Enhancing a Physicist's Role in Radiation Therapy Treatment Plan Assessment

WE-FG-BRA-5

Lessons Learned From Upstream Physics Peer Review of Plan Quality with the Eclipse Treatment Planning System

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### UC San Diego Health

RETHINKING MEDICAL PHYSICS

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## Disclosure

- I have no relevant financial disclosures
- Chair of AAPM Work Group on Prevention of Errors in Radiation Oncology
- Member of Task Group 275 Strategies for Effective Physics Plan and Chart Review in Radiation Therapy

## Physics Plan Review

### MEDICAL PHYSICS

The International Journal of Medical Physics Research and Practice

Aapm Scientific Report 🛛 🔂 Free Access

#### Strategies for effective physics plan and chart review in radiation therapy: Report of AAPM Task Group 275

Eric Ford 🔀, Leigh Conroy, Lei Dong, Luis Fong de Los Santos, Anne Greener, Grace Gwe-Ya Kim, Jennifer Johnson, Perry Johnson, James G. Mechalakos, Brian Napolitano, Stephanie Parker, Deborah Schofield, Koren Smith, Ellen Yorke, Michelle Wells ... See fewer authors

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Table S1.A.ii. Photon/electron EBRT initial plan/chart review checks. Review check data are drawn from the AAPM all-member survey. For each check the number of corresponding failure modes (FM) is listed as well as the highest *RPN* of the corresponding FM. FMs that were not included in the final ten-point FMEA are listed as "N/A". Status indications are: ++ priority check (*RPN*>100 and use>60%), + physics check target for improvement (*RPN*>100 and use>60%), and "OP" other professional priority check (i.e. *RPN*>100 but outside the physics domain). The column "Auto. target" indicates checks that are targets for automation. "F" full automated. "P" partial automation, i.e. can potentially automate whether particular information is present (e.g. a document exists) but not whether the information in it is correct.

Physics che	ck item	Corresponding failure modes	# FM	Highest RPN	Use Freq	Status	Auto targe
Patient asse	essment						
PA-Q1-1	Prescription (with respect to standard of care or institutional clinical guidelines)	6,9,13,15,17,20,26,28,34,67	10	175.3	86%	++	
PA-Q1-2	Prescription approval by attending radiation oncologist	6,17,74,87	4	175.3	92%		F
PA-Q1-3	Diagnosis definition including imaging and outside records	5,8,13,31,45,48	6	180.3	37%	OP	
PA-Q1-4	Pathology Report	5	1	180.3	18%	OP	
PA-Q1-5	Medical Chart to confirm laterality, site, etc.	5,31,48	3	180.3	57%	+	
PA-Q1-6	Special Considerations for radiotherapy (e.g. pacemakers, ICDs, pumps, etc.)	2,19,23,46,68,73,83,91,107,110	10	214.1	89%	++	Р
PA-Q1-7	Previous radiotherapy treatments	2,4,10,12,23,58	6	214.1	87%	++	Р

### Process step (RPN>100 and use>60%)

Patient assessment ✓ 15 check items Simulation

✓ 22 check items
 Treatment planning
 ✓ 124 ab a alk items

✓ 134 check items

## Motivation

#### • FMEA study of surface image guided radiosurgery

Rank	Step	Potential failure modes	Potential cause of failure	Potential effects of failure	0	S	D	RPN
1	31. Contour critical structures	Inaccurate contours	Poor image quality Poor registration	Excessive dose to critical structure	6	8	6	288
1	79. Apply CBCT couch shifts	Inaccurate CBCT–CT registration	Insufficient training Poor image quality Inattention.	Geometric miss	6	8	6	288
3	29. Previous tx CT registered to planning CT	Inaccurate CT–CT registration	Failed to save registration. Registration error	Retreat previous target.	5	8	7	280
4	39. Review OAR statistics	Critical structure doses not checked	Inattention	Excessive dose to critical structure	5	8	6	240
4	29. Previous tx CT registered to planning CT	Not done	Inattention	Retreat previous target	5	8	6	240
4	33. Insert Rx and contour target volumes	Contours accidentally changed by planner	Contours not locked	Underdosing of target volume	6	8	5	240
7	23. Images labeled with acquisition date and technique	Incorrect date label	Transcription error	May cause confusion and/or affect MD decision making	5	6	7	210
8	84. Monitor SIG indicated offsets to ensure patient position is within tolerance	SIG system fails to detect patient movement	SIG system failure	Geometric miss	3	8	8	192
9	59. Ensure SRS QA has been completed (Winston–Lutz, etc.) (P)	SRS QA not checked	Inattention	System out of tolerance	6	6	5	180
9	60. Ensure daily integrated IGRT QA has been performed (P)	IGRT QA not checked	Inattention	System out of tolerance	6	6	5	180

