



A Teaching Affiliate
of Harvard Medical School

The Green Revolution: Massachusetts General Hospital's Conversion to Electronic Medical Records

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1811 - 2011



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Talk Overview

Electronic Conversion

- Rationale
- Timeframe
- Workflow Impact
- Technical Aspects
- Limitations + Modifications
- Dosimetry Role



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Massachusetts General Hospital



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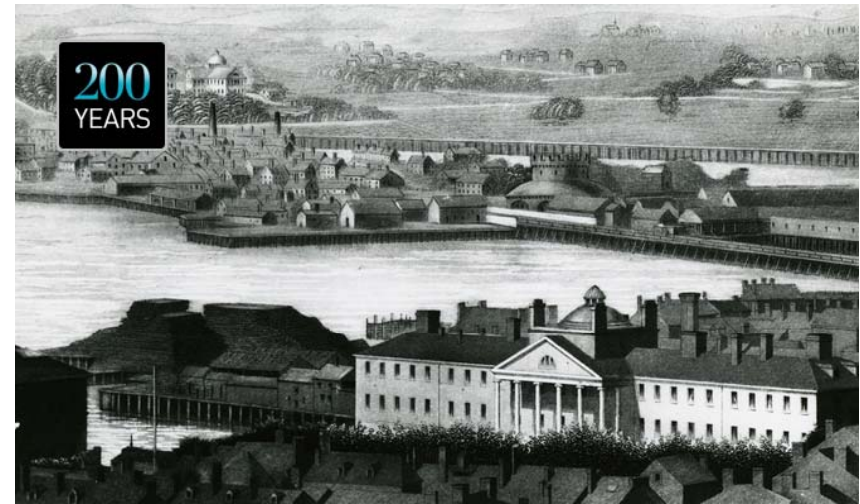
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Massachusetts General Hospital

- Clark Center for Radiation Oncology - Boston, Massachusetts
 - Treat approximately 200 patients per day
- Francis H. Burr Proton Therapy Center - Boston, Massachusetts
 - Treat approximately 50 patients per day
- Satellite Facilities
 - 3 locations in Boston suburbs
 - MGH/North Shore Cancer Center - Danvers, Massachusetts
 - Newton Wellesley Hospital - Newton, Massachusetts
 - Emerson Hospital - Concord, Massachusetts
 - Combined to treat approximately 100 patients per day

Massachusetts General Hospital

- Main Campus Staff Makeup
 - 22 Radiation Oncologists
 - 11 Medical Residents
 - 23 Medical Physicists
 - 22 Medical Dosimetrists
 - 50 Radiation Therapy Technologists
 - 10 Information Systems Technologists
 - 16 Nurses
 - 20 Administrative Assistants
 - 15 Management Personnel



Rationale

- Hospital wide decision
 - MGH aspires to be paperless facility
- Improve Overall Efficiency
- Cost Effective
 - Save \$35,000 per year in paper-related costs
- Government Role
 - [American Recovery and Reinvestment Act of 2009](#)
 - Subsidies for physicians
 - 2015 for Medicare/Medicaid reimbursements



Rationale

- Networking among multiple facilities
 - Main Campus – Downtown Boston
 - Burr Proton Facility – Downtown Boston
 - MGH/North Shore Cancer Center – Suburban Boston
 - Newton Wellesley Hospital – Suburban Boston
 - Emerson Hospital – Suburban Boston
- Ease of medical record sharing
 - Electronic files sent to/from outside institutions for review
 - Patients are primarily local to New England, but sizeable national and international patient population

Timeframe

- Winter 2008
 - Feasibility Study with hospital seed money
 - Project Launch
 - Multi-dimensional task group formed
 - Physician, Therapy, Nursing, Physics, Information Systems, and Administrative staff
 - Role Group Specific workflow to be generated
 - Spring 2009 deadline set for rollout
- Spring 2008
 - Workflow items analyzed
 - Gap analysis performed
 - Vision statement generated with timeline

Timeframe

- Summer 2008
 - Multiple Record & Verify solutions studied
 - Onsite visits to other institutions
 - Contract with consulting group
 - Onsite visit for workflow observation for generation of Future State and Implementation plans
- Fall 2008
 - ASTRO Annual Meeting for product demonstrations for possible solutions
 - Department-wide town meeting to generate buzz
 - Weekly Task Group meetings begin

Timeframe

- Winter 2008/2009
 - Every element of paper chart MUST have electronic replacement solution
 - Infrastructure Upgrade
 - Treatment Planning hardware + software upgrade
 - Networked for remote planning capabilities
 - Address available solutions to gap analysis

Timeframe

- **Winter 2008/2009**
 - Infrastructure Upgrade (continued)
 - Record & Verify upgrade
 - Make use of currently available solutions to address workflow issues
 - Implementation of Radiation Oncology image storage system
 - New hardware in clinical areas to support electronic records
 - Installation of hardware at new satellite facility (Newton Wellesley Hospital)
 - Electronic record from inception

