Managing Variability in Hospital Patient Flow: A Necessary Foundation for Quality, Safety Improvement and Cost Reduction

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Objectives

• Demonstrate the effect of patient flow management on quality of care, patient safety, mortality rate and hospital margins
New IOM report

BEST CARE AT LOWER COST

The Path to Continuously Learning Health Care in America
Building a safe and efficient health care delivery without managing patient flow: Phase I
Building a safe and efficient health care delivery without managing patient flow: Phase II
Management of health care delivery system is a science

Health care delivery systems cannot be managed based just on feelings, experience, benchmarking and brainstorming

Which problem is easier to solve:

\[ \int \cos(ln(x)) \, dx = \frac{x}{2} \cdot [\sin(ln(x)) - \cos(ln(x))] \]

or … to design effective and efficient health care delivery system?
## Two Medical ICUs with the Same Patients Acuity

<table>
<thead>
<tr>
<th></th>
<th>5 beds</th>
<th>10 beds</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average LOS</td>
<td>2.5 days</td>
<td>2.5 days</td>
</tr>
<tr>
<td>Admission rate</td>
<td>1pt/day</td>
<td>2pts/day</td>
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Do they have the same waiting times to be admitted to these units?
1\textsuperscript{st} ICU
\[ \tilde{T}_w = 0.13 \text{ days} \]

2\textsuperscript{nd} ICU
\[ \tilde{T}_w = 0.018 \text{ days} \]
“Hospitals have direct control over operational efficiency, and have a number of variables within their control. They include such factors as impatient bed capacity, ancillary service delays, the scheduling of services and support staff…”

“4.1 Hospital chief executive officers should adopt enterprise-wide operations management and related strategies to improve the quality and efficiency of emergency care.”
4.3 Training in operations management and related approaches should be promoted by professional associations; accrediting organizations, such as the Joint Commission on Accreditation of Healthcare Organizations (JCAHO) and the National Committee for Quality Assurance (NCQA)…"
Gaps Cited by the Institute of Medicine in Crossing the Quality Chasm (2001)

- Ineffectiveness of care
- Lack of efficiency in delivery system
- Inadequate safety
- Insufficient patient-centerness
- Inadequate timeliness of care
“If one performs a “Google” search with the key words: “health reform” and “US OR America” for 2007, one will find about 160,000 links. If one does the same for 2010, there will be over 2.5 million links. If one adds to the above Google search “quality OR safety”, the number 2.5 million links is reduced to a still impressive number of over 1.6 million links. Currently, we probably have more quality specialists in the healthcare delivery system than the number of avoidable annual deaths, and yet, the results are far from satisfactory. If instead of “quality OR safety” one adds to the above mentioned Google search just two words “operations management”, 1.6 million links would shrink to just 400(!) This is a perfect evidence of our continuing unrealistic attempts to improve the healthcare delivery system and to add to it millions of uninsured, without analyzing its operations.”*

*)“Mismanaged hospital operations: a neglected threat to reform” Health Affairs Blog, February 22, 2011.
“There is no other industry (except maybe education) that is improving its product without optimizing its operations. In any industry, with no exceptions, operating systems have a huge impact on work climate, staffing, financial results and customer satisfaction (see two well-known Harvard Business School case studies: *McDonald’s Corp.* and *Burger King Corp.*), and yet we are trying to change our health care delivery system without changing its core operations.”

*)“Mismanaged hospital operations: a neglected threat to reform”

*Health Affairs Blog, February 22, 2011.*
Can one achieve high quality of care without addressing variability in patient flow?
Imagine a Boeing 737 that has to carry 300 people aboard on a particular day from point A to point B. Some people will have a seat, others would have to sit in the aisle. What would be passengers’ safety level on this plane? What would be the quality of service provided by the four flight attendants? What would be the cost of fixing up such a plane after the flight? How about having rather Boeing 747 more suitable for this load? The problem is that on the way back from point B to point A there are only 100 passengers to be carried. Then, using either plane would introduce significant waste, although for Boeing 747 greater than for Boeing 737. Suppose that this is an everyday pattern. What plane should one choose: more expensive but safer (under this scenario) Boeing 747 or cheaper but unsafe Boeing 737?

