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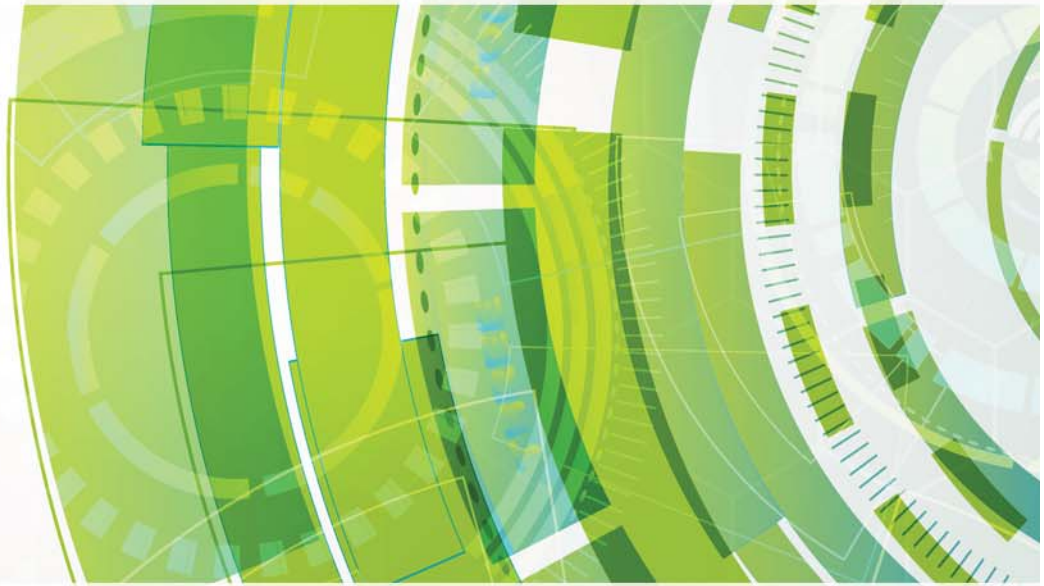
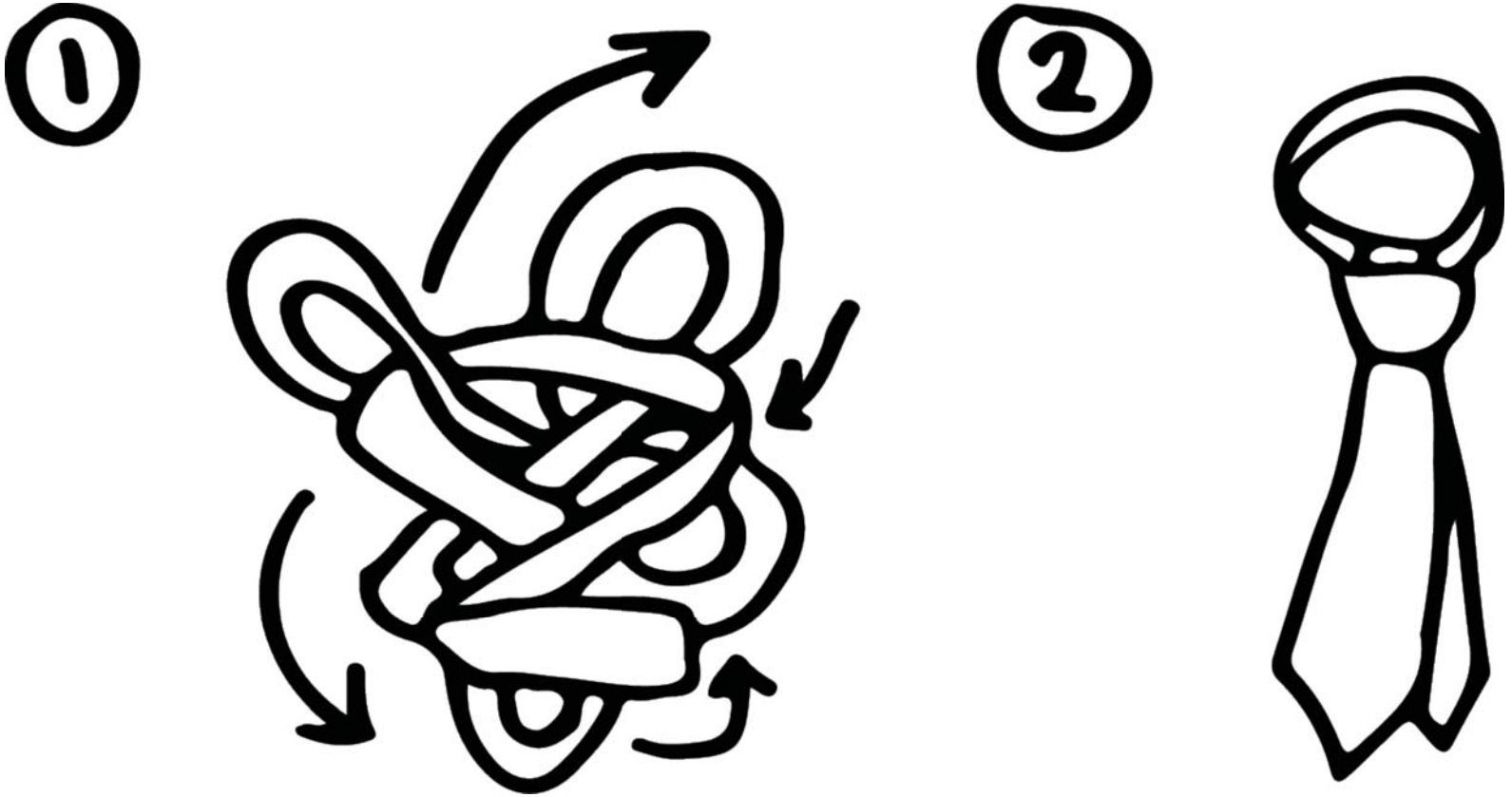
The Science of How

Jeanne Huddleston, M.D.



