Optimizing Treatment Planning Process in Clinical Environment with Lean Six Sigma

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AAPM 2016 Tuesday 1:45 - 3:45 PM

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Outline:

- 1. Introduction to Lean Six Sigma
- 2. Planning goal
- 3. Influence of upstream and downstream operations
- 4. Reduction of delay between planning steps
- 5. Optimizing planning process itself

What is the Study Subject

- Clinical Environment like community hospital
 - Routine clinical service mainly, min unusual treatment
 - Favor more towards efficiency
 - Work assignment change, like dosimetrist contour OAR
 - ${\ensuremath{\bullet}}$ Min physics support, commissioning done by 3^{rd} party
 - Min IT support, like API scripting, admin right, policy for remote desktop/remote assistant
- Paperless environment with EMR
 - A data in digital format with image, plan, treatment record, RT image, etc.

Reality Facing

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• On Tx Patients doubled from 30+ to 60+, 3 Linac in 2 Sites,

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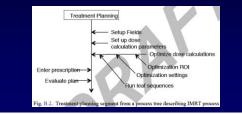
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- HDR APBI&GYN every day
- Plan modification required frequently
- IMRT QA low pass rate, especially SBRT/SRT
- Chart Check/IMRT QA till late night, even weekend
- Postpone Tx starting date frequently

Tools available

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- TG-100 Risk Analysis for quality/safety
 - Process Map
 - FMEA (Failure mode and effects analysis)
 - Fault Tree
- Lean Six Sigma for consistency/efficiency



- Lean Six Sigma is a methodology that relies on a collaborative team effort to improve performance by systematically removing waste;
- Waste is any step or action in a process that is not required to complete a process successfully (also called "Non Value-Adding")
- Same goal to seek to eliminate waste and create the most efficient system possible
- Different approaches to identify the root cause of waste.
 - Lean practitioners believe that waste comes from unnecessary steps in the production process that do not add value to the finished product
 - "We will not put into our establishment anything that is useless" by Henry Ford
 - Six Sigma proponents assert that waste results from variation within the process.

What is Lean Six Sigma

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- 8 kind of wastes in Lean, acronym "DOWNTIME"
- Defects =Products or services that are out of specification that require resources to correct
- Over production = Producing too much of a product before it is ready to be sold
- Waiting = Waiting for the previous step in the process to complete
- Non-Utilized Talent = Employees that are not effectively engaged in the process
- Transportation = Transporting items or information that is not required to perform the process from one location to another
 Inventory = Inventory or information that is sitting idle (not being processed)
- processed)
 Motion = People, information or equipment making unnecessary motion due to workspace layout, ergonomic issues or searching for misplaced
- due to workspace layout, ergonomic issues or searching for misplaced items
- Extra processing = Performing any activity that is not necessary to produce a functioning product or service

Vhat is Lean Six Sigma

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- Identified waste/variation, agree with other's experience
 - Need for plan modifications --- Defects
 Products or services that are out of specification that require resources to correct
 - Delays in physician contouring ---- Waiting, Inventory
 - Waiting for the previous step in the process to complete
 Inventory or information that is sitting idle (not being processed)
 - Delayed IMRT QA --- Non-Utilized Talent
 - · Delays in Plan/Chart checks --- Waiting, Inventory
 - Extra Paperwork --- Extra processing
 Performing any activity that is not necessary to produce a functioning product or service

Potters L, Kapur A; Implementation of a "No Fly" safety culture in a multicenter radiation medicine denartment: Pract Radiat Oncol. 2012 Jan-Mar;2(1):18-26

Planning Goal --- "Value"

Efficient

- Benchmarked by turn around time
- Real working time and dead time
- High Quality
 - Benchmarked by dose constraint
 - Isodose distribution
- Error Proof
 - · Benchmarked by mistakes, incident and near-miss
 - Find known error easily
 - Known error check list
 - Incident report system and periodic review
 - System wide reminder/alert on error prone scenario
 - Prone or Feet-first patient \rightarrow shift direction
 - Couch kick \rightarrow collision

Simulation

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- Start from simulation scheduling
- Planning
 - All steps include physics check and patient specific QA
- Treatment
 - End after first day of treatment

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 - Delayed IMRT QA --- Waiting, Inventory
 Delays in Plan/Chart checks --- Waiting, Inventory
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Simulation

- Simulation request need to be clearly documented
- ◆ Adequate personnel to cover like 4D, SRS/SBRT
- Adequate equipment for simulation like spare vacuum bag
- When unusual cases identified in simulation, notify physicist/dosimetrist early to be prepared.

