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A Novel Software Tool for the Standardization of Structures and Dose Constraints to Facilitate a More Efficient Clinical Workflow

M. Wagar[1], L. Yuan[1], L. Padilla[1]
[1]Department of Radiation Oncology, Massey Cancer Center, Virginia Commonwealth University, Richmond VA

VCU Health

INTRODUCTION

In departments that consist of multiple physicians, physicist, and dosimetrists, there can be as many different permutations of naming conventions and color coding of structures as there are staff members. Similarly, there can be differences in plan evaluation goals and constraints for a given treatment site and fractionation depending on the physician. This lack of standardization can make information harder to process and can make plan and peer review more difficult. Standardization of these elements through an automated tool, to the extent possible, would reduce inefficiencies, improve compliance to community standards, and alleviate cognitive load during physician plan and peer review.

AIM

To develop a tool to automate the standardization of structures (nomenclature and display), and dose constraints to increase workflow efficiency throughout the process of contouring, treatment planning and peer review evaluation in a radiation oncology department.

METHODS

Structure dictionaries were developed following TG-263[1] recommendations to standardize the nomenclature, color-coding, and contour line thickness and style.

Prescription-agnostic dose constraint templates for various sites were created using QUANTEC[2] and relevant clinical protocols. Two sets of dose constraint templates were created, one for conventional and one for stereotactic fractionations.

An in-house program was developed in Python v3.0 to automatically create structure and dose constraint templates based on standardized information, and user input. Structures used for planning but not used for dose evaluation were also included based on the treatment site indicated by the user.

Two outputs were generated:

(1) an XML file, compatible for import into Eclipse TPS (Varian Medical Systems), including al l the information required to create a clinical protocol in Eclipse with structure and plan objective templates

(2) a CSV plan evaluation file formatted to match the input of a plan evaluation script developed for Eclipse Scripting API (ESAPI) by a University of Michigan team[3,4], distributed on the NRG website[5], and modified in-house to identify the patient and plan uniquely and extend it functions.

RESULTS

A Graphical User Interface (GUI) for the program was created to improve ease of use and allow for the following user inputs (Figure 1):

- Selection of desired prescription-agnostic template
- Boost status
- Number of PTVs
- Number of fractions

Upon receipt of user input, the script generates an XML and a CSV files as output (Figure 2).

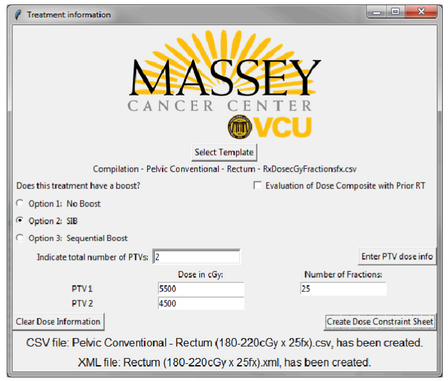

Figure 1: GUI for the Python Program

```
- <Phases>
  - <Phase ID="Plan1">
      <Mode>Photon</Mode>
      <DefaultEnergyKV xsi:nil="true" />
      <FractionCount>25</FractionCount>
      <FractionsPerWeek xsi:nil="true" />
      <FractionsPerDay xsi:nil="true" />
      <TreatmentUnit>TBMCV1</TreatmentUnit>
      <TreatmentStyle>Conformal</TreatmentStyle>
      <ImmobilizationDevice />
      <LocalizationTechnique />
    - <Prescription>
      - <MeasureItem ID="PTV_4500">
          <Type>3</Type>
          <Modifier>0</Modifier>
          <Value>95.0</Value>
          <TypeSpecifier>45.0</TypeSpecifier>
          <ReportDQPValueInAbsoluteUnits>false</ReportDQPValueInAbsoluteUnits>
        </MeasureItem>
      + <MeasureItem ID="PTV_4500">
      + <MeasureItem ID="PTV_5500">
      + <MeasureItem ID="PTV_5500">
      + <MeasureItem ID="PTV_5500">
      - <MeasureItem ID="Bladder">
          <Type>4</Type>
          <Modifier>1</Modifier>
          <Value>45.0</Value>
          <TypeSpecifier>50</TypeSpecifier>
          <ReportDQPValueInAbsoluteUnits>true</ReportDQPValueInAbsoluteUnits>
        </MeasureItem>
```

