

# Optimizing the Treatment Planning Process

## Systems Engineering Tools for Treatment Planning Process Optimization in Radiation Medicine

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## SESSION LEARNING OBJECTIVES

1. Gain familiarity with the workflow of modern treatment planning process.
2. Understand the scope and challenges of managing modern treatment planning processes.
3. Gain familiarity with Six Sigma approaches and their implementation in the treatment planning workflow.
  - Summary of our initiatives at North Shore-LIJ
  - Lean 6 $\sigma$  reducing *Overhead: Head & Neck Process Illustration*
  - 6 $\sigma$  DMAIC in Treatment Process : *Safety, Quality*



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## Disclosures

- None



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## NSLIJHS QM TEAM

- Louis Potters, MD
- Beatrice Bloom, MD
- Lucille Lee, MD
- Brett Cox, MD
- Rajiv Sharma, MD
- Regina Stanzione (ADMIN)
- Carol Morgenstern, RN
- Elaine Montchal, RN
- Jacob Pinsky (IT)
- James Mogavero (IT)
- Henry Chou, PhD (IT)
- Ajay Kapur, PhD
- Yijian Cao, PhD
- Anurag Sharma, MS
- Gina Goode, CMD
- Jeffrey Antone, CMD
- Lili Vijeh, CMD
- Petrina Zuvic, RTT
- Nilda Adair, RTT
- Sherin Joseph, RTT
- Catherine Riehl, RTT
- Michael Interrante, RTT




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## Radiation Medicine at North Shore-LIJ



- A blend of Academic, Private and Community Based Practice
- 8 Locations, 16 Radoncos, 7 dosimetrists, 18 physicists, >100 staff;
- 2800 consults/yr; 200 patients/day
- Various treatment platforms
  - Trubeams, EX series, Gamma Knife, Cyberknife, Tomotherapy, Zeiss, HDR, PSI, SIRT, Xofigo ....
- Paperless and Quality Checklist (QCL) Driven since 2007




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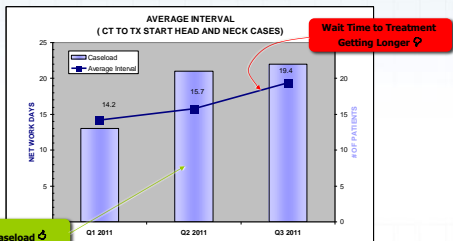
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## A Head and Neck Problem (2011)



A Rising Caseload

Wait Time to Treatment Getting Longer

Can we reduce wait time while absorbing increased volume? Simple High Impact Solutions?




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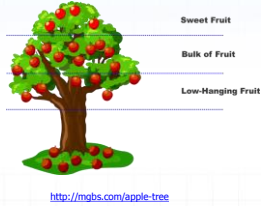
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## LEAN SIX SIGMA ILLUSTRATION

### • What is Lean Six Sigma?

- collaborative team
- improve performance
- **remove overhead**



## Kaizen H&N Project

### 1 GATHER THE TEAM



### 2 PROCESS MAPPING



### 3 DEFECT IDENTIFICATION



#### TIMWOOD

- Transportation.
- Inventory.
- Motion.
- Waiting.
- Overproduction.
- Overprocessing.
- Defects/Rework.
- Also include people (human capital).

### 4 DEFECT STRATIFICATION

Categories	# of Cat.
Repetitive Steps	30
Scheduling	13
Safety	4
Technical Workflow	12
Process Workflow	23
Systems Integration (Technical)	3
<b>Total</b>	<b>85</b>

### 5

### PRIORITIZATION MATRIX



## SOLUTIONS

#### Short Term

- ✓ Place scanner by nurse's WS
- ✓ Merge outlook/Mosaic schedules
- ✓ Appointment Checklist
- ✓ Morning Huddles – SMART Rounds
- ✓ Recruitment of PA

### 6

### IMPLEMENT SOLUTIONS

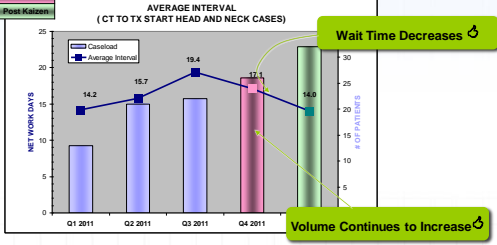
Category	Item	Owner	Start Date	End Date
Inventory	Place scanner by nurse's WS	[Name]	[Date]	[Date]
Inventory	Merge outlook/Mosaic schedules	[Name]	[Date]	[Date]
Inventory	Appointment Checklist	[Name]	[Date]	[Date]
Inventory	Morning Huddles – SMART Rounds	[Name]	[Date]	[Date]
Inventory	Recruitment of PA	[Name]	[Date]	[Date]
Process	Velocity Purchase [Contours, Fusion]	[Name]	[Date]	[Date]
Process	Development of Whiteboard	[Name]	[Date]	[Date]