- Check list for Simulation Variations
 - Metal artifact: like prosthesis, breast expander, dental filling
 - Dose limiting: pacemaker/ICD, fetus, gonald
 - Electron: small field, large oblique angle, extended SSD, backscatter for keloid
 - Breast: Flash, breast expander
 - ◆ Nose/extremities: water, rice, bolus
 - Simulation mistake: arm in beam, non-bladder control, excessive gas in rectum, object on patient, accessory/setup error
 - Indexer, respiration belt clipper
 - Recon cutoff like heavy patient
 - ◆ Patient setup off-center: collision

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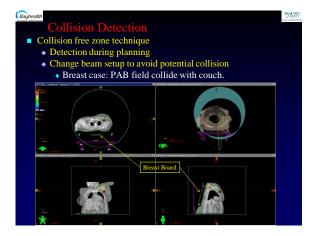
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Influence of downsti Treatment delivery Variation

- · Gantry clearance, especially with couch kick
- CBCT clearance

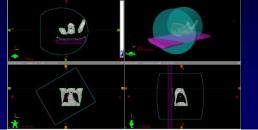
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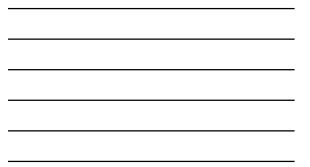
- Electron cone clearance
- · Schedule linac simple sim in additional CT sim
- In-consistent setup
- · Same immobilization device between sim and treatment Couch kick minimization
- Larger PTV margin for couch kick
 Treatment MU/Time
 - Non-SRS mode has max 999 MU limit
 Tx time is not enough for arc patient
- Exact Couch side rail/bar
 Rail-in affect AP/PA KV imaging
 Rail-in give more room for rail-free arc
- Gantry angle sorting
 Sort KV setup fields/CBCT, 90 deg difference
 - Sort MV treatment fields
 - 179.9 or 180.1 instead of 180.0

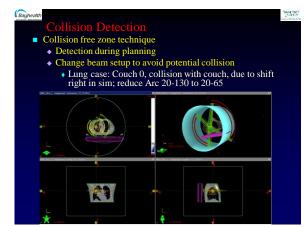


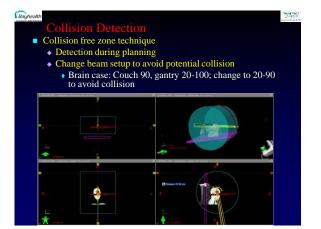
- Collision Detection
 Collision free zone technique
 Detection during planning
 Change beam setup to avoid potential collision
 - Change beam setup to avoid potential collision
 Lung case: Couch 30, Gantry 179-181; change to Arc 0-181 to avoid collision

Weeker State









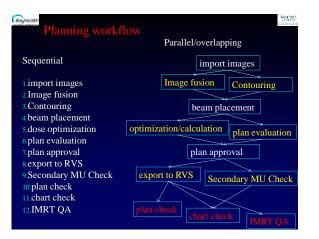


Identified waste/variation, agree with other's experience

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Week in

- Need for plan modifications --- Defects
 Delays in physician contouring --- Waiting, Inventory
- Delayed IMRT QA --- Waiting, Inventory
- · Delays in Plan/Chart checks --- Waiting, Inventory
- Extra Paperwork --- Extra processing



Contour

- Wait for image import for contour
- 1st priority task for dosimetrist
 Wait for Dx image for fusion
- Most OAR can be contoured without fusion
- No time (too much time needed)
 - Automatic contour (smart seg, model based, autoseg with SPICE)
 - Resident contour/Attending review

 - Dosimetrist OAR/Attending GTV
 Dedicated/blocked time for MD contouring
- Remote contour
 - Citrix
 - Remote desktop to resume work easily
- Forgot
 - Communication/Reminder

Plan approval

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- Plan quality deficient (Constraint not met)

 - Automatic plan quality analyze with DVH
 Communicate early, like half way of planning
- No time (too much time needed)
 - Automatic plan quality analyze with DVH
 - Remote review anywhere
 - Citrix/Remote desktop/Remote Assistance
 - MD shares same screen with dosimetrist to evaluate and approve plan
- Forgot
 - Communication/Reminder

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- Communication
 - ◆ QCL limited to responsible person
 - Global patient process status like dashboard
 in-time notification
 - - EMR connect to email system, outlook
 - · External script or manually to send email
 - External script or manually to send sms text message
 - Notify repeatly
 - Phone Call
 - Face to face talk to the responsible person

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Bayhealth Reduction of delay between planning step Dashboard to tracking plan status Hadman Q. J. Hadman Q. Hadman Q. J. Hadman Q. Hadman Q.

- Hardware On the Wall
- 3rd party software
 Tracking plan status

 - Tracking plan status
 Store process information
 Streamline workflow
 Increase in efficiency
 Improving patient safety by allowing more time for quality assurance
 processes

◆ EMR/RVS

- Care Path
- QCL

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 D DiCostanzo, S Thompson, J Woollard, N Gupta and A Ayan, MO-F-CAMPUS-T-02: An Electronic Whiteboard Platform to Manage Treatment Planning Process, Med. Phys. 42, 3572 (2015)
 S Laub, M Dunn, G Galbreath, S Gans and M Pankuch; MO-D-213-01: Workflow Monitoring for a Hij Volume Radiation Oncology Center, Med. Phys. 42, 3553 (2015) , nitoring for a High

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QA 🛛

- Secondary check fail check list
 - Ref point outside of PTV, close to field edge or skin
 - Equivalent path length
 - High gradient area
 - Low dose region
 - Flash
 - · Heterogeneity interface like lung/bone
 - Artifact
 - IMRT QA

Bayhealth Reduction of dela	y be	etw	'ee	n I	ola	nr	ing	ste	ps		West Stars Biological Sciences
QA											
 Secondary check f 	ail										
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IMRT QA

