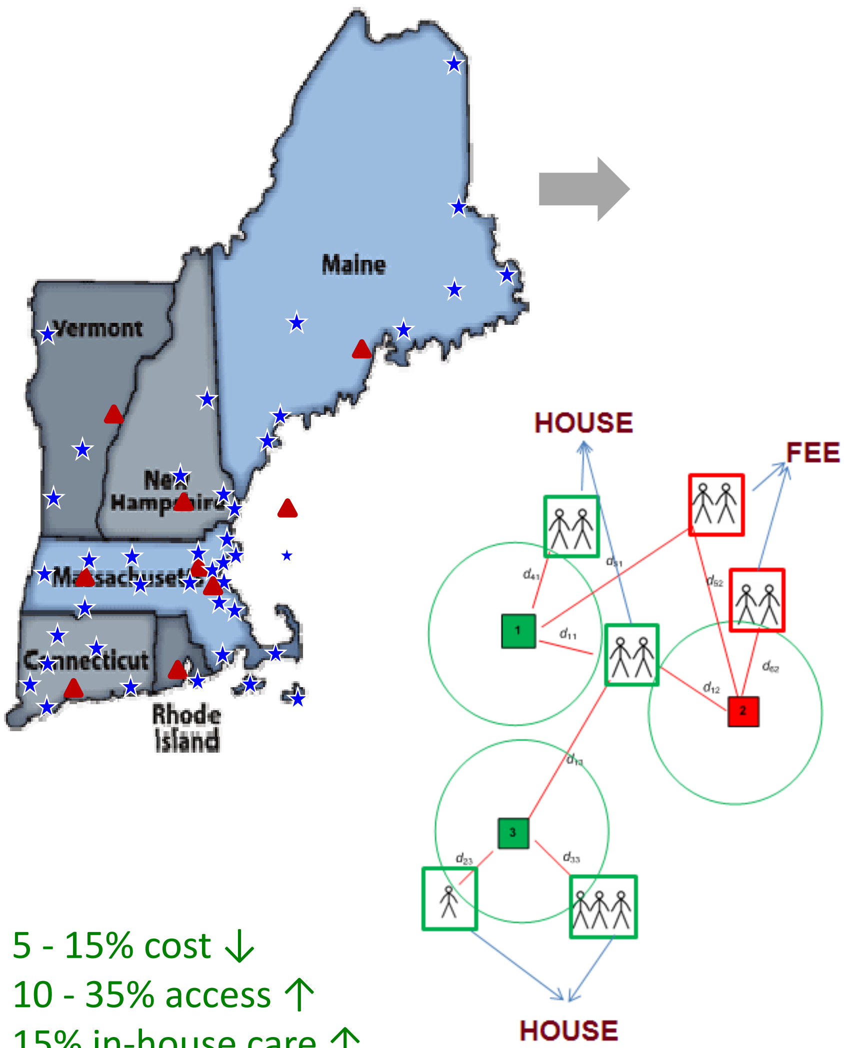


More complex example: PCP team continuity



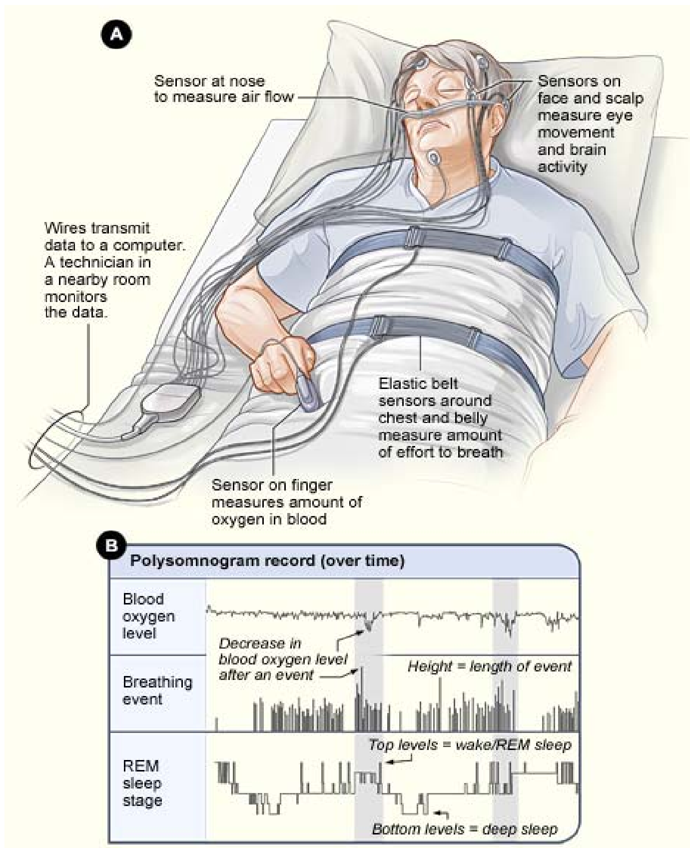
Marco example: Network design

Conceptual model

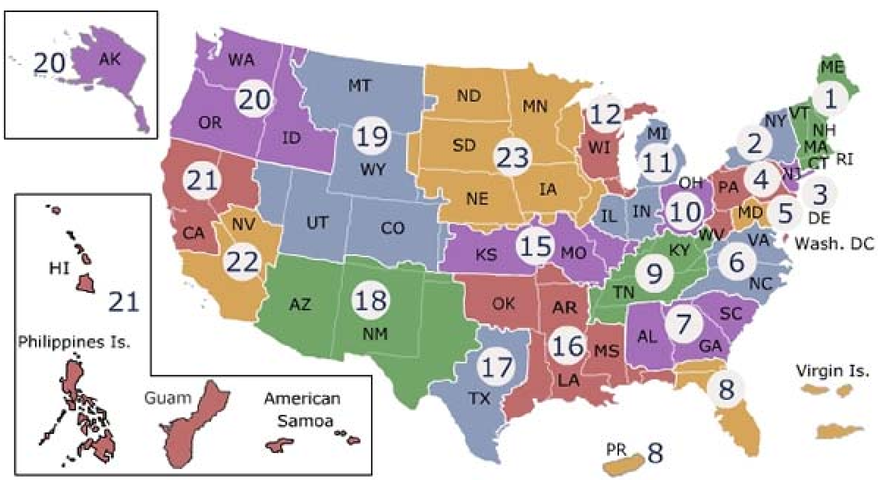


5 - 15% cost ↓
10 - 35% access ↑
15% in-house care ↑

- Abnormal sleep breathing
- 20% veterans, $534m (2010)
