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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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

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

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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 automation, that is, can potentially be fully 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 check item		Corresponding failure modes	# FM	Highest RPN	Use Freq	Status	Auto. target
Patient assessment							
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%	++	P
PA-Q1-7	Previous radiotherapy treatments	2,4,10,12,23,58	6	214.1	87%	++	P

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

Patient assessment

✓ **15** check items

Simulation

✓ **22** check items

Treatment planning

✓ **134** check items

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Motivation

- FMEA study of surface image guided radiosurgery

TABLE IV. Top ten failure modes ranked by RPN.

Rank	Step	Potential failure modes	Potential cause of failure	Potential effects of failure	O	S	D	RPN
1	31. Contour critical structures	Inaccurate contours	Poor image quality Poor registration Insufficient training	Excessive dose to critical structure	6	8	6	288
1	79. Apply CBCT couch shifts	Inaccurate CBCT–CT registration	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)

Clinical Investigation: The Profession

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Quantitative Assessment of Workload and Stressors in Clinical Radiation Oncology

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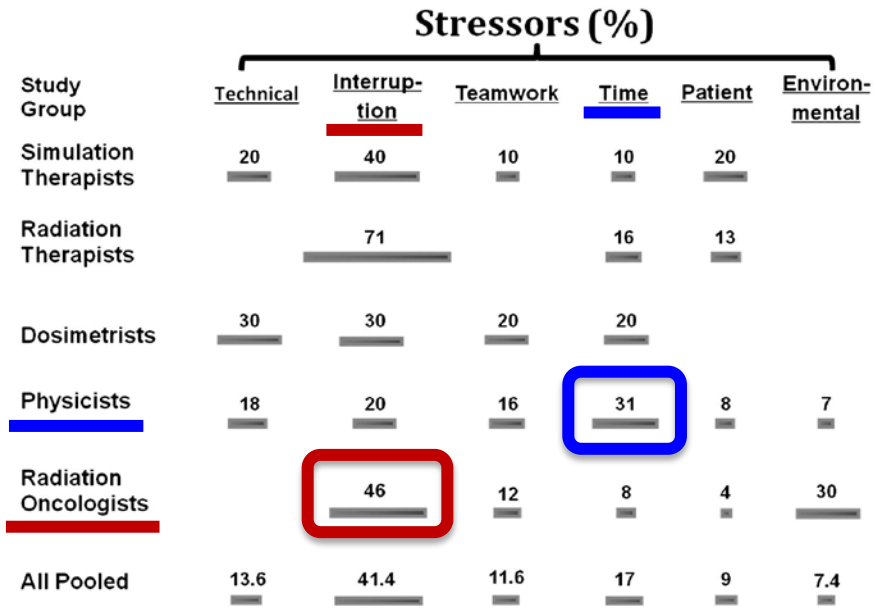

Fig. 1. Graphic representation of different sources of stressors. Bar width is approximately proportional to the percentage of the different type of stressors experienced by each radiation oncology professional subgroup. The last row in the table represents the pooled average. Stressor types are defined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