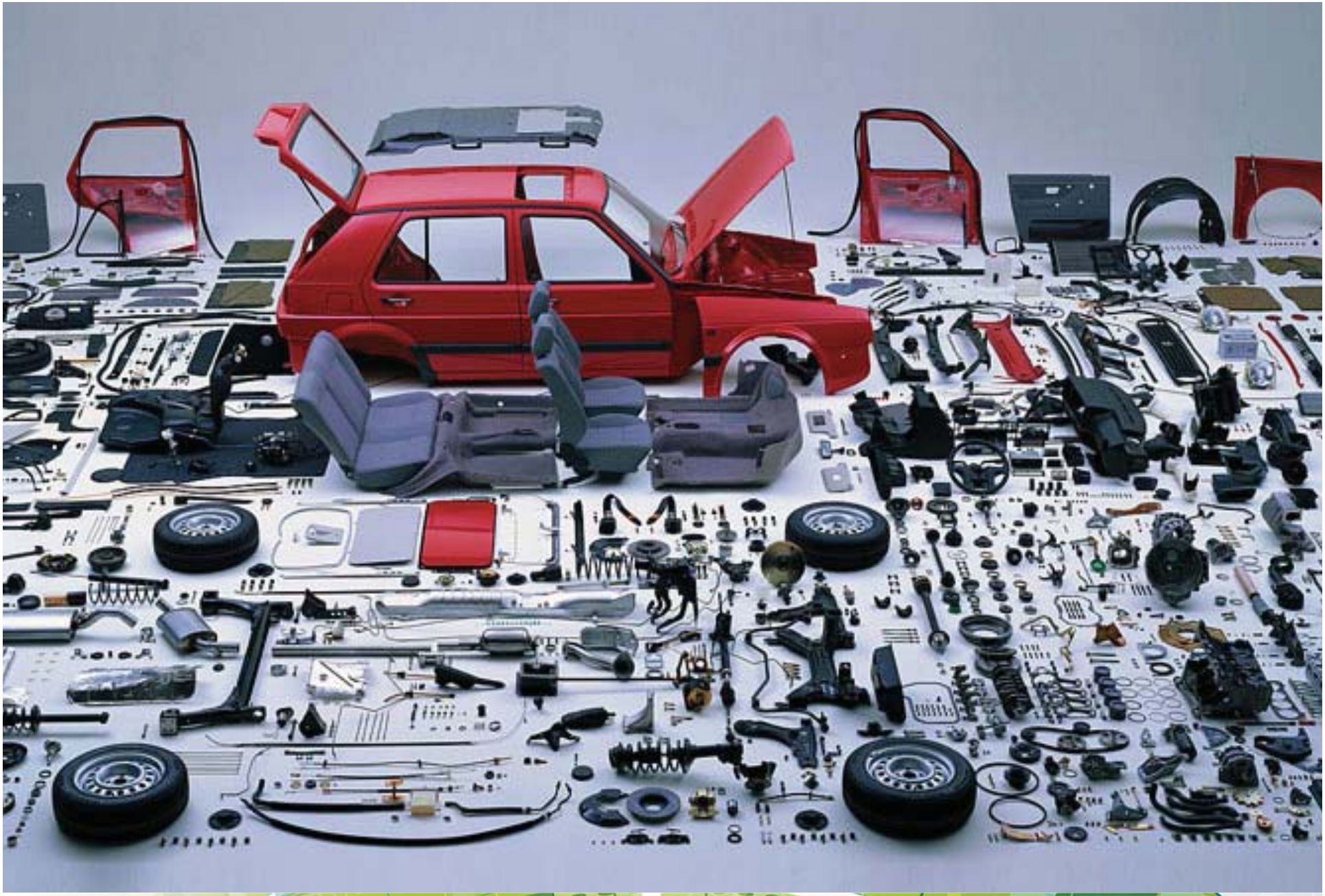


$9.8 Billion*

***Cost of health care associated infections annually.**

$4.5 Trillion*

***Projected spending on health care in America by 2019 (19.3% GDP).**



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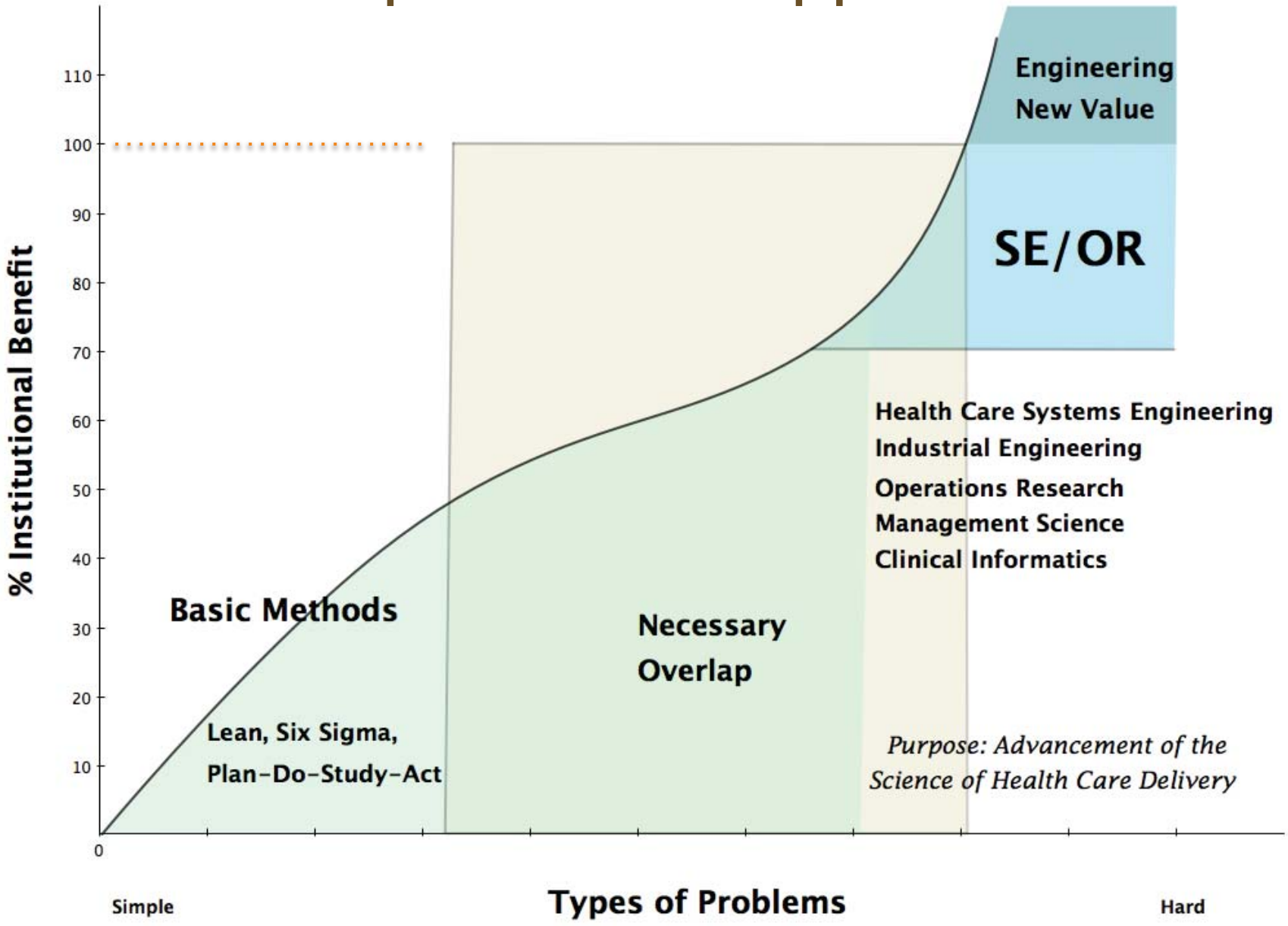
Leadership: Problem Domains

- Capacity and resource management
- Safety (employee and patient)
- Workload and treatment optimization
- Process efficiency and reliable care delivery
- Systems integration across transitions of care
- Workforce projections with possible staffing models
- Workflow reorganization in new physical space
- Economic analyses with generation of novel payment models
- Patient-centered outcomes research

Process Improvement Approaches



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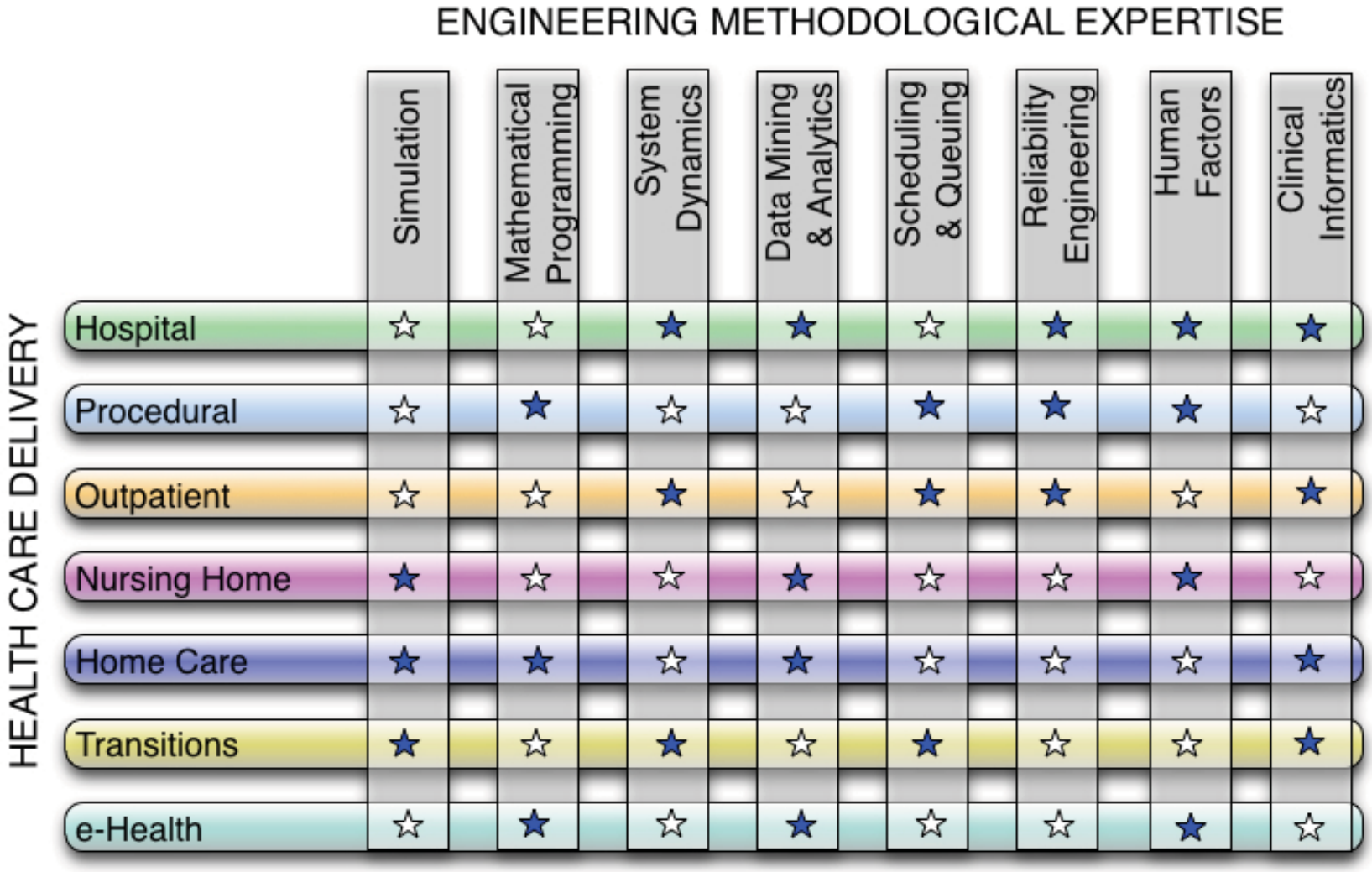
Building the HSE Program



MAYO CLINIC ROBERT D. AND PATRICIA E. KERN

CENTER FOR THE SCIENCE OF HEALTH CARE DELIVERY

The Mayo Clinic Center for the Science of Health Care Delivery (2011)

To create, evaluate and implement high value patient-centric care delivery

Objectives

- Improve our delivery systems to provide high value and reliable care
- Increase our national leadership in value driven care delivery
- Disseminate our knowledge
- Execute the Mayo Strategic and Operating Plan

HEALTH CARE SYSTEMS ENGINEERING

Improving health care delivery systems, as well as increasing the efficiency and effectiveness of health care delivery, by applying engineering, management and translational science principles

PATIENT-CENTERED OUTCOMES

Focusing on the entire patient journey to develop, study, test, implement and share new models of patient-centered health care delivery

POPULATION HEALTH SCIENCE

Creating optimal health and well-being in an 11-county area in southeastern Minnesota by focusing on prevention and health promotion

SURGICAL OUTCOMES

Improving the quality of surgical patient care at Mayo Clinic and in the U.S. with a focus on access, safety, quality and outcomes

VALUE ANALYSIS

Studying the value of health care delivery at Mayo Clinic and other organizations by analyzing cost, utilization, quality, safety, patient-reported outcomes and other measures

THEMES

Orthopedics, mental health and palliative care are priority areas within the center's five programs

Reducing Breast Lumpectomy Reoperation

Surgical Outcomes Program

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Reducing Breast Lumpectomy Reoperation

Surgical Outcomes Program

National cohort: **13.2%**

Mayo cohort: **3.6%**

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Collaborating to Achieve Value