Timeframe

- Spring/Summer 2009
 - Testing & implementation of paperless solutions
 - Staff Training
 - Main Campus + Satellite staff
 - Approximately 220 staff members
 - Newton Wellesley treats first paperless patient
 - First paperless patient at main campus
 - August 15, 2009
 - Transition coincided with accreditation from American College of Radiology (ACR)
 - Electronic solutions eased ACR application process



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Timeframe

- Fall/Winter 2009
 - Full Implementation of home-grown Workflow Manager
 - Gap Analysis
 - Shore up loose ends
 - Reassess current state
 - Physician Training
 - Rollout based on disease site
- March 2010
 - Full paperless conversion at main campus



Workflow Impact

- Examine workflow of entire department
 - Document process from initial consultation to follow-up visits
 - Current state physical record
 - Need to know where to start
 - Every point that the chart passes for each clinical area
 - Physicians, Nursing, Therapy, Physics, Administration

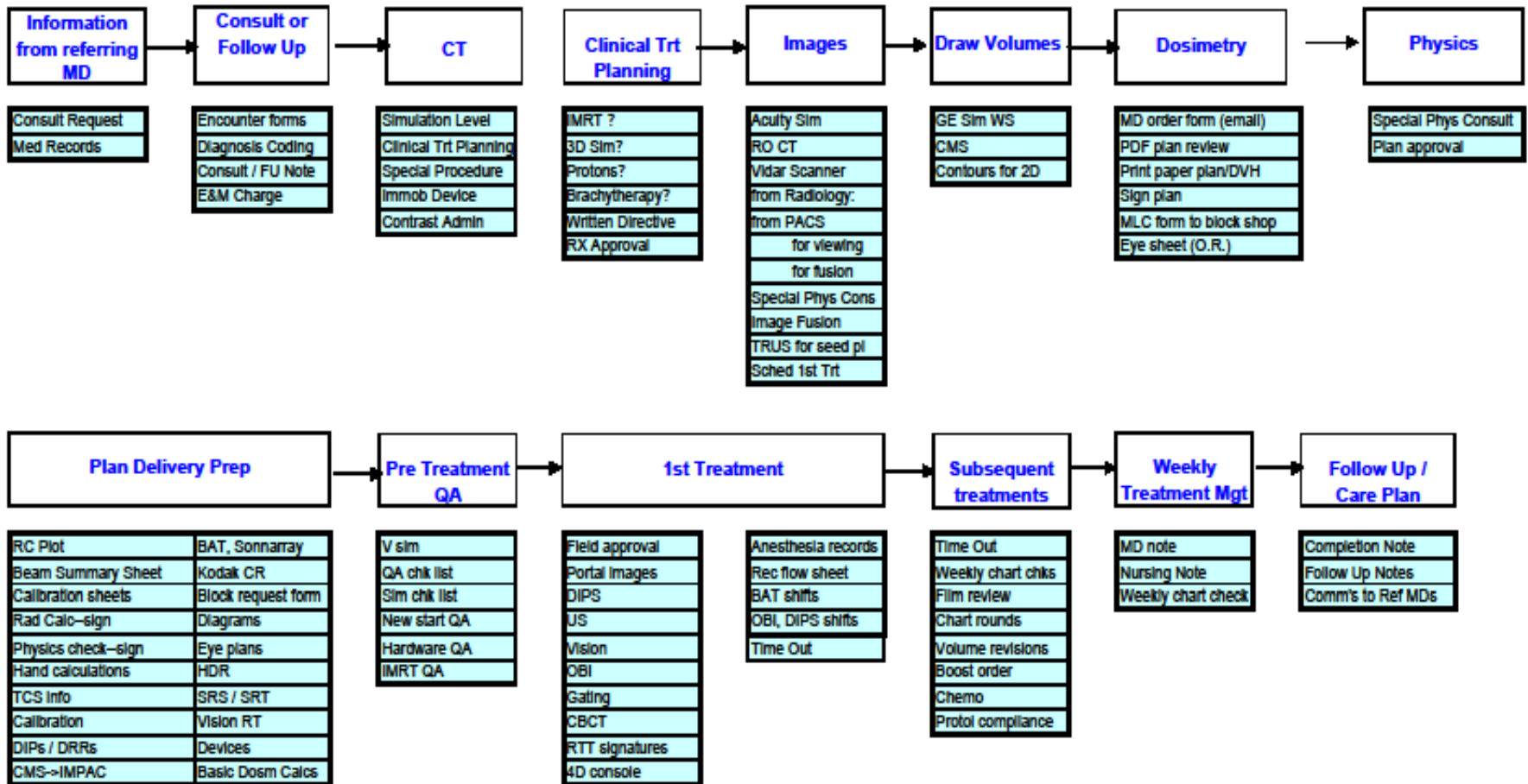


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Workflow Impact

Process Map: Procedures Requiring Documentation / Signatures



Workflow Impact

- Thorough examination of paper record
 - Gap Analysis
 - What purpose does this paperwork serve?
 - What do we need a solution for?
 - What is redundant?
 - How can we best use what we currently have?
 - What might we need to purchase?