- Inadequate access to testing



Macro capacity / care location example



Click on the VISN number or region for information about VAMC pricing there.

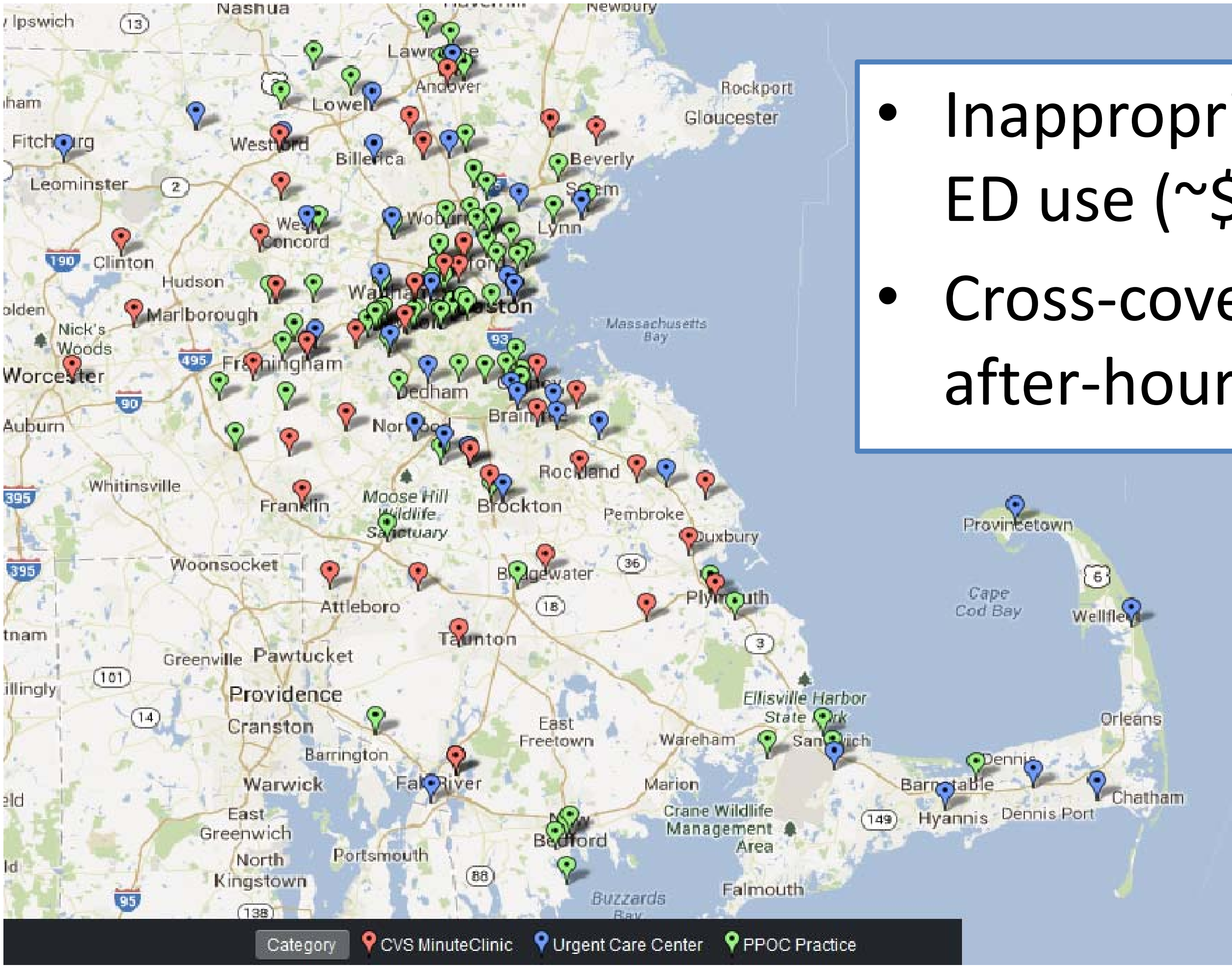
<u>Questions</u>

- Where to locate which care services?
- In what capacities?
- Which patients receive care where?
- What if demand changes?