Value Analysis Program

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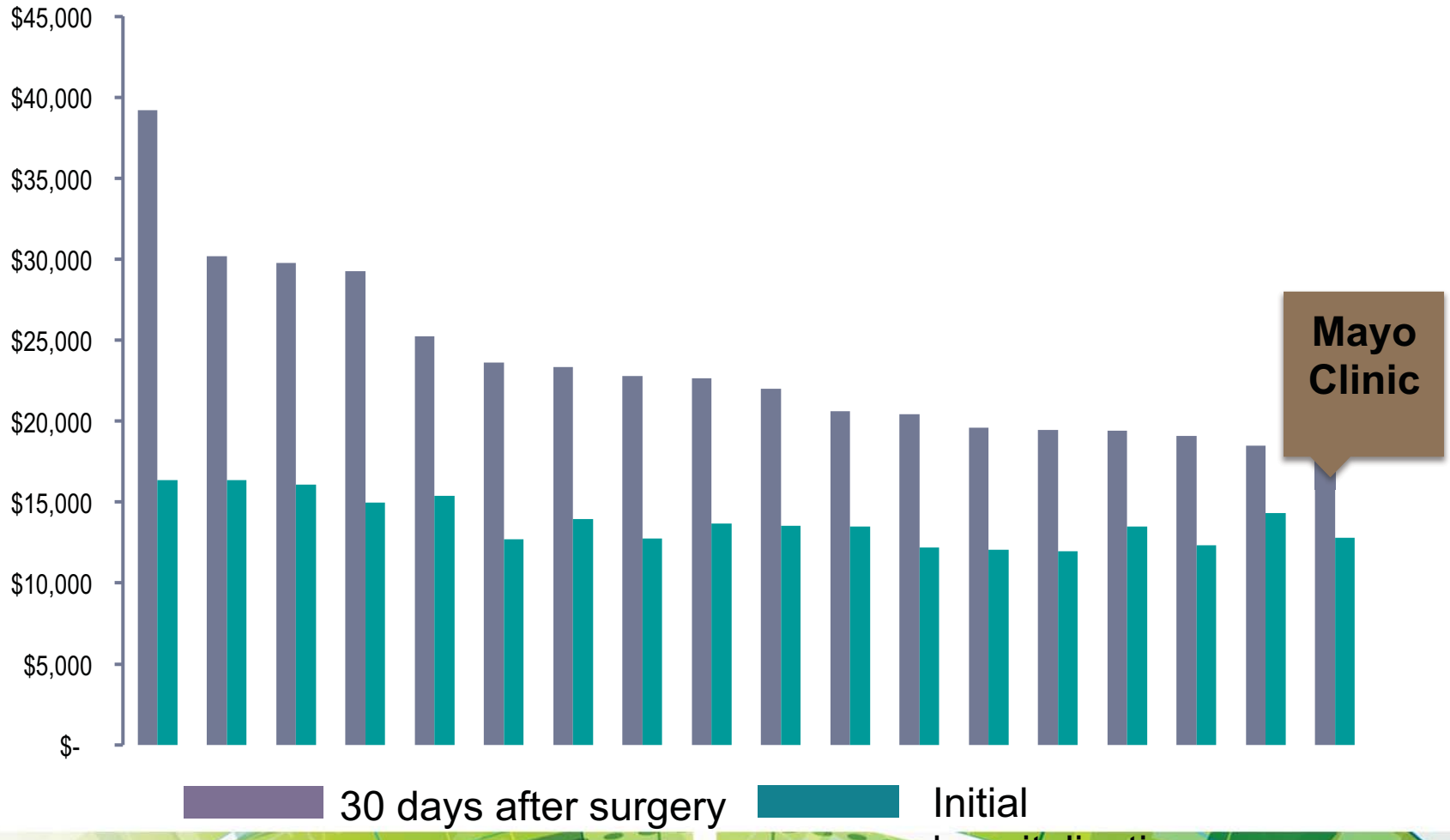
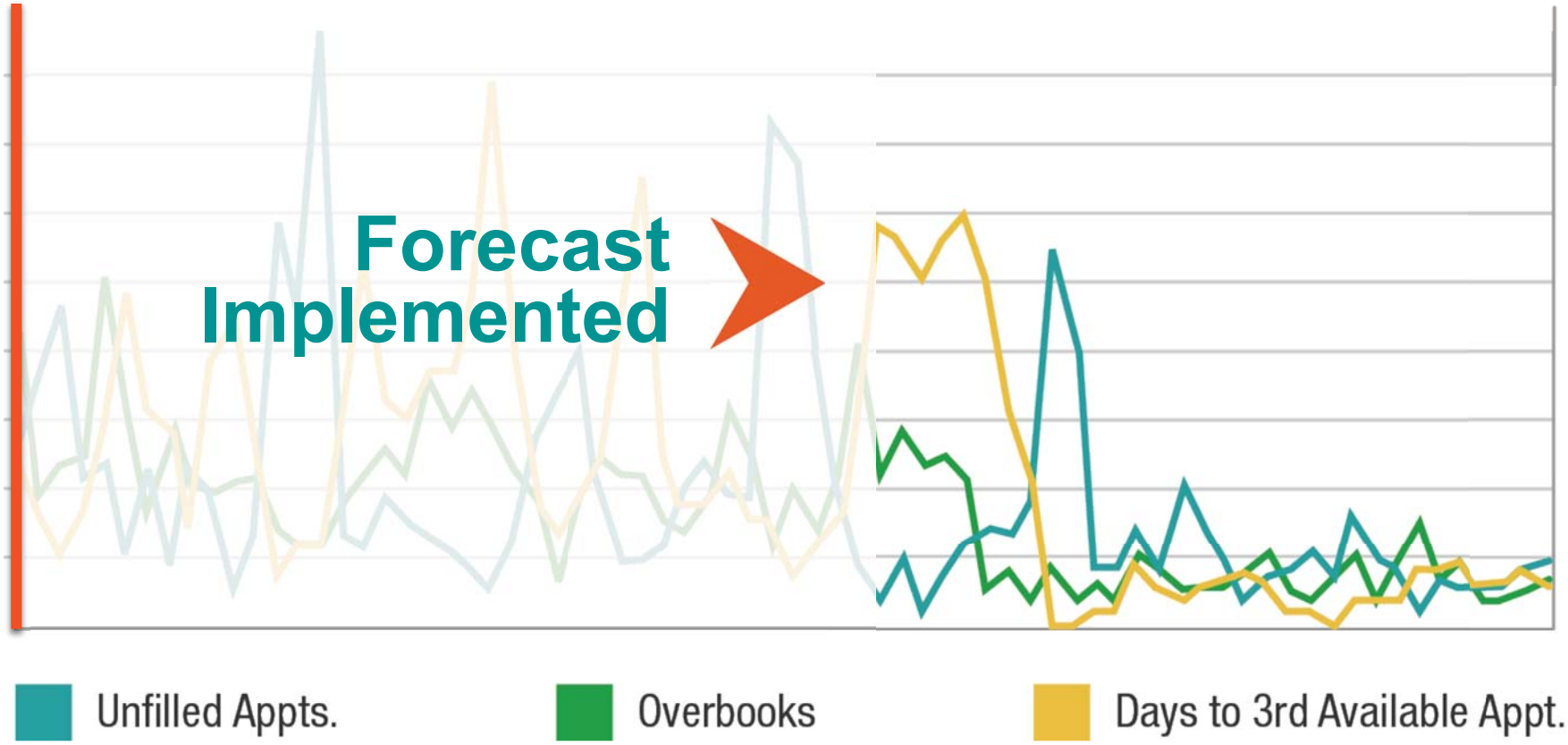
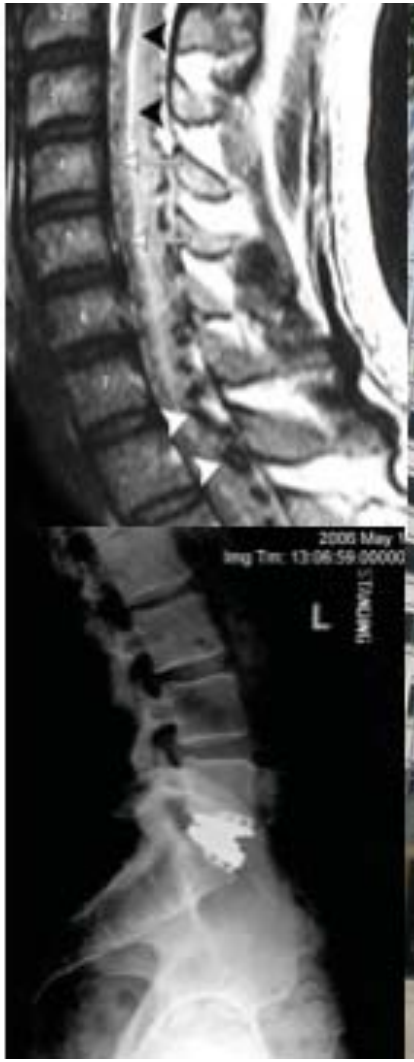
Total Episode Medicare Costs
Hip & Knee Replacement



Neurology Appointments



Perspectives to be considered



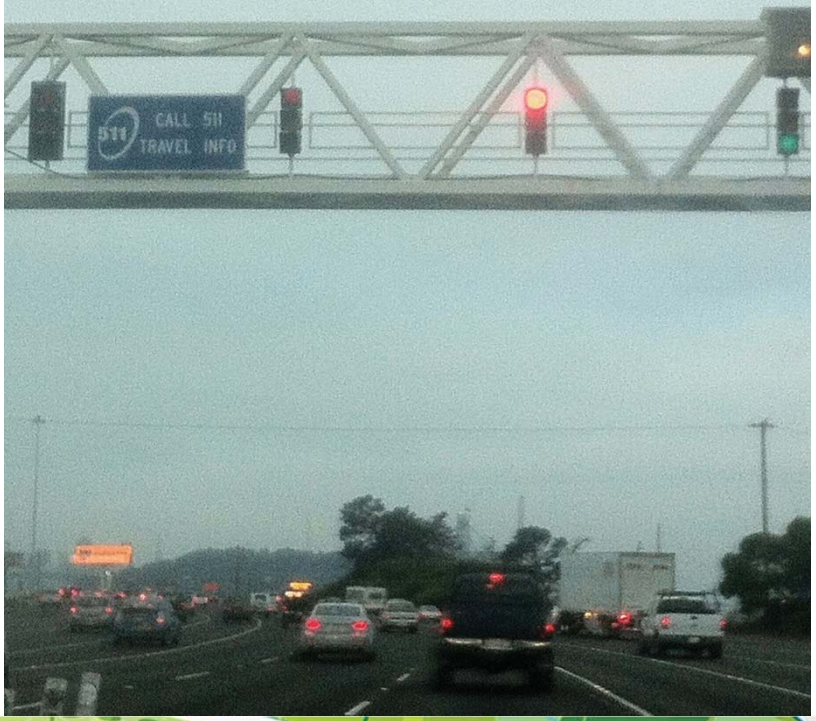
Problem

- More than 40% of a hospital's revenue comes from Operating Rooms (Health Care Financial Management Association)
- ORs count for large proportion of hospital's expenses
- Patient waiting time for surgery can be very high
- Highly variable OR utilization
- Spine surgeries are the most costly surgeries in the US (Agency for Healthcare Research and Quality)
- Spine surgeries ranked as the sixth most common surgeries in the US

Dynamic Facilitation of Flow

Ubiquitous signals at urban on-ramps help regulate the smooth flow of vehicles on to the freeway…