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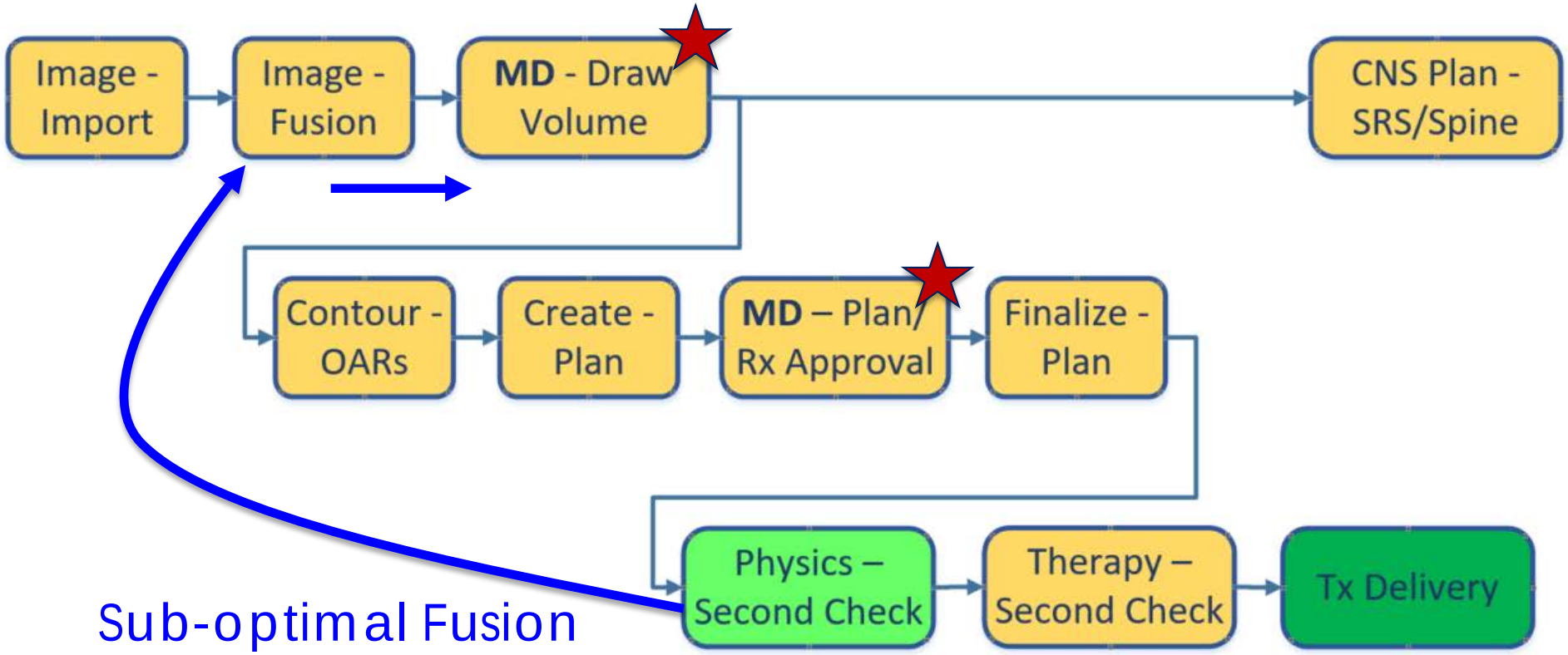
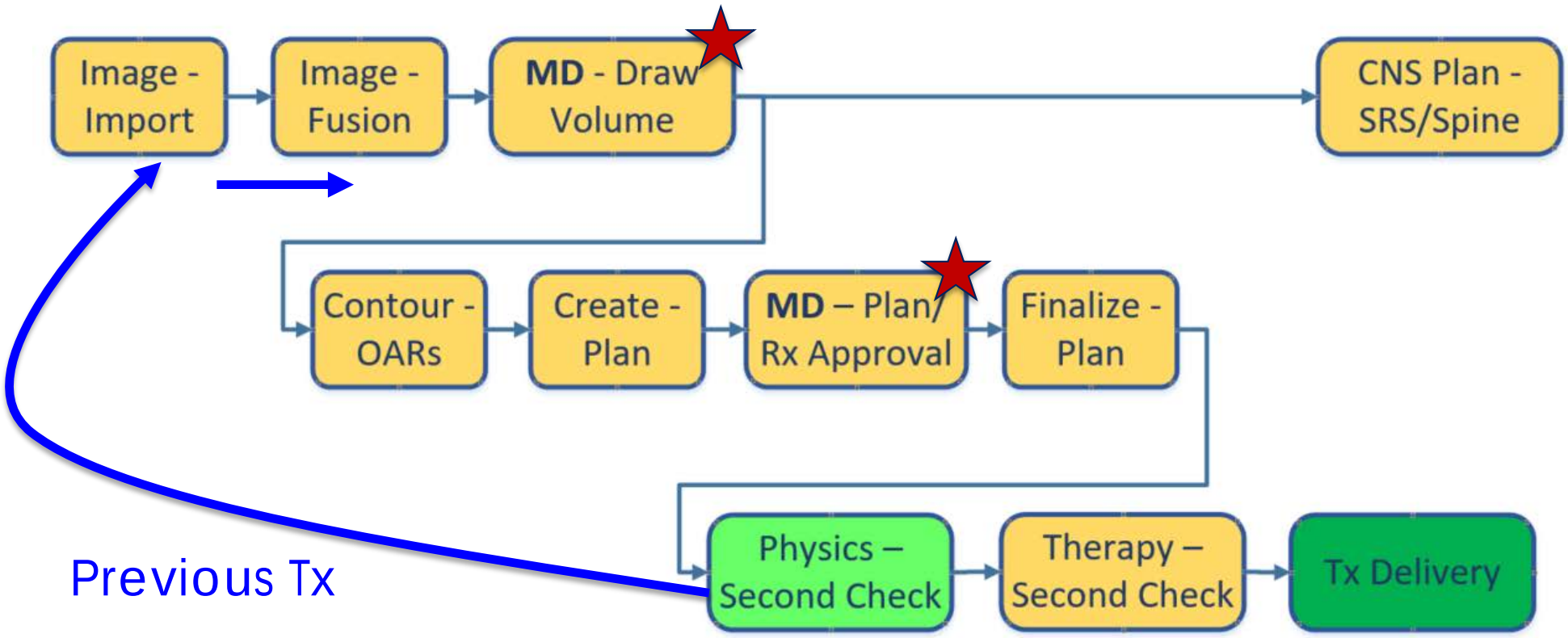
Motivation