<u>Objectives</u>

- Max within network care
- Minimize cost
- Minimize distance

Example: Pediatric evening coverage



- Inappropriate evening ED use (~$30m/year)
- Cross-coverage for after-hours

Who
When
Where
?

End-user tools (excel example)

Model in Words

Maximize: Coverage preferences

While:

- Satisfying all demand
- Balancing burden on MDs

Model in Math

$$Max \sum_i \sum_j c_{ij} x_{ij}$$

subject to

$$\sum_j x_{ij} = D_i \qquad \forall\, i$$

$$\sum_i x_{ij} \geq S^{min} \qquad \forall\, j$$

$$\sum_i x_{ij} \leq S^{max} \qquad \forall\, j$$

$$x_{ij} \in \{0, 1\} \qquad \forall\, i, j$$

Day	Patient Demand	Number of Physicians needed
Monday	4	1
Tuesday	12	3
Wednesday	10	2
Thursday	8	2
Friday	6	2

Hours/Shift	4
% of Shift Spent Caring for Patient	75%
Visit Duration (minutes)	35

Preferences

	Monday	Tuesday	Wednesday	Thursday	Friday
Physician 1	2	3	5	1	4
Physician 2	1	5	2	4	3
Physician 3	5	2	4	3	1
Physician 4	4	1	3	5	2
Physician 5	3	5	1	2	3
Physician 6	1	4	5	3	2
Physician 7	3	2	4	1	5
Physician 8	2	1	3	5	4
Physician 9	5	3	1	2	4

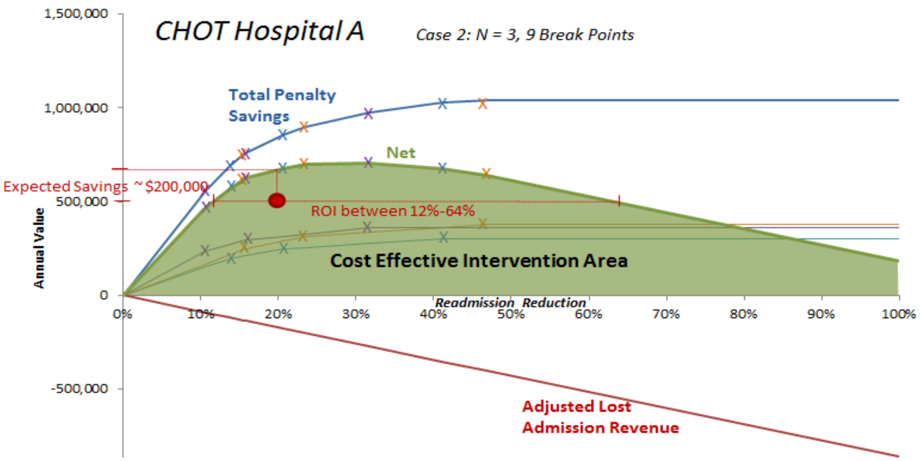
Make Schedule

Schedule

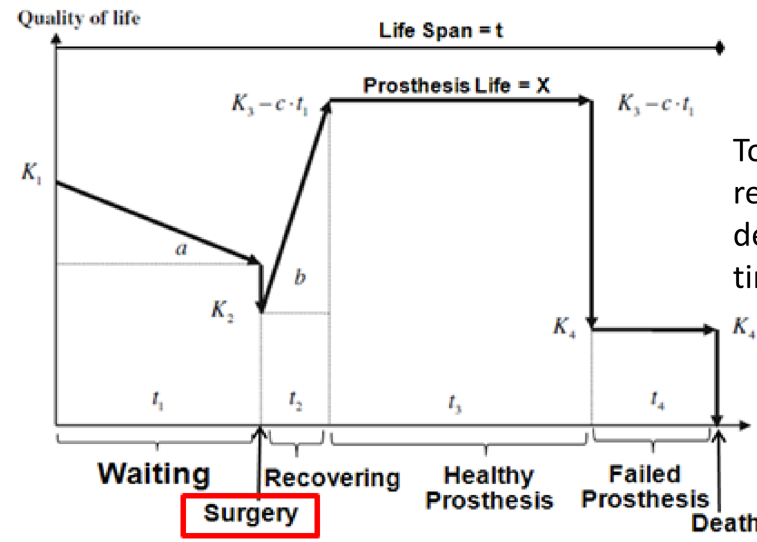
	Monday	Tuesday	Wednesday	Thursday	Friday
Physician 1	Off	Off	Working	Off	Off
Physician 2	Off	Working	Off	Off	Off
Physician 3	Working	Off	Off	Off	Off
Physician 4	Off	Off	Off	Working	Off
Physician 5	Off	Working	Off	Off	Off
Physician 6	Off	Working	Working	Off	Off
Physician 7	Off	Off	Off	Off	Working
Physician 8	Off	Off	Off	Working	Off
Physician 9	Off	Off	Off	Off	Working
Total	1	3	2	2	2

