Solve patient flow to enhance safety: There is a way!

Eugene Litvak
Peter Lachman
Jason Leitch

IHI Forum 2014
Disclosures

The speakers do not have any disclosures relevant to today’s session and discussion
Faculty

- Jason Leitch BDS
  - Clinical Director, Quality Unit, Scottish Government Health Department

- Peter Lachman MD
  - Deputy Medical Director, Great Ormond Street Hospital for Children NHS Foundation Trust

- Eugene Litvak PhD,
  - President and CEO, Institute for Healthcare Optimization
Aims

The impact of falling budgets and increasing demand on health services requires a new approach to solving intractable problems.

In this session participants will learn that one can deliver safe and high quality care, improve outcomes and improve patient experience by changing the operational paradigm.

This session demonstrate that principles of managing operations lead to cost-effective ways to deliver safe care. The theory will be illustrated by real time case studies and participatory work.
Learning Objectives

After this session, participants will be able to:

- Explain the relationship between flow safety and cost
- Implement in a health care setting the principles of managing operations
- Describe the key challenges in redesigning the flow of patients to improve safety
Part 1
INTRODUCTION TO THE PROBLEM
The growing finance gap

Peter Lachman
Setting the Context

- Is the central problem in healthcare cost or quality?
- Does your organization need additional resources?
- Is your biggest problem deciding where to close services or how to improve quality …or both?
- Does managed care/capitation accompanied by reduced budget leads to poorer quality of care.
U.S. Spends Much More on Health Care Than 12 Industrialized Nations, but Quality Varies

The U.S. Spends the Most per Person on Health Care Annually

$7,960

$5,352

$2,983

Americans Pay More for the Same Health Care Goods and Services

Physician Fee for Hip Replacement (public payer)

Most Commonly Prescribed Drugs

In-Hospital Deaths After a Heart Attack Admission (per 100 patients)

Health spending per person

Select a country to see the gains that would result.

If the U.S. had the same level of spending as United Kingdom, $1.7 trillion fewer dollars would be spent.
## EXHIBIT ES-1. OVERALL RANKING

<table>
<thead>
<tr>
<th>Country Rankings</th>
<th>AUS</th>
<th>CAN</th>
<th>FRA</th>
<th>GER</th>
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<td>4</td>
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### OVERALL RANKING (2013)

<table>
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<th>CAN</th>
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<td>11</td>
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<td><strong>Timeliness of Care</strong></td>
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### Health Expenditures/Capita, 2011**

<table>
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<th>Country</th>
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<td>$3,405</td>
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<tr>
<td>US</td>
<td>$8,508</td>
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</tbody>
</table>

Notes: * Includes ties. ** Expenditures shown in $US PPP (purchasing power parity); Australian $ data are from 2010.

Select a country to see the gains that would result.

If the U.S. performed at the level of United Kingdom, 24 million fewer adults would wait six days or more to see a doctor or nurse.

Patients in the U.S. are less likely than those in other countries to have rapid access to primary care when they need it. But U.S. patients do generally have quick access to specialty care.
Visited emergency room for a condition that could have been treated by a regular doctor

Select a country to see the gains that would result.

If the U.S. performed at the level of Australia, **21 million** fewer adults would visit an emergency room.

Difficulty accessing primary care, including on nights and weekends, can lead patients to seek care at the emergency room. Forty percent of U.S. adults who had visited an emergency room reported they could have been treated by their regular doctor, had he or she been available.

<table>
<thead>
<tr>
<th>Country</th>
<th>Percent of People</th>
<th>Dollars Spent Per Person</th>
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</thead>
<tbody>
<tr>
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<td>15%</td>
<td>$</td>
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<tr>
<td>Australia</td>
<td>6%</td>
<td>$</td>
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<td>Germany</td>
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<td>France</td>
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<td>Netherlands</td>
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<td>$</td>
</tr>
<tr>
<td>Canada</td>
<td>17%</td>
<td>$</td>
</tr>
</tbody>
</table>
Spending more does not improve quality

CMS data:

Higher spending states have poorer quality

Figure 1 English NHS funding: real annual changes, 1997/8 to 2020/21

Figure 3.1: The funding gap by 2021/22, assuming English NHS funding rises as set out in the 2010 Spending Review to 2014/15 and is frozen in real terms after, and without the effect of QIPP savings.

Note: The funding gap for PCT-commissioned NHS services in England is displayed together with the estimate for the departmental expenditure limit, in brackets.