Manger et al., Medical Physics, 42 (5), 2449-2461 (2015)

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**Clinical Investigation: The Profession** 

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### Quantitative Assessment of Workload and Stressors in Clinical Radiation Oncology

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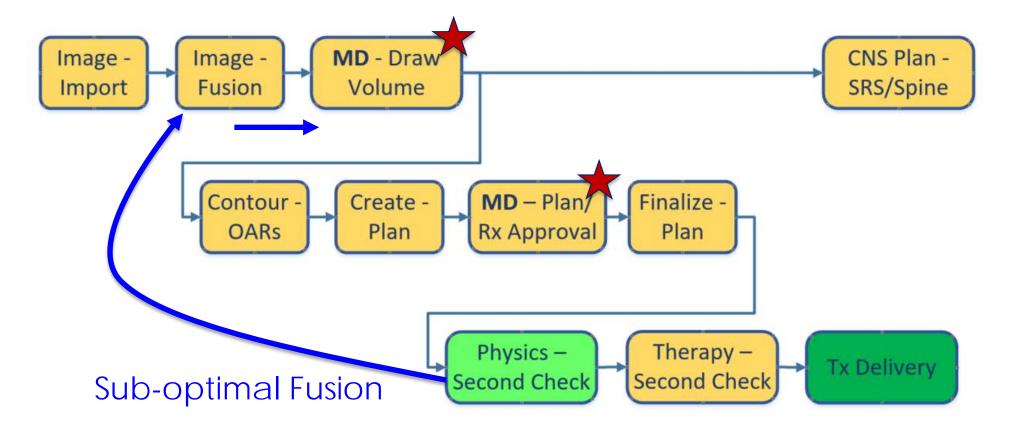
		Stressors (%)					
Study Group	Technical	<u>Interrup-</u> tion	Teamwork	<u>Time</u>	Patient	<u>Environ-</u> <u>mental</u>	
Simulation Therapists	20	40	10	10	20		
Radiation Therapists		71	-	16	13		
Dosimetrists	30	30	20	20			
Physicists	18	20	16	31	8	7	
Radiation Oncologists		46	12	8	4	30	
All Pooled	13.6	41.4	11.6	17	9	7.4	

Fig. 1. Graphic representation of different sources of stressors. Bar width is approximately proportional to the percentage of the different type of stressors experienced by each radiation oncology professional subgroup. The last row in the table represents the pooled average. Stressor types are defined in Methods and Materials.