7. Policy and clinical decision making

Incentive policy analysis (readmissions)

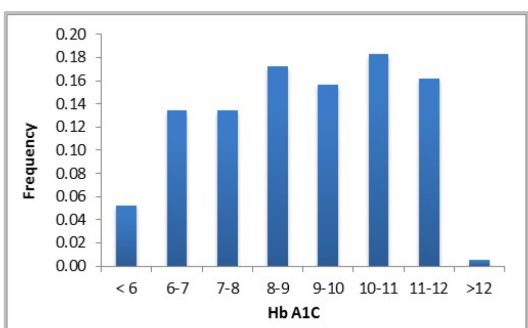


Treatment decision optimization

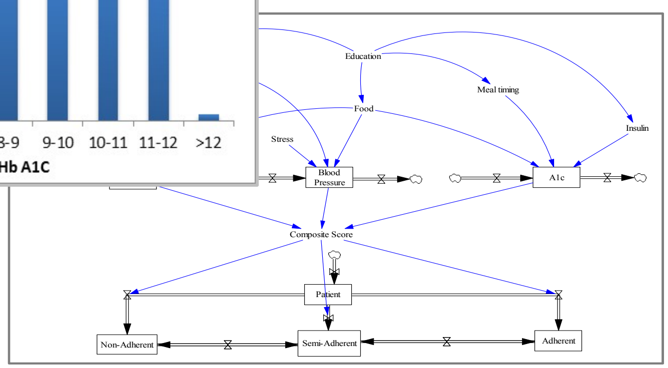


Total joint replacement decision and timing

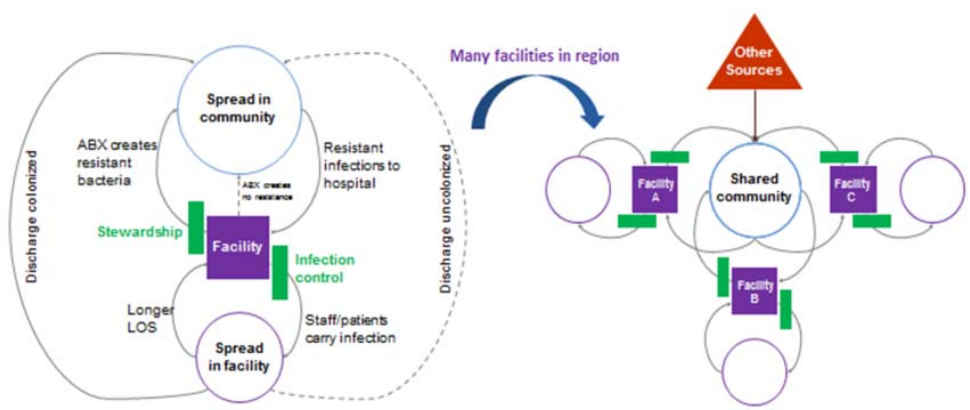
Diabetes self-care adherence



System dynamics behavior change model



