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JOINT AAPM | COMP MEETING

Clinical Testing of an Automated Physicist Chart Checking Tool in Head and Neck Treatment Planning

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BACKGROUND AND MOTIVATION

Background and Motivation:
- Pre-treatment physicist chart-check is a key quality assurance (QA) step in external beam radiation therapy (EBRT).
- Manual chart checking by Medical Physicists aims to identify treatment planning errors before treatment delivery.

Challenges:
- The process is time-consuming, influenced by cognitive bias, and reviewer variability.
- Automation has been recommended by professional guidelines such as the AAPM TG 275[1] to improve consistency and efficiency of physicist chart/plan checking.

Objectives:
- **Manual Error Detection:** Evaluate manual chart-check error detection among clinical physicists.
- **Automated Tool Performance**: Development and Clinical testing of an automated chart-check software tool.

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MANUAL ERROR DETECTION

❖ **Methods:**
- Thirteen intentional errors were implanted in a single head and neck treatment plan.
- Ten Medical Physicists performed the standard manual chart check and recorded the detected errors.

❖ **Results:**
✓ High Detection (≥90%):
○ Prescription and dose-related errors
○ Density overrides
✓ Moderate Detection (60–90%):
○ Incorrect treatment site labeling
○ Technique and tolerance table selection
✓ Low Detection (≤50%):
○ insertion of incorrect support structure (IGRT couch)
○ Incorrect prescription target naming
○ Incorrect volume type (0%)

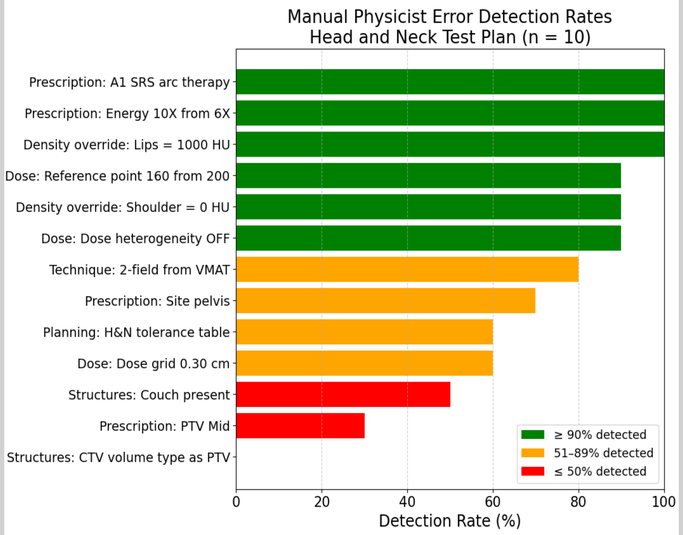

Figure 1: Manual physicist detection rates for 13 intentional error types, showing the percentage of ten clinical medical physicists who identified each error during manual chart review.

❖ **Discussion:**
➢ **Detection Rate vs Clinical Experience:** No clear relationship between years of clinical experience and error detection performance (see Figure 2).
- Variability likely due to workload or engagement, cognitive bias. Also, a large number of errors that physicists do not usually see in clinical scenarios.

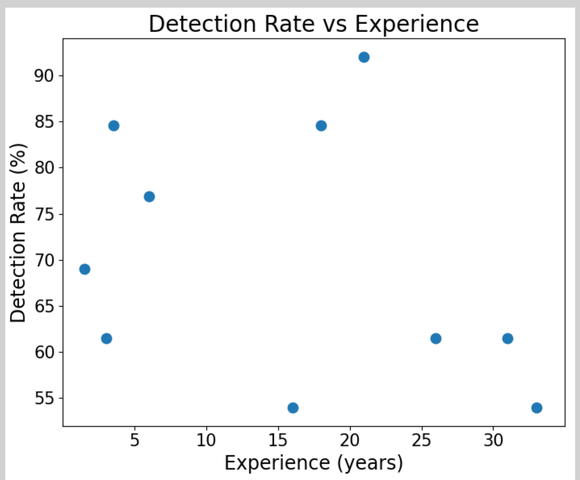

Figure 2: Overall manual physicist error detection rate versus clinical experience for ten clinical medical physicists.

AUTOMATED TOOL PERFORMANCE

❖ **Motivation for Automation:** Manual checks frequently miss structure naming inconsistencies, configuration issues, and similar standardization related items.
❖ **Clinical Need:** Automated tools can perform repetitive checks consistently, reduce fatigue-related omissions, improve standardization and Support physicists rather than replace them
- The fully automated tool was developed using the Varian Eclipse v16.1 API [2]. It performs 27 automated QA checks, and the results are exported to a HTML file as shown in Figure 3 for the head and neck test plan.