Workflow Impact

- Dosimetry Specific Tasks in Paper Environment
 - Planning Directives
 - E-mail to Dosimetry Head with modality, prescription, + constraints
 - Paper Charts left for dosimetry staff outside CT simulator
 - Plan Approval
 - Done in face to face session between dosimetrist & physician
 - Paper Plan Printouts
 - Signed by physician upon approval
 - Stored in paper chart for future reference

Workflow Impact

- Dosimetry Specific Tasks in Paper Environment
 - Hand Calculations
 - Calculation Sheet generated with relevant factors
 - 2D Simulations with patient contour
 - Contour documentation stored in paper chart for future reference
 - Related simulation forms printed to be stored in chart
 - Treatment Chart preparation
 - Treatment field parameters
 - Delineate fields for specific daily treatments



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Workflow Impact

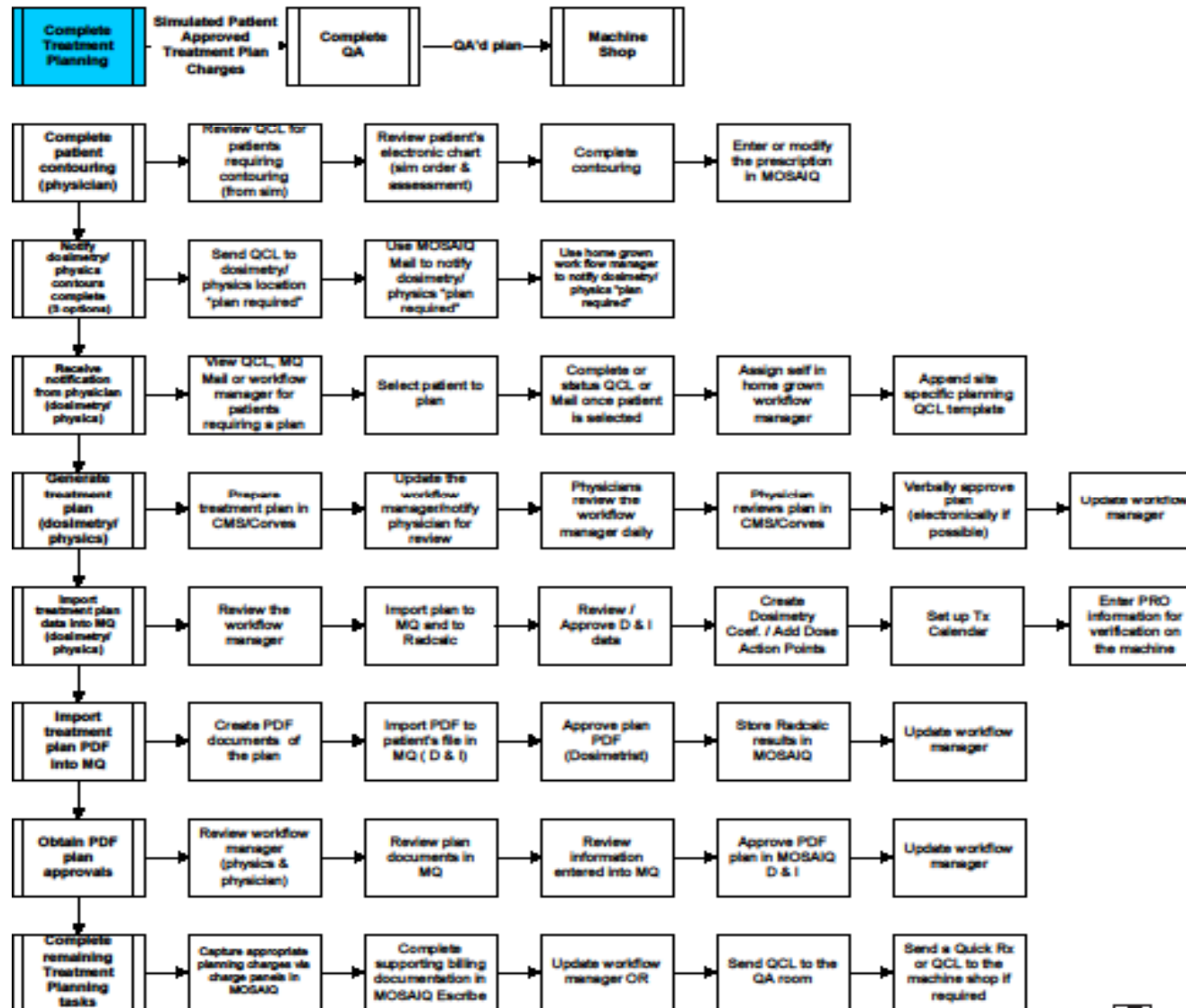
- Dosimetry Specific Tasks in Paper Environment
 - Chart Quality Assurance
 - Transport of paper chart to physicist or therapist responsible
 - Chart heads to treatment machine post QA
 - Billing Documentation
 - Several standard request forms depending on service rendered
 - Stored in paper chart for future reference

Workflow Impact

- Electronic Conversion
 - Generate ideal future state plan
 - Opportunity to address gaps in workflow
 - Study current electronic environment
 - Can you achieve ideal state with the current infrastructure?
 - If not, what modifications do you need?