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- ~20% IMRT fail with 95 pass rate with 3% 3mm criteria
 - Mostly SBRT/SRT
 - Difficult Plans
 - High modulation
- · Physicist hesitate to do IMRT QA, which cause delay
- Even introduced different workflow
 - Export plan fields first for IMRT QA
 - If pass, plan approval, export document, chart check

QA 🛛

- IMRT QA Check list
 - Check printout/GUI
 - Wrong patient, plan, QA plan, QA dose export
 - Wrong Calibration file, energy and cal date
 - Wrong criteria, Gamma/absolute, 3%, 3mm
 - 10x10 standard field
 - Wrong setup
 - · Laser off
 - Output drift
 - Standard plan delivery
 MLC calibration
 MLC QA

- Trouble shooting steps

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- Array calAbsolute cal
- Anglar cal
- ◆ Arc vs. IMRT
- Sliding window vs. step and shoot
- Composite vs. Per beam
- Modulation vs. Static fields
- 10x10cm static
- Chamber vs. diode

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- QA 🛛 • IMRT QA fail
 - Limit segment size, MU
 - Tune-up commissioning model
 Optimize dosimetric leaf gap
 Make up missing output factor for small field

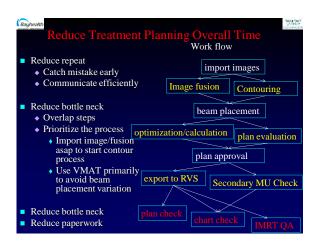


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Reduce Treatment Planning Overall Time

Reduce repeat

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- Catch mistake early
 Communicate efficiently
- Overlap steps
- Prioritize the process
 - Import image/fusion asap to start contour process
- Prioritize the process
- Reduce bottle neck
- Reduce paperwork



Went from

Plan/DVH Check	PATIENT NAME:				DATE & TIME	1/14/2014
	Prescribed Dose	(5GyX5) = 25Gy	RLL			
 Manual DVH Check 	Actual Doses to Treatme		CTV_RLL	95%	25.97 Gy	
m' '			PTV_RU	95%	25.41 Gy	
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		Li Large Bronchus Exp		2.11	2.75	
	\$700 Date restrictors for argan	Skin	< 12.00	33.2 Oy (#3-0y/16)	34 Oy (8 Oy / 5c)	
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Script of Pinnacle/Eclipse	SPINK	D0.01cc [cGy] D0.35cc [cGy]	is less than	2303.03	751.85
	SPINE	D0.3502 (0x)	is less than	2303.00	628.15
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• 5-10Sec	SPINAL_C.	D1,29cc (cGy) D0.05cc (cGy)	is less than	1450.00	725.05
• Can be used by dosimetrist after	ESOPHIG.	D5.00cc kGM	is less than	1950.00	89.43
	HEART	D0.00cc (c0)	is less than	3800.00	460.16
each optimization cycle	HEART	D15.00cc [c0y]	is less than	3200.00	124.84
1	DESC_AO.	D0.00cc3cGel D10.00cc3cGel	is less than	4903.03	NIA
 Can be used by Physician to 	AORTICA.	D0.00cc (cGal	is less than	4903.00	
	AORTICA.	D10.00cc [cGy]	is less than	4300.00	189.68
review before plan approval	BRONCH.	D0.00ec [::Gy]	is less than	3493.03	805.00
Dlan mark minimum standard	BRONCH.	D4.00cc [cGg]	is less than is less than	1650.00	6.00
 Plan meet minimum standard 	BRONCH.	D0.00cc (cGy) D4.00cc (cGy)	is less than	3480.00	683.94
before Physicist chart check	SKIN	D0.00cc (c5y)	is less than	3600.00	
	SKIN	D1.00ec [d5y]	is less than	3329.00	1899.95
 Permanent Record included in 	SKIN Rits	D 10.00cc (cGy) D0.00cc (cGy)	is less than is less than	3320.00 4300.00	990.97 4274.04
	Ribs	D0.00cc (cGa)	is less than	4300.00	3834.41
plan printout	Liver	D0.00 (% of dose)	is less than	100.00	0.86
	Liver	D700.00cc [cGy]	is less than	2103.00	1.82
	Stomach	D0.00cc (cGy)	is less than	2720.00	NM
	Stomach LUNG R	D10.00cc [cGy] D1000.00cc [cGy]	is less than	1760.00	22.15

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 Plan Check --- DVH check tool Homemade software Commercial Plan quality software Script of Pinnacle/Eclipse
Plan Objectives in Eclipse ◆ 5-10Sec

Chart Check

- Minimum standard clearly outlined Check list with mandatory/optional item

- Animment standards extently Optional item Couch position wrong Rail in our insmatch Arifiact override and density assignment wrong Contour mem mismatch Contour mem mismatch Contour mem or include all PTVs Contour PTV CTV mismatch with multiple targets Contour net enough in SI direction Gantry 180.1 for right side target Bolus Custom unselected, Bolus thickness not defined Treatment Time 0.0 or too short No DRR. NRR not associated, DRR association mismatch Field no tolerance: table, mismatch GBCT wrong structure set Patient orientation wrong Shift wrong Field Size 3 cm Dose rate < 600 MU/min for SBRT/SRT MU >= 1000 MU for non-SRS mode

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Chart Check

Bayhealth

- Minimum standard clearly outlined
- Check list with mandatory/optional item
- Script assisted check