#### Long Term

- ✓ Velocity Purchase [Contours, Fusion]
- ✓ Development of Whiteboard

## Quick Results .. Sustained...

### 1. Early Response to Solutions for MD, 1 Tx machine



16 -> 14 day turnaround despite 2.5X increase in volume for MD

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## SIX SIGMA DMAIC INITIATIVES

Enhance Safety, Quality  
In Treatment Planning Workflow

North  
Shore-LIJ

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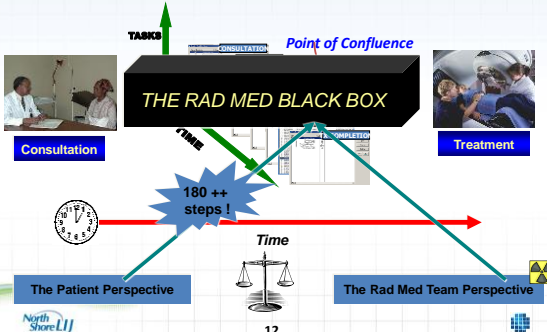
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## The Radiation Medicine System

The value added by the system depends on how well the parts are interconnected (Rechtin, 2000)



North  
Shore-LIJ

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## NSLIJHS : The beginnings: 2007-2009

- **Tasks Accomplished**

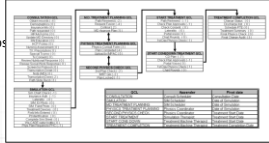
- Incorporated many recommendations
- Paperless EMR across Health System
- Quality Checklist Process (QCL) Driven

• Training  
• Staffing  
• P&P  
• Incident Learning  
• Communication  
• Checklists

• QC  
• Documentation  
• PMI  
• Dosimetric Audits  
• Accreditation  
• Safety Culture

- **Opportunity to become evidence/outcome driven**

- Performance metrics on process steps
  - mean, standard deviation
- Measurable, analyzable and potentially controllable
- Amenable to 6 $\sigma$  process control
- All sites, locations



A 6 sigma opportunity!

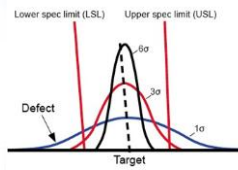
North Shore LIJ

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## Shifting Focus to 6 $\sigma$

- **Focuses on quality by identifying & mitigating causes of defects and minimizing variability in processes.**

- Define, Measure, Analyze, Improve and Control Quality [DMAIC]



SIGMA LEVEL $\sigma$	DEFECTS PER MILLION OPPORTUNITIES	EXAMPLES
2	308,538	Restaurant Bills Airline Baggage Doctor's Prescription
3	66,807	Average Company
4	6,210	
5	233	Best Companies
6	3.4	Airline Safety

North Shore LIJ

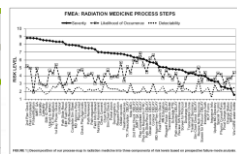
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### DEFINE: High Risk Steps

## What are the high risk steps?

- **Moving toward safer radiotherapy requires active surveillance of associated failures, causes and effects, & evidence-based mitigation**

- Surveillance may be reactive (incident learning) or proactive (FMEA etc)
- Assumption: every effect has cause (s); every cause may have an effect (s)
- Must used combined approach, neither is independently sufficient



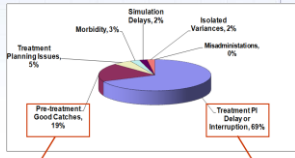
North Shore LIJ

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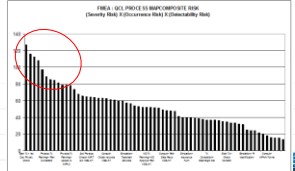
## DEFINE: High Risk Steps

**Incident**  
Incident learning and failure-mode-and-effects-analysis guided safety initiatives in radiation oncology  
doi:10.1186/1745-6215-11-118  
Jin Han, Chi-Chieh Chang, Hai-Wei Chen, Pei-Chi Wu, Wen-Ming Chen, Wen-Chang Chang, Chi-Sheng Huang, Tzong-Hong Jason Jan, Yi-Hsin Shiao, Li-Feng Chen, Sheng-Chieh Chen, Sheng-Chieh Chen, Sheng-Chieh Chen, Sheng-Chieh Chen