Workflow Impact



Workflow Impact

- Dosimetry Specific Tasks in Electronic Environment
 - Planning Directives
 - Need manner to track progress of patient planning process from global perspective
 - Physicians, dosimetry, physicists, therapists all interested in progress
 - Remove limitation of access to all planning directives
 - ACR Guidelines for plan directives

Workflow Impact

- Dosimetry Specific Tasks in Electronic Environment
 - Workflow Manager
 - Versatile database that tracks patient planning progress in real time
 - Accessible from any desktop PC network-wide
 - Singular reservoir for all patient planning information
 - Physicians acknowledge contours completed and upload planning directives via templates
 - Generates automated e-mail reminders for tasks due
 - Dosimetrists acknowledge planning tasks as they are completed

Workflow Impact

- Workflow Manager

Current State: Contours and Prescription

TCS Plan ID:

Task	Assigned To	Status	Completion Date	Completed By	Notes <input type="button" value="update_notes"/>
Contours and Prescription	Unknown	Incomplete		Unknown	<input type="text"/>
Assign Dosimetrist	Doppke	Incomplete		Unknown	<input type="text"/>
Treatment Planning	Wolfgang	Incomplete		Unknown	<input type="text"/>
Ready for MD	Wolfgang	Incomplete		Unknown	<input type="text"/>
MD Approved	Unknown	Incomplete		Unknown	<input type="text"/>
QA Ready	Wolfgang	Incomplete		Unknown	<input type="text"/>
Pre-Treatment QA	therapist	Incomplete		Unknown	<input type="text"/>
Physics Chart Check	Wolfgang	Incomplete		Unknown	<input type="text"/>
MD Peer Review	Unknown	Incomplete		Unknown	<input type="text"/>

Workflow Impact

- Dosimetry Specific Tasks in Electronic Environment
 - Plan Generation + Approval
 - Remote access capability via any desktop PC network-wide
 - Plan preparation & review can take place at satellite facilities
 - Done via face to face interaction with physician
 - Prescription parameters updated in R&V at time of approval
 - Plan Documentation
 - Electronic Copy of plan uploaded to Record & Verify system
 - Physician and physics approvals required for treatment
 - All plans documented in Record & Verify system