 - Critical to check --- check with script for each plan
 Prescription including site, Fx, dose/fx, fx#, total dose
 Fields including Energy, MU, control point etc

 - Isocenter/shift
 DRR iso
 CBCT iso
 - Prone to miss --- check with script for each patient
 approval all fields

 - approval all documents

 - Prone to miss --- check with script for every day
 Complete QCL due, Chart check OK/Note
 Complete scheduled task, Chart check OK/Note

	• (to check cription ind	cluding site, Fx, o	lose/fx	, fx#, t	otal dose	
		 Presc 	cription in	cluding site, Fx, o	lose/fx	, fx#, t	otal dose	
		V I ICSC	lipu on in	ciuding site, i x, e	1030/17	, 1.1., 0		
0.000	1.0	0.0 0.6	cold RadiationName Co	etrolPoint Machineld MachineScale			antryRtn GantryRtsDirec	
Dose Noi-ract	2.0 70		ARC CW 220.30	114.0 TrueBeam SN1154 VAR EC	MeV Radiationly	(0) 0	2700 CW	ction of
349.0	3.0 70	0.0 2100.0.5	ARC CW 278-50	114.0 TrueDeam SH1154 Photon SMALL		501.0	270.0 CW	
0.0	3.0 70	0.0 2100.0 6	ARC CCW 50-270	58.0 TrueBeam SM1154 VAR EC	60 X	600.0	50 0 CC	
351.0	3.0 70	6.0 2100.0 E	ARC CCW 50-270	38.9 TrueBeam SN1154 Photon SMALL	50 X	600.0	50.0 CC	
0.0	3.61 70	8.8 2100 # CBCT		1.8 Troofbeam SH1154 Photos SMALL	KV/	0.0	0.0	
0.0		6.6 2100.6 KVAP	AP SETUP	TrueBeam SN1154 VAR_EC	6.0 X	600.0	0.0 PROME	
0.0	3.0 70		AP SETUP	1.0 TrueBeam SH1154 Photon SMALL	50X	0.0	0.0	
0.0	1.6 70	0.0 2100.0 KVLT	LT LAT SETUP	TrueBeam SN1154 VAR_EC		600.0	50.0 NONE	
0.0	2.0 70		PA SETUP	TranBeam SN1154 VAR EC	601	600.0	150.0 NOVE	
0.0	3.0 70	6.0 2100.0 KVPA	PASETUP	1.6 TrueBaser SN1154 Photon SMALL	KY .	0.0	100 C FRUITE	
	3.0 70		RT LAT SETUP	TrueBeam SN1154 VAR EC	6.0 X	600.0	270.0 10000	
0.0		0.0 2100.0 KVRT	NT LAT SETUP	1.8 TrueBeam SW1154 Photon SMALL	KV.	0.0	270.0	
0.0	3.0 70							

Bayhealth Reduce Treatment Planning Overall Time Initial Chart Check

- Critical to check
 - Fields including Field ID, Field name, Machine, Control Point, Energy, Energy type, Dose Rate, Gantry start, Gantry stop, Gantry direction
 Collimator, couch, Jaw, SSD, MU, Treatment Time, Addon, etc

