Optimizing Treatment Planning Process in Clinical Enviroment

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Objectives:

1. Be familiar with the workflow of modern treatment planning process.
2. Understand the scope and challenges of managing modern treatment planning process.
3. Be able to implement some management techniques like Lean Six Sigma system introduced in the symposium.

Outline:

1. Planning goal
2. Influence of upstream and downstream operations
3. Reduction of delay between planning steps
4. Optimizing planning process itself

What is the Study Subject

- Clinical Environment like community hospital
  - Routine clinical service mainly, min unusual treatment
  - Favor efficiency over quality
  - Work assignment change, like dosimetrist contour OAR
  - Min physics support, commissioning done by 3rd party
  - Min IT support, like API scripting, admin right, policy for remote desktop/remote assistant

Planning Goal

- 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 bi-weekly review
  - System wide reminder/alert on error prone scenario
    - Prone or Feet-first patient → shift direction
    - Couch kick → collision

What is the Study Range

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

Influence of upstream operations

- Insurance pre-approval
  - "IMRT may be covered for a diagnosis that is not listed when at least one of the following conditions is present:
    - A non-IMRT technique would substantially increase the probability of clinically meaningful normal tissue toxicity.
    - The same or an immediately adjacent area has been previously irradiated and the dose distribution within the patient must be sculpted to avoid exceeding the cumulative tolerance dose of nearby normal tissue."
  - Breast IMRT, esophagus IMRT, etc
  - Often need to do both 3D and IMRT to show improvement in order to get pre-approval
  - Due to uncertain of the approval status, both plans need to be ready for treatment

Influence of upstream operations

- Simulation
  - Who schedule the simulation?
    - Front desk is convenient
    - Sim therapist is better choice, or therapist review sim schedule at least one day ahead.
  - 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.

Influence of upstream operations

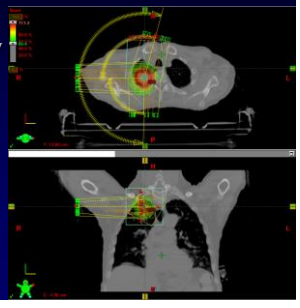
- Unusual cases in Simulation
  - Metal artifact: like prosthesis, breast expander, dental filling
  - Dose limiting: pacemaker/ICD, fetus, gonald
  - Electron: small field, large oblique angle, extended SSD, backscatter for keloid
  - Breast: Flash, breast expander
  - Nose/extremities: water, rice, bolus
  - Simulation mistake: arm in beam, non-bladder control, object on patient, accessory/setup error

Influence of downstream operations

- Treatment delivery consideration
  - Collision
    - couch kick clearance
    - electron cone clearance
  - In-consistent setup
  - 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

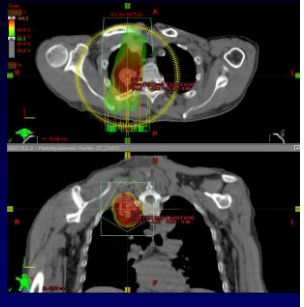
Influence of downstream operations

- Collision
  - Patient has difficulty to hold arm position during treatment
  - both arm up, no gantry clearance with arm
  - Cone beam panel collision can be resolved



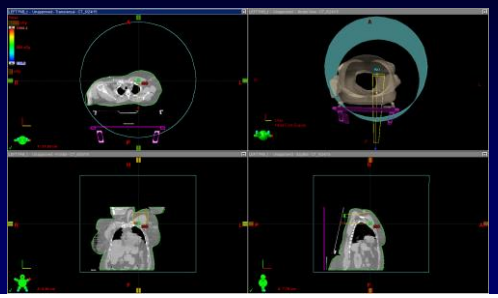
Influence of downstream operations

- Collision
  - Re-sim Option 1
    - both arm down, no clearance issue
    - Arc Avoid arm/shoulder
    - Plan quality deteriorate greatly
  - Re-sim Option 2
    - Right arm up, left arm down
    - Tattoo right side instead of middle
    - Right half arc
  - Planning makeup
    - Couch kick
    - Right Partial arc
    - Adding margin