- 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

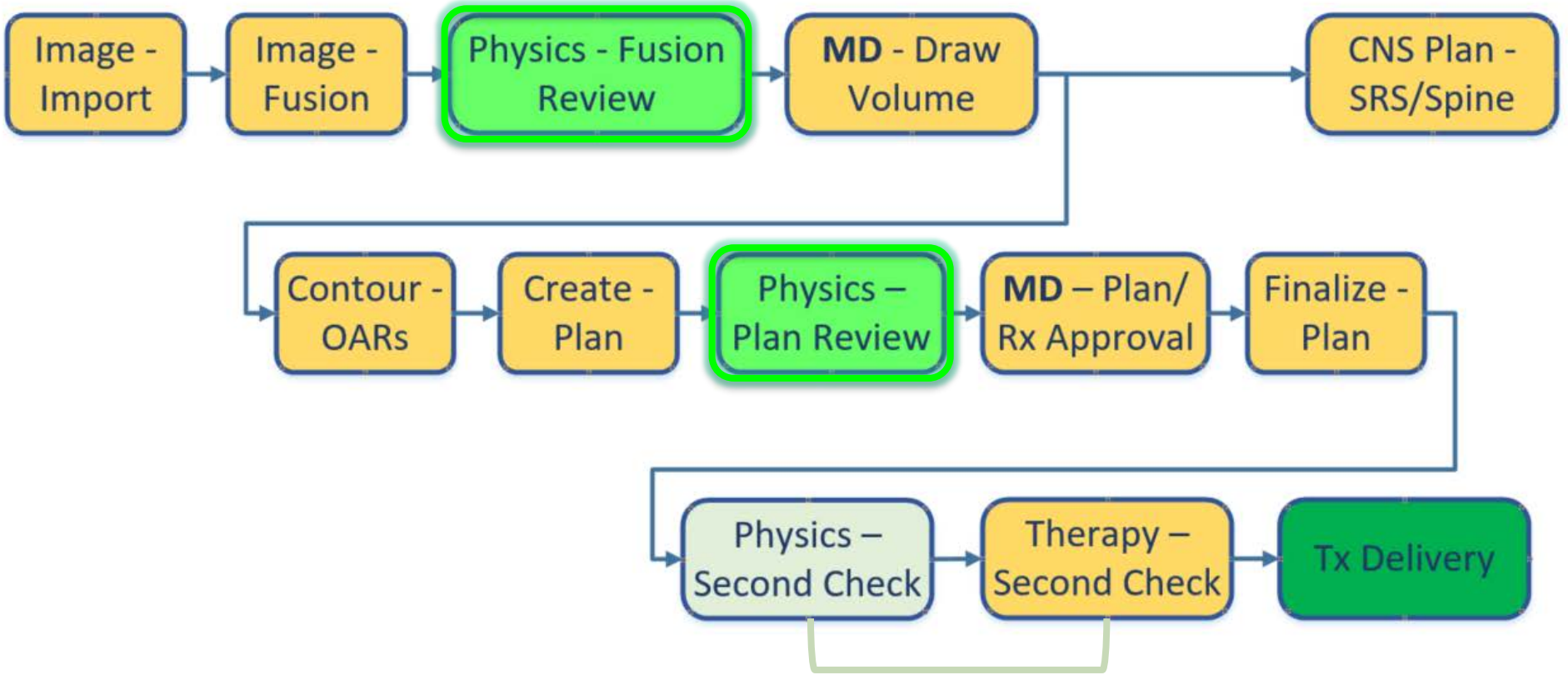
Care Path (Traditional)