- Combined Procedures
- Tx: Prescription
- Tx: Consent
- Path Reviewed (Before Sim)
- Contour
- Plan Completed
- 2nd Plan Check
- IMRT QA
- Laterality (start Tx)
- 1st Day Physic Check



**Errors Propagate** **Task Delays Occur**



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## MEASURE

### Baseline High Risk Tasks

- Metadata for QCL<sup>H</sup> at baseline:
  - 40% of QCL<sup>H</sup> were delayed
  - 70% of contours and plan tasks were delayed
  - Majority of patients had some QCL<sup>H</sup> delayed, yet staff rushed to 'get it done'
  - Large variability in staff performance on QCL<sup>H</sup>

**We were at higher risk than perceived**

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## ANALYZE

### Why defects? Three Main Causes for Failures

1. **Timeliness & accuracy of high-risk-process steps**
  - 40% variances germinated from issues clustered around tasks
  - Requisite information at the right time from the right source
  - Ineffective handoffs/communications, coordination
  - Not just staff delinquencies
2. **Cultural pathogens**
  - Delay Rushed Processes (>75% of pts with QCL<sup>H</sup> delays not delayed)
  - Experience based rather than evidence based directives
3. **Variability**
  - Handful of staff: ++ high-risk task delays/issues >> pt volume/complexity
  - More patient effects—delays, safety events

**Call for Better Standards, process interlocks, peer review, coordination**

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**IMPROVE**

## Risk Mitigation Strategies

INITIATIVE	SEVERITY	LIKELIHOOD	DETECTABILITY	METRIC
Care Pathway Standardization	X		X	Compliance Rate
Toxicity Scale Standardization	X		X	Inter-rater reliability kappa
Pre Tx Planning Peer Review [SMART Rounds]	X	X	X	MD GPA on Peer Review
No Fly Policy	X	X	X	Delay Rates
Electronic Whiteboard		X	X	Incident Reporting Rates
Monitoring High Risk Task Operation			X	Z-scores




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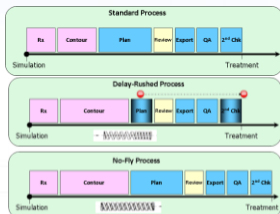
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**IMPROVE**

### Common Terminology Criteria for Adverse Events (CTCAE) Version 4.02

**REDUCE VARIABILITY**



**PEER REVIEW INTERLOCKS BEFORE TX PLANNING**

**PROCESS INTERLOCKS BEFORE TREATMENT**




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**IMPROVE**

**WHITEBOARD: COORDINATION & TRANSPARENCY IN WORKFLOW**

- EBRT Management
- Incident Reporting
- Plan Census
- SMART Rounds
- HDR Management
- 1<sup>st</sup> Day Physics Check




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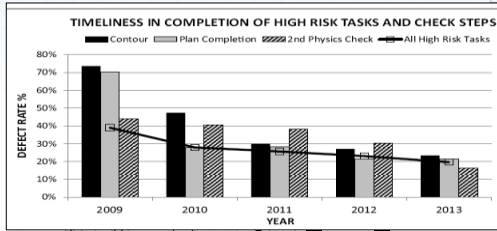
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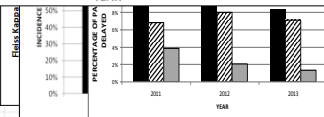
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**CONTROL**

## SUSTAINED OUTCOMES



- Operational Z-scores
  - Increased from 1.7




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## SUMMARY

- 6σ tools led to workflow and safety culture improvements
  - Provided a structured framework to guide quality management & report regularly
  - Sustained improvements over the past 5 years of implementation in our department.
- Driving initiatives has challenged traditional norms of operations
  - such as expediting treatment initiation in delay-rushed environments
  - sustaining care pathways that are more experience based than evidence-based
- Implementation has met with substantial cultural barriers
  - Working practices evolve over decades, and changing them creates uncertainty
  - The inertia of sustaining past cultures and arguments for not changing tend to persevere
  - Direct persuasion only goes so far.
- Other centers could institute these initiatives without replicating formative effort, yet for others there may be value in validating this work




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## REFERENCES

**2012**

- pro: Six sigma tools for a patient safety-oriented, quality-checked direct radiation medicine department
- pro: Implementation of a "No Fly" safety culture in a multiantenna radiation therapy department
- OUR PLEDGE TO A BETTER DAY
- Development, implementation, and compliance of treatment pathways in radiation medicine

**2013**

- Incident learning and failure-mode-and-effects-analysis guided safety initiatives in radiation medicine

**2014**

- The safety hazard

**Thank You!**  
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