Reference Nuffield Trust
Figure 2 Actual and projected UK NHS spending as a percentage of GDP

Sources: Office for National Statistics 2014; Office for Budget Responsibility 2013b; HM Treasury 2013a

NB: UK NHS spend projections assume that growth from 2012 equals inflation (GDP deflator) and that GDP grows at the central Office for Budget Responsibility (OBR) projection in its 2013 Fiscal Sustainability Report (OBR 2013b).
Providers Will Find Increasing Pressures to Focus on Costs and Waste

Traditionally, healthcare providers have prospered without needing to focus on costs and waste…

…but several forces suggest that this will not continue

- Emphasis on revenue growth
- Little price transparency
- Less competitive than most industries
- Typically funded with insured dollars

- Cost inflation > incomes
- Increased out-of-pocket funding
- CMS initiatives focusing on efficiency and cost
- Threat of disruptive, lower cost entrants
- Better credit rating for high safety/high quality providers
The challenge to improve value

Can we look at ways of delivering health care at lower cost at the same time we increase quality and safety?
What is value?

Value should always be defined around the customer, and in a well-functioning health care system, the creation of value for patients should determine the rewards for all other actors in the system.

Since value depends on results, not inputs, value in health care is measured by the outcomes achieved, not the volume of services delivered, and shifting focus from volume to value is a central challenge.

Nor is value measured by the process of care used; process measurement and improvement are important tactics but are no substitutes for measuring outcomes and costs.

What Is Value in Health Care?
Part 2
Introduction to Management Operations

Eugene Litvak
Institute for Healthcare Optimization
Innovation Advisors Program

The Innovation Center seeks to deepen the capacity for transformation by creating a network of experts in improving the delivery system for Medicare, Medicaid and CHIP beneficiaries. The Innovation Advisors Program will inspire dedicated, skilled individuals in the health care system to deepen several key skill sets, including:

- Health care economics and finance;
- Population health;
- Systems analysis; and
- Operations research
Changing Patient Flow through the Parts of the System May Not Optimize Overall Patient Flow

- Can one reduce ED overcrowding just by improving patient flow through the ED?
- Can one improve ICU patient flow by increasing its size?
Reducing the Time of Patient Transfer…

… between two hospital units or the length of stay in the unit may not be right goal

- Do we really want to transfer patients from the ED to Med/Surg bed in one hour?

- Should we “fight” for reducing ICU length of stay?
High Census May Not be a Good Reason for Adding More Beds

- Midnight or midday census? The answer might be …"neither"

- Does the patient mix matter? Which patients mix?

- Does the size of your hospital/unit matter?

- What would you do when your waiting room is full?
Is Your Goal to Have a High Utilization of Your Resources?

- Is this a right goal?
  - What happens when your resources are highly utilized?
  - When utilization is high enough?
Can Your Hospital or Physician Office Reduce Overcrowding?

- Should this be your goal?
  - Do you want to attract more patients?
  - Would more patients reduce overcrowding and wait times?
What is the Right Goal for Patient Flow Improvement?

- Can Operations Management help you to achieve this goal?

- There is a right goal for patient flow improvement – patient throughput and access to care while improving or controlling quality of care!
The Central Health Care Problem: Cost or Quality? To Treat or To Save Money?
Operations Management: An Art or a Science

- Real life problems are not labeled
- Intuitive solutions are frequently wrong
Operations Management

- Complex scientific decisions in uncertain environment
Boundaries: Scientific Limitations, Intuition, and Politics

- Good theory or good results?
- To be right or to be helpful? (Mad bear story)
- What does a model? Simplification of reality or replacement of reality?
- A model for people or a model for robots?
- Unobtainable (?) data
- To be “good” or to be “lucky”?
- Problems unsolved and problems unsolvable
Operations Management

- Main Components
  - Optimization
  - Queuing Theory
  - Network Theory
  - Inventory Management
Part 3 – Table work
Why is Operations Management Theory Relevant to Health Care?

Jason Leitch
A case history - discuss in your groups

You are the duty manager on for the day at your hospital. What are the key issues that face you during the day to ensure there is a good flow and no delays?

10 minutes
Feedback

- How did you assess the problem?
- What data did you have?
- What solutions did you have?

10 minutes
Part 4
Introduction to Queuing

Eugene Litvak
Two Medical ICUs with the Same Patients Acuity

<table>
<thead>
<tr>
<th>5 beds</th>
<th>10 beds</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average LOS  = 2.5 days</td>
<td>Average LOS  = 2.5 days</td>
</tr>
<tr>
<td>Admission rate = 1pt/day</td>
<td>Admission rate = 2pts/day</td>
</tr>
</tbody>
</table>

Do they have the same waiting times to be admitted to these units?
$\bar{T}_w = 0.13$ days

$\bar{T}_w = 0.012$ days
How Many Beds/Nurses/Exam Rooms Do You Need?