Abx stewardship



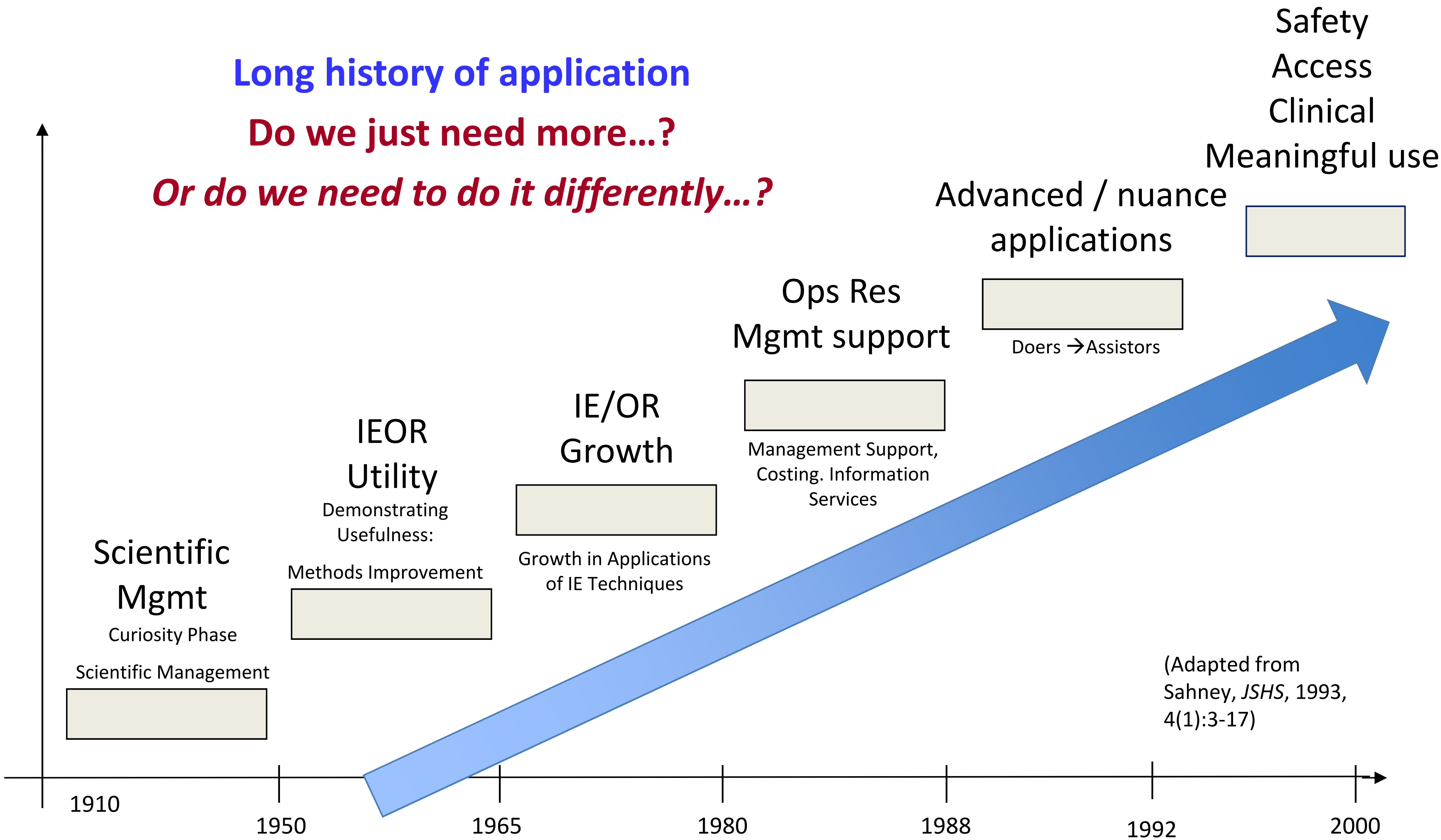
History of IE in HC

Historical IE applications

Long history of application

Do we just need more…?

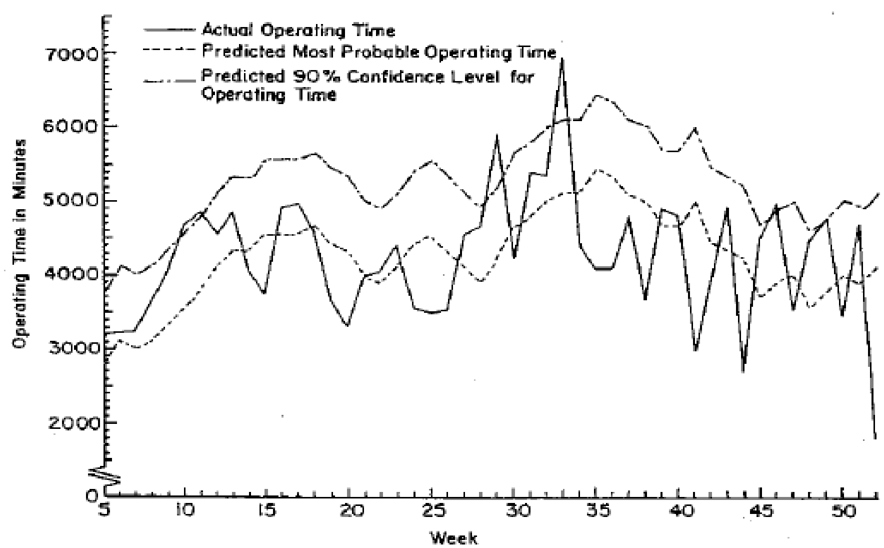
Or do we need to do it differently…?



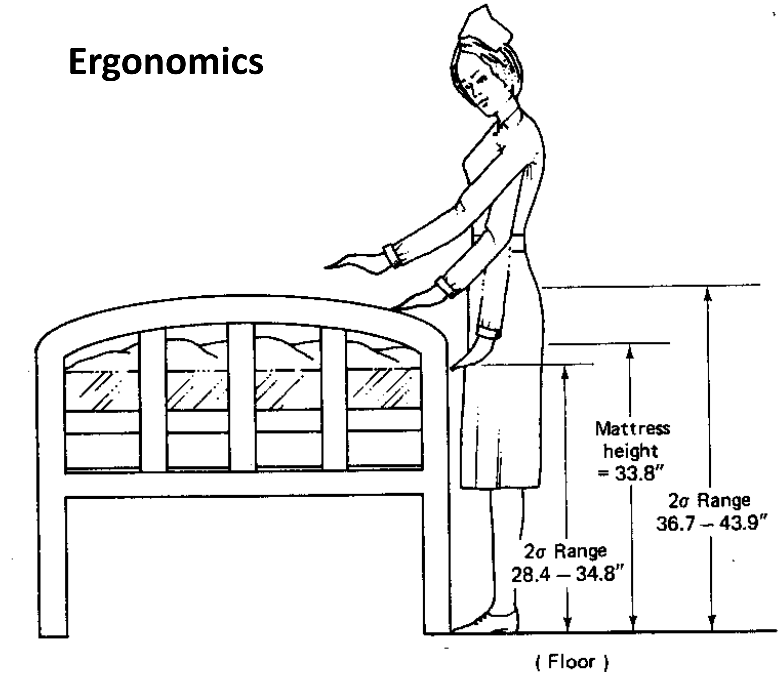
(Adapted from Sahney, *JSHS*, 1993, 4(1):3-17)