Care Path (Traditional)



Care Path (upstream)



Upstream Physics Plan Review

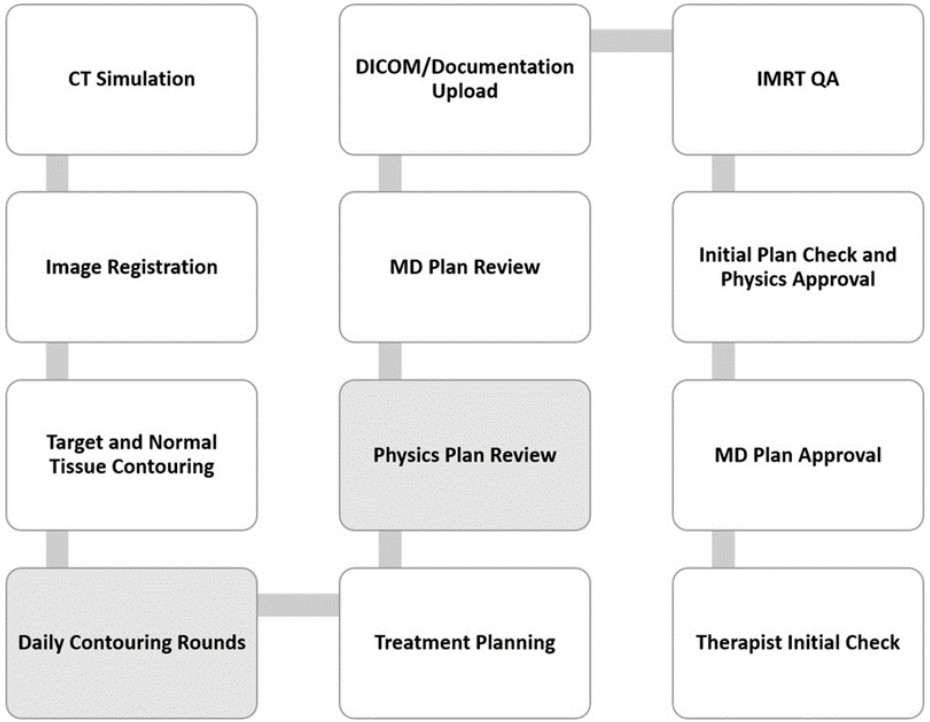


FIGURE 1 Treatment planning workflow at our institution. Shaded boxes highlight additional quality assurance steps compared with the conventional treatment planning process

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MANAGEMENT AND PROFESSION

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

Adam C. Riegel[1,2] | Cynthia Polvorosa[1] | Anurag Sharma[1] | Jameson Baker[1,2] | William Ge[1] | Joseph Lauritano[1] | Emel Calugaru[1] | Jenghwa Chang[1,2] | Jeffrey Antone[1] | Angela Oliveira[1] | Walkiria Buckenberger[1] | William Chen[1,2] | Yijian Cao[1,2] | Ajay Kapur[1,2] | Louis Potters[1,2]