Suppose you are coming to a bank...
How Many Beds/Nurses/Exam Rooms Do You Need?

Suppose you are coming to a bank…
Service Mechanism

- Single Server
  00000

- Multiple Servers
  - Serial Servers
  - Parallel Servers
Types of Service

- Queues with waiting
- Queues with rejections
Service Discipline

- First come, first served
- Last come, first served
- Random
- Priorities
Service Time

- Constant service time
- Exponential service time
- Non-stationary service time
- Correlated service time (peak, off-peak hours)
Arrival Patterns

- Regular arrivals with unpunctuality
  - Request $n$ arrivals at the time $(t_n + \varepsilon_n)$
- Aggregated (group) arrivals
- Discrete-time arrivals $(t_1, t_2, \ldots, t_k)$
- Non-stationary arrivals (peak, off-peak arrivals)
- Correlated arrivals (length of the queue)
- Arrivals in a continuous flow (gas)
Main Characteristics

1. Queues with rejections
   - Absolute throughput – the average number of requests served during one time unit
   - Relative throughput – the ratio between the average numbers of requests served and arrived during one time unit
   - Average number of occupied service units
   - Average number of free service units
   - Probability of rejection
Main Characteristics

2. Queues with waiting
   - Average length of queue – the average number of requests waiting for service
   - Average number of requests in the system – the average total number of request being served and waiting for service
   - Average request’s waiting time
   - Average request’s time in the system – the average total time service and waiting time for a request
Notations and Parameters

- **S** - Number of servers

- **\( \lambda \)** - Average number of arrivals per unit of time, \( \lambda = 1/t_a \) (\( t_a \) – average interarrival time interval)

- **\( \mu \)** - Average number of request served per unit of time, \( \mu = 1/t_s \) (\( t_s \) – average service time interval)

- **\( \rho \)** = \( \lambda / \mu \)

- **\( \bar{U} \)** = \( p / S \) – average system’s utilization rate

- **\( p_n \)** – The probability of the system to be in the state \( n \) when \( n \) requests “arrive” to the system:
Queues with Waiting (Parallel Servers)
Queue with Random Arrivals and Exponential Service Time (M/M/S)

**Notations and Parameters**

- **No requests** \((n = 0)\)
  \[
  p_0 = \left[1 + \frac{\rho}{1!} + \frac{\rho^2}{2!} + \ldots + \frac{\rho^{(s-1)}}{(S-1)!} + \frac{\rho^S}{S!(1 + \rho/S)}\right]
  \]

- **No queue** \((0 \leq n \leq S)\)
  \[
  p_n = \frac{p_0\rho^n}{n!}
  \]

- **Queue** \((n > S)\)
  \[
  p_n = \frac{p_0\rho^n}{S!S^{(n-s)}}
  \]
Main Characteristics

- Probability $P(S_s)$ that all the servers are serving requests can be computed by the following formula:
  $$P(S_s) = \rho^s \cdot S \cdot p_0 / S! \cdot (S - \rho)$$

- The average number ($\bar{N}_l$) of requests in line can be computed by the following formula:
  $$\bar{N}_l = P(S_s) \cdot \rho / (S - \rho) = [\rho^{(s+1)} \cdot S \cdot p_0] / [S!(S - \rho)^2]$$

- The average number ($\bar{N}_s$) of requests in service is equal to: $\bar{N}_s = \rho$

- The average number ($\bar{N}$) of requests in system can be computed by the following formula:
  $$\bar{N} = \bar{N}_l + \bar{N}_s$$
- The average waiting time ($\tilde{T}_w$) for a request can be computed by the following formula:
  $$\tilde{T}_w = \frac{\tilde{R}_l}{\lambda}$$

- The average system time ($\tilde{T}$) for a request can be computed by the following formula:
  $$\tilde{T} = \frac{\tilde{R}_l + \tilde{R}_s}{\lambda}$$
\[ \lambda = 0.8 \cdot \mu \cdot S \]

\[ \rho = 0.8 \cdot S \]
Applying Queuing Theory: Examples

1. Triage
2. Two ICUs
Example: Triage on Monday

On Monday morning at 8am, there are 2 triage nurses on duty. They can each serve one patient every 3 minutes. The Monday morning arrival rate is 20.8 patients/hour.