0.0	3.0	700.0	2100.0 5		CW 278				Beam SN111					600.0	270 0 CW		
349.0	3.0	709.0	2100.0.5		CW 278				Deem SM112						270.0 CW		
0.0	3.0	700.0	2100.06	ARC	COW 5	270	56	U.D. True	Beam SN11	VAR E	EC			600.0	50 0 CC		
351.0	3.0	705.0	2100.0 %	ARC	CCW 5	270	- 98	-Tras	Beam SN11	Photon	SMALL			600.0	50.0 CC		
0.0	3.01	708.8	2100.0 CBC	r -				D True	The own States	Photos	SMALL	XV.		0.0	0.0		
0.0	3.01	708.0	2100.0 KVAJ	P AP S	ETUP	_		Tran	Beam SN11	VAR E	EC	6.0 X	-	600.0	0.0.14074		
0.0	3.0	700.0	2100.0 KVAI	P APS	RTUP			True	Beam SHITE	4 Photon	SMALL	KV		0.0	0.0		
0.0	3.6	700.0	2100.0 KVL	LTL	AT SET	192		Tree	Beam SN111	VAR E	EC	6.0 X		600.0	50.0 NONE		
0.0	3.8	705.0	2100.0 KVL		AT SET	1		# Tras	Beam SN11	H Photon	SMALL	KV.		0.0	30.0		
0.0	3.0	700.0	2100.0 KVP	A PAS	ETUP			Tran	Beam SN11	VAR E	EC	60X		600.0	160 0 NONE		
0.0	3.0	700.0	2100.0 KVP	6 PA 5	GUTB		1	# True	Bears SN11	4 Photon	SMALL	KV		0.0	180.0		
0.0	3.0	708.0	2100.0 KVR	I RTL	AT SET	UP .		True	Beam SN11	VAR E	EC			600.0	270.0 THONE		
			2100.0 KVR									KV		0.0	270.0		
0.0	3.0				AT ST				Beam SW11				(Class)			AddOnNess	AddOnT
ntryVarian C 270 0		Norian 160 0	CouchRtn 0	CouchVarian 180 0	CollO(1		Colf¥1	Colling 1.0	SSD MURee	mded Tre	eatmentTin	ne SetupFiel 1.6		SetupTechniqu SOCENTRIC	AddOnid 0076	AddOnName MLC120TB	
ntryVarian C 270 0 270 0	20.0	1/Varian 160 0 26 0	CouchRtn I	CouchVarian 180 0 0.0	CollOt	ColOG	CollY1	Coll/12	\$50 MURos	anded Tre 643.0 643.0	eatmentTin	ne SetupFiel 1.6 2.0	0.01	SetupTechniqu SOCENTRIC	e AddOnid 0076 None	MLC120TB	MLC
ntryVarian C 270 0 270 0 90 0	20.0 20.0 340.0	160 0 160 0 20 0 200 0	CouchRtn 0 0 0 0 0 0 0	CouchVarian 180 0 0 0 180 0	CollOCT	ColDG	CollY1	10 1.0 1.0	\$50 MURer 107 107 56 9	anded Tre 543.0 543.0 548.0	eatmentTin	ne SetupFiel 1.6 2.0 1.6	0.01	SetupTechniqu	e AddOnid 0076 None 0075		MLC
ntryVarian C 270.0 270.0 90.0 90.0	20.0 20.1 340.1 340.1	160 0 160 0 200 0 200 0 340 0	CouchRtn 0 0 0 0 0 0 0 0 0 0 0	CouchVarian 180 0 0.0 180 0 0 0	CollOCT	ColDG	CollY1	10 1.0 1.0	\$50 MURor 117 117 96.9 95.9	nded Tre 643.0 648.0 648.0 648.0	eatmentTin	ne SetupFiel 1.6 2.0 1.6 2.0	0.01	SetupTechniqu SOCENTRIC	e AddOnid 0076 None	MLC120TB	MLC
ntryVarian C 270.0 270.0 90.0 90.0 90.0	20.0 20.0 340.0	160 0 200 0 200 0 340 0 0 0	CouchRtn 0 0.0 0.0 0.0 0.0 0.0	CouchVarian 180 0 180 0 180 0 0 0	CollOt	ColDG	CollY1 1	Coll/Y2 19 19 19	\$50 MURor (n.7 96.9 95.9 10.9	anded Tre 543.0 543.0 548.0	eatmentTin	ne SetupFiel 1.6 2.0 1.6	0.01	SetupTechniqu SOCENTRIC SOCENTRIC	e AddOnid 0076 None 0075	MLC120TB	MLC
ntryVarian C 270 0 270 0 90 0 90 0 90 0 96 0 180 0	20.0 20.1 340.1 340.1	160 0 160 0 200 0 200 0 340 0	CouchRtn 1 0.0 0.0 0.0 0.0 0.0	CouchVarian 180 0 180 0 180 0 0 0 180 0	ColD(1	ColDG	CollY1	Coll/Y2 19 19 19	\$50 MURor 117 117 96.9 95.9	nded Tre 643.0 648.0 648.0 648.0	eatmentTin	ne SetupFiel 1.6 2.0 1.6 2.0 3.0	0.01	SetupTechniqu SOCENTRIC	e AddOnid 0076 None 0075	MLC120TB	MLC