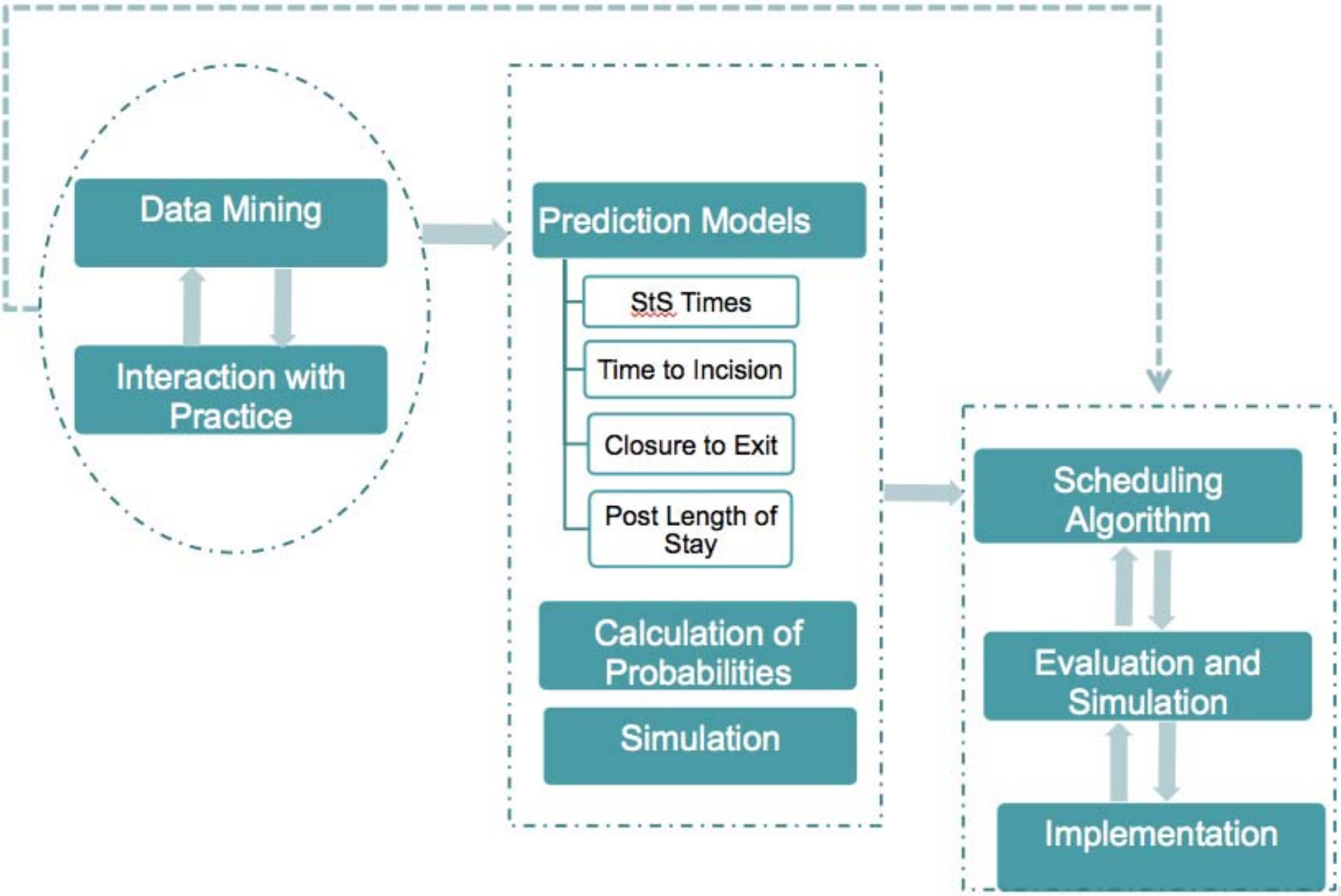
…thereby ensure that freeways operate at maximum capacity



Clinical Covariates = Face Validity

- Age
- Number of levels
- Approach
  - Anterior
  - Posterior
  - Lateral
  - Staged
- Cervical, thoracic or lumbar
- Deformity
- Decompression
- Grafting
- Fusion
- Revision
- Instrumentation

The defining characteristics of each of the 10 Types of surgery are Detailed in Appendix A.


Data Mining
Interaction with Practice
Prediction Models
StS Times
Time to Incision
Closure to Exit
Post Length of Stay
Calculation of Probabilities
Simulation
Scheduling Algorithm
Evaluation and Simulation
Implementation

ROI Secondary To:

- Cost reduction
  - From 3 to 2 ORs
  - Fewer “no-hitters”
  - Decreased weekend stays of Medicare patients
  - Less use of ORs outside of prime time

Increased revenue

- More cases
- Case mix

"I have always thought a good deal of Lincoln's Gettysburg address. There's a line in it which explains why we want to do this thing. It is *'that these dead shall not have died in vain.'* We know how hard it is for those who have had the misfortune of deaths in their families, of deaths that might have been avoided. What better could we do than take young men and help them become proficient in the profession so as to prevent needless deaths?"

Foundation life goal, Dr. William J. Mayo, tells senators.
Minneapolis Morning Tribune, March 23, 1917.

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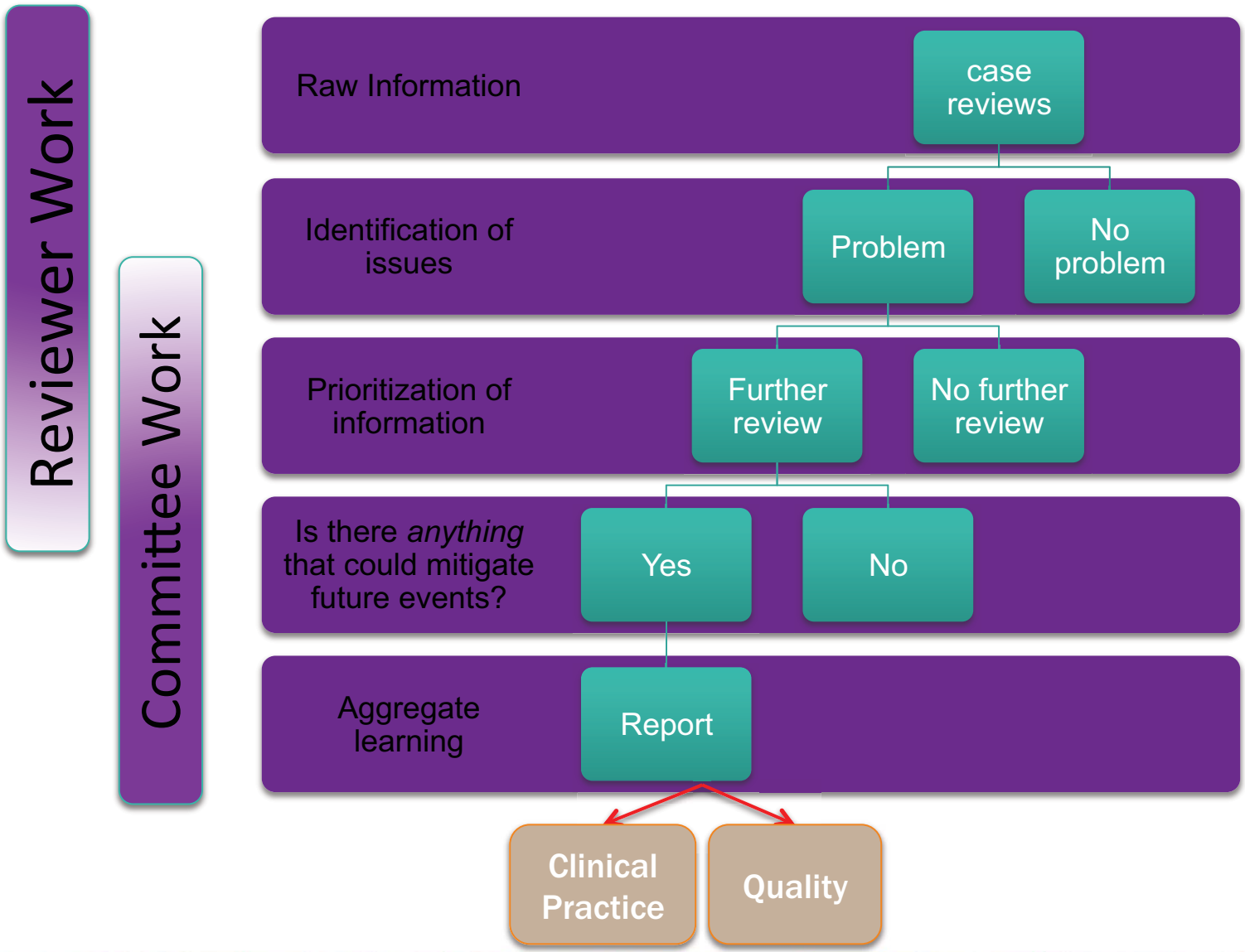
Original Charge from HPS

- To create a meaningful mechanism to review deaths at MCR hospitals:
  - Thorough understanding
  - Measurable
  - Improvable
- To identify and quantify unanticipated deaths
- To identify rate of adverse events in patients who die in MCR hospitals
- To classify and quantify system level changes which will improve mortality rate.