What is the waiting time?
The average patient waiting time ($\bar{T}_w$) can be computed by the following formula:

$$\bar{T}_w = \bar{R}_l/\lambda$$

The average number ($\bar{R}_l$) of patients in line can be computed by the following formula:

$$\bar{R}_l = P(S_s) \cdot \rho / (S-\rho)$$

Probability $P(S_s)$ that all $S$ “servers” are busy:

$$P(S_s) = \rho^s \cdot S \cdot \rho_0 / S! \cdot (S-\rho) \quad (Table)$$
\( \lambda, \mu, S \)

\[ \lambda = 20.8 \ , \ \mu = 1/3 \text{min} = 20, \ S = 2 \]

\[ \rho = \frac{\lambda}{\mu} = 1.04 \]

\[ P(Ss) \ (\text{table}) \approx 0.33 \]

\[ \dot{R}_l = P(Ss) \cdot \rho \cdot (S - \rho) = 0.33 \cdot 1.04/(2 - 1.04) \approx 0.36 \]

\[ \dot{T}_w = \frac{\dot{R}_l}{\lambda} = \frac{0.36}{20.8} = 0.017 \text{ h} = 1.04 \text{ min} \]
Example: Triage on Friday

- On Fridays at 4 PM, the arrival rate is about 10.3 patients/hour. There is one triage nurse at this time, who can serve one patient every 3 minutes.

- What is the waiting time?
\( \lambda, \mu, S \)

\( \lambda = 10.3, \mu = 1/3 \text{min} = 20, S = 1 \)

\( \rho = \lambda/\mu = 0.52 \)

\( P(Ss) \) (table) \( \approx 0.52 \)

\( \dot{R}_l = P(Ss) \cdot \rho/(S-\rho) = 0.52 \cdot 0.52/(1 - 0.52) \approx 0.56 \)

\( \dot{T}_w = \dot{R}_l/\lambda = 0.56/10.3 = 0.054 \text{ h} = 3.28 \text{ min} \)
Two Medical ICUs with the Same Patients Acuity

<table>
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</tr>
</tbody>
</table>

Do they have the same waiting times to be admitted to these units?
1st ICU

$\lambda, \mu, S$

$\lambda = 1, \mu = 1/2.5 = 0.4, S = 5$

$\rho = \lambda/\mu = 2.5$

$P(S_s) \text{ (table)} \approx 0.13$

$R_l = P(S_s) \cdot \rho / (S - \rho) = 0.13 \cdot 2.5 / (5 - 2.5) \approx 0.13$

$T_w = R_l/\lambda = 0.13/1 = 0.13 \text{ days}$
\( \lambda, \mu, S \)
\( \lambda = 2, \mu = 1/2.5 = 0.4, S = 10 \)

\( \rho = \frac{\lambda}{\mu} = 5 \)

\( P(Ss) \) (table) \( \approx 0.036 \)

\( \bar{R}_l = P(Ss) \cdot \rho / (S - \rho) = 0.036 \cdot 5 / (10 - 5) \approx 0.036 \)

\( \bar{T}_w = \frac{\bar{R}_l}{\lambda} = 0.036/2 = 0.018 \) days
1st ICU

\[ \check{T}_w = 0.13 \text{ days} \]

2nd ICU

\[ \check{T}_w = 0.018 \text{ days} \]
Part 5
Introduction of Variability Concept and Methodology

Eugene Litvak
Institute for Healthcare Optimization
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
New IOM report

BEST CARE AT LOWER COST
The Path to Continuously Learning Health Care in America
“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.”

Quotes from the 2006 IOM report *The Future of Emergency Care in the U.S. Health System (Hospital-Based Emergency Care: At the Breaking Point)*
“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)…”

Quotes from the 2006 IOM report
The Future of Emergency Care in the U.S. Health System
(Hospital-Based Emergency Care: At the Breaking Point)
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
Major health care delivery problems

- Patient Safety
- Nurse understaffing/overloading
- ED diversions/access to care
- High cost
- Hospital resources needed for bioterrorism preparedness

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

![Graph showing # of Patients over Time]
Systemic Effects of Peak Loads

- Internal Divert – Patients sent to alternative floors\Intensive Care locations
- Internal Delays – PACU backs up
- External Divert - ED divert
- Staff overload – medical errors and inability to retain staff
- System Gridlock – Increase in LOS
- Decreased throughput and revenue
Controlling the total cost, without knowing cost of delivery, decreases quality.

Take-out Pizza Example


“By applying variability methodology, queuing theory and the I/T/O model, hospitals can identify and eliminate many of the patient flow impediments caused by operational inefficiencies”

“By smoothing the inherent peaks-and-valleys of 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”

Quotes from the 2006 IOM report
The Future of Emergency Care in the U.S. Health System
(Hospital-Based Emergency Care: At the Breaking Point)
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?
1. Clinical Variability
2. Flow Variability
3. Professional Variability

- Random
- Can not be eliminated (or even reduced)
- Must be optimally managed
Designing and Testing Complex Mechanical Systems: The Family Car

- Hitting a pothole vs. high speed impact against the wall
- Health care “financial bumper”

Are the stresses an intrinsic part of health care delivery?
What makes hospital census variable?
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
Why managing variability today is more important than before?
Does the healthcare system need more capacity?
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?