ntryVarian C 270 0 270 0 90 0 90 0 90 0 180 0 90 0	20.0 20.0 340.0 340.0 0.0	ol/Varian 160 0 200 0 200 0 340 0 0 0 160 0	CouchRtn 1 0.0 0.0 0.0 0.0 0.0 0.0	CouchVarian 180 0 180 0 180 0 0 0 180 0 180 0 0.0	ColD(1	ColDC	CollY1 1	CollY2 19 19 19 19	\$50 MURor 10.7 56.3 55.5 10.9 10.9	643.0 643.0 648.0 648.0 648.0	eatmentTin	ne SetupFiel 1.6 2.0 1.6 2.0	0.01	SetupTechniqu SOCENTRIC SOCENTRIC	e AddOnid 0076 None 0075	MLC120TB	MLC
ntryVarian 0 270 0 90 0 90 0 90 0 100 0 90 0 90 0	20.0 20.0 340.0 340.0 0.0 0.0	01/Varian 1(0 0 200 0 340 0 340 0 1(0 0 0.0	CouchRtn 6 0.0 0.0 0.0 0.0 0.0 0.0 0.0	CouchVarian 180 0 180 0 0 0 0 0 180 0 180 0 180 0	ColD(1	ColDC	CollY1 1	CollY2 19 19 19 19	\$50 MURor \$17 \$53 \$55 \$03 \$03 \$03 \$03 \$03 \$03 \$03 \$03	643.0 643.0 648.0 648.0 648.0	eatmentTin	te SetupFiel 1.6 2.0 1.6 2.0 3.0 0.0	0.01	SetupTechniqu SOCENTRIC SOCENTRIC	e AddOnid 0076 None 0075	MLC120TB	MLC
ntryVarian C 270 0 270 0 90 0 90 0 90 0 180 0 90 0	20 0 20 0 340 0 346 1 0 0 0 0 0 0	01/Varian 160 0 200 0 340 0 0 0 160 0 180 0	CouchRin 6 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.	CouchVarias 180 0 180 0 0 0 180 0 180 0 180 0 180 0 180 0	CollO(1	ColD()	CollY1 1 19 19 19 5.0	Coll72 19 19 19 19 19 19 50 50	\$50 MURer \$17 \$53 \$53 \$53 \$53 \$53 \$53 \$53 \$53	anded Tre 543.0 543.0 548.0 548.0 548.0 548.0 548.0 548.0 548.0	eatmentTin	ne SetupFiel 1.6 2.0 1.6 2.0 3.0	0.01 0.01 1.01	SetupTechniqu SOCENTRIC SOCENTRIC SOCENTRIC SOCENTRIC	e AddOnid 0076 None 0075	MLC120TB	MLC
ntryVarian C 270 0 90 0 90 0 90 0 100 0 90 0 180 0 180 0 0 0	20 0 20 0 340 0 346 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	01/Varian 160 0 200 0 340 0 0.0 180 0 180 0 180 0 0.0	CouchRtn 1 00 00 00 00 00 00 00 00 00 00 00	CouchVarian 180 0 180 0 180 0 180 0 180 0 180 0 180 0 180 0	ColD(1	ColD()	CollY1 1 19 19 19 5.0	Coll72 19 19 19 19 19 19 50 50	\$50 MURor \$17 \$53 \$55 \$03 \$03 \$03 \$03 \$03 \$03 \$03 \$03	anded Tre 543.0 543.0 548.0 548.0 548.0 548.0 548.0 548.0 548.0	eatmentTin	ne SetupFiel 1.6 2.0 1.6 2.0 1.0 2.0 2.0 2.0	0.01 0.01 1.01	SetupTechniqu SOCENTRIC SOCENTRIC	e AddOnid 0076 None 0075	MLC120TB	MLC
ntryVarian C 270 0 90 0 90 0 90 0 90 0 90 0 90 0 90 0	20 0 20 0 340 0 346 0 0 0 0 0 0 0 0 0 0 0 0 0	01/Varian 160.0 200.0 340.0 180.0 180.0 180.0 180.0 180.0	CouchRtn 4 00 00 00 00 00 00 00 00 00 00	CouchVarias 180 0 180 0 0 0 180 0 180 0 180 0 180 0 180 0	CollX1	ColDX	CollY1 1 19 19 50 50 50	5.0 5.0	SSD MURee 917 953 953 953 903 903 903 903 903 903 903 903 903 959 959 952 2	anded Tre \$13.0 \$13.0 \$13.0 \$13.0 \$140.0	eatmentTin	te SetupFiel 1.6 2.0 1.6 2.0 3.0 0.0	001 001 101 101	SetupTechniqu SOCENTRIC SOCENTRIC SOCENTRIC SOCENTRIC	e AddOnid 0076 None 0075	MLC120TB	MLC