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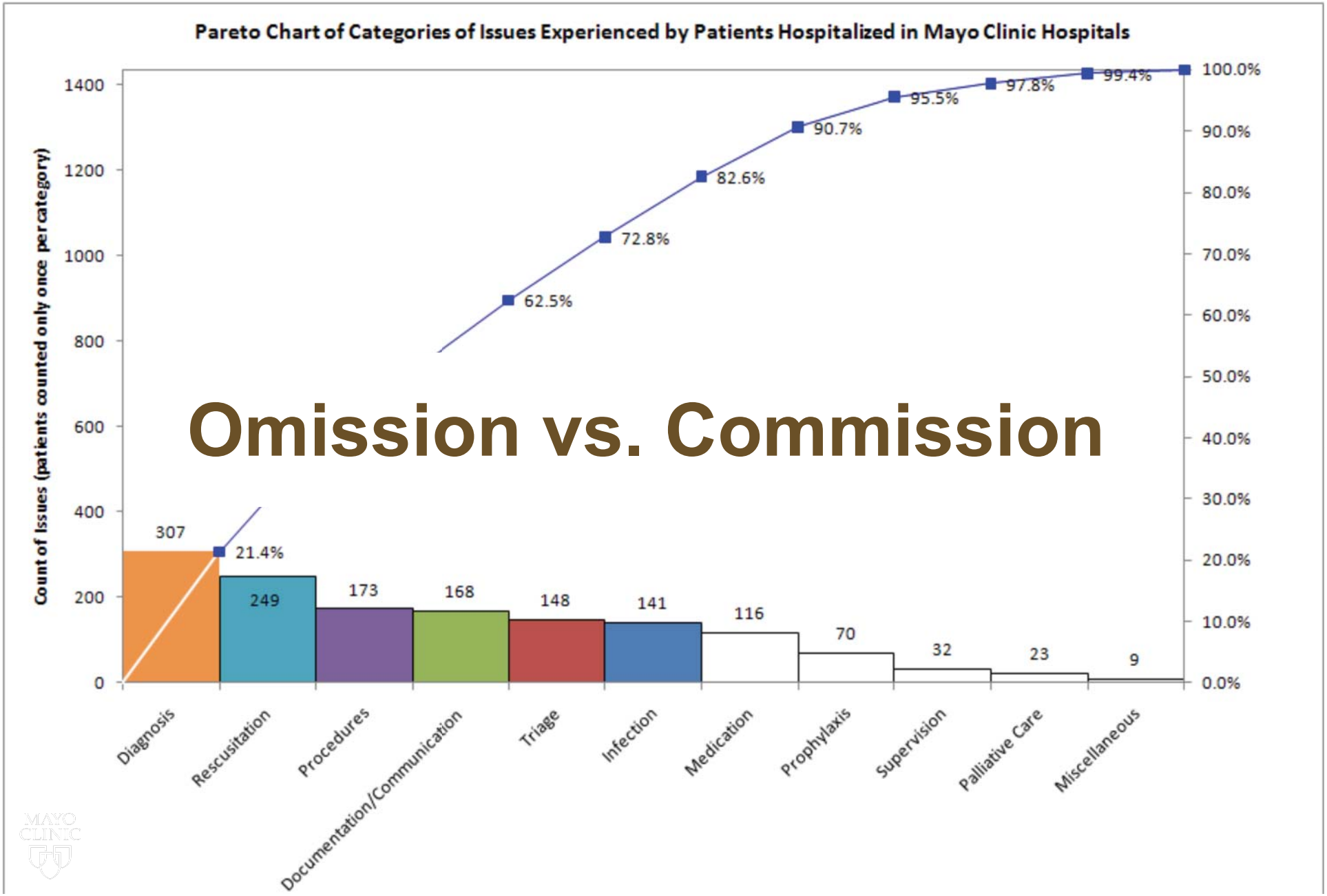
How the review process flows to completion

Multidisciplinary reviews identify multidisciplinary "issues" with practice

- **Ongoing culture shift with issue identification**
- **Long gone are the days of "nurses' jobs" or "physicians' responsibilities"**
- **Physician involvement**
- **Integral part of how business is done**
  - Leadership involvement
  - Leadership accountability



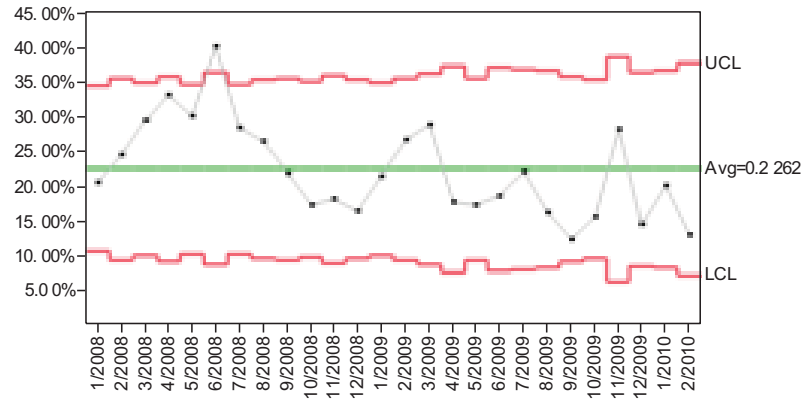
Omission vs. Commission

Systems and Processes of Care
(quantitative analysis, 2007)

- Most triage issues result in a FTR
  - RR 61.8 (95% CI 34 - 111)
- Primary causes of FTR and unanticipated death
  - Unrecognized septic and hypovolemic shock
  - Missed diagnosis
- Autopsy rate - 26%
  - cause of death determined by autopsy at least once per month

Making a Difference through 2009

P-chart of % of deaths with issues identified



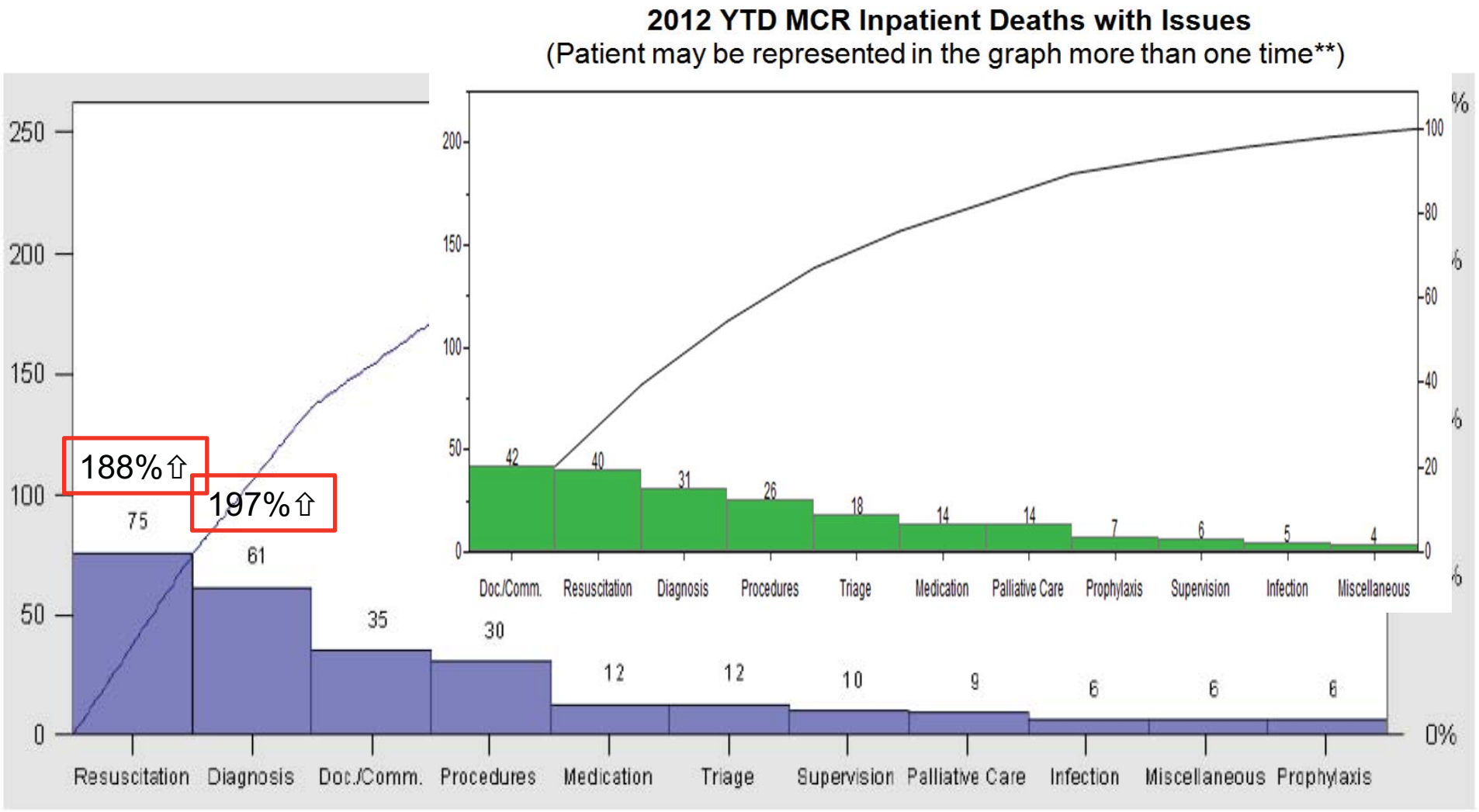
Data source: MRS Mortality Registry

- Nursing sepsis education
- Wipe C-diff initiative
- Sepsis order set
- Admission office
- Airway management protocol
- Other localized efforts: official reads on outside films, consultant notification of patient condition change, NGT suction and chest tube inservices, DOM encouragement of RRT utilization

MRS System Findings (2010)

- Narcotic-induced respiratory depression
  - postoperative
  - OSA
- Failure-to-Rescue
- Failure-to-Recognize
  - Septic shock
  - Hypovolemic shock
  - Mesenteric ischemia
- Triage of unstable patients
- Supervision

Pareto Chart: All Issues 2012 vs 2013



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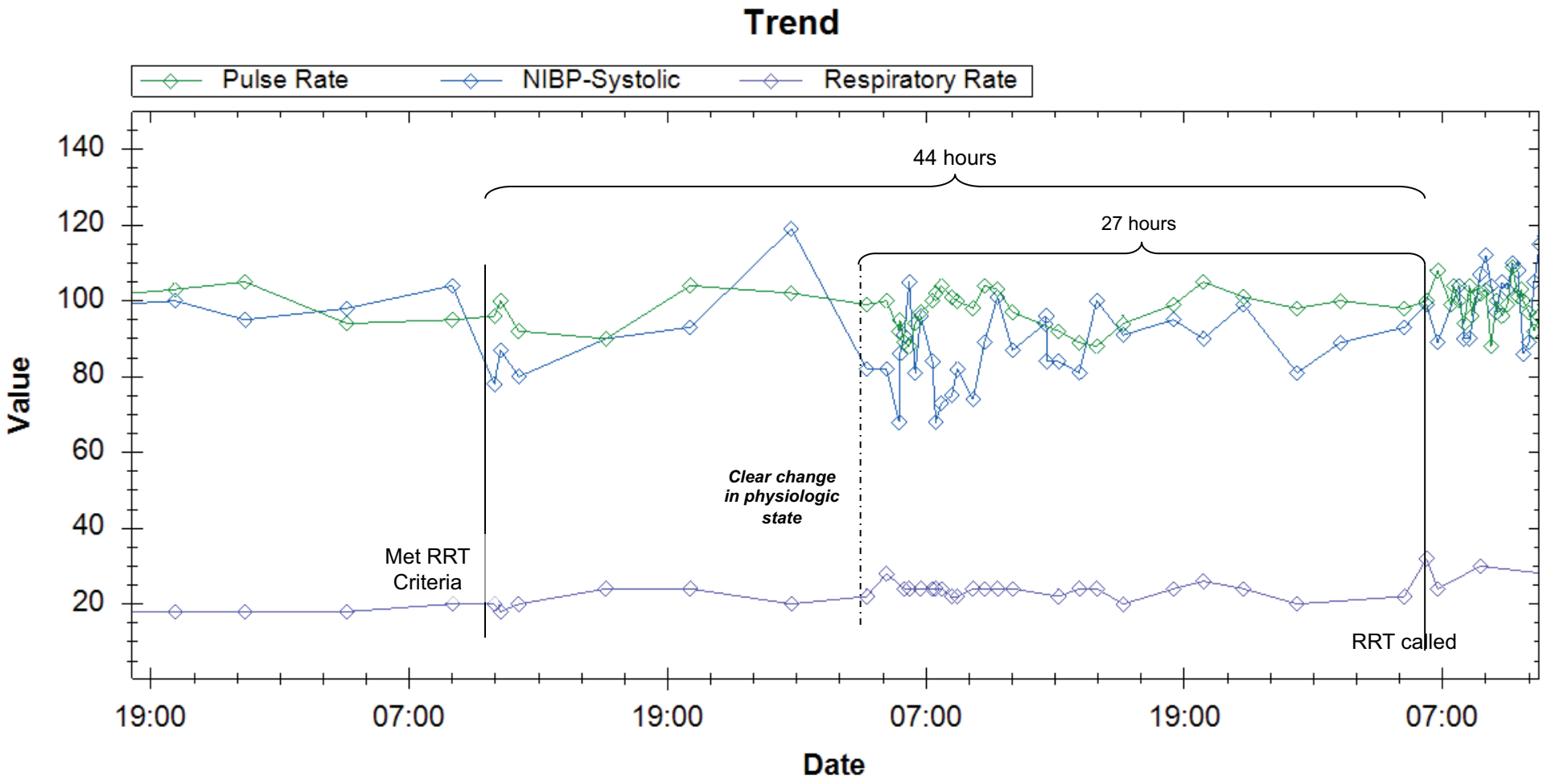
Labs:
Hb: 7.1
Creat (9/29): 3 (2-month baseline): 1.6
Leukocytes: 2.3