**This is a wrong question that we are trying to answer in healthcare. The right question is: Why do we have to carry 300 passengers one way and 100 – another way?**
Major health care delivery problems:

- Patient Safety
- Nurse understaffing/overloading
- ED diversions/access to care
- High cost

*Addressing variability is necessary, although not sufficient, to satisfactorily resolve these problems.*
How unsmooth census looks like? (no holidays, no weekends, weekdays only)
How did we staff, and how do we staff


The Ideal Healthcare System

(100% efficiency)

1. All patients have the same disease with the same severity.
2. All patients arrive at the same rate.
3. All providers (physicians, nurses) are equal in their ability to provide quality care.
Can your health care delivery system become a Toyota product line?
Variability As the Source of System Stress

1. Clinical stress
2. Patient flow stress
3. Stress by variation in professional abilities or teaching responsibilities
I) Clinical Variability
II) Flow Variability
III) Professional Variability

} Natural Variability

- Random
- Can not be eliminated (or even reduced)
- Must be optimally managed
What Makes Hospital Census Variable?

![Graph showing the number of patients over time]
What Makes Hospital Census Variable?

- If ED cases are 50% of admissions
  *and* …
- Elective-scheduled OR cases are 35% of admissions
  *then* …
- Which would you expect to be the largest source of census variability?
The Answer Is…

The ED and elective-scheduled OR have approximately equal effects on census variability.

Why?
Because of another (hidden) type of variability…
Artificial Variability

- Non-random
- Non-predictable (driven by unknown individual priorities)
- Should not be managed, must be identified and eliminated
A key root cause of hospital bottlenecks and inefficiency

Daily Weekday Emergency and Elective Surgical Admissions June - August 2008

Artificial Variability

Slide provided by Sandeep Green Vaswani, Institute for Healthcare Optimization
Impact of Artificial Variability
Managing variability is necessary, although not sufficient, to satisfactorily resolve these problems.

- Decreased access, particularly for some of the sickest patients
- Extended delays in care delivery
- External and internal diversion of patients
- Nurse understaffing / overloading resulting in lower quality and safety

  “Census increases up to 25% above an adequate staffing level subject all patients in the nursing unit in question to the 7% increase in [mortality] risk…”

- Decreased provider and staff satisfaction, decreased retention / recruitment
- Overall underutilization of assets leading to decreased revenue and increased cost

Artificial Variability is undesirable for
- Patients
- Providers
- Administration
- Payers (Govt. and private)

1 Litvak, E., et. al., Managing Unnecessary Variability in Patient Demand to Reduce Nursing Stress and Improve Patient Safety, Joint Commission’s Journal on Quality and Patient Safety, June 2005 Volume 31, Number 6
http://www.ihi.org/NR/rndonlyres/E18D05FD-F4E5-448D-8CBE-217CB5C03B7C/0/ManagingUnnecessaryVariabilityinPatientDemand.pdf
Elective Surgical Requests vs. Total Refusals

- elective surgical patients seeking ICU admission
- patients diverted or rejected from the ICU

Why managing variability today is more important than before?
Does the healthcare system need more capacity?

![Graph showing the number of patients over time](image)
At what cost?

- Typical cost of new capacity
  - Inpatient beds - $1M in capital and $250K-800K annual operating expense
  - Operating rooms - $2 – 7 Million, $250K+ annual operating expense
  - Major imaging (CT, MRI, PET/CT, etc.) – approx. $1M+
  - Cardiac Catheterization Lab – approx. $2M

- Nursing and other provider shortages?
Variability and access to care

- ED
- ICU
- Floors
- Scheduled demand
Alternative to Managing Variability!
Variability and mortality


http://www.ihi.org/NR/rdonlyres/E18D05FD-F4E5-448D-8CBE-217CB5C03B7C/0/ManagingUnnecessaryVariabilityinPatientDemand.pdf

“Each additional patient per nurse was associated with a 7% increase in the likelihood of dying within 30 days of admission and a 7% increase in the odds of failure-to-rescue”*

Example:

Assumptions:

- 200 surgical beds
- Average census for surgical beds 160
- Staffing level 40 nurses (1 nurse per 4 patients)
- Average residual from 160 patients census is 20% or 32 patients
- Patients are distributed evenly between the nurses

How the mortality rate will change with 20% increase in surgical demand?
Results:

- 32 additional patients will be distributed evenly between 32 nurses: 1 additional patient per nurse or $4 + 1 = 5$ patients per nurse.

- These 32 nurses now will take care of 160 patients, whose mortality rate increases by 7%.

- If these additional 32 patients will be distributed evenly between 16 nurses, then each such nurse will take care of $4 + 2 = 6$ patients.

- These 16 nurses now will take care of 96 patients, whose mortality rate increases by 14%.
Patient Mortality and Patient Flow

Nurse Staffing and Inpatient Hospital Mortality, Needleman J., Buerhaus P., et al.