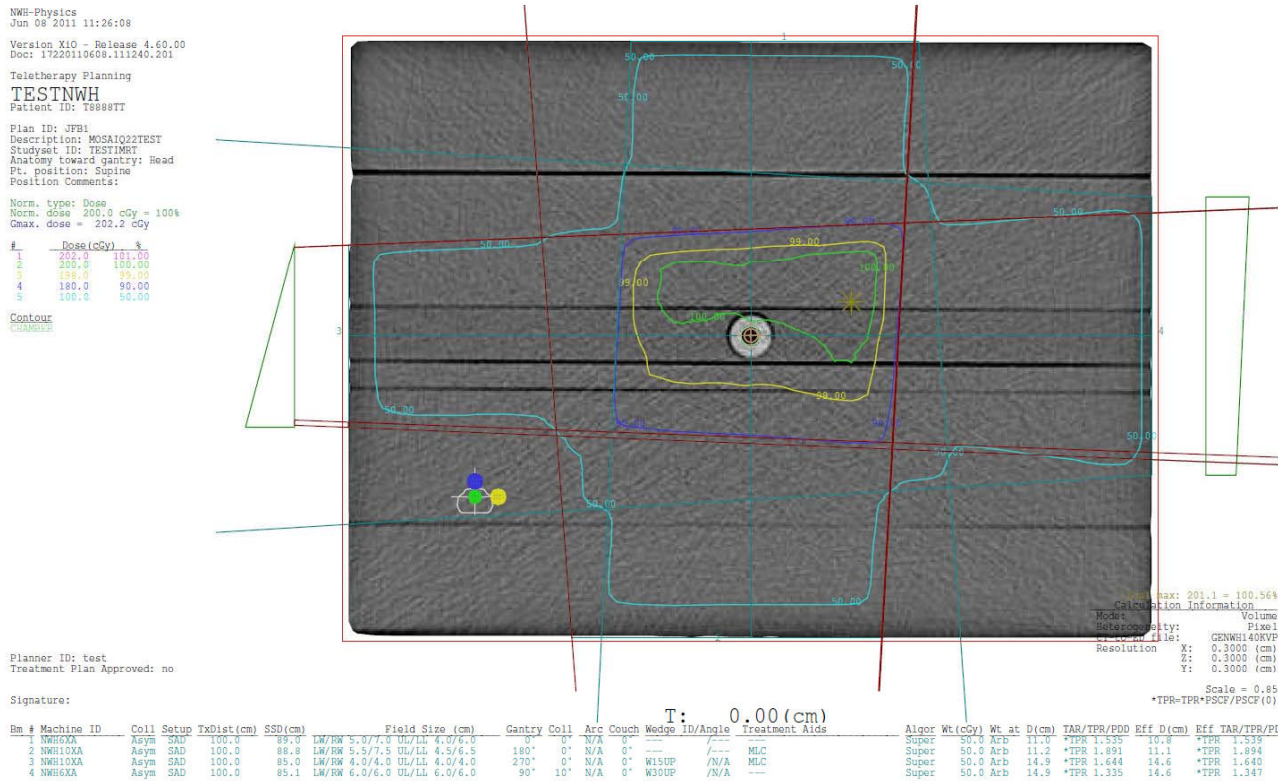


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Workflow Impact

- Dosimetry Specific Tasks in Electronic Environment
 - Plan Documentation



Workflow Impact

- Dosimetry Specific Tasks in Electronic Environment
 - Hand Calculations
 - Spreadsheet uploaded to Record & Verify system for physician + physicist review and approval
 - 2D Simulations
 - All simulation information captured on electronic plan printout
 - Chart Preparation
 - MU Second Check documentation used for daily therapy field verifications during timeout procedure
 - Record & Verify system used to delineate fields for daily treatment



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Workflow Impact

- Dosimetry Specific Tasks in Electronic Environment
 - Hand Calculations

PHOTON MU HAND CALCULATION WORKSHEET

Patient Name: _____
 ID#: _____
 Machine: _____

Field Letter # of Sites	Field Size (cm/cm)	Equivalent Area (cm ²)	SAD / SSD	Energy (MV)	S Factor / Output Factor	Wedge Angle / Orientation	Wedge Factor	Try Factor	Other Transmission Factors	Depth (cm)	TPR / % DD	D Factor / K Factor	Isocore	Dose (cGy)	eGy/MU	MU	Initial
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COMMENTS:

Workflow Impact

- Dosimetry Specific Tasks in Electronic Environment
 - Chart Preparation

	210	280	0	85	160
03/09/2011	RPO 210 PANCREAS	RAO 280 PANCREAS	ANTERIOR PANCREAS	LAO 85 PANCREAS	LPO 160 PANCREAS
Machine	1 Clinac	1 Clinac	1 Clinac	1 Clinac	1 Clinac
Energy	6	6	6	6	6
Modality	X-Rays	X-Rays	X-Rays	X-Rays	X-Rays
MU	113.79	126.33	166.02	140.97	109.94
Dose	28	34	51	47	20
Bolus					
Block					
SSD	85.2	81.3	89.9	86.3	86.8
Gantry	210	280	0	85	150
Collimator	40	0	315	325	35
Couch	0	0	0	0	0
Coll X1	5.80	6.00	8.00	7.00	5.00
Coll X2	8.00	6.20	5.50	5.50	8.50
Coll Y1	10.00	7.50	10.50	8.00	9.50
Coll Y2	9.90	7.00	9.00	9.00	8.50
Wedge Name	NONE	NONE	NONE	NONE	NONE
Wedge Code	NONE	NONE	NONE	NONE	NONE
Electron Cone	---	---	---	---	---

Workflow Impact

- Dosimetry Specific Tasks in Electronic Environment
 - Chart Quality Assurance
 - Workflow Manager used to alert physics and therapy QA staff of chart availability for review
 - Automated by acknowledgement of completion of prior task
 - Billing Documentation
 - Templates within Record & Verify used for documentation
 - Patient specific information automatically populated within document

Technical Aspects

- Improvements Necessary for Conversion
 - Hardware
 - Software
 - Staff Training



Technical Aspects

- Hardware Improvements
 - PC Upgrades
 - Approximately 300 PCs replaced department-wide to cope with increase in workload and compatibility
 - Additional PCs in planning workspace for use with monitor toggle for plan review and R&V data entry
 - Network Capability
 - Bandwidth capacity increased to account for increase of data flow



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Technical Aspects

- Hardware Improvements
 - Data Storage
 - Upgrade to storage servers for Record & Verify and Imaging
 - Remote storage off-site
 - Data storage backup at second off-site location
 - Tablet Technology
 - For gathering patient consent for upload to hospital-wide database
 - Still in development and implementation

Technical Aspects

- Hardware Improvements
 - Desktop Monitor Improvements
 - Installation of extra monitors inside & outside treatment delivery rooms
 - Charting purposes
 - Treatment verification
 - Installation of extra monitors for each physics and dosimetry staff member
 - Charting purposes
 - Chart quality assurance



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Technical Aspects

- Hardware Improvements
 - Monitor Improvements for Treatment Delivery – In Room



Technical Aspects

- Hardware Improvements
 - Monitor Improvements for Treatment Delivery – In Room



Technical Aspects

- Hardware Improvements
 - Monitor Improvements for Treatment Delivery – At Treatment Console



