Automated and standardized HDR Brachytherapy Treatment Plan QA via API scripting

Bin Cai, PhD

Assistant Professor of Radiation Oncology

Department of Radiation Oncology
Division of Medical Physics
WUSM / Siteman Cancer Center

Disclosures

- Research grant from Varian Medical System outside the presented work.

Objective

(1) To introduce the design and implementation of automated plan checking tools with API-based programming or scripting in a commercially available TPS

(2) To validate and evaluate these QA tools by using mock HDR Brachytherapy plans with simulated errors.

Background

- HDR remote-afterloading brachytherapy
  - mature technology
  - many published guidelines and guidance documents to help establish safety and quality management programs (TG-56, TG-59)

- Near-misses and medical events still happen
  - Most incidents due to human failures/errors (ICRP 97)
  - Most often with actions having the least time available (references below)
  - 4 out of 10 major error categories leading to ME were related to the treatment planning process (Thomadsen, 2014)

Richardson et al, PRO , 2, 157-163, 2012. Thomadsen et al, IJROBP, 57, 1492-1508, 2003. Wilkinson et al., Brachytherapy, 12, 382-386, 2013. Thomadsen et al, PRO, 4, 65-70, 2014.

Background

- Plan quality assurance (Plan QA) can increase the detectability of planning errors
- Plan QA typically includes an evaluation of plan quality and a check of plan parameters

e.g. Checklists and forms (specific procedure/applicator); independent verification before treatment delivery;

However:

- often manually performed → subject to errors
- relies on the reviewer's expertise → inconsistencies
- can be iterative: customized plans → further plan optimization → repeat plan QA → repeat retrieval of plan parameters & plan evaluation → takes time

Wilkinson et al., Brachytherapy, 12, 382-386, 2013.
Fraass et al., Medical Physics, 25, 1773-1829, 1998.

Features of HDR

- HDR BT demands high efficiency:
  - short time-frames (applicator placement, planning, and treatment)
  - leaving limited time for plan QA
- HDR BT demands high accuracy:
  - delivery of dose in few fractions & high dose rates
  - prevent severe dosimetric errors and medical events

- HDR brachytherapy team to be efficient, accurate, and consistent → increased need for automated plan QA tools.
- Tools embedded w/in the treatment planning system (TPS) → ideal for convenience and reduce errors

A