1970s examples

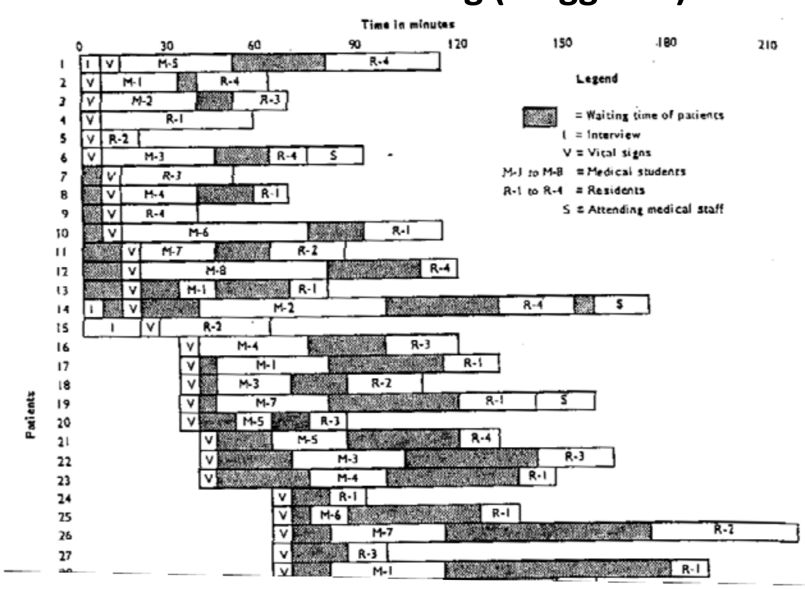
Operating Room Usage



Ergonomics



Block Scheduling (Staggered)



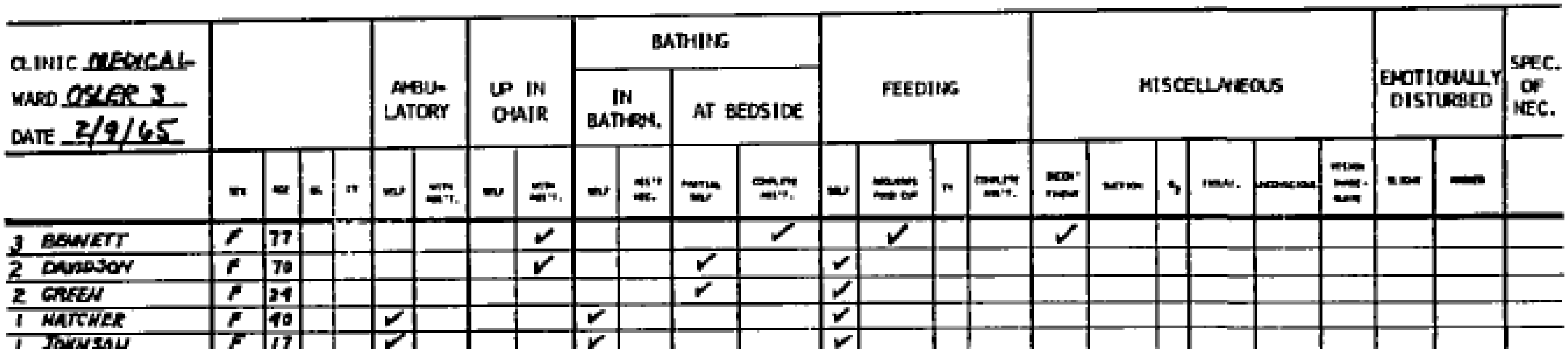
Capacity Planning

TABLE 14-1. Facilities Required for Maternity Service

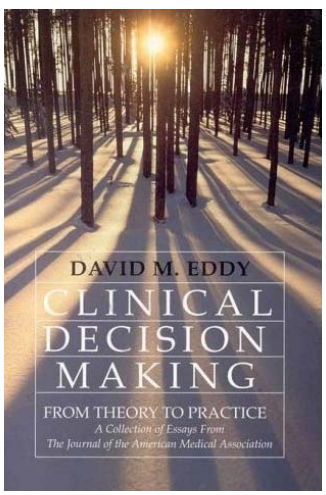
	90% Service		*95% Service*			
Admis-sions per yr	*beds*	*beds per 100 patients per yr*	*beds*	*beds per 100 patients per yr*	*beds*	*beds per 100 patients per yr*
580	13	2.24	14	2.42	17	2.93
1693	33	1.94	35	2.07	40	2.36
2771	51	1.84	54	1.95	60	2.17
3874	70	1.81	73	1.88	80	2.06
5000	89	1.78	93	1.86	102	2.04
5506	98	1.78	102	1.85	110	2.00
6106	110	1.80	114	1.86	122	2.00
7229	124	1.72	128	1.76	135	1.87
8161	145	1.78	150	1.84	160	1.96
9424	165	1.75	170	1.82	180	1.91

