Benchmarking the performance of a commercial plan check tool and standardized electronic checklists using TG-275 high risk failure modes

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INTRODUCTION AND AIM

The American Association of Physicists in Medicine (AAPM) Medical Physics Practice Guidelines 4.a and the report of Task Group (TG) 275 recommend the use of checklists and automation as strategies for effective treatment plan and chart review, thereby reducing errors and increasing quality of care. The AAPM TG-275 report performed a Failure Modes and Effects Analysis (FMEA) on the treatment planning process to identify the required elements of a checklist for plan review by qualified medical physicists.

Our clinic currently employs a standardized pre-treatment quality assurance process including physics plan review and physician peer review using an electronic, dynamic checklist method implemented within the oncology information system (OIS) as well as a commercial plan evaluation tool that plugs into the treatment planning system (TPS).

Automated verification of target and organs-at-risk contouring integrity, planning margins, and dosimetric constraints, as well as verification of numerical or binary conditions may be superior to manual inspection by a trained user with or without the use of checklists.

In this work, we evaluate the ability of a commercial automated plan check tool and standardized electronic checklists to identify the critical failure modes identified by the AAPM TG-275 report on strategies for effective treatment plan and chart review.

METHODS

An automated plan check tool called ClearCheck (version 1.66, Radformation, New York, NY) is evaluated. ClearCheck software is integrated into the Eclipse TPS and can perform over 100 structure, dose, and plan checks including collisions.

An electronic dynamic checklist implemented within the ARIA OIS (version 15.6, Varian Medical Systems, Palo Alto, CA) is also evaluated. The electronic dynamic checklists can retrieve real-time contextual information from the patient's chart and treatment plan to be used by the user in completing the checklist. Although our clinic employs dynamic checklists for many quality control (QC) processes, only the physics initial plan review and physician peer review checklists were evaluated (Figures 1 and 2).

Using the highest risk failure modes identified by the FMEA in the AAPM TG-275 report, the number of failure modes addressed by ClearCheck and by the physics initial plan review and physician peer review electronic checklists were determined. Checks performed exclusively by each tool were identified. Overlapping and complementary check coverage was also evaluated for each tool.

RESULTS

The TG-275 report identified 46 failure modes with highest risk to patient safety. Examples are given in Table 1.

The electronic checklists for physics initial plan review either directly check or prompts the user to check 78% of these failure modes. ClearCheck evaluates 13% of the critical failure modes identified in TG-275. The physician peer review checklist in use at our clinic evaluates 54.3% of the failure modes. Results are shown in Table 2.

There was 100% overlap between the failure modes checked by the standardized checklist for physics plan review and ClearCheck. However, ClearCheck tests are automated and do not depend on user-compliance as with user-initiated tests or manual inspection.

When ClearCheck and the physics plan review checklist are coupled with an electronic checklist for physician peer review, failure mode coverage by all methods increased to 97.8%.

Table 1. Examples of Critical Failure Modes from TG-275

Failure Mode	Risk Priority Number
Incorrect MD contours	261.3
Improper PTV margins	198.0
Previous RT not accounted for	181.2
Plan dose doesn't match intended	175.3
Inaccurate dosimetrist OAR contours	175.2
Incorrect critical structure dose	150.3
Poor image registration with prior studies	144.2
Incorrect fractionation/intent	143.2
Incorrect target dose	137.9
Incorrect intent: boost/no boost	131.9
Incorrect laterality of treatment site	114.8
Treatment device omitted (e.g. bolus)	112.7
Suboptimal plan/technique	108.3
Shifts not communicated in setup notes	107.3
Incorrect isocenter placement	107.0
Incorrect CT scan used for plan	104.9