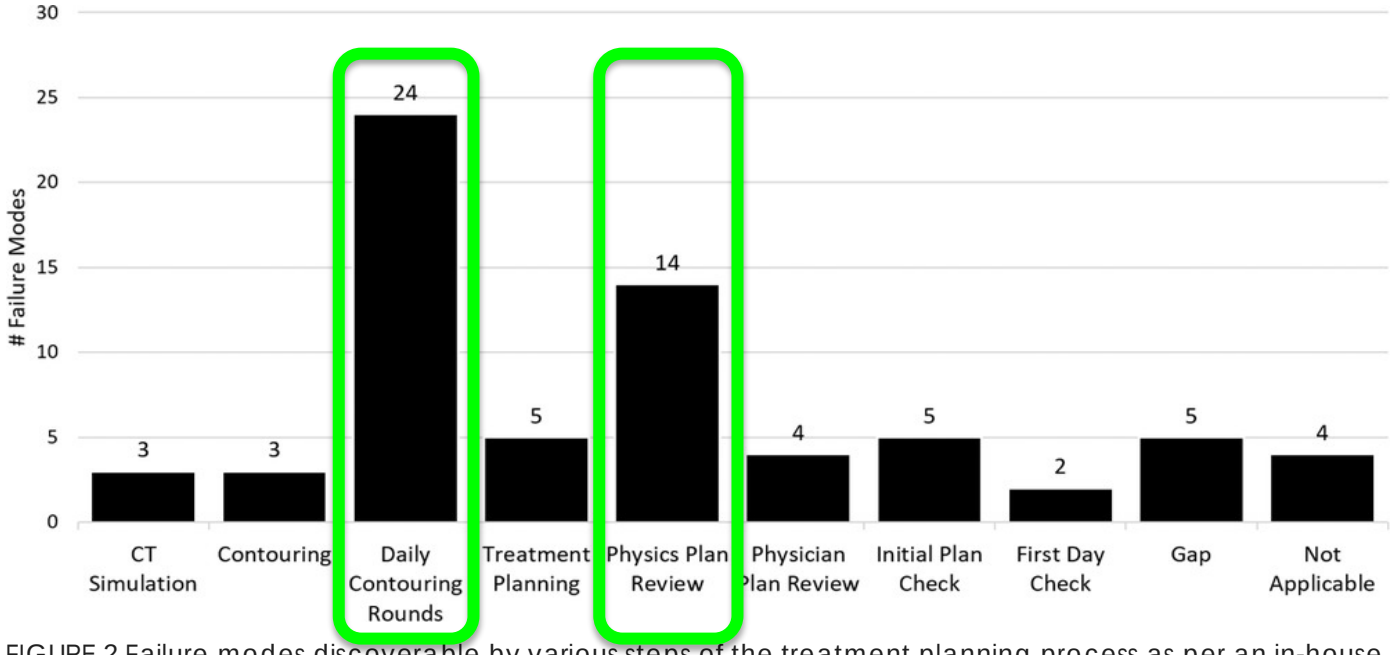

FIGURE 2 Failure modes discoverable by various steps of the treatment planning process as per an in-house committee consisting of 10 physicists. Each failure mode could be covered by multiple quality assurance steps