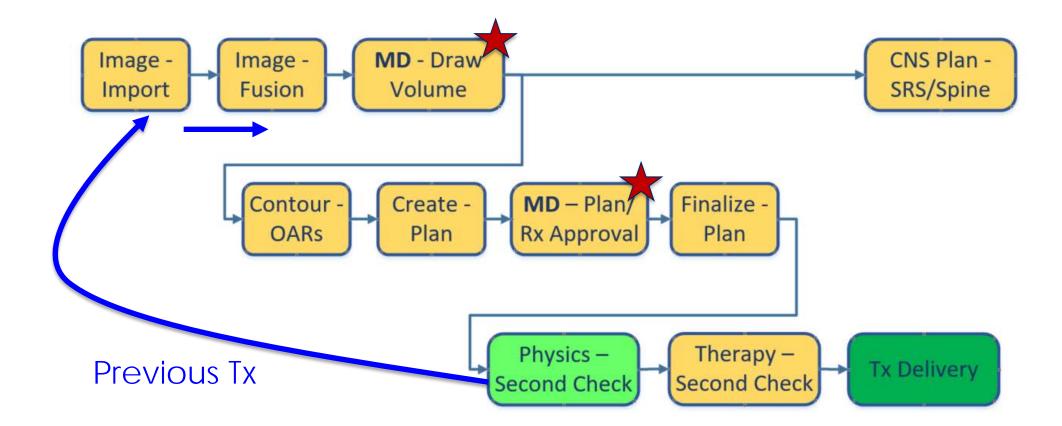
## Motivation

- Move the safety barrier close to the origin of the errors
- Save the cost of quality by mitigating the rework and delay
- Relief the stress of the time constraints
- Avoid a moral compromise or burnout
- Engage the clinical decision early stage
- Physicist move to the planner role whenever needed

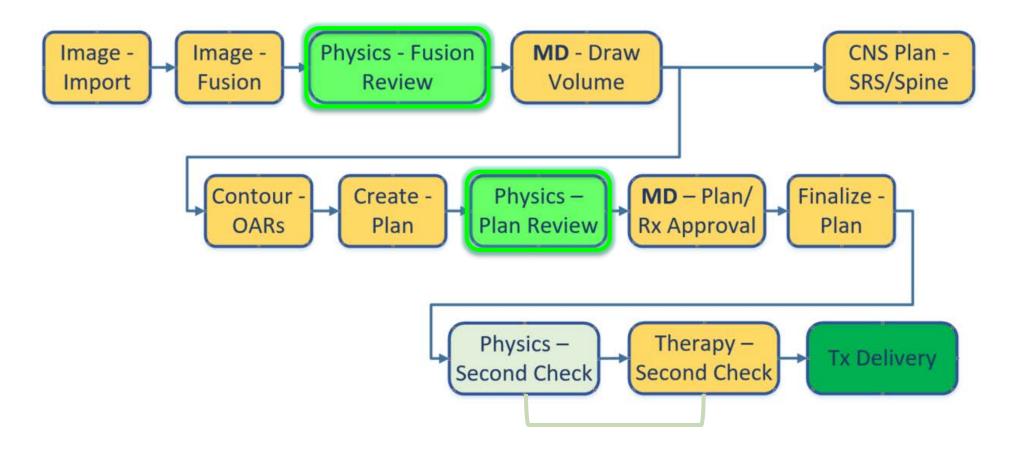
## Care Path (Traditional)



## Care Path (Traditional)



## Care Path (upstream)



## Upstream Physics Plan Review

30

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MANAGEMENT AND PROFESSION

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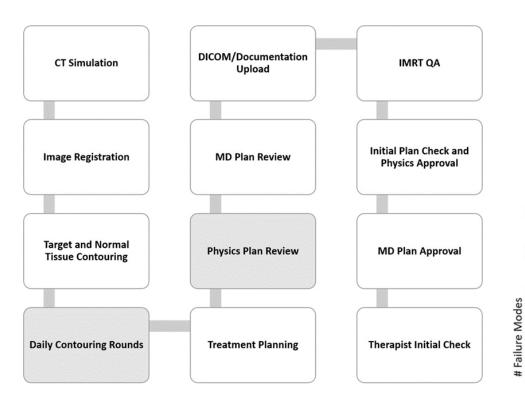


FIGURE 1 Treatment planning workflow at our institution. Shaded boxes highlight additional quality assurance steps compared with the conventional treatment planning process