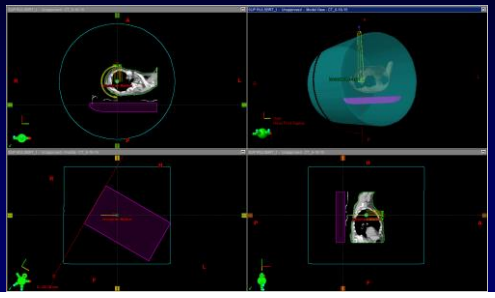
Influence of downstream operations

- Collision free zone technique
  - Detection during planning
  - Change beam setup to avoid potential collision



Influence of upstream/downstream operations

- Collision free zone technique
  - Detection during planning
  - Change beam setup to avoid potential collision

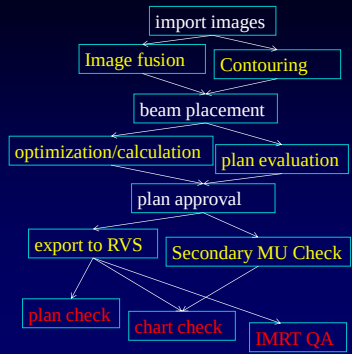


Planning workflow

Sequential

1. import images
2. Image fusion
3. Contouring
4. beam placement
5. dose optimization
6. plan evaluation
7. plan approval
8. export to RVS
9. Secondary MU Check
10. plan check
11. chart check
12. IMRT QA

Parallel/overlapping



Reduction of delay between planning steps

- Real working time
- Dead time/delay

- Limited resource
- Lack of communication
- Lack of time

Reduction of delay between planning steps

- Contour
  - Wait for image import for contour
    - 1st priority task for therapist
  - 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

Reduction of delay between planning steps

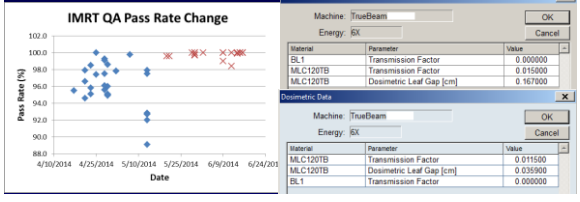
- Plan approval
  - Plan quality deficient (Constraint not met)
    - Automatic plan quality analyze with DVH
    - Communicate early, like half way of planning
  - No time (too much time needed)
    - Automatic plan quality analyze with DVH
    - Remote review anywhere
      - Citrix/Remote desktop/Remote Assistance
      - MD shares same screen with dosimetrist to evaluate and approve plan
  - Forgot
    - Communication/Reminder

Reduction of delay between planning steps

- 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

Reduction of delay between planning steps

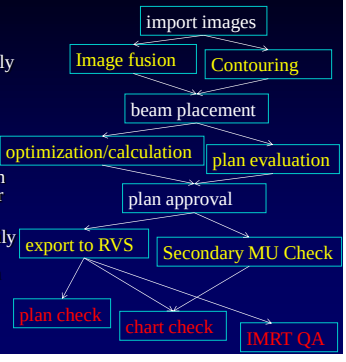
- QA
  - IMRT QA fail
    - Limit segment size, MU
    - Tune-up commissioning model
      - Optimize dosimetric leaf gap
      - Make up missing output factor for small field size



Reduce Treatment Planning Overall Time

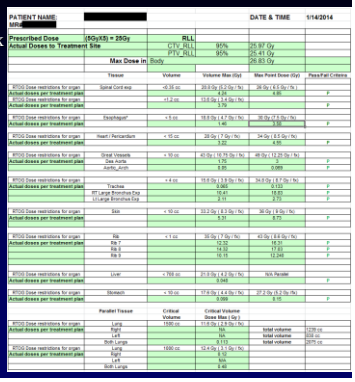
- Reduce repeat
  - Catch mistake early
  - Communicate efficiently
- Reduce bottle neck
  - Overlap steps
  - Prioritize the process
    - Import image/fusion asap to start contour process
    - Use VMAT primarily to avoid beam placement variation
- Reduce paperwork