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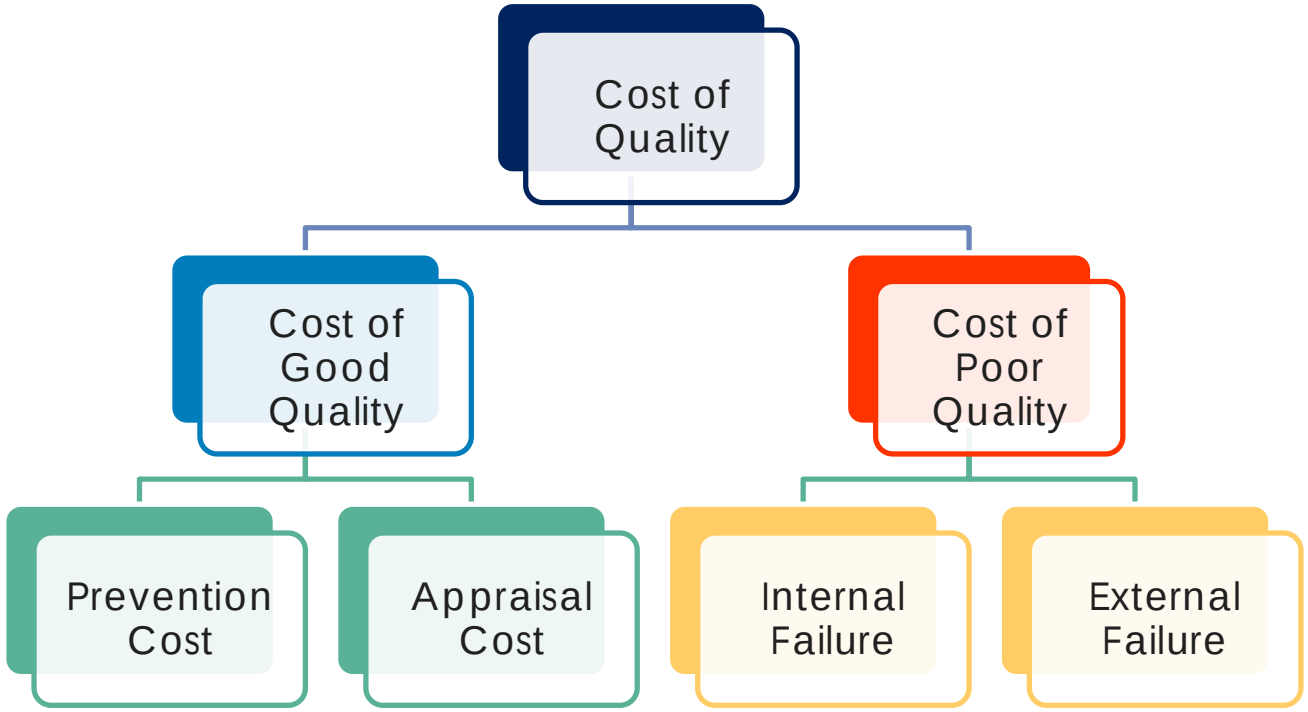
Plan Review – Cost of Quality



- Quality planning
- Quality improvement projects (designing scripting, automation, hard stop

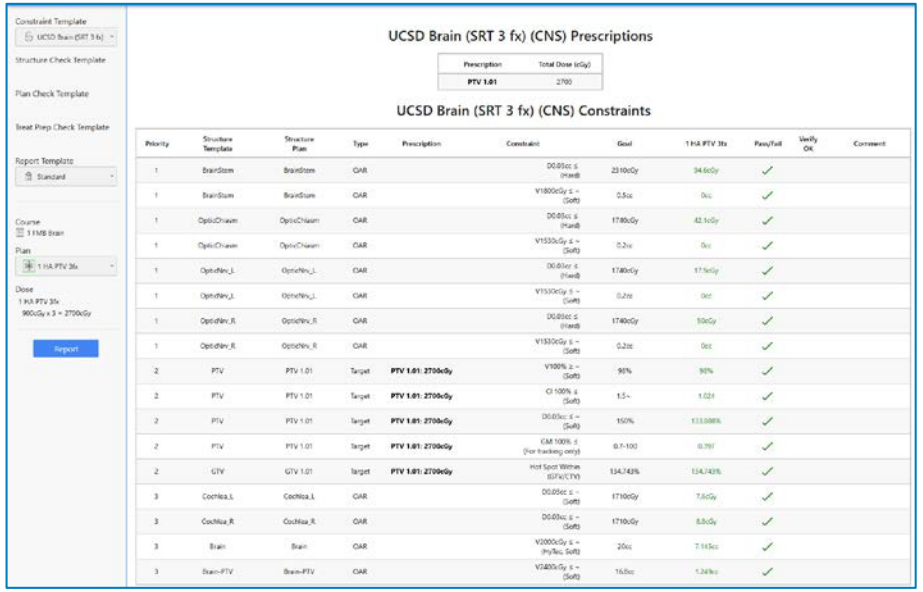
- Rework
- Delays
- Downtime
- Lack of flexibility and adaptability