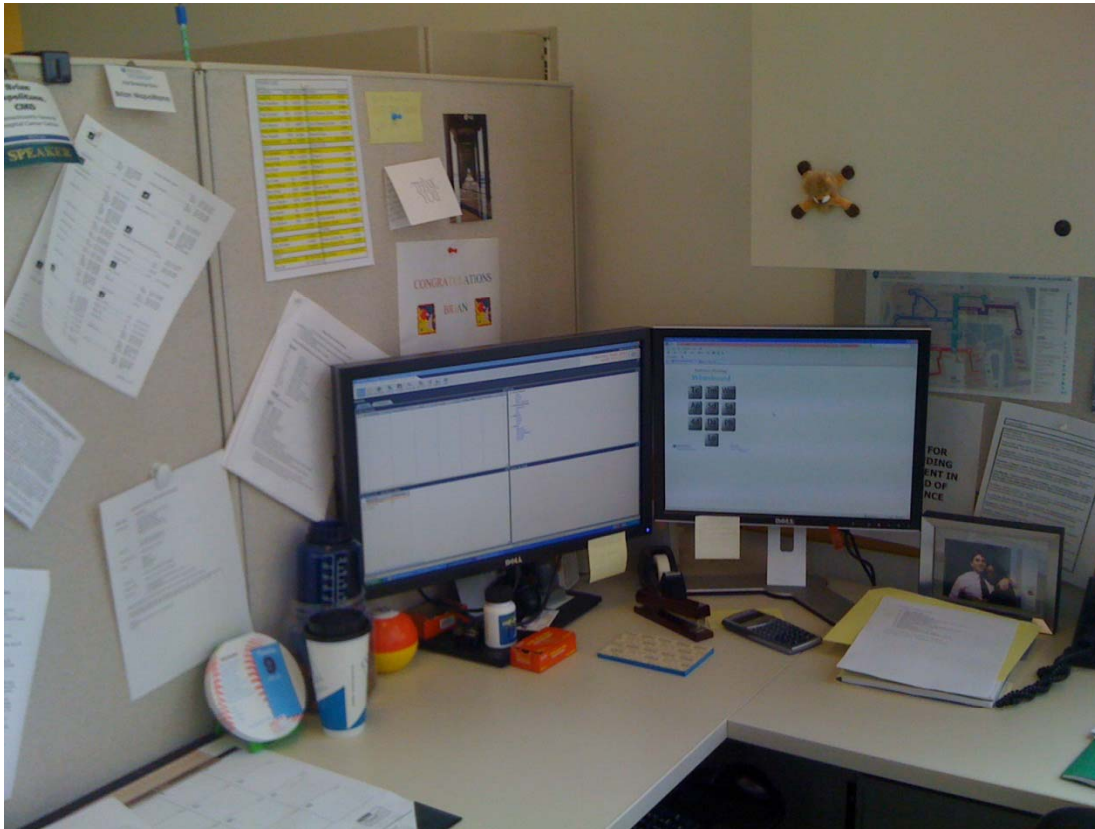
Technical Aspects

- Hardware Improvements
 - Monitor Improvements for Treatment Delivery – At Treatment Console



Technical Aspects

- Hardware Improvements
 - Monitor Improvements for Physics & Dosimetry

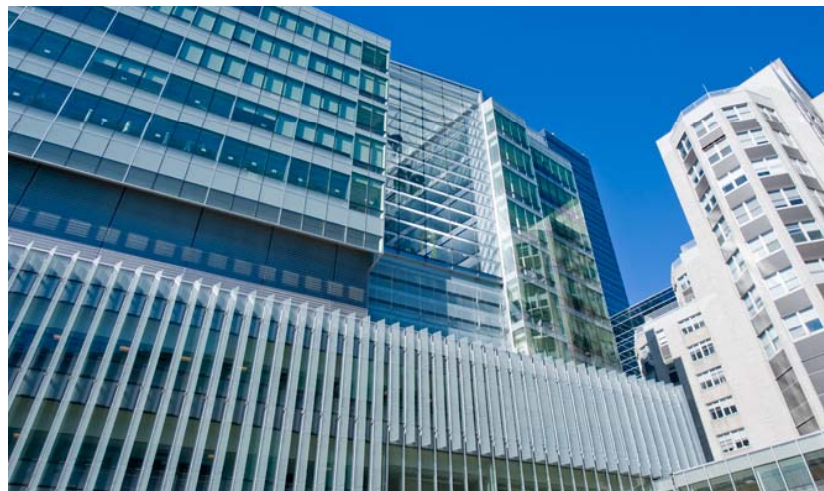


Technical Aspects


- Software Improvements
 - Record & Verify System Upgrade
 - Necessary for document generation purposes
 - Improvements in data storage
 - Improved imaging technology
 - Improve electronic functionality
 - New User Interface provides more immediate access
 - Subsequent versions have improved tools for electronic records

Technical Aspects

- Software Improvements
 - Record & Verify System Upgrade
 - What does the new chart interface look like?
 - How does the diagnosis get entered?
 - How does the prescription get documented?
 - Where do the plans appear?