Slide provided by Sandeep Green Vaswani, Institute for Healthcare Optimization
Is this about access to care?
Variability and access to care

- ED
- ICU
- Floors
- Scheduled demand
Alternative to Managing Variability!?
Can you solve your ED, ICU or Med/Surg units overcrowding without smoothing elective admissions?

Can you match your capacity and demand without throwing excessive resources at the system by other means without smoothing elective admissions?
After elective patient flow is smoothed *(and only then!)* the right size of the hospital units could be determined for both scheduled and unscheduled admissions.
Do you always place every patient into the appropriate bed? What happens if you do not?

How important is to know the right size of the unit?
Rapid Response Team

Does the Rapid Response Team helps at your hospital?

Why?

Elective Surgical Requests vs Total Refusals

Variability and health care-associated infection

“There was a significant association between patient-to-nurse ratio and urinary tract infection (0.86; P ¼ .02) and surgical site infection (0.93; P ¼ .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 .03) and surgical site infection (1.56; P < .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.”

Variability and Readmissions

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
Is this about nurse staffing as well?

Can you provide an adequate nurse staffing without smoothing elective admissions?
What is easier: to talk to your colleagues or to the lawyers?!


http://www.healthleadersmedia.com/content/LED-269595/PDH-Understaffing-a-Possible-Factor-in-Deaths-at-CRMC##
Five ways of staffing

Nursing August 2011


1. Staff hospitals 24/7 according to the peaks in both bed occupancy and admissions.
2. Be “creative” by introducing dynamic PNRs that will fluctuate in a synchronous manner with census and admissions.
3. Legislate/regulate PNRs.
4. Preserve the status quo and do nothing.

http://www.nhmedmallawyer.com/blog/post/sho
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*

- “…higher numbers of nurse hours per patient, larger proportions of RNs and high levels of competition with other hospitals were all correlated with higher levels of NQF Safe Practices adoption.”**

*Dennis S. O’Leary - former president of JCAHO (personal communication)

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 $4 + 1 = 5$ patient 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%.
“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 “

Five ways of staffing

Nursing August 2011

http://journals.lww.com/nursing/Fulltext/2011/08000/Nurse_staffing__hospital_operations__care_quality_.1.asp
Quality and Safety Corner at [www.ihoptimize.org](http://www.ihoptimize.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 »](http://www.ihoptimize.org)
Part 6
Applications to the health care problems
Applying theory to the front line

Eugene Litvak
Jason Leitch
Peter Lachman
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

Phases 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 ≈ $1 million in capital cost + over $.25 million annual operational cost)
Managing variability in patient flow: Success stories

Managing Patient Flow: A Focus on Critical Processes

http://store.trihost.com/jcaho/product.asp?dept%5Fid=34&catalog%5Fitem=712
Case Study: Cincinnati Children’s

- 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
Their opinion…

“This is the best thing for ortho since I have been here…we get our cases done earlier which makes our families very happy…patients don’t have to wait NPO until the evening. The weekends are unbelievably good, the OR hostility that was previously present has been virtually eliminated”. (Ortho surgeon, Division director)
“I feel there is an improvement in our time and efficiency when assigning staff. We are assigning add-on staff the day before instead of pulling them from other rooms...” (OR nurse)
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.
Case Study: Mayo Clinic (Fl)