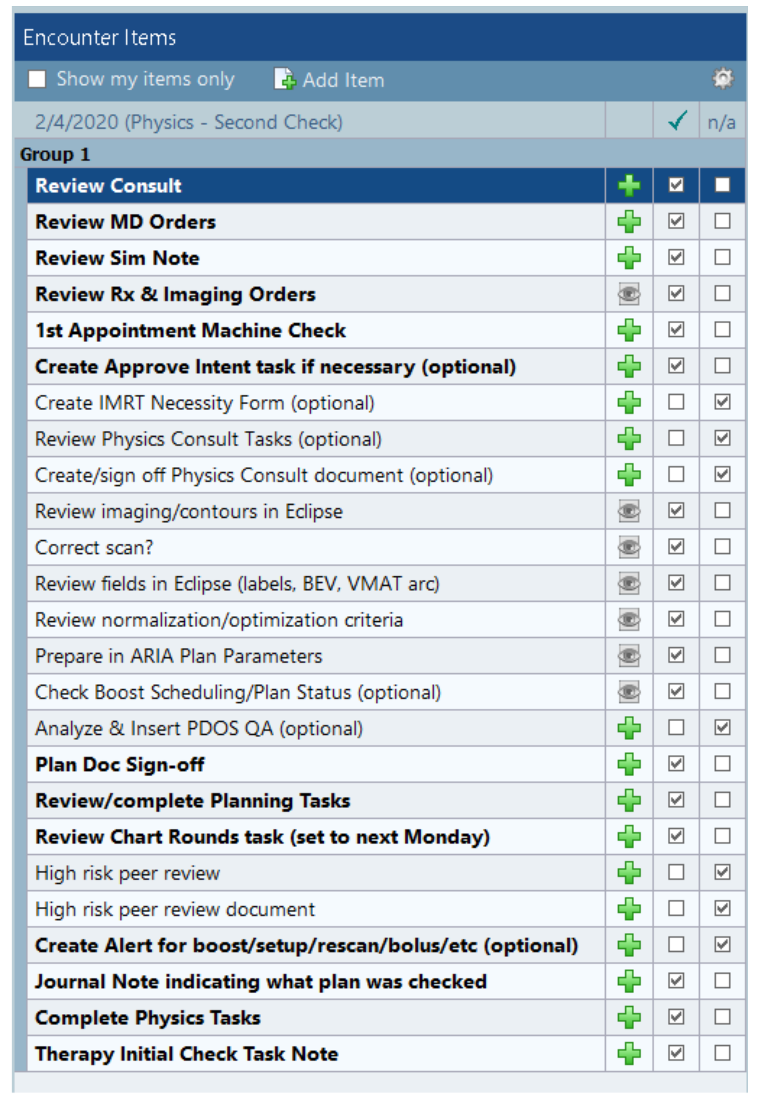

Figure 1: Dynamic check list for Physics Initial Plan Review

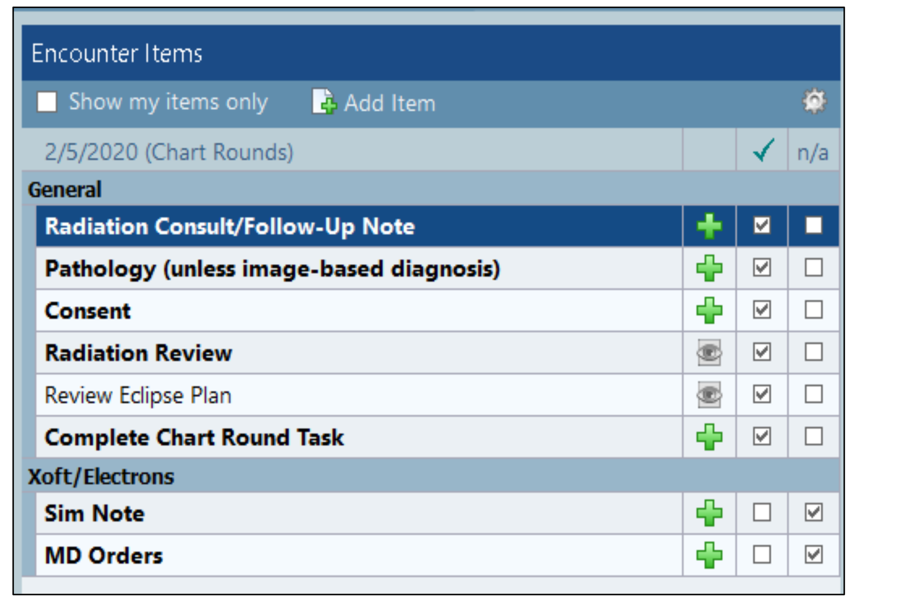

Figure 2: Dynamic check list for Physician Peer Review

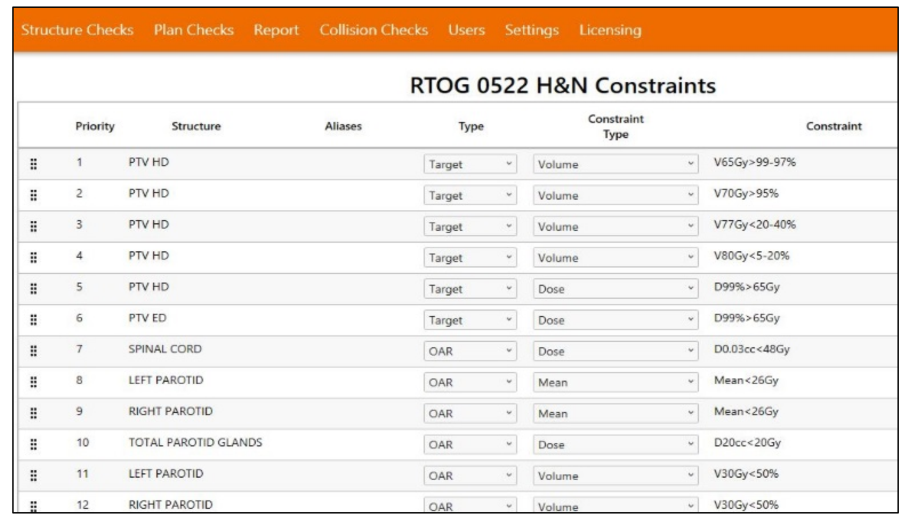

Figure 3: Example of ClearCheck dose constraints test setup

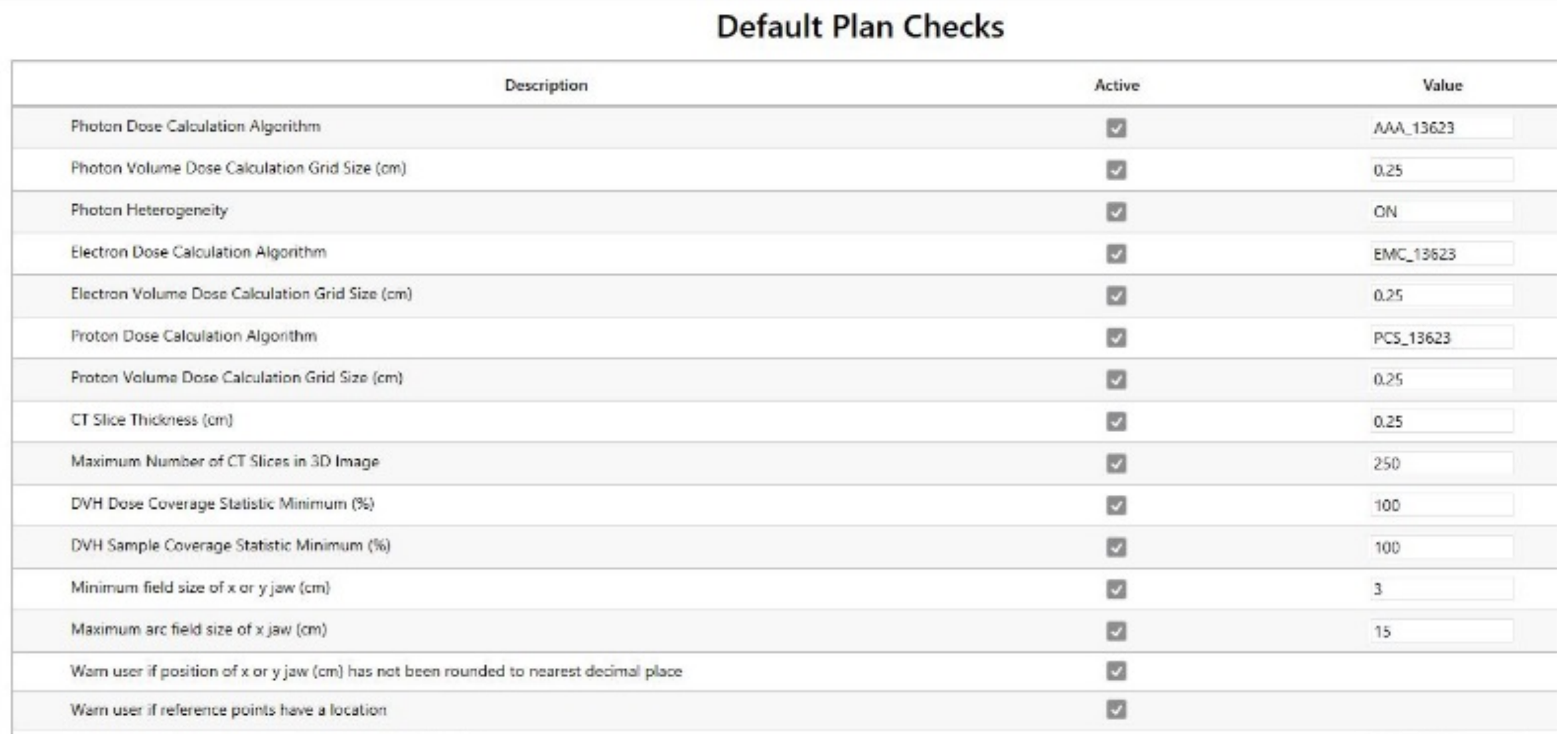

Figure 4: Example of configuration screen for ClearCheck default plan parameter checks

Table 2. Comparison of failure mode coverage ability by each plan check method

	Physics Plan Review	ClearCheck	MD Peer Review	Combined
Checks of TG-275 Failure Modes	36	6	25	45
% of TG-275 Failure Modes (n=46)	78.3	13.0	54.3	97.8
Exclusive Check	18	0	9	

DISCUSSION AND CONCLUSIONS

Dynamic checklists implemented in ARIA represent a flexible, secure, robust and easily implemented method for improving quality in physics initial plan review and physician peer review.

Although the current version of ClearCheck does not check all failure modes identified in TG-275, the software tool checks many plan conditions that while not critical to patient safety, are nevertheless important for plan quality and treatment deliverability. Furthermore, ClearCheck offers a qualitative advantage over user-initiated checklist items in that tests are automatic and do not depend on user compliance complete the check or manual inspection to verify parameters.

Automated plan check tools such as ClearCheck may be most effective when used to offload the verification of parametric and binary conditions from manual inspection, decreasing the mental workload this requires of the physicist while increasing the time available to perform other tasks and checks such as complex plan quality and patient safety issues that are not currently supported by automation.

This work demonstrates that no single method can address all failure modes identified in TG-275, and tools such as standardized checklists and automation software such as ClearCheck should be used as part of a comprehensive physics plan review and physician peer review strategy. QC tools and processes should be continuously refined based on methods such as FMEA and feedback from incident learning systems.

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