Bayhealth	Ways from
Reduce Treatment Planning Overall Time	
Initial Chart Check	
 Critical to check 	
 Patient orientation, 	

- Setup Isocenter/shift
 DRR isocenter/gantry angle, association for Tx

							-										
		Verification	CrechLatDelta	CouchLingDella			ThePitch			ING Assoc Machineld		RadiationName	GantryRtn 2/8.00				
	PS	Verily	CrechLatDelta	2.00	1.50	0.80		0.00	1,00	1.00 Tradear/SN1154		ARC CW 278-50	GantryMbn 270.00		1.40		
5	PS PHOTON_S PS	Vecity Vecity Vecity	1.65	2.00	1.50 Y.56	0.80	0.00	0.00 0.00 0.00			5		270.00	20.01		5.8	1
5	PS PHOTON, S	Vecity Vecity Vecity	1.65	2.00	1.50 Y.56	0.80	0.00	0.00	1.00	1.00 TraeBears SN1154	5	ARC CW 279-50	270.00	20.01	1.40	5.8	1
5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5	PS PHOTON_S PS PHOTON_S	Varity Vecity Vecity Vecity	1.65 5.70 5.70 5.70 5.70	2.0 2.0 2.0 2.0 2.0 2.0	1.54 1.54 1.54 1.54	0.80 0.88 0.84 0.84	0.93	0.93 0.99 0.93 0.93 0.93 0.93	1.00	1.00 Tradean SU154	5	ABC CW 276-56 ABC CCW 90-271	276.00	20.01	1.40	-5.8	
-	PS PHOTON S PHOTON S PHOTON S PHOTON S PHOTON S	Vacity Vacity Vecity Vecity Vecity Vecity	1.65 5.70 1.75 1.70 1.70 1.70	2.0 2.0 2.0 2.0 2.0 2.0 2.0 2.0 2.0 2.0		0.84	0.00	8.00 8.00 8.00 8.00 8.00 8.00 8.00	1.00	1.00 TrueBears SH154	5 6 8//4/2	ARC CW 278-56 ARC CCW 90-271	2/6.00 96.00	20.01	1.40	5.8	4
	PS PS PS PS PS PHOTON S	Varity Varity Verity Verity Verity Verity Varity	1.65 1.70 1.75 1.70 1.70 1.70 1.70	200 200 200 200 200 200 200 200 200 200		0.84	0.00	8.00 8.00 8.00 8.00 8.00 8.00 8.00 8.00	1.00 1.00 1.00 1.00	1.00 Tradition SH154 1.00 Tradition SH154 1.00 Tradition SH154 1.00 Tradition SH154	5 4 KVAP KVAP	ARC CW 275-56 ARC CCW 90-275 AP SETUP AP SETUP	2/6.00 10.00	20.01	1.0	5.8 5.8 5.8	
	PS PHOTON_S PS PS PHOTON_S PS	Vacity Vacity Vacity Vacity Vacity Vacity Vacity Vacity	1.65 1.70 1.75 1.70 1.70 1.70 1.65	2.00 2.00 2.00 2.00 2.00 2.00 2.00 2.00	1.5	0.80	0.00	8.00 8.00 8.00 8.00 8.00 8.00 8.00 8.00	1.00 1.00 1.00 1.00 1.00 1.00	1.00 Tradition S01154 1.00 Tradition S01154 1.00 Tradition S0155 1.00 Tradition S0155 1.00 Tradition S0155	5 6 RVAP RVAP RVAP	ARC CW 276-56 ARC CCW 10 276 AP SETUP AP SETUP LT LAT SETUP	2/6.00 10.00 6.00 50.00	20.01	1.40	5.0 5.0 5.0 5.0 5.0 5.0 5.0 5.0 5.0 5.0	
	PS PHOTON_S PS PS PHOTON_S PS PHOTON_S	Vanity Vanity Vanity Vanity Vanity Vanity Vanity	1.65 1.00 1.05 1.00 1.05 1.00 1.00 1.05 1.00 1.05 1.00	2.0 2.0 2.0 2.0 2.0 2.0 2.0 2.0 2.0 2.0	1.5 1.5 1.5 1.5 1.5 1.5 1.5 1.5 1.5	0.80	0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.0	8.00 8.00 8.00 8.00 8.00 8.00 8.00 8.00	1.00 1.00 1.00 1.00 1.00 1.00	1.00 Tradition S01150 1.00 Tradition S01150 1.00 Tradition S01150 1.00 Tradition S01155 1.00 Tradition S01155 1.00 Tradition S01155	5 6 RVAP RVAP RVAP RVAT RVAT	ARC CW 276-56 ARC CCW 90-276 AP SETUP AP SETUP LTLAT SETUP	276.00 96.00 0.00 50.00 16.00	20.01	1.40	5.0 5.0 5.0 5.0 5.0 5.0 5.0 5.0 5.0 5.0	
	PS PHOTON S PS PS PS PS PHOTON S PHOTON S PS	Vacity Vacity Vacity Vacity Vacity Vacity Vacity Vacity Vacity Vacity Vacity Vacity Vacity	1.65 1.70 1.73 1.70 1.70 1.85 1.70 5.65 1.70 5.65 1.70	2.0 2.0 2.0 2.0 2.0 2.0 2.0 2.0 2.0 2.0	1.50 1.50 1.50 1.50 1.50 1.50 1.50 1.50	0.80	0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.0	0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.0	1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00	1.00 Tradition S01154 1.00 Tradition S01154 1.00 Tradition S01154 1.00 Tradition S01154 1.00 Tradition S01154 1.00 Tradition S01154	5 6 FULL FULL FULL FULL FULL FULL	ARC CW 20159 ARC CCW 90 270 AP SETUP AP SETUP LT LAT SETUP LT LAT SETUP	2/6,00 10,00 10,00 56,00 16,00 16,00	20.01	1.0	5.8 5.8 5.8 5.8 5.8 5.8 5.8 5.8	
	PS PHOTON_S PS PS PS PS PS PNOTON_S PS PNOTON_S	Verity Verity Verity Verity Verity Verity Verity Verity Verity	1.65 1.70 1.75 1.70 1.70 1.70 1.65 1.70 1.65 1.70 1.65 1.70	2.0 2.0 2.0 2.0 2.0 2.0 2.0 2.0 2.0 2.0	1.50 1.50 1.50 1.50 1.50 1.50 1.50 1.50	0.80	0.30 6.30 6.40 0.30 0.30 0.30 0.30 0.30 0.30 0.30 0	0.03 0.01 0.03 0.03 0.03 0.03 0.03 0.03	1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00	1.60 Transform 520150 1.60 Transform 520150	5 6 8024P 8024P 8041 8041 8041 8044 8044 8044	ARC CW 20556 ARC CCW 90.270 AP SETOP LT LAT SETUP LT LAT SETUP PA SETUP PA SETUP	2/0.00 10.00 0.00 10.00 10.00 10.00 10.00	20.01		5.8 5.8 5.8 5.8 5.8 5.8 5.8 5.8 5.8 5.8	
15 F3 F3 F5 F5 F5 F5 F3 F3 F3 F3	PS PHOTON S PS PS PS PS PHOTON S PHOTON S PS	Vacity Vacity Vacity Vacity Vacity Vacity Vacity Vacity Vacity Vacity Vacity Vacity	1.65 1.70 1.73 1.70 1.70 1.85 1.70 5.65 1.70 5.65 1.70	2 0 2 0 2 0 2 0 2 0 2 0 2 0 2 0 2 0 2 0	1.54 7.54 7.54 7.54 7.54 7.54 7.54 7.54 7	0.80	0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.0	0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.0	1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00	1.00 Tradition S01154 1.00 Tradition S01154 1.00 Tradition S01154 1.00 Tradition S01154 1.00 Tradition S01154 1.00 Tradition S01154	5 6 RUAP RUAP RUA RUA RUA RUA RUA	ARC CW 20159 ARC CCW 90 270 AP SETUP AP SETUP LT LAT SETUP LT LAT SETUP	2/6,00 10,00 10,00 56,00 16,00 16,00	20.80 340.40 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.		5.8 5.8 5.8 5.8 5.8 5.8 5.8 5.8 5.8 5.8	