#### Assessing initial plan check efficacy using TG 275 failure modes and incident reporting

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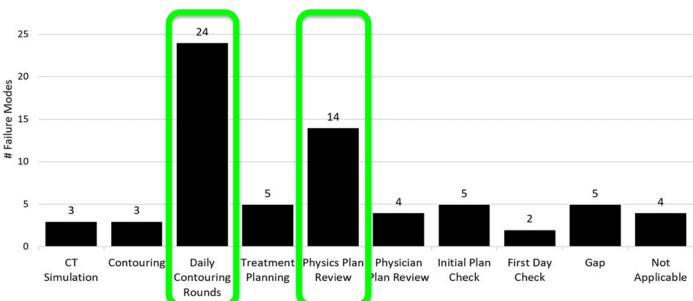
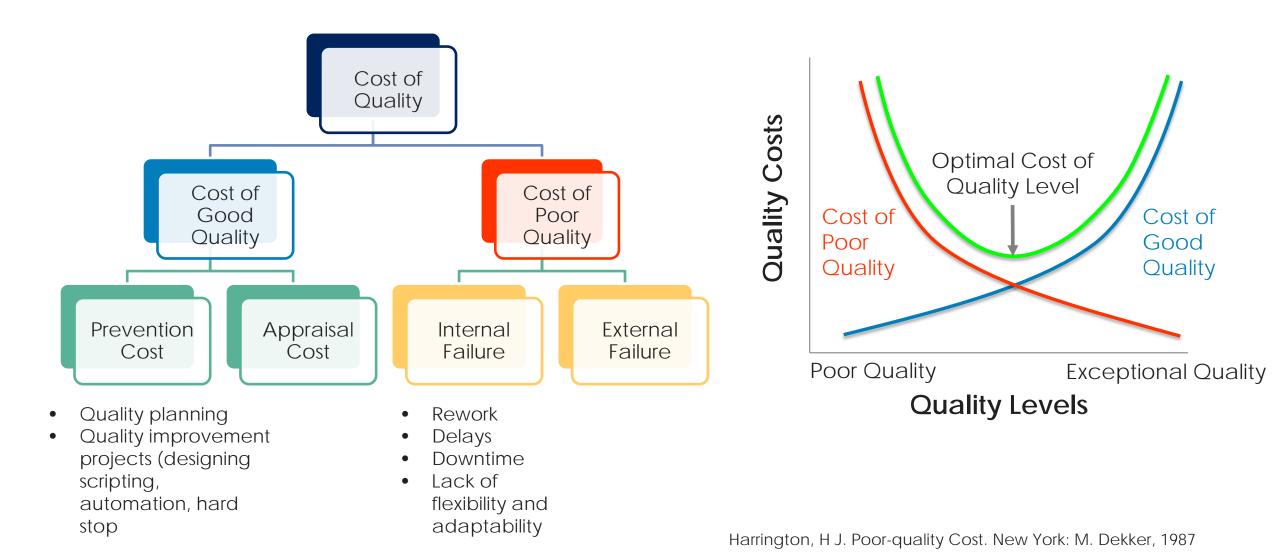


FIGURE 2 Failure modes discoverable by various steps of the treatment planning process as per an in-house committee consisting of 10 physicists. Each failure mode could be covered by multiple quality assurance steps

## Plan Review – Cost of Quality



# **Quality Improvement Projects**

- Standards and Guidelines, Encounters (Checklists)
- RapidPlan: Kevin L. Moore, Automated Radiotherapy Treatment Planning, Seminars in Radiation Oncology, Vol 29 (3), 2019, <u>https://doi.org/10.1016/j.semradonc.2019.02.003</u>
- EZFIUENCE: Irena Dragojević, Jeremy D. P. Hoisak, Gina J. Mansy, Douglas A. Rahn, Ryan P. Manger, Assessing the performance of an automated breast treatment planning software, Vol 22 (4), 2021, <a href="https://doi.org/10.1002/acm2.13228">https://doi.org/10.1002/acm2.13228</a>
- Auto Contouring
- Script based Secondary Calculation
- Script based Plan check: Automatic plan quality check, collision etc.
- One-click Plan document printing