AutoPhysicsCheck_NECB.02.t

1. Detected plan type: Rx technique not recognized: '2 Field Plan'

2. Site and Laterality:

Prescription Site	Rx Site Laterality	Rx ID Laterality	Isocenter Laterality	Status
PELVIS	UNDEFINED	BILATERAL	MIDLINE	PASS

3. Plan approval history:

Status	Name	Date	Time
Planning Approved	Kaur Sarbjeet	2026-01-12	02:49
Planning Approved	Kaur Sarbjeet	2026-01-11	23:28
Rx Approved By	Kaur Sarbjeet	-	-

4. Plan approval: Not reviewed by Rx approver

5. Primary image time: 2025-10-24 09:32 | Age: 265 days | Older than 28 days

6. Secondary images times:

Modality	Name	Date	# of days from Primary
CT	CT_C01	2025-10-24	0

7. Beam Naming conventions: A2, A1 | beam naming expected B1-B9

8. Prescription feasibility: Rx status = 'Draft' (expected: Approved) | Rx target 'PTV_Intermediate' not found in structures |

9. Imaging device: PASS

10. Primary image resolution: PASS

11. Registered image resolution: Not tested

12. Dose grid resolution: PASS

13. Dose max range: 109.1% | PASS

14. Dose max location: PASS | Rx PTVs: PTV_Low, PTV_High

15. Beam settings: A2: TolTbl='4 Head/Neck' (expected '1 Standard') | A1: TolTbl='4 Head/Neck' (expected '1 Standard') | CBCT: TolTbl='4 Head/Neck' (expected '1 Standard')

16. Bolus usage:

Name	Type	Override	Rx	Plan	Treatment Beam	Setup Beam	Status	Issue
zBolus		-	No	No	No	No	PASS	-

17. Reference points: NECB.02.t(dose)

18. Support structure, Body: Neuro/HN | IGRT couch present

19. Overrides:

Name	HU	Type	Status	Issue
Shoulders	0HU		Warning	Unknown
Density_Unit	0HU		PASS	-
Density_High	5275HU		PASS	-
Lips	1000HU		Warning	Unknown
CouchSurface	-300HU	SUPPORT	PASS	-
CouchInterior	-1000HU	SUPPORT	PASS	-

20. Target contours:

Target	Type	# of distinct region	Issue
CTVn_High	CTV	2	-
CTVn_Low	PTV	2	-
CTVn_Mid	CTV	2	-
CTVp_High	CTV	1	-
GTVn	GTV	6	-
GTVp	GTV	1	-
CTVn_Low	PTV	-	Wrong DICOM type

21. OAR contours: Not Tested

22. Isocentre position: PASS | Targets used: PTV_All |

23. Dose per MU: PASS

24. Plan Normalization: PASS

25. DVH parameters: PASS

26. Dose Calculations: Warning: HU outside calibrated range | Dose calc grid = 0.3 cm | Photon dose calc

27. PO Field Direction and Beam Parameter: N.A.

Help

Figure 3. Automated Plan Check Script Output for Head and Neck Test Plan.

✓ Manual review time calculated by summing the average times for the 27 checks performed by script, with each check repeated manually three times, compared with automated chart checking tool/script run time as shown in Figure 4.

➢ **Script Sensitivity** $= \frac{True\ Positives}{True\ Positives + False\ Negatives}$

True positives = 12 detected errors
False negatives = 1 missed error
- Script Sensitivity $= \frac{12}{12+1} = 92.3\%$
  - The only missed error, incorrect prescription site "pelvis", because the tool uses the prescription as the reference/ Gold standard.

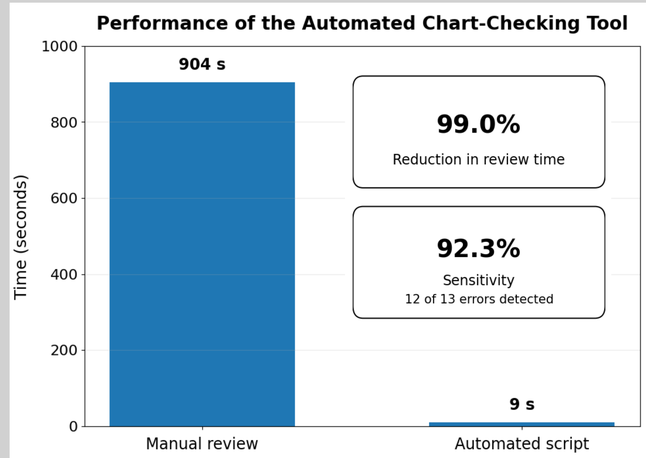

Figure 4. Time comparison of Manual review versus automated tool.

CONCLUSION AND FUTURE PLANS

- Manual physicist chart checks show considerable variability in error detection.
- An automated ESAPI-based chart-check tool was successfully developed and validated.
- This work demonstrates that automated checks provide an additional safety layer that complements, rather than replaces, manual review in complex head-and-neck radiotherapy workflows.
- These results support further refinement of the software and its integration into both medical physics chart checks and dosimetry review to identify errors earlier in the treatment planning workflow.

REFERENCES

1. Ford, E., et al. (2020), Strategies for Effective Physics Plan and Chart Review in Radiation Therapy: Report of AAPM Task Group 275. Medical Physics, 47(10), e1-e20.
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