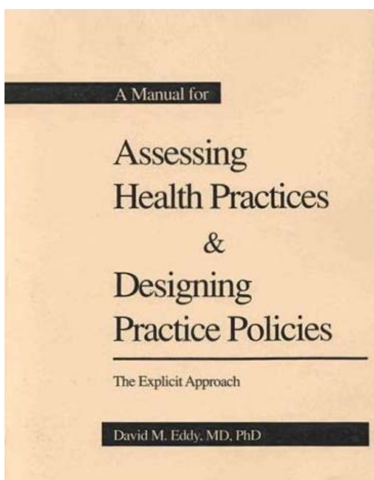
*LR = Labor rooms; PPR = Postpartum rooms; CSR = Caesarean section rooms; DR = Delivery rooms

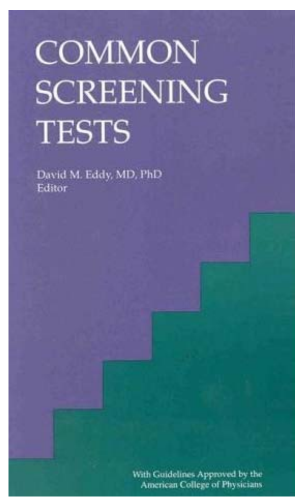
Nurse rotations - IP (H. Wolfe, 1965)



Cancer screening - Markov (D. Eddy, 1980)







Founder and medical director of Archimedes

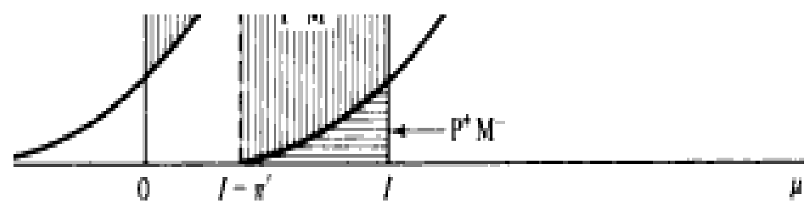


FIGURE 4-3 Effect of a more effective mammogram on the measured

Eddy, David M. (1980). *Screening for Cancer: Theory, Analysis and Design*. Englewood Cliffs: Prentice-Hall, Inc ISBN 978-0137967896

Oldies but goodies

Time and Motion Study

1945

LILLIAN M. GILBRETH
Personnel Consultant, Montclair, N. J.

SINCE the very beginning of time and motion study, hospital problems have been closely associated with it. During his early days in the construction business Frank Gilbreth had a friend who was going through his internship and through him became tremendously interested in problems of hospital administration, in technics of management and in all the activities that go on in a hospital. Naturally, the most fascinating of these were in the area of surgery and in the work of the surgeon and all those who assisted him in the operating room. Several accidents at this time gave him first-hand experience as an observer which he utilized to the full.

Later as he developed the technics both of micromotion study and of the cyclegraph method of recording the tasks of motions, he had the needs of the hospital in mind, and the publications of the time and since that time, both in the hospital field and in that of industrial management, take account of the applications of these technics in the hospital field.

Since that time those who have been carrying on the development of time and motion study or work simplification have added to and adapted the technics until it would now seem time for the hospital group itself to take over the entire project of the utilization of available material in this field, to evaluate what has been done, to estimate what needs to be done and to utilize to the full the cooperation that is available from all of us who are working in the time and motion study field.

Of the material that is available for review and evaluation, much concerns itself directly with hospital problems. Groups of doctors, nurses, hospital administrators, hospital personnel people, those in charge of dietetics, of laundry and of other areas of hospital work have invited management men and specialists in time and motion study to speak at their meetings and in many cases have discussed the papers intelligently and comprehensively and have followed the meetings with applications of principles and technics to their own problems or with projects which have been carefully carried through.

In many cases material that might be of great and immediate use in hospitals is in the management literature but not in the hospital vocabulary. The underlying principles of time and motion study are applicable in the hospital field as in all other fields, but it is for the hospital man rather than the time and motion man to make it clear how many of these are directly applicable in the hospital field and how many must be adapted for use there.

Through the years we have been accustomed to having every person who becomes interested in time and motion study and the possibility of its application to his work start by saying, "But of course my work is different." When such a person sees *similarity* in his work to work in other areas we have made a good start, and review and evaluation can take place. We usually establish these likenesses through the old questions: What is being done? Who does it? Where? When? How? Why? These would certainly apply to all fields. It is through attempts to answer these questions that organization charts, functional charts, job analyses, personality analyses and all