Work flow



Reduce Treatment Planning Overall Time

- Plan Check
  - Manual DVH Check
  - Time consuming
    - 15-30min
  - Error prone
    - 1-2 error/sheet



PATIENT NAME: [redacted]
MRN: [redacted]
DATE & TIME 1/14/2014

Prescribed Dose (60y/6f) = 25Gy		RLL		
Actual Doses to Treatment Site		PTV_RLL	95%	25.97 Gy
		PTV_RLL	95%	25.41 Gy
	Max Dose in: Body			26.83 Gy

	Tissue	Volume	Volume Max (Gy)	Max Point Dose (Gy)	Pass/Fail Criteria
RTOG Dose restrictions for organ	Spinal Cord.esp	<0.35 cc	30.0 Gy (5.2 Gy / fx)	36 Gy (6.5 Gy / fx)	
Actual doses per treatment plan			4.54	4.85	P
RTOG Dose restrictions for organ		<1.2 cc	53.5 Gy (9.4 Gy / fx)		
Actual doses per treatment plan			3.79		P
RTOG Dose restrictions for organ	Esophagus*	< 5 cc	18.8 Gy (4.7 Gy / fx)	30 Gy (7.5 Gy / fx)	
Actual doses per treatment plan			1.40	3.92	P
RTOG Dose restrictions for organ	Heart / Pericardium	< 15 cc	28 Gy (7 Gy / fx)	34 Gy (8.5 Gy / fx)	
Actual doses per treatment plan			5.20	4.85	P
RTOG Dose restrictions for organ	Great Vessels	< 10 cc	40 Gy (10.75 Gy / fx)	48 Gy (12.25 Gy / fx)	
	Ao Ascite		1.75	0	P
	Aortic_Arch		8.95	0.089	P
RTOG Dose restrictions for organ		< 4 cc	15.8 Gy (3.5 Gy / fx)	34.8 Gy (8.7 Gy / fx)	
Actual doses per treatment plan	Trachea		6.940	6.133	P
	RT Large Bronchus Esp		10.41	10.83	P
	LT Large Bronchus Esp		2.11	2.73	P
RTOG Dose restrictions for organ	Skin	< 10 cc	33.2 Gy (8.3 Gy / fx)	36 Gy (9 Gy / fx)	
Actual doses per treatment plan			5.31	8.73	P
RTOG Dose restrictions for organ	Rib	< 1 cc	35 Gy (7 Gy / fx)	43 Gy (8.6 Gy / fx)	
Actual doses per treatment plan	Rib 7		14.32	14.31	P
	Rib 8		14.32	17.61	P
	Rib 9		16.15	12.246	P
RTOG Dose restrictions for organ	Liver	< 700 cc	21.0 Gy (4.2 Gy / fx)	N/A Parallel	
Actual doses per treatment plan			0.040		P
RTOG Dose restrictions for organ	Stomach	< 10 cc	17.6 Gy (4.4 Gy / fx)	27.2 Gy (6.2 Gy /fx)	
Actual doses per treatment plan			0.000	0.15	P

	Parallel Tissue	Critical Volume	Critical Volume Dose Max (Gy)		
RTOG Dose restrictions for organ	Lung	1500 cc	17.5 Gy (2.9 Gy / fx)		
Actual doses per treatment plan	Right		NA	total volume	1738 cc
	Left		NA	total volume	808 cc
	Both Lungs		5.113	total volume	2875 cc
RTOG Dose restrictions for organ	Lung	1000 cc	12.5 Gy (2.1 Gy / fx)		
Actual doses per treatment plan	Right		N/A		
	Left		N/A		
	Both Lungs		5.40		