Technical Aspects



Paperless Test2, BNN
Age: 20
Unit#: TP1-11-11
Dx: 185 Prostate Gland 3

Attending MD: Test, Only
Referring MD:

Allergies Edit

Alerts Edit

Notes

Type	Category	Created	Created By	Edited	Edited By	Subject
Diagnosis	CLINICAL	3/9/2010 12:56:34 PM	BNN	3/9/2010 1:17:58 PM	KES	Diagnosis 185 Prosta...
Prescription	CLINICAL	3/9/2010 1:41:45 PM	BNN	3/9/2010 1:41:45 PM	BNN	Physician Notes Go H...

Notes Detail

Physicians are notating any daily setup instructions here for both therapy and physics purposes. Items such as daily bolus and breathhold technique will be seen here.

Technical Aspects

Diagnosis and Staging

Affirm Diagnosis **This diagnosis has not been affirmed.** Wait Code: []

Diagnosis: [] Category: [] Initial Diagnosis: []
Laterality: [] Type: Primary Consultation: 3/9/2010
Morphology: [] Primary: [] Inactive Diagnosis: []

Notes: []

Staging Tumor Details Additional Classifiers Collaborative Staging

Clinical **This diagnosis and morphology cannot be autostaged.**

T: [] Stage: [] Confirm: []
N: [] Staged By: Napolitano, Brian HP Grade: []
M: [] Edition: [] Age at Dx: []
N/A: [] Manually Stage

Pathologic

T: [] Stage: []
N: [] Staged By: Napolitano, Brian
M: [] Edition: []
N/A: [] Manually Stage

Diagnosis Specific Values []

Close Display Folder [] Add Value

Configure... [] OK [] Cancel []

Technical Aspects

Rx Site: Prostate + Sem Ves Status: Pending

Technique:

Modality:

Dose Spec:

Rx	Dose	Modality	Fractionation	Status
		En Face		
		HDR Ir-192		
		IMRT		
		IO RT		
		LDR Seeds		
		Mini Tangent Boost		



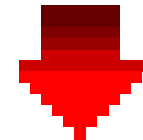
Rx Site: Prostate + Sem Ves Status: Pending

Technique: IMRT

Modality:

Dose Spec:

Rx	Dose	Modality	Fractionation	Status
		10 Mv Pho		
		12 MeV e-		
		15 Mv Pho		
		16 MeV e-		
		18 Mv Pho		
		20 MeV e-		
		4 Mv Pho		
		4&10 Mv Ph		
		6 MeV e-		
		6 Mv Pho		



Rx Site: Prostate + Sem Ves Status: Pending

Technique: IMRT

Modality: 6 Mv Pho

Dose Spec:

Rx	Dose	Modality	Fractionation	Status
		1:2, AP:PA		
		100% isodo		
		5 cm PA		
		6 cm PA		
		70% isodos		
		8 cm PA		
		80% isodos		
		90% isodos		
		95% isodos		
		96% isodos		

Dose Limits:

Pattern:



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Technical Aspects

Diagnoses and Interventions - Paperless Test2, BNN

Radiation | Medical | Surgery | General | Admin | Level: Order Set

- Dx: Prostate Gland
 - Radiation Oncology Course: 1
 - Rad Rx: New RX - 3D - 6 Mv Pho Dose: 1000 cGy @ 200 cGy x 5
 - Treatment Fields
 - A1 - AP PROSTATE - LIN 2 - 6 X
 - P1 - PA PROSTATE - LIN 2 - 6 X
 - Rad Rx: Prostate + Sem Ves - IMRT - 6 Mv Pho Dose: 5000 cGy @ 200 cGy x 25
 - Treatment Fields
 - SET1 - SETUP INSTRUCTIONS - 6 X
 - A - AP PROSTATE - 6 X
 - P - PA PROSTATE - 6 X
 - AX - AP KV SETUP - KV Setup
 - Radiotherapy Fractionation
 - Tx Plans
 - DOCUMENT.PDF
 - 1DOCUMENT.PDF
 - test.PDF
 - PROSTATE + SV TX PLAN.PDF

Close

Add

- Diagnosis
- Care Plan
- Order Set
- Tx Plan
- Rad Rx
- Tx Field
- Simulation
- Site Setup

Change

Delete

Refresh

Status

Dosimetry

Archived Objects



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Technical Aspects

- Software Improvements
 - Workflow Manager
 - In-house development
 - Fills gaps in processes that were not commercially available
 - Modified to suit our needs
 - Continuous modifications to streamline process
 - Additional functionality added as needed

Technical Aspects

- Software Improvements
 - Treatment Planning Software
 - Improved connectivity
 - Remote Access
 - Improved electronic medical record tools
 - Plan Output options
 - Connectivity to Record & Verify system