- “There was a significant association between increased mortality and increased exposure to unit shifts during which staffing by RNs was 8 hours or more below the target level “

- “The association between increased mortality and high patient turnover was also significant “
What is easier: to talk to your colleagues or to your lawyers?!


http://www.healthleadersmedia.com/content/LED-269595/PDH-Understaffing-a-Possible-Factor-in-Deaths-at-CRMCC##
Variability and Quality of Care*

Inadequate numbers of nursing staff contribute to 24% of all sentinel events in hospitals. Inadequate orientation and in-service education of nursing staff are additional contributing factors in over 70% of sentinel events.

*) Dennis S. O’Leary, - former President JCAHO (personal communication)
Maintaining higher affordable nurse staffing levels is only possible by managing variability in patient flow.
Variability and health care-associated infection

Jeannie P. Cimiotti DNS,RN, Linda H. Aiken PhD, Douglas M. Sloane PhD, Evan S. Wu, BS

American Journal of Infection Control: August 2012- Volume 40, pp 486-490

“There was a significant association between patient-to-nurse ratio and urinary tract infection (0.86; P ¼ 0.02) and surgical site infection (0.93; P ¼ 0.04). In a multivariate model controlling for patient severity and nurse and hospital characteristics, only nurse burnout remained significantly associated with urinary tract infection (0.82; P ¼ 0.03) and surgical site infection (1.56; P < 0.01) infection. Hospitals in which burnout was reduced by 30% had a total of 6,239 fewer infections, for an annual cost saving of up to $68 million.”
Does variability affect readmission rate?

“The main outcome variable is unplanned patient readmission to the neurosciences critical care unit within 72 hrs of discharge to a lower level of care. The odds of one or more discharges becoming an unplanned readmission within 72 hrs were nearly two and a half times higher on days when ≥9 patients were admitted to the neurosciences critical care unit …”

“The odds of readmission were nearly five times higher on days when ≥10 patients were admitted …”

*) Baker, David R. DrPH, MBA; Pronovost, Peter J. MD, PhD; Morlock, Laura L. PhD, et al. Patient flow variability and unplanned readmissions to an intensive care unit. Critical Care Medicine: November 2009 - Volume 37 - Issue 11 - pp 2882-2887
Does the Rapid Response Team helps at your hospital?

Why?


http://jama.ama-assn.org/content/304/12/1375.full?ijkey=951c7c932f9a2618e8d538f136fdcc77748fab8b&keytype2=tf_ipsecsha
Quality and Safety Corner at [www.ihooptimize.org](http://www.ihooptimize.org)

The Institute for Healthcare Optimization’s approach to managing variability in healthcare delivery addresses some of the most intractable quality and safety issues such as readmissions, mortality, infections, ED boarding and others. [Learn more »](#)
How do you do this

Questions that you may have:

• Why are we doing this project?
• Why will this project succeed?
• What exactly are we going to do?
• How much additional work is this going to mean for me?
• How will we ensure this project doesn’t do damage to what currently works?
Why do this project?

- Bumped or delayed elective surgery cases
- Delays in securing OR access for urgent and emergent cases (transplantations)
- Overburdened nurses, medical errors, high overtime, excessive nurse vacancies
- Lack of timely access to nursing units
- Prevent ED overcrowding and boarding
- Improve patient, provider and staff satisfaction

“By smoothing the inherent peaks and valleys in patient flow, and eliminating the artificial variabilities that unnecessarily impair patient flow, hospitals can improve patient safety and quality while simultaneously reducing hospital waste and cost.” Institute of Medicine, June 2006

JCAHO’s Patient Flow Leadership Standard - "LD.3.15 The leaders develop and implement plans to identify and mitigate impediments to efficient patient flow throughout the hospital.”
Expertise Necessary for Success

The key pillars of expertise that drive success in an OR redesign project are:

- Application of operations management to healthcare
- Clinical expertise
- Hospital management expertise
- Project management and data analysis experience
IHO Approach to OR Design and Patient Flow Improvement

Phase I
Separation of OR Flows

Phase II
Smoothing of Elective Flows

Phase III
Determination of Bed and Staffing needs
Project Overview

Phase I
Separation of OR Flows
9 months

Goals
• To assess the extent of artificial patient volume variability and patient flow bottlenecks in key areas of the hospital, and their ripple effects on quality and cost of care
• To separate flows of scheduled (elective) patients from that of unscheduled (emergent/urgent) and work-in patients through the OR