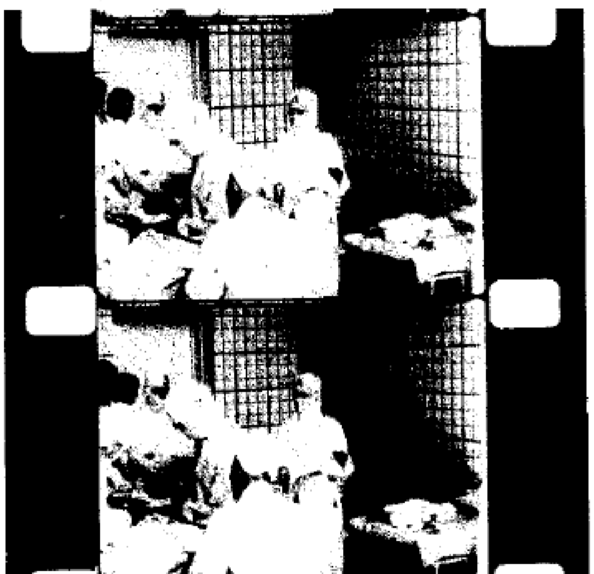


FIGURE 4-1. Frames from early Gilbreth film depict motion study of a surgical procedure. (By permission from the Society for Advancement of Management.)

Surgical Demand Scheduling: A Review

By James M. Magerlein and James B. Martin

1978

This article reviews the literature on scheduling of patient demand for surgery and outlines an approach to improving overal os- pital surgical suites. Reported scheduling systems are ose that schedule patients in advance of the surgical date a ile available patients on the day of surgery. Approaches cal procedure times are also reviewed, and the article concludes with a discussion of the failure to implement the majority of reported scheduling schemes.

During the past decade, considerable work has gone into the development of less-costly hospital systems that can also maintain or even improve the associated quality of care. The surgical suite, which has only recently received attention, is a potentially major area of hospital cost containment for two interrelated reasons: (1) surgical suites generally have high costs and historically low facility and/or personnel utilization rates; and (2) surgical patients provide a significant portion of the demand served by other hospital departments. To realize the full potential for cost containment, surgical suite management policies must consider both the surgical suite itself and its interactions with other areas of the hospital. The primary benefits to be derived from improved management policies would result from better coordination of the demand for hospital services by surgical patients and the levels of resources provided—beds, operating rooms, surgeons, anesthesiologists, and surgical and floor nurses. Improved coordination of demand and supply would allow resource reduction and would limit periods of overuse of resources, thus lowering hospital costs and/or improving the quality of care.

There are four basic approaches to achieving improved coordination of demand and supply:

1. Providing the proper levels of resources. Examples include the number of operating rooms within the surgical suite and the

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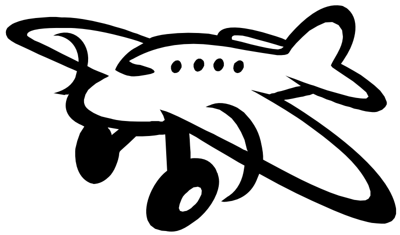
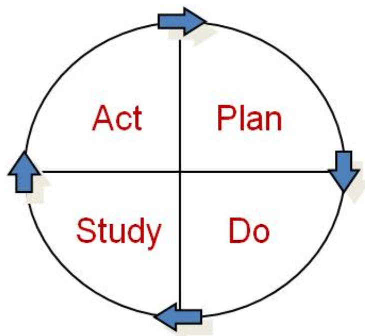
Healthcare and IE today

Lots of basic CQI methods + Some more advanced methods

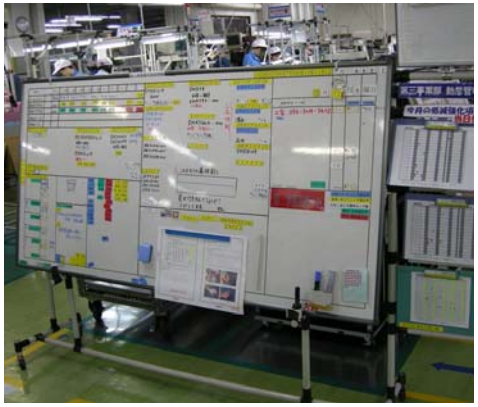
Airlines

- Reliability
- Scheduling
- Overbooking



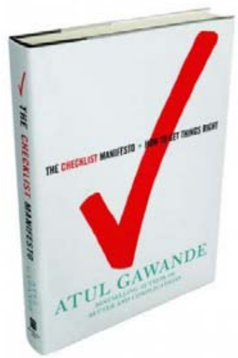


Visual controls



Lean / Six sigma

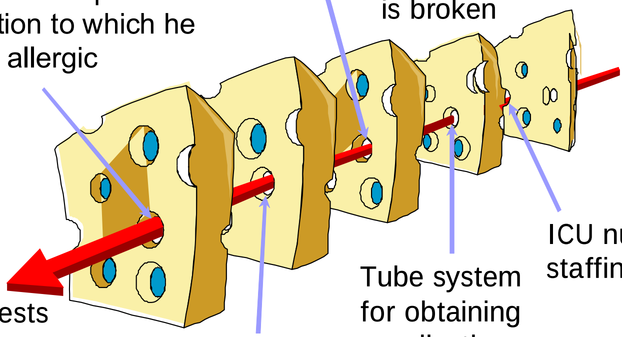
- Waste reduction
- Quality improvement



Human factors

- Error, safety, Ultra-reliability
- Redundancy, forcing functions

Medication Errors



J. Reason, 1990
J. Reason and Johns Hopkins Medicine

Discussion

www.hsye.org

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