 Initial Chart Ch Critical to cl 	eck 1eck	anning Overall T ture set, iso set flag	ime
	et Structure SetId Structure		
	00 CT_12-18-15 1.2.246.3	152.71.4.882283254716.31562.20151220095047	
	00 CT_12-18-15 1.2.246.3	02.71.4.882283254716.31562.20151220095047	
1.49 -5.84 2.00 1	00 CT_12-18-15 1.2.246.3	152.71.4.882283254716.31562.20151220095047	
1.49 5.84 2.00 1	00 CT 12-18-15 1.2.246.3	152.71.4.882283254716.31562.20151220095047	
1.49 5.84 2.00 1	00 CT 12 18 15 1.2.246.1	52.71.4.882283254716.31562.20151220095047	
1.49 -5.84 2.00 1	00 CT_12-18-15 1.2.246.3	52.71.4.882283254716.31562.20151220095047	
1.49 5.84 2.00 1	80 CT_12-18-15 1.2.246.1	152.71.4.882283254716.31562.20151220095047	
1.49 5.84 2.00 1	00 CT_12-18-15 1.2.246.3	52.71.4.882283254716.31562.20151220095047	
1.49 5.84 2.00 1	00 CT_12.18.15 1.2.246.3	152.71.4.882283254716.31562.20151220095047	
1.49 -5.84 2.00 1	00 CT_12-18-15 1.2.246.3	52.71.4.882283254716.31562.20151220095047	
1.49 5.84 2.00 1	00 CT_12:18:15 1.2.246.3	152.71.4.882283254716.31562.20151220095047	
	00 CT_12-18-15 1.2.246.3	152.71.4.882283254716.31562.20151220095047	
1.49 5.84 2.00 1	00 CT_12-18-15 1.2.246.3	152.71.4.882283254715.31562.20151220095047	

- Identified waste/variation, agree with other's experience Need for plan modifications --- Defects
 Delays in physician contouring --- Waiting, Inventory
 Delays in Plan/Chart checks --- Waiting, Inventory
 Delays in Plan/Chart checks --- Waiting, Inventory
 Extra Paperwork --- Extra processing

Weine Stars

- Patient Load Spike
 - Weeks even months
 - Increase man power Increase working time
 - Last a couple of days
 - No more than 2 FTE*Day for each starting day, the cases over 2 need to be postponed automatically during scheduling right after simulation
 - Quick turnaround will be handled case by case, since it is hard to change the start date of previously scheduled patient
 - · Re-treat will be handled case by rectack where it takes longer time to figure out the vicinity of the previous dose to current Tx, on which planning difficulty depend.

3D	FTE*Day	
Breast 4F	0.50	
Breast Tang	0.30	
Lung	0.25	
	0.25	
Spine		
Brain Pelvic	0.25	
	0.25	
Extremity	0.25	
Electron	0.25	
Other	0.25	
IMRT	Day	
Head Neck	1	
Prostate with CD	1	
Prostate	0.5	
Lung	0.5	
Spine	0.5	
Brain	0.5	
Other	0.5	
SRS/SBRT	Day	
Lung	1	
Spine	1	
Brain	1	
Other	1	

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Option 1

Bauhealth

Plan Check

- MD approve the plan
- Chart Check
 - · dosimetrist generate plan printout and load to EMR

 - Physicist approve the plan printout
- Option2
 - Plan Check • MD approve the plan
 - MD lock the plan
 - Chart Check
 - · dosimetrist generate plan printout and load to EMR and dosimetrist approve printout
 - Physicist check plan printout approval date/time matching with TPS
 - · Physicist approve the plan printout

Bayhealth

Prostate patient,

- Plan 0, prostate+SV+LN
- CD1, prostate+SV
- ◆ CD2, prostate
- Option1
 - Plan and approve 3 plans at the beginning,
 - QCL to export fields and plan printout/document 3 times at different dates
 - IMRT QA, Physics chart check, approve fields and plan printout 3 times,
- Option2
 - Plan and approve 3 plans at the beginning,
 - Export Fields, plan printout/document once for all 3 plans
 IMRT QA and Physics chart check once for all 3 plans

 - Physicist approve fields and printout once for all 3 plans
 - QCL dosimetrist to approve plan printout at different dates, and bill on corresponding date

- Standardize the protocol
 - Prescription
 - Dose Constraints
 - Contour naming
 - Field naming
- Automatic Contour
 - Smart segmentation does not work well
 - Might need to create our own expert case library
- Automatic Planning
 - Rapid Plan evaluation and license
- Treatment Delivery Monitoring and process optimization
 Weekly Chart Check

 - Catch error early

Vendor

Bayhealth

- Varian
- Elekta
- SNC
- Physicist in BHS
 - Song Wang
 - ♦ Zhiqiu Li
- Dosimetrist in BHS
 - Michael Maille
 - Johnny Michel

Went ing?

West Star

- Facilities Columbia
 - Cornell
 - William Beaumont
 - ◆ Wayne State U
 - ◆ LIJ
 - Duke
 - UPenn
 - U Maryland
 - NYU