## Plan Review – Scripting, Automation

Constraint Template													
6 UCID ban (SRT 3.6) *					UCSD Brain	(SRT 3 fx) (CNS) Pres	criptions						
Structure Check Template					,	hescription Total Dose (cGy)	1						
						PTV 1.01 2700	1						
Plan Check Template		LICED Brain (SDT 2 fr) (CNS) Constraints											
Treat Prep Check Template	UCSD Brain (SRT 3 fx) (CNS) Constraints												
	Priority	Structure Template	Structure Plan	Тури	Prescription	Constraint	Gead	1 HA PTV 3h	Pavy/Tail	Verily OK	Connent		
Report Template	3	BrainStom	BrainStern	GAR		D0.05ec s. Handi	2310cOy	34.6cOy	1				
		ðrairStum	BraixStom	CAR		V1800cOy s - (Soft)	0.5cc	0vic	1				
Course 111MB Brain	t	OpticDrawn	OpticChiaim	CAR		D0d3cc s (Hand)	1740cGy	42.1cGy	1				
Plan	+	OpticOrase	Optichisism	CAR		V1530cGy ± ~ (500)	0.214	Ore	1				
		OpticNex_L	OptieNin_L	EAR		D0.43er s (Hard)	1740eGy	17.5eGy	1				
Dose 1 HA PTV 35	t	Operative_L	OpheNex_L	CAR		¥1530eGy 5 ~ (Set)	0.200	Occ	1				
900cGy x 3 = 2750cGy	1	Opticher, R	OpticHink,R	GAR		D0.03ec s (Hard)	1740cGy	10eGy	1				
Report	1	OpticNey,R.	OpticNex_R	CAR		V1530cGy s - Cott	0.200	0ec	1				
	z	PTV	PTV 1.01	Target	PTV 1.01 2700:0y	V100% 2 - (Soft)	90%	50%	1				
	2	PTV	PTV 1.01	Target	PTV 1.01: 2700c0y	CI 100% a (Soft)	1.5~	1.024	1				
	2	PTV	PTV 3.01	Target	PTV 1.81 2700+Gy	D0.03cc: 5 - (5oR)	150%	122,000%	1				
	2	PTV	PTV 1.01	Target	PTV 1.01: 2700cGy	GM 100% 3 (For tracking only)	0.7-100	0.297	1				
	2	GTV	GTV 1.01	larget	PTV 1.01: 2700eGy	Hot Spot Within (SFN/CTV)	134,743%	154743%	1				
	3	Cochlea,3.	Cochica.L	CAR		00.05ec s - Ciota	1710cQy	7,600y	1				
	3	Cochice,R	Cochilas,R.	CAR		D0.00cc s - (Soft)	1710u0y	8.8cOy	1				
	Normal         Normal         Statute         Normal         Normal         Normal           1         Bardom         Bardom         Out         1 <td>V2000cGy s = (Hy3ec Soft)</td> <td>2005</td> <td>7.545cs</td> <td>1</td> <td></td> <td></td>	V2000cGy s = (Hy3ec Soft)	2005	7.545cs	1								
	3	Stan-PTV	Bram-PTV	CAR		V2400cGy s ~ (Soft)	16.5er	524hr	1				

		Brain SRS/SRT Pla	an Checks			
Plan Check	Expected	1 HA PTV 3fx	Pass/fail			
Photon Dose Calculation Algorithm	AAA_16010	AAA_14010	1			
Photon Volume Dose Grid Size (cm)	0.125	0.125	1			
Photon Heterogeneity	ON	ON	~			
CT Slice Thickness (cm)	0.12	0.12	~			
DVH Structure Dose Coverage (90	≥ 99%	> 99%	1			
DVH Structure Sample Coverage (%)	2 99%	2 99%	1			
Minimum Field Size of X or Y Jaw (on)	All Fields ≥ Min	All Fields 2 Min	1			
Reference Points Have No Location	All Reference Points Have No Location	All Reference Points Have No Location	1			
Maximum MU Duty Cycle	s 4	2.94	1			
Minimum MU for a Field in Field Segment or Static MLC Field (MU)	All Fields ≥ 4MU		1			
Maximum MU for the specified Treatment Technique (MU)	All Fields s Technique Max MU	All Fields & 10000MU	~			
Same Iso (cm)	All Fields	x: -1.12 yi 13.09 zi 3.69	1			
Same Machine	All Fields	DelMar/Bsn1018	<i>✓</i>			
Same Technique	All Fields	SRS ARC	1			
Same Desa Rate	All Fields	1400	~			
Structure HU Override	Structure	Encompass Base: HU=-400 Encompass: HU=400	Δ			
Check that DRRs are attached to all fields	All Fields	All Fields have DRR attached	~			
Jaw Tracking Enabled	Jaw Tracking	DeMartBen1018: Jaw Tracking Enabled	1			
Prescription Checks	Frescription Checks	See Prescription Checks Table	1			
lutomatically run CollisionCheck to check for collisions	No Collisions or Warnings	1 CW 6180.1 C0: Structure 0 (0) HU 6 (0). 2 CCW 6175/9 C45: Structure 0 (0) HU 0 (0) 3 CCW 60 C115: Structure 0 (0) HU 0 (0) 4 CW 6180.1 C270: Structure 0 (0) HU 0 (0) CBC1: Structure 0 (0) HU 0 (0)	1			