Expected Benefits
• Increase in surgical capacity / volume (Note: there will be absolutely no decrease in any individual surgeon’s volume as a result of this project)
• Decrease in patient wait times for emergent and urgent surgeries
• Decrease in OR overtime
• Increase in staff and patient satisfaction
Expected Results

**Phase I**
Separation of Scheduled v. Unscheduled OR Flow

**Expected Benefits**
- Increase in surgical capacity / volume (*Note: there will be no decrease in any individual surgeon’s volume as a result of this project*)
- Decrease in patient wait times for emergent and urgent surgeries
- Decrease in OR overtime
- Increase in staff and patient satisfaction

**Phase II and IIb**
OR and Cath Lab Smoothing

**Expected Benefits**
- Further increases in capacity / throughput
- Enhanced patient placement in preferred beds
- Decrease in nursing stress
- Decrease in mortality and medical errors related to delays and patient misplacement
- Increase in transplantations volume
- Prevention of ED overcrowding

**Phase III**
Determination of Bed and Staffing needs

**Expected Benefits**
- Further decreases in patient wait times where they exist
- Further enhancement of patient placement
- Decrease in staffing expense
- Enhanced utilization of existing resources
- Accurate determination of capacity growth need (Additional Med/Surg bed requires $\approx 1$ million in capital cost + over $.25 million annual operational cost)
• Weekend waiting time (for urgent / emergent surgeries) down 34% despite 37% volume increase, Weekday waiting time down 28% despite 24% volume increase (results for the first three months after implementation)

• Surgery volume has sustained 7% growth per year for the last two years

• Initially an equivalent of 1 OR capacity freed up

• OR overtime down by 57% (approx. $559K saved annually)

• Inpatient occupancy increased from 76% to 91% resulting in $137 million/year plus 100 new beds avoided capital cost (over $100 million)

• Substantially improved provider satisfaction

Source: Frederic Ryckman, MD, Cincinnati Children’s Hospital Medical Center
Case Study – Cincinnati Children’s Survey

- “We have not had anywhere near the patient complaints or physician complaints. Physician and Family satisfaction has skyrocketed…” - Orthopedic Surgeon, Division Director

- “The family satisfaction with their experience is better than it used to be.” – ENT Surgeon, Attending

- “As a general observation, nursing staff ‘on call’ are not staying as late due to add-ons remaining at change of shift.” - OR Nurse

- “…We get our case done early, and patients don’t have to wait NPO until the evenings to have their surgery. This has made call much less stressful for my surgeons and myself…” - Orthopedic Surgeon, Division Director
Case Study – Boston Medical Center

- Surgical throughput up 10%
- Bumped surgeries down 99.5%
- Reduced nurse stress; 1/2 hour reduction (6%) in nurse hours per patient day in one unit ($130,000 annual saving)
- ED waiting time down 33%
- 2.8 hour wait in one of state’s busiest EDs vs. 4 to 5+ hours for most of the academic hospitals in Boston

Source: John Chessare, MD, then Chief Medical Officer at Boston Medical Center
Case Study – Palmetto Health Richland

- Waiting time for urgent / emergent surgical cases decreased 38% while overall surgical volume grew about 3%
- Annual margin growth opportunity of $8M per year, $2.5M of which has been realized
- Results achieved in less than 1 year

Source: Ellis Knight, MD, MBA, then Chief Medical Officer at Palmetto Health Richland, now Sr. VP for Ambulatory Services for the Palmetto Health System
State-wide collaborative to improve patient safety and quality of care while reducing its cost

On January 30, NJHA in collaboration with The Institute for Healthcare Optimization kicked off Partnership for Patients-NJ, part of a national initiative from the U.S. Department of Health and Human Services to improve the quality, safety and affordability of healthcare, Learn more»

Patient Flow/Throughput
The New Jersey Hospital Association has provided IHO Variability Methodology™ to NJ hospitals to help them improve patient safety and flow/throughput. Some of these resources and the list of the NJ Patient Flow Collaborative Members have been publicly disseminated, Learn more»
What is here for me?

**Patients:**
- Reduced waiting time and improved access to care
- Reduced mortality and medical errors

**Nurses:**
- Reduced overtime
- Reduced workload
Physicians:

- Reduced waste of time
- Increased patient throughput
- Reduced overtime

Hospital:

- Better utilization of resources
- Reduced hours of ED overcrowding
- Staff and patient satisfaction
- More staffing resources: better tolerating peak loads
- Reduced mortality and medical errors
- Reduced length of stay
- Increased hospital throughput and revenue
What is next?
Three alternatives:

- Provide the resources (e.g., staffing) sufficient to meet current patient peaks in demand - historical scenario *(a dream about the old good times)*

- Staff below the peaks and tolerate ED diversions, nursing overloading and medical errors - current scenario *(go back home and pretend that we did not discuss these issues as it is much easier to create a new patient centeredness committee than to make tough changes required to achieve patient safety)*

- Smooth artificial variability and provide the resources to meet patient (vs. provider) driven peaks in demand. *Variability methodology can quantify and justify such additional resources*
Patient driven health care?