	A	B	C	D	E	F	G
1	Structure	Structure Id	Aliases	DVH Objective	Evaluation	Variation	Priority
2	PTV_4500			V45.0Gy[%]	>95	90	
3	PTV_5500			V55.0Gy[%]	>95	90	
4	PTV_5500			D0.03cc[Gy]	<60.5	<63.2	
5	Bladder			D50%[Gy]	<45	57.5	
6	Bowel_Bag			D0.03cc[Gy]	<50	52	
7	Bowel_Bag			V40Gy[%]	<30	70	
8	Bowel_Bag			V45Gy[cc]	<195	Y	
9	Bowel_Bag-PTV			V45Gy[cc]	<195		
10	Femur_Head_L			D50%[Gy]	<30		
11	Femur_Head_L			D5%[Gy]	<44		
12	Femur_Head_R			D50%[Gy]	<30		
13	Femur_Head_R			D5%[Gy]	<44		
14	Genitals			V20Gy[%]	<50	100	
15	Genitals			V30Gy[%]	<35	90	
16	Genitals			V40Gy[%]	<5	80	

Figure2: Sample XML file (top) and CSV file (bottom) for dose constraints

These to files are created for the following reasons:

(1) The XML file can be imported into Eclipse to create a clinical protocol template (Figure 3) that includes:

a. A structure template with standardized structure nomenclature and display to minimize manual editing by the planner. This include the color and style of the structure, the DVH line color, style and width, etc. Such standardization facilitates legibility and understanding of the DVH and contours during individual MD review and peer review.

b. A plan objective template that allows for dose evaluation of targets and critical structures matching the desired dose prescription

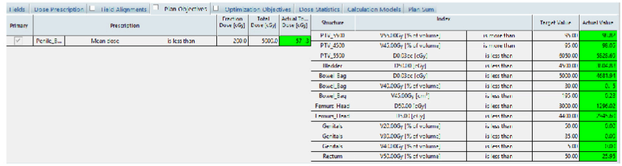

Figure3: Sample Plan Objectives Display in Eclipse TPS.

(2) The CSV file allows the planner to run an ESAPI script to create an easy-to-read summary of dose constraints and target coverage goals used to evaluate the plan (Figure 4)

This script significantly decreases the time needed to create clinical protocols in Eclipse. It can create a new protocol based on the user input and template selection in less than 15 seconds.

Implementation of this tool can lead to increased uniformity in naming and display of structures. The standardization of structure nomenclature and display and plan evaluation metrics can facilitate plan review by individual MDs as well as lower the cognitive load during peer review.

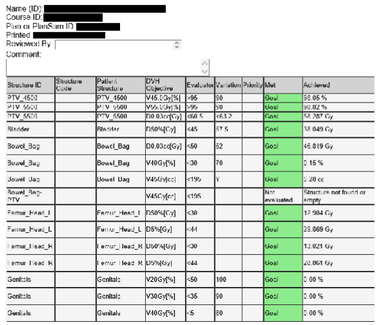

Figure4: Sample Dose Constraint Report

CONCLUSIONS

This program improves planning workflow efficiency, standardization-compliance, and peer review of contours and plan evaluation parameters.

CONTACT INFORMATION

laura.padilla@vcuhealth.org; matthew.wagar@vcuhealth.org; lulin.yuan@vcuhealth.org

REFERENCES

[1] Mayo C.S., *et al.*, "The Report of AAPM Task Group 263: Standardizing Nomenclatures in Radiation Oncology," Alexandria, VA: American Association of Physicists in Medicine, 2018

[2] Bentzen S.M., *et al.*, "Quantitative Analyses of Normal Tissue Effects in the Clinic (QUANTEC): An Introduction to the Scientific Issues", Int J Radiat Oncol Biol Phys. 2010 Mar 1;76(3 Suppl):S3-9

[3] Mayo C.S., *et al.*, "Incorporating big data into treatment plan evaluation: Development of statistical DVH metrics and visualization dashboards." Advances in radiation oncology, 2017. **2**(3): p. 503-514.

[4] Mayo C.S., *et al.*, "Establishment of practice standards in nomenclature and prescription to enable construction of software and databases for knowledge-based practice review." Practical Radiation Oncology, 2016. **6**(4): p. e117-26.

[5] https://www.nrgoncology.org/