Harrington, H J. Poor-quality Cost. New York: M. Dekker, 1987

Quality Improvement Projects

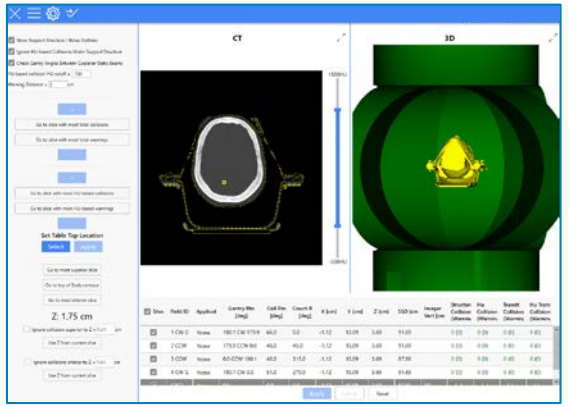
- Standards and Guidelines, Encounters (Checklists)
- RapidPlan: Kevin L. Moore, Automated Radiotherapy Treatment Planning, Seminars in Radiation Oncology, Vol 29 (3), 2019, https://doi.org/10.1016/j.semradonc.2019.02.003
- EzFluence: Irena Dragojević, Jeremy D. P. Hoisak,Gina J. Mansy,Douglas A. Rahn,Ryan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