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#### • Plan Quality

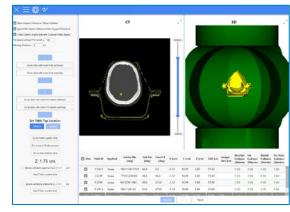
- Target coverage
- Sparing of OARs
- Plan confirms to
  - clinical trial (if applicable)
- Structures used
   during optimization
- Dose distribution
- Hot spots

#### • Plan Checks

- Cal Algorithm, setting
- CT slide size
- Plan confirms to clinical trial (if applicable)
- Structures used during optimization
- Dose distribution
- Hot spots

			UCSD B	rain SRS Struc	ture Checks	5
Structure Template	Structure Plan	Stray Pixels Volume Under 0.5 cc	Structure Holes Volume Over 0.1 cc	Slice Gaps	High Resolution	Laterality 3D View Pass/ Verify Comment Fail OK
GTV1	GTV 1.01	1	1	~	~	
PTV1	PTV 1.01	1	1	1	1	<ul> <li>Structure Checks</li> </ul>
BrainStem	BrainStem	1	1	~		Nomenclature
OpticChiasm	OpticChiasm	1	1	1		
OpticNrv_L	OpticNrv_L	1	~	1		<ul> <li>Stray Pixels</li> </ul>
OpticNrv_R	OpticNrv_R	1	~	1		Slice Gaps
Cochlea_L	Cochlea_L	1	1	1		
Cochlea_R	Cochlea_R	~	~	~		High resolution
Brain-PTV	Brain-PTV	~		~		<ul> <li>Laterality</li> </ul>
Brain	Brain	1		1		Laterality

#### Collision Check



## Improved safety features: Hard stops

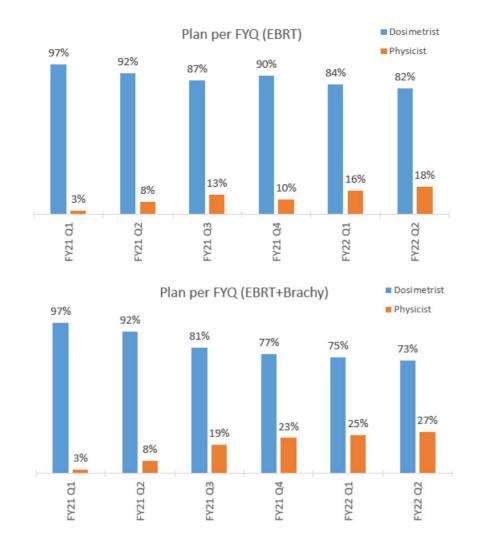
- Setup note: ISO shift Delta Couch
- Couch parameters
- Bolus sign-off
- High-Dose sign-off
- Collision Detection
- Rx mis-match with planning dose
- IGRT scheduling
- Tx time calculation

# Expanded Clinical Roles for Physicists

Automation has lowered barriers for physicist to re-engage with routine planning

Goals

 Minimize continuous MD reengagement with the workload
 More efficient planning
 Less errors / High quality
 More clinical decision making by physicists



Courtesy by Dr. Hoisak 2022 AAPM Spring Clinical Meeting

## Conclusion

- Physics plan/chart review should be based on risk analysis
- Practices should work to incorporate physics reviews as early in the workflow
- Consider automated tools (67% check items are possible full automation + maybe automation)

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### RETHINKING MEDICAL PHYSICS