CHANGES IN OPERATIONAL PERFORMANCE OF OPERATING ROOMS

<table>
<thead>
<tr>
<th></th>
<th>Pre-Re-Design</th>
<th>Post-Re-Design</th>
<th>% Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surgical Cases (count)</td>
<td>11,874</td>
<td>12,367</td>
<td>4%</td>
</tr>
<tr>
<td>Surgical Minutes</td>
<td>1,757,008</td>
<td>1,844,479</td>
<td>5%</td>
</tr>
<tr>
<td>Prime Time OR Utilization</td>
<td>61%</td>
<td>64%</td>
<td>5%</td>
</tr>
<tr>
<td>Number of Overtime FTE's (average)</td>
<td>7.4</td>
<td>5.4</td>
<td>-27%</td>
</tr>
<tr>
<td>Staff Turnover Rate</td>
<td>20.3%</td>
<td>11.5%</td>
<td>-43%</td>
</tr>
<tr>
<td>Daily Elective Room Changes (Average/Mon)</td>
<td>80</td>
<td>25</td>
<td>-69%</td>
</tr>
<tr>
<td>Daily Elective Room Changes (%)</td>
<td>8%</td>
<td>2%</td>
<td>-70%</td>
</tr>
<tr>
<td>Cost/Case (added 15 OR Staff FTEs)</td>
<td>$1,062</td>
<td>$1,070</td>
<td>0%</td>
</tr>
<tr>
<td>Cost/Minute of Surgery (added 15 OR Staff FTEs)</td>
<td>$7.18</td>
<td>$7.26</td>
<td>1%</td>
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<tr>
<td>Staff Turnover Cost (millions)</td>
<td>$2.47</td>
<td>$1.40</td>
<td>-43%</td>
</tr>
<tr>
<td>Overtime Cost Savings</td>
<td></td>
<td>$111,488</td>
<td></td>
</tr>
<tr>
<td>Total OR Net Revenue (fee increase adjusted)</td>
<td>$93,929,569</td>
<td>$98,686,693</td>
<td>5%</td>
</tr>
<tr>
<td>Net Operating Income</td>
<td>$15,877,986</td>
<td>$21,957,708</td>
<td>38%</td>
</tr>
<tr>
<td>Operating margin</td>
<td>17%</td>
<td>22%</td>
<td>28%</td>
</tr>
</tbody>
</table>

Case Study: Johns Hopkins Hospital

Major Metrics

- Urgent/Emergent Access (Average Waiting Time and Compliance with targets)
- Throughput (Average case volume NHD)
- Prime Time Utilization (% of allocated used)
- After Prime Time work (Average minutes used)

Source: Dr. Jackie Martin, Medical Director of Perioperative Services for the Johns Hopkins Hospital; Professor, Anesthesiology and Critical Care Medicine
In Summary

- Waiting time decreased by 39%
- Compliance increased by 16.7% despite no dedicated Cardiac or Pediatric level rooms
  - Level I compliance increased from 24% to 81%
- Throughput increased
  - 5 cases per day in the GOR/Weinberg
  - 4 cases per day in JHOC
- Prime Time Utilization provides additional room for substantially more throughput
  - Additional 7 cases per NHW at 85% PT utilization
- No increase in afterhours case minutes
- 6.6% decrease in the proportion of overtime minutes
- Case length decrease reflects increased team performance
  - Provides 1 “free” additional room per day

Source: Dr. Jackie Martin, Medical Director of Perioperative Services for the Johns Hopkins Hospital; Professor, Anesthesiology and Critical Care Medicine
### Phase I Estimated ROI

<table>
<thead>
<tr>
<th>Relative to Assessment (Mar-Jun 2010)</th>
<th>Relative to Pre-Implementation (Sep-Nov 2011)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Previous Cases/ NHW</td>
<td>87</td>
</tr>
<tr>
<td>Current Cases/ NHW</td>
<td>92</td>
</tr>
<tr>
<td>Incremental Cases/ NHW</td>
<td>5</td>
</tr>
<tr>
<td>Incremental Margin/ Year*</td>
<td><strong>$6,350,000</strong></td>
</tr>
</tbody>
</table>

*Assumes $5,000 margin per case x 254 Non-Holiday Weekdays per Year

**Source:** Dr. Jackie Martin, Medical Director of Perioperative Services for the Johns Hopkins Hospital; Professor, Anesthesiology and Critical Care Medicine
Elliot Hospital  (Maternity ward)

- Eliminated morning chaos
- Reduced the demand for additional staffed beds by 6 positions (50%)
- Improved quality of care
IHO State-wide collaborative to improve patient safety and quality of care while reducing its cost

Partnership for Patients - New Jersey

News

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»

U.S. Senator Robert Menendez (Senate Finance Committee) at the Partnership for Patients New Jersey kick-off on January 30, 2012
IHO State-wide collaborative to improve patient safety and quality of care while reducing its cost

- 11,800 to 17,300 additional patients that could be treated without adding inpatient beds or operating rooms
- Roughly 20,000 additional patients that could be accommodated in hospital emergency departments
- 21 percent to 85 percent decrease in wait times for emergency department patients to be admitted to a hospital bed
- Reductions in the length of hospital stays ranging from 3 percent to 47 percent for certain groups of patients

Collaborative in Scotland
Three alternatives:

- Provide the resources (e.g., staffing) sufficient to meet current patient peaks in demand - historical scenario

- Staff below the peaks and tolerate ED diversions, nursing overloading and medical errors - current scenario

- **Smooth artificial variability and provide the resources to meet patient (vs. schedule) driven peaks in demand. Variability methodology can quantify and justify such additional resources**
What would be national return on investment from applying these concepts?