Reduce Treatment Planning Overall Time

- Plan Check
  - DVH check tool
  - Homemade software
  - Commercial Plan quality software
  - Script extension of Pinnacle/Eclipse
  - Plan Objectives in Eclipse
    - 5-10Sec
    - Can be used by dosimetrist after each optimization cycle
    - Can be used by Physician to review before plan approval
    - Plan meet minimum standard before Physicist chart check

Structure	Index		Target Value	Actual V...
GTV	D95.00 (% of dose)	is more than	95.00	105.02
PTV	D95.00 (% of dose)	is more than	95.00	103.55
SPINAL_...	D0.00cc (cGy)	is less than	3000.00	751.95
SPINAL_...	D0.35cc (cGy)	is less than	2300.00	676.97
SPINAL_...	D1.20cc (cGy)	is less than	1450.00	628.15
SPINAL_C...	D0.00cc (cGy)	is less than	3000.00	839.15
SPINAL_C...	D0.35cc (cGy)	is less than	2300.00	768.23
SPINAL_C...	D1.20cc (cGy)	is less than	1450.00	726.06
ESOPHAG...	D0.00cc (cGy)	is less than	3500.00	849.47
ESOPHAG...	D5.00cc (cGy)	is less than	1950.00	69.43
HEART	D0.00cc (cGy)	is less than	3800.00	460.16
HEART	D15.00cc (cGy)	is less than	3200.00	124.84
DESC_AO...	D0.00cc (cGy)	is less than	4900.00	N/A
DESC_AO...	D10.00cc (cGy)	is less than	4300.00	N/A
AORTIC A...	D0.00cc (cGy)	is less than	4900.00	441.18
AORTIC A...	D10.00cc (cGy)	is less than	4300.00	169.56
BRONCH...	D0.00cc (cGy)	is less than	3480.00	880.86
BRONCH...	D4.00cc (cGy)	is less than	1650.00	0.00
BRONCH...	D0.00cc (cGy)	is less than	3480.00	663.94
BRONCH...	D4.00cc (cGy)	is less than	1650.00	0.00
SKIN	D0.00cc (cGy)	is less than	3600.00	2387.09
SKIN	D1.00cc (cGy)	is less than	3320.00	1899.95
SKIN	D10.00cc (cGy)	is less than	3320.00	690.97
Ribs	D0.00cc (cGy)	is less than	4300.00	4274.04
Ribs	D1.00cc (cGy)	is less than	3500.00	3934.45
Liver	D0.00 (% of dose)	is less than	100.00	0.00
Liver	D700.00cc (cGy)	is less than	2100.00	1.62
Stomach	D0.00cc (cGy)	is less than	2720.00	N/A
Stomach	D10.00cc (cGy)	is less than	1760.00	N/A
LUNG_R	D1000.00cc (cGy)	is less than	1240.00	22.15
LUNG_R	D1500.00cc (cGy)	is less than	1160.00	0.00
LUNG_L	D1000.00cc (cGy)	is less than	1240.00	8.27
LUNG_L	D1500.00cc (cGy)	is less than	1160.00	0.00
LUNGS-GTV	D1000.00cc (cGy)	is less than	1240.00	75.18
LUNGS-GTV	D1500.00cc (cGy)	is less than	1160.00	25.66

Reduce Paperwork

- Option 1
  - Plan Check
    - MD approve the plan
    - Dosimetrist lock the plan
  - Chart Check
    - dosimetrist generate plan printout and load to EMR
    - MD approve the plan printout
    - 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

Reduce Paperwork

- 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

Future Work

- Automatic Contour
  - Smart segmentation does not work well
  - Might need to create our own expert case library
- Automatic Planning
  - Rapid Plan evaluation and license
- Physicist Planning
  - Routine planning done primarily by dosimetrist
  - Non-standard plan done mainly by physicist