• Do patients want to spend hours/days in overcrowded EDs?
• Do they want to be taken care of by stressed nurses and as a result be subjected to medical errors?
• Do they want to acquire hospital infection?
• Do they want to be readmitted and start all over again?
• Do they want to deteriorate during their hospital stay?
What would be our national return on investment from applying these concepts?
We are 1/3 empty and overcrowded!!!
National Opportunity – An Example*

- Based on AHA 2007 data, overall nationwide hospital inpatient occupancy was about 65%.

- Even if one were to assume that all admissions are urgent in nature (statistically random arrivals), 80% occupancy should be achievable (based on queuing methodology) without compromising access or quality of care.¹

- A mix of elective and random admissions allows for achievement of even greater occupancy with simultaneously improved patient safety and quality of care.

- By comparison, US airlines operated at just under 80% in 2007 and 2008² and US utilities operated at an 80-90% utilization in 2007-2008³

National Opportunity Financial Impact

• **Total capital plus operational cost in 10 years is between $400 billion and over $1 trillion**

Endorsements

• **Institute of Medicine reports**: The Institute of Medicine in its reports has recommended Variability Methodology as a measure to improve patient safety, reduce hospital overcrowding and health care cost.

• **American Hospital Association’s Hospitals in Pursuit of Excellence**: The Institute for Healthcare Optimization’s approach is recognized by the American Hospital Association as a key principle for achieving IOM’s Six Aims for Improvement: care that is safe, timely, effective, efficient, equitable, and patient-centered.

**American Nursing Association**: ANA has endorsed Variability Methodology as a key measure for providing safe staffing


• **Government Accountability Office**: The Government Accountability Office recognizes variability in elective admissions as one of the key drivers of ED overcrowding (see page 23).
Effects of Flow Variability on Quality of Care and Patient Safety

- 2-4% increase in mortality risk for each exposure to an understaffed shift
- Up to 500%+ increase in odds of readmission
- Unmanageable Nurse: Patient staffing leading to overwork and stress
- Diversion and delays for Emergency Department patients
- Increased medical errors, infections, and non-compliance with NQF safe practices
- Unnecessary launches of Rapid Response Teams

Resource Utilization

“Optimized use of personnel, physical space, and other resources Providing high-value care requires the efficient use of finite resources, yet much of health care today is suboptimal on both counts. Operations-management tools can help improve returns on fixed capital investments. Variability in the flow of patients into a hospital unit results in overcrowding, worse health outcomes due to fluctuations in staffing levels, increased staff stress, lower patient and staff satisfaction, reduced access to care, and higher costs. Strategies such as Queuing Theory and Variability Methodology can be used to eliminate sources of artificial variability, improving occupancy without increasing staffing or capacity or reducing lengths of stay. Furthermore, systematic process improvement efforts such as Lean can be used to make more efficient use of personnel and other resources. Structured analysis of daily work can eliminate inefficiencies, increase value-added time spent with patients, reduce staff stress, and optimize the use of supplies and other resources.”
“…rely on systems engineering and operations research to smooth the flow of patients through the health care system. Backups in emergency rooms, periodic crowding in hospitals, and the lack of specialty postoperative beds are often symptoms of uneven scheduling of admissions, suboptimal scheduling of operating rooms, and inadequate discharge planning. Hospitals that apply systems engineering to scheduling and resource use can save many millions of dollars individually and billions in the aggregate, reduce overcrowding, and improve staff satisfaction and performance. Organizations such as the Institute for Healthcare Optimization are showing the way.23“ *)


Readings

Managing Patient Flow in Hospitals: Strategies and Solutions, Second Edition


http://www.ihoptimize.org/knowledge-center-publications.htm
Summary

• **Scientific** managing variability in patient flow is absolutely necessary to increase overall hospital patient throughput while improving quality of care, patient safety and reducing nursing workload.

• It requires *rigorous data analysis, scientific management of operations, clinical and organizational behavior expertise.*
Mortality, Readmissions, Medical Errors, High Cost vs. Health Care “Culture”: What Will Prevail?

You decide!
Questions:

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