OECD Acute Care Bed Occupancy

Acute Care Bed Occupancy 2009
OECD Health Data

<table>
<thead>
<tr>
<th>Country</th>
<th>Occupancy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Canada</td>
<td>90%</td>
</tr>
<tr>
<td>Norway</td>
<td>88%</td>
</tr>
<tr>
<td>Switzerland</td>
<td>86%</td>
</tr>
<tr>
<td>Ireland</td>
<td>86%</td>
</tr>
<tr>
<td>UK</td>
<td>84%</td>
</tr>
<tr>
<td>Japan</td>
<td>79%</td>
</tr>
<tr>
<td>Austria</td>
<td>79%</td>
</tr>
<tr>
<td>Spain</td>
<td>79%</td>
</tr>
<tr>
<td>Germany</td>
<td>76%</td>
</tr>
<tr>
<td>Italy</td>
<td>76%</td>
</tr>
<tr>
<td>France</td>
<td>73%</td>
</tr>
<tr>
<td>U.S.</td>
<td>67%</td>
</tr>
</tbody>
</table>
US hospitals are 1/3 empty and overcrowded!!!
National Opportunity – An Example

• Based on AHA 2010 data, overall nationwide hospital inpatient occupancy was about 66%
• 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
• Potential savings of tens of billions of dollars annually

1 From Front Office to Front Line- Joint Commission Resources, chapter 4: Optimizing Patient Flow by Managing its Variability


National Opportunity – An Example

“Early hospital adopters such as Cincinnati Children’s Hospital (CCH) have been able to increase hospital throughput capability by more than 15%\(^1\). If the experience of early hospital adopters proves generalizable, it will reduce U.S. hospital cost per admission by \(\sim 15\) percent. Since hospitalizations, including outpatient procedures, consume over 30 percent of US health care spending, this single improvement would reduce the cost of U.S. health insurance by roughly 4-5 percent if hospitals pass savings through to insurers and insurers, in turn, to insurance buyers. It is also likely to reduce hospital mortality by sparing hospital nursing units preventable bulges in the number of new patients they must admit in a single day.” \(^2\)

These 4%-5% mean over \$1 trillion in 10 years.


Variability Methodology® Endorsements

- **Institute of Medicine ED report**: The Institute of Medicine has embraced Variability Methodology’s role in addressing the problem of ED overcrowding in its 2006 report,

- **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.


- **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

Unmanageable Nurse: Patient staffing leading to overwork and stress

2-4% increase in mortality risk for each exposure to an understaffed shift

Up to 500%+ increase in odds of readmission

Diversion and delays for Emergency Department patients

Increased medical errors, infections and non-compliance with NQF safe practices

Unnecessary launches of Rapid Response Teams

Patient Flow Variability

“...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“ *)


Mortality, Readmissions, Medical Errors, High Cost vs. Health Care “Culture”: What Will Prevail?

You decide!
The systems approach to flow at GOSH
Great Ormond Street

- Analysed our data to see variability
- Then developed programmes to implement change
- The following data is from one of the workstreams
Great Ormond Street

- Tertiary and quaternary hospital
- No Emergency Room
- However variability is still a problem
- How do we deal with this
  - Analysis of data
  - Understand the problem
  - Develop the model for system wide change
Where is the problem?

- Inpatient beds
- Diagnostic procedures
- Operating room
- Outpatients
ANALYSIS 2008
GOSH Admissions By Date

Program for Management of Variability in Health Care Delivery  Boston University Health Policy Institute
Admissions By Urgency and Date

Program for Management of Variability in Health Care Delivery  Boston University Health Policy Institute
Elective Inpatient Admissions by Use of Theatres
Non-holiday Weekdays

Program for Management of Variability in Health Care Delivery  Boston University Health Policy Institute
Inpatient vs. Day Case Admissions: Non-holiday Weekdays Only

Program for Management of Variability in Health Care Delivery  Boston University Health Policy Institute
Discharges by Date

Program for Management of Variability in Health Care Delivery  Boston University Health Policy Institute
Summary

- While day case patients comprise majority of admissions, true inpatients have most impact

- Substantial variability in elective admissions
  - Theatre cases comprise large majority

- Wasted bed & theatre capacity

- Improved scheduling of elective admissions, especially theatre cases, needed
# Recommendations to GOSH