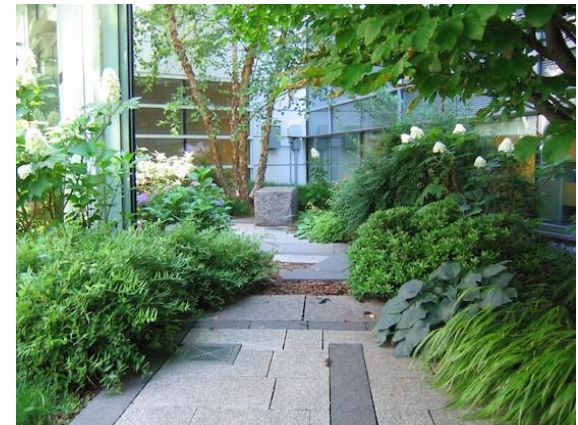


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Technical Aspects

- Staff Training
 - Record & Verify System
 - Multi-step process
 - To be completed over several months
 - Multiple site visits by vendor training staff
 - 4 weeks spread over 3 months
 - Timed to coincide with “Go Live”
 - Customized training modules designed with vendor input



Technical Aspects

- Staff Training
 - Record & Verify System
 - Training designed to have department-wide champions
 - Staff to be used as references in clinic for future
 - » “Train the trainer”
 - Covered all aspects of workflow in electronic format
 - Including process improvement modifications
 - Staff cross-trained to understand various clinical process independent of role group
 - » Example – Dosimetry trained in treatment delivery process in paperless environment



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Limitations

- Many process have simple electronic solutions
 - Many redundancies in documentation with paper
 - Workflow solutions may also expedite conversion
- Some processes not as straight forward
 - Time consuming
 - Cumbersome
 - No viable electronic solution
- Improvements to be made
 - Functionality



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Limitations

- When the Record & Verify system is down, we do not treat!



Limitations

- Initial Hurdles
 - Compatibility
 - Newer version of Record & Verify software would not run on hospital-wide PC Operating System platform
 - Planned OS Upgrade implemented shortly after compatibility limitation discovered
 - Staff resistance
 - Role group champions for electronic conversion
 - Town Hall Meetings for staff to express concerns



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Limitations

- General Patient Information
 - Physician Peer Review
 - Approximately 60 new patient presentations per week
 - Cumbersome to toggle through necessary documentation
 - Still searching for solution
 - Therapy Specific Information
 - Not readily apparent where information is
 - Multiple places for entry
 - Examples - Protocol Enrollment, Chemotherapy, Prior Radiation Treatments

Limitations

- General Patient Information
 - Simulation Images
 - Association of images to multiple prescriptions
 - Number of images per individual prescription
 - Patient Specific Diagrams
 - Therapy Setup Tattoos
 - Prior treatment - Which are new versus old?
 - Anatomical Drawings
 - Breast lumpectomy location
 - Bladder tumor location diagram



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Limitations

- Treatment Plan Documentation
 - Electronic Document Generation
 - Toggle between paper & electronic print is needed
 - Need for treatment plan notes to appear on printout
 - Multiple single page printouts need to be combined to one document
 - In-house macro written for process currently
 - Improvement to come in subsequent TPS version



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Limitations

- Treatment Plan Documentation
 - Record & Verify System process
 - Signature limitations
 - Role group approvals
 - Plans sorted in generic Treatment Plan folder
 - Can be associated to plan or course
 - Prefer to be listed within the treatment course
 - Documents slow to generate + load



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Limitations

- Treatment Plan Documentation
 - Record & Verify System process
 - Can only have one document open at any time
 - Plan documents printed to electronic format & opened on second monitor screen for chart check
 - Cannot open document at the same time as treatment field within Record & Verify
 - Need copy of plan document open for check of treatment field parameters

Limitations

- Treatment Process Documentation
 - Brachytherapy
 - High Dose Rate
 - Interface development and upgrades for documentation
 - Prostate Seed Implants
 - Modification of Ultrasound for digital image capture & transfer
 - Operating Room PC modifications and upgrades
 - Interface development for documentation



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Limitations

- Treatment Process Documentation
 - Special Procedures
 - Intra-Operative Radiation Therapy
 - Additional PC technology necessary in OR
 - Paperless made physics check process easier
 - » Document generation during surgical procedure
 - » Electronic storage of machine data
 - » Electronic calculation check documentation generation

Limitations

- Treatment Process Documentation
 - Special Procedures
 - Intra-Oral Electron Therapy
 - Daily calculations based on setup
 - Need versatile document for daily therapy delivery
 - » Daily treatment parameter modifications
 - » Monitor Unit modifications based on different setup
 - Superficial/Orthovoltage Therapy
 - No interface with Record & Verify
 - Paper documents scanned into R&V

Summary

- Many reasons to make the paperless transition
 - Efficiency
 - Cost
 - Government Role
- Timeframe suits needs of all aspects of the clinic
 - Set deadline & stick to it
- Workflow
 - What your current state is
 - What you strive to be
 - What processes need to/will change



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Summary

- Technological Solutions

- What do you have?
- What do you need?
- What can you create yourself?



- Limitations

- Establish realistic expectations department-wide
- Recognize limits of current electronic solutions
- What gaps need to be filled?

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- Kathy Bruce, MBA, RT(T)
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- MGH Department of Radiation Oncology
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Summary

- Questions?



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