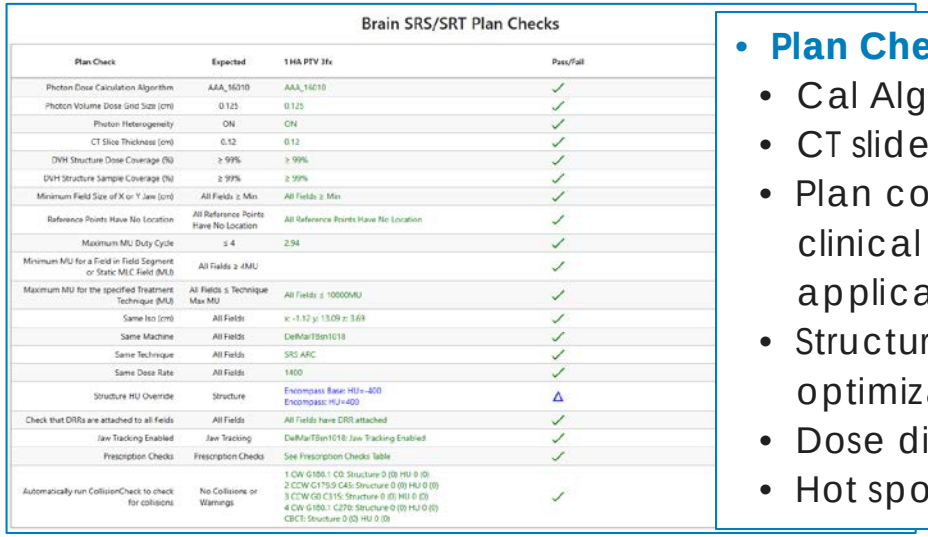
Plan Review – Scripting, Automation



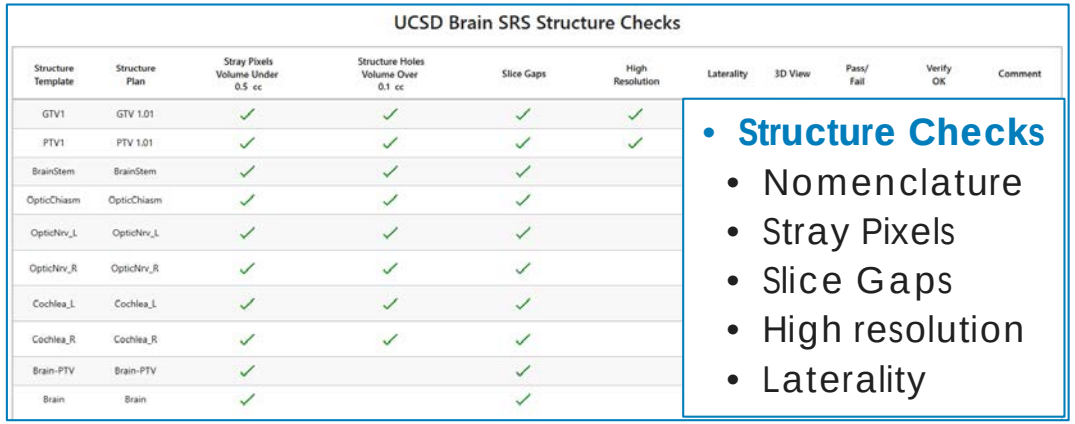
- **Plan Quality**
  - Target coverage
  - Sparing of OARs
  - Plan confirms to clinical trial (if applicable)
  - Structures used during optimization
  - Dose distribution
  - Hot spots

- **Collision Check**





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



- **Structure Checks**
  - Nomenclature
  - Stray Pixels
  - Slice Gaps
  - High resolution
  - Laterality

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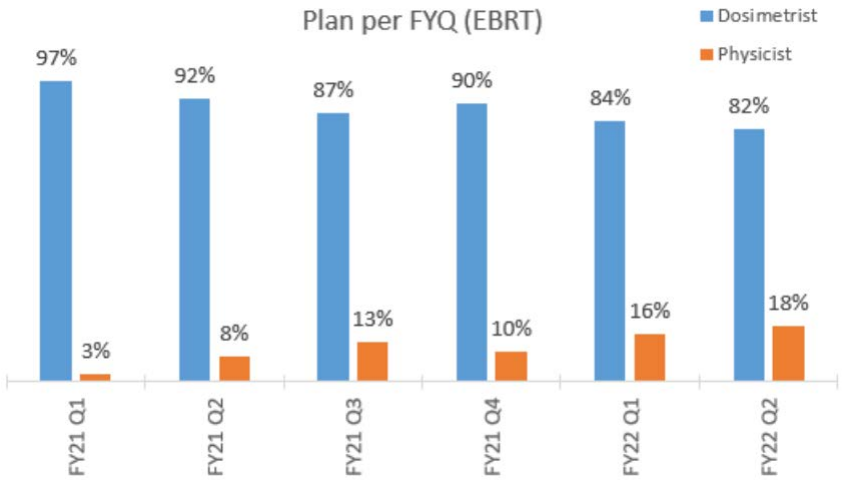
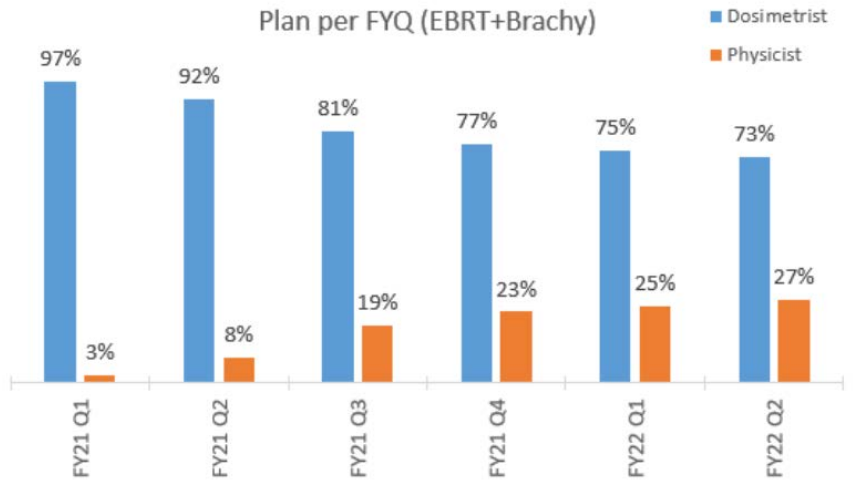
Improved safety features: Hard stops

- 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 re-engagement 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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