<table>
<thead>
<tr>
<th>Recommendation</th>
<th>Current</th>
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</thead>
<tbody>
<tr>
<td>Central management of admissions</td>
<td>Yes ...starting</td>
</tr>
<tr>
<td>Establishment of a central ‘patient flow team’</td>
<td>Yes</td>
</tr>
<tr>
<td>Central management of operationally-relevant information systems</td>
<td>Yes</td>
</tr>
<tr>
<td>Improve collection and reporting of flow data</td>
<td>Yes</td>
</tr>
<tr>
<td>Separate emergency and elective beds</td>
<td>No</td>
</tr>
<tr>
<td>Separate resources for day case and inpatients</td>
<td>+/-</td>
</tr>
<tr>
<td>Determine best management strategies for ‘high utiliser’ patients</td>
<td>+/-</td>
</tr>
<tr>
<td>Reconfigure wards into larger units</td>
<td>+/-</td>
</tr>
</tbody>
</table>
GOSH WORK 2009 -2010
CARDIO RESPIRATORY
Cardiac VFM Pilot: Weekly Theatre Throughput and Critical Flow Failures

- **High variability - process unpredictable**
- **Reduced variability - process more predictable**

**New solution go live**

**PDSA: flow management taken on by operational manager**

- **Increasing NHS + IPP throughput**
- **Decreasing critical flow failures** (cancellations, emergency refusals and nursing shifts lost to sickness)

**Weekly theatre throughput**

**Weekly theatre critical flow failures**

**Date**

Copyright Great Ormond Street
Theatre Cancellations

The percentage of cancelled cardiac theatre cases

The percentage of cardiac theatre cases cancelled each week that were not performed on the day, or on the day after the initial cancellation.

<table>
<thead>
<tr>
<th>Pre go-live average</th>
<th>Target</th>
<th>Current</th>
</tr>
</thead>
<tbody>
<tr>
<td>13%</td>
<td>10%</td>
<td>6.3%</td>
</tr>
</tbody>
</table>
# Emergency Booking Summary (VCB only)

Click on classification to drill down

<table>
<thead>
<tr>
<th>Classification</th>
<th>Total</th>
<th>Hit Target</th>
<th>Missing Booking Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emergency A &lt; 30 Minutes</td>
<td>1</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Emergency B &lt; 2 Hours</td>
<td>8</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>Emergency C &lt; 4 Hours</td>
<td>20</td>
<td>10</td>
<td>1</td>
</tr>
<tr>
<td>Emergency D &lt; 8 Hours</td>
<td>9</td>
<td>6</td>
<td>0</td>
</tr>
<tr>
<td>Emergency E &lt; 24 Hours</td>
<td>17</td>
<td>13</td>
<td>0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Average Wait (mins)</th>
<th>Percent Hit Target</th>
<th>Target</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>100.0%</td>
<td>30</td>
</tr>
<tr>
<td>565</td>
<td>62.5%</td>
<td>120</td>
</tr>
<tr>
<td>339</td>
<td>50.0%</td>
<td>240</td>
</tr>
<tr>
<td>713</td>
<td>66.7%</td>
<td>480</td>
</tr>
<tr>
<td>870</td>
<td>76.5%</td>
<td>1440</td>
</tr>
</tbody>
</table>
Emergency C < 4 Hours

Emergency theatre cases for VCB theatres - past month

Emergency D < 8 Hours
U4 (H4/H1) - End utilisation of original planned theatre hours: All Main Theatres, Cleft

- % patient operations hours utilised (U4)
- Week start date

- Measure
- UCL
- LCL
- Mean
Decrease in lost time

Percentage of scheduled theatre time lost to late starts: Safari (heam/onc)
And to late finishes
Decease in cancellations
Decrease cancellations
The future

- Good foundation to address underlying variation
- Good data set available
- Now looking at case by case variation
Patients:

• Reduced waiting time and improved access to care
• Reduced mortality and medical errors

Nurses:

• Reduced overtime
• Reduced workload
Conclusion- What is here for me?

**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
Readings

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

http://www.ihoptimize.org
http://www.ihoptimize.org/knowledge-center-publications.htm
Quality and Safety Corner

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, ED boarding and others. Learn more »

Healthcare Cost Corner

Hospital costs can be decreased by millions of dollars annually by adopting the Institute for Healthcare Optimization’s approach to managing variability in healthcare delivery. Learn more »

A Case Study

How one hospital increased annual revenue by $137M, and avoided $100M in cost, while improving quality of care Learn more »

ROI Estimator

Estimate your hospital's ROI. Read More »
Some helpful links:


http://www.rwjf.org/pr/product.jsp?id=50488


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.
What is next?
Three alternatives:

1. Provide the resources (e.g., staffing) sufficient to meet current patient peaks in demand - historical scenario

2. Staff below the peaks and tolerate ED diversions, nursing overloading and medical errors - current scenario

3. Smooth artificial variability and provide the resources to meet patient (vs. schedule) driven peaks in demand. Variability methodology can quantify and justify such additional resources