Case Example

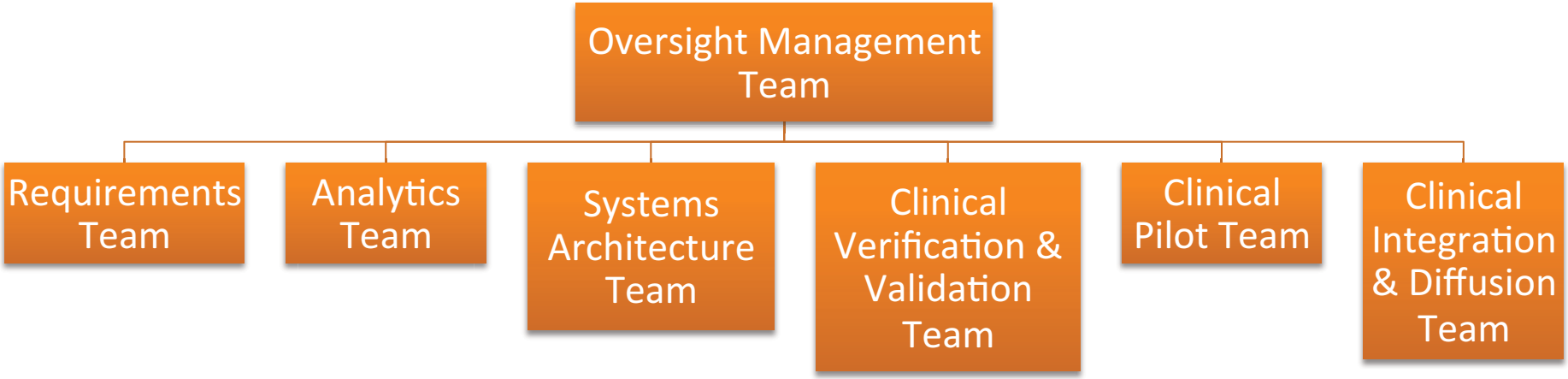


55-year-old male with CLL with MUD peripheral blood stem cell transplant 7/10 (2 months before). Dismissed 9/14
Readmitted the following day for weakness, poor intake, diarrhea, depression.
During hospitalization: GVHD of the gut, CMV positive; AKI.
Graph starts at hospital day 14.

9/28 11am: Systolic BP in the 70-80s for 1 hour.
9/29 4am: Systolic BP 82, stayed erratic, mostly under 90 throughout the day. SI>1.
9/30 7am: RRT called

Example provided by MRS

Health Care Systems Engineering Approach to Process Discovery, Design & Implementation



• Identify and understand all stakeholder needs • Classify and quantify user requirements • Develop use cases	• Identification of covariates predictive of deterioration • Model pre and post intervention system performance	• Integrate stakeholder needs, results of analytics and operational use specifications • Develop predictive algorithms and decision support • Determine metrics	• Verification of outcome and process measures • Statistical validation of predictive model • Iterative sensitivity & specificity testing of predictive algorithms	• Develop pilot • Implement pilot • Evaluate pilot • Determine timing and sequence of scalable implementation and diffusion	• Develop implementation plan • Develop ongoing measurement and monitoring plan • Diffusion
Reengineering Phase				Implementation Phase	Diffusion Phase
Failure Modes and Effect Analysis, Data mining, Predictive analytics, Financial Effect Analyses Workflow analyses & Simulation Modeling				Iterative DMAIC steps	Mayo Clinic Model of Diffusion

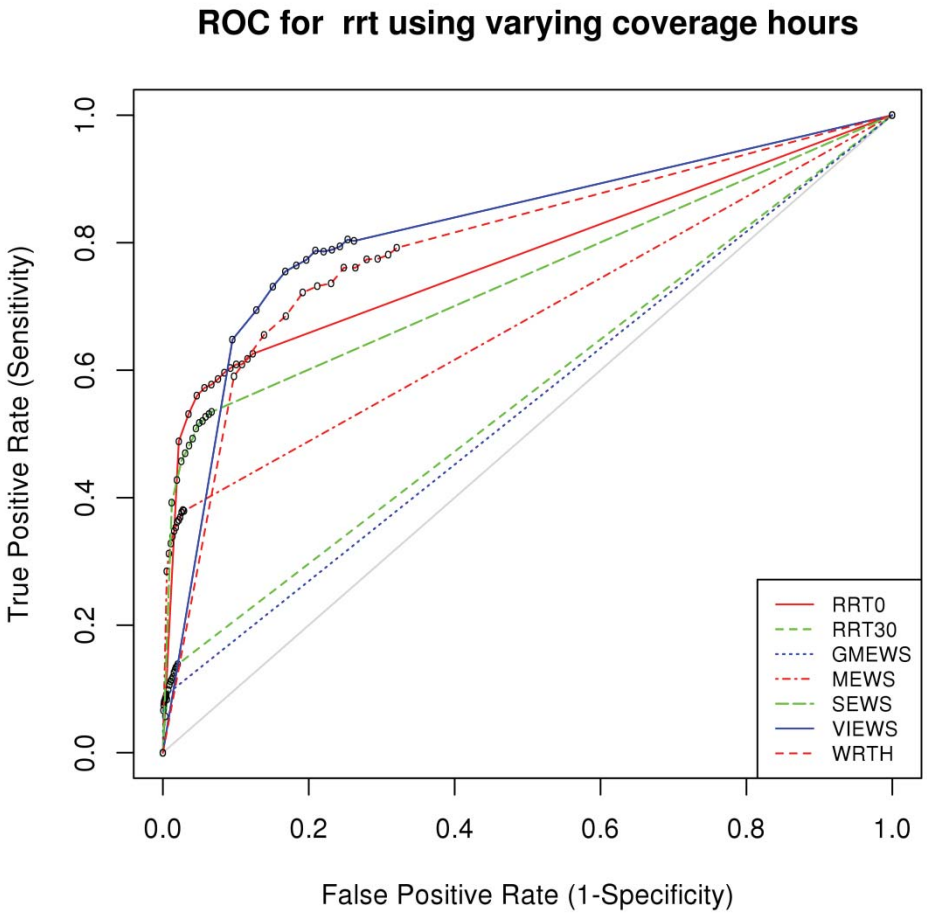
Top 5 Failure Modes (MCR)

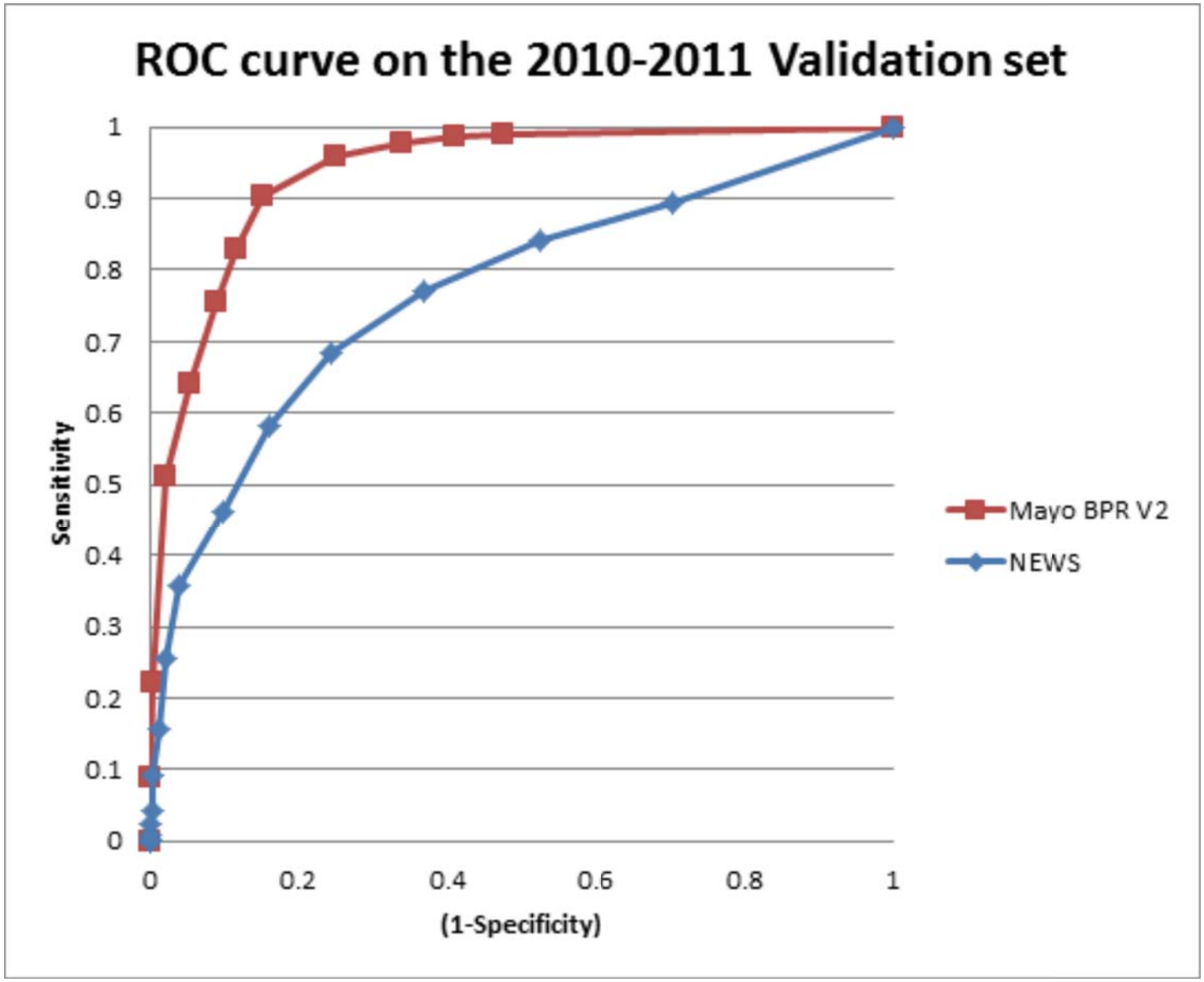
- The patient's clinical condition is not re-assessed at the bedside following new interventions (medication, fluid bolus, tests results). This may result in a loss of important information with delayed recognition of needed intervention or treatment failure.
- Care providers of all types can feel that there are too many complex things to do in a short period of time. This may result in important care processes slipping through the cracks (including recognition that a patient's condition is changing).
- A physician does NOT review nursing notes documented in the electronic medical record. This may result in an incomplete understanding of patient clinical condition.
- Care team attributes a patient's acute physiological deterioration to the wrong cause. This may result in in correct treatment choices and a delay in the appropriate care.
- Some care providers (nurses or physicians) believe that a standard, or clear definition of acute patient deterioration does NOT exist. This may result in uncertainty and variation amongst providers of how and when to respond to acute patient needs.

Next 5 Failure Modes (MCR)

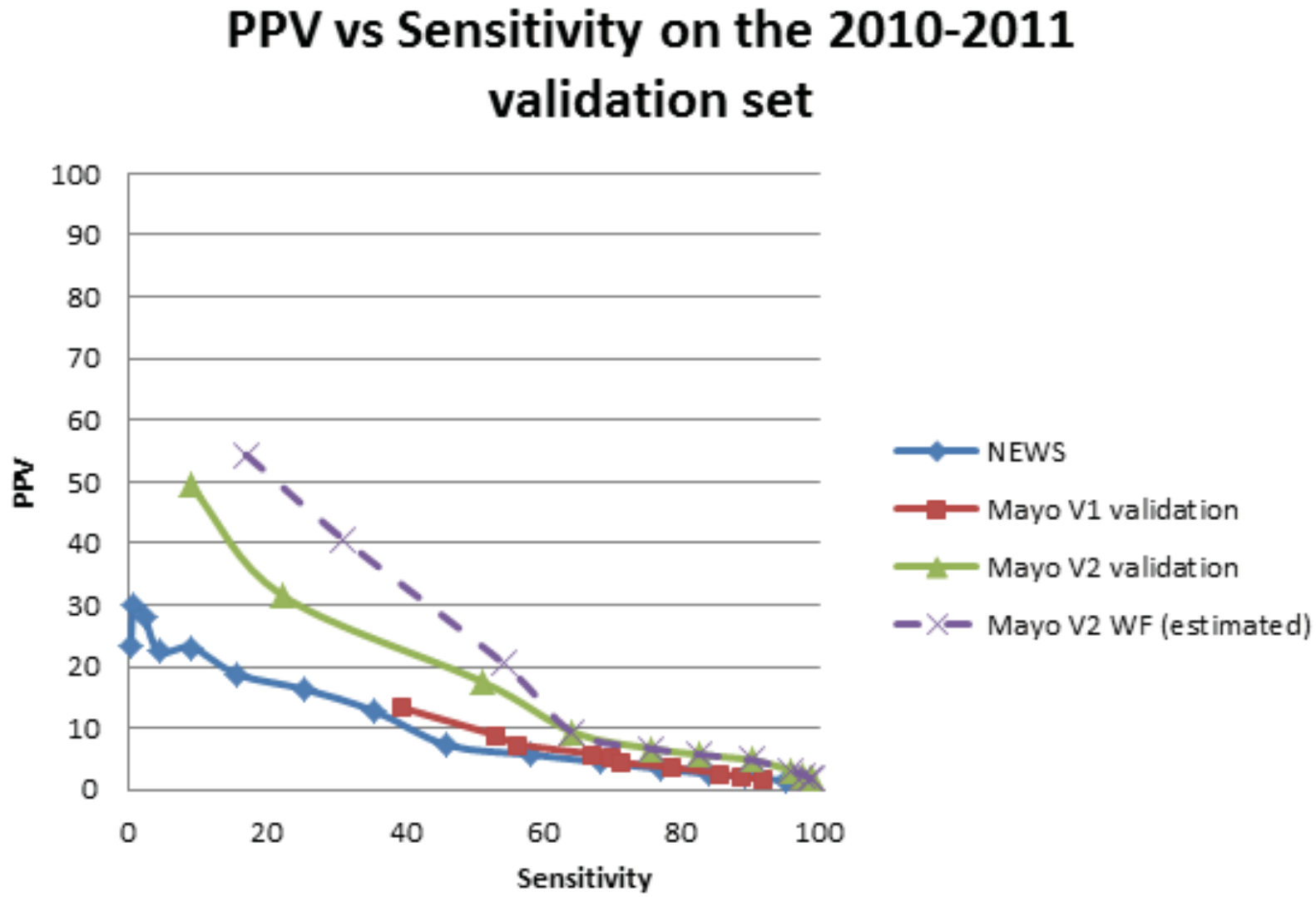
- Care team fails to recognize subtle changes in vital sign trends over time. This may result in delayed recognition and interventions for a deteriorating patient.
- A physician, nurse practitioner or physician assistant uses 'copy and paste' to document in Clinical Notes from one day to the next. This may result in inaccurate representations of patient's current clinical condition.
- A patient's condition is continuing to deteriorate after several interventions. The nurses do not call the RRT because the primary service is at the bedside and ordering these interventions. This may result in a delay of care escalation.
- A physician is concerned about being judged as clinically weak, or incompetent, if the RRT is called for one of his/her patients. This may result in an under-utilization of the RRT expertise.
- A physician or nurse may NOT call the RRT, even when the patient is meeting calling criteria, because he/she believes the clinical calling thresholds are not relevant to their patient.

ROC Curves of Published Early Warning Scores and current MCR RRT criteria




ROC curve on the 2010-2011 Validation set
Sensitivity
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
0.2
0.4
0.6
0.8
1
(1-Specificity)
Mayo BPR V2
NEWS

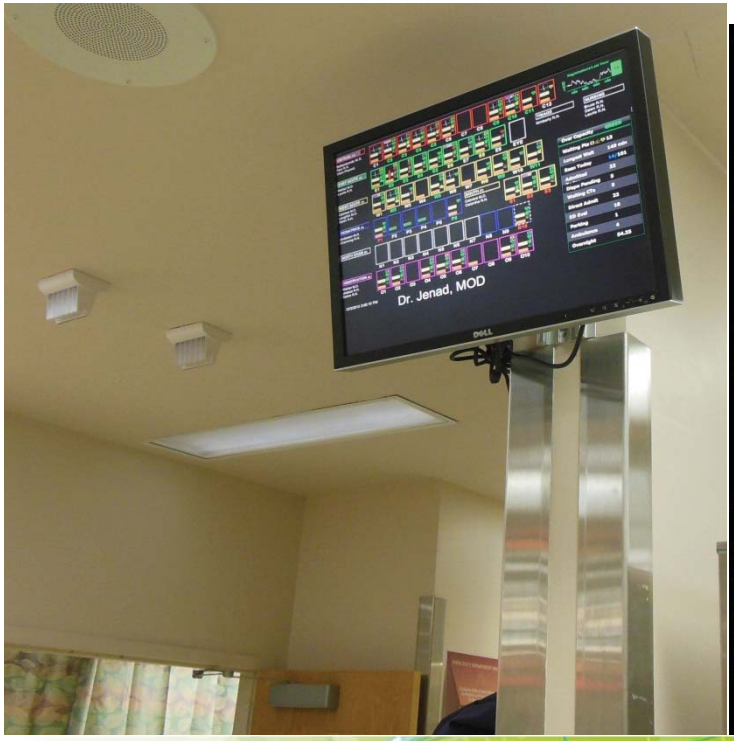
Contribution of Worry Factor



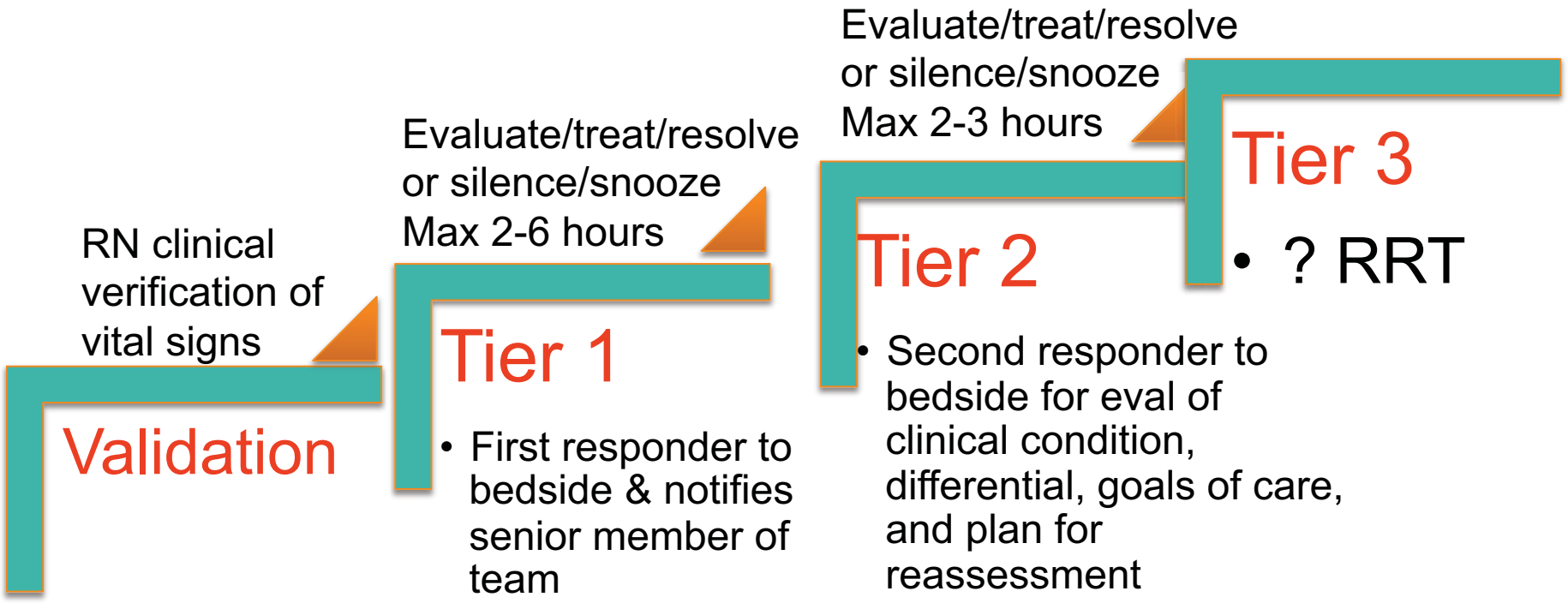
System Architecture Requirements:

- Tiered rescue model with time limited escalation of expertise with demonstrated clinical response
  - Bedside evaluations
  - Increased provider vigilance
  - RRT to be called when their specific expertise is needed
- Promotes teamwork and communication
- Makes the deterioration and results of interventions visibly obvious to bedside providers
- Allows all types of students, residents and fellows to learn
- Allows patient and family preferences to be incorporated into rescue response
- Makes practice constraints evident
- Leverages technology at the point of care (bedside)

"Guardian Angel" at the Bedside: **Saving Lives**



Tiered, time-limited escalation of expertise at the bedside



Concept derived from 6 RN focus groups & discussions with MERS, Sepsis MTR, CC-IMP & HIM quality committee including their practice leadership. MANY details to sort through as portion of Phase 2 BPR Charter. The practice must design the process and policies.

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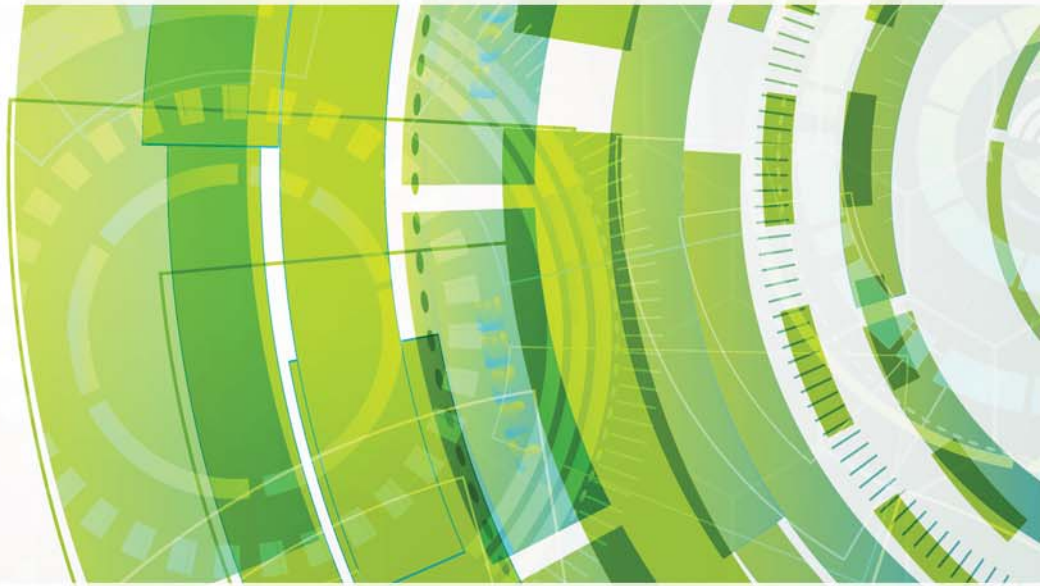
Mayo Clinic Clinical Engineering Learning Laboratories



Clinical Engineering Learning Laboratories provide real-time practice and outcomes measurement to support interdisciplinary teams of engineers and health services researchers embedded into busy, live patient care environments.

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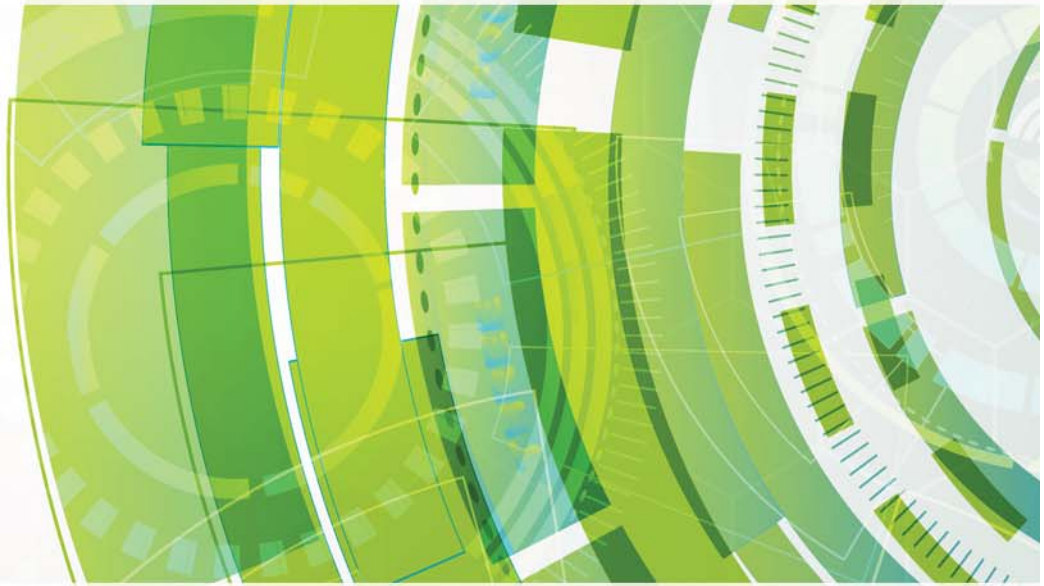
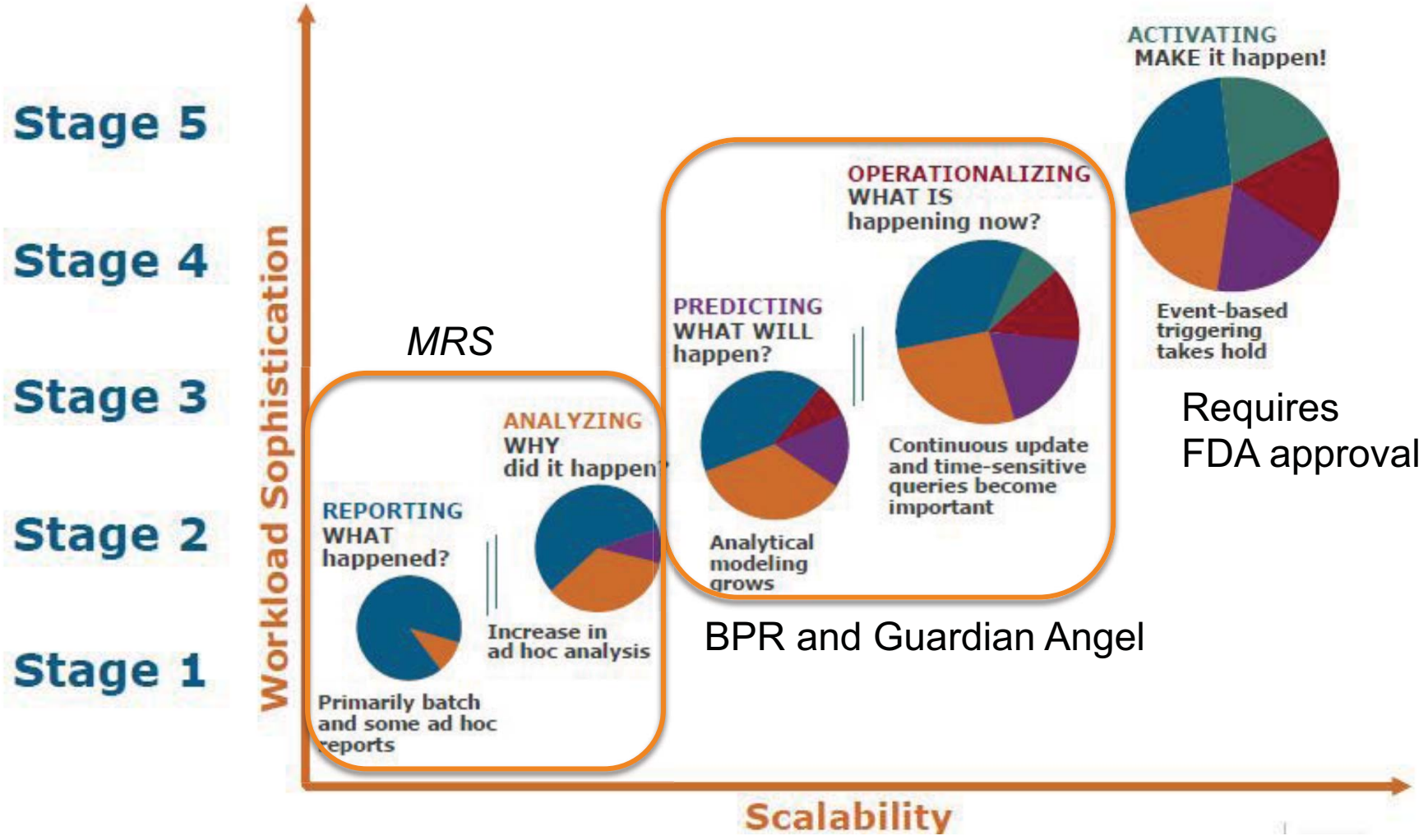
Implementation



Analytics and IT in Health Care



Requires
FDA approval

BPR and Guardian Angel

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Patients need us to tell their stories.
Clinicians need scientific evidence.

Hospitals need both… NOW:
stories and analytics to learn,
improve systems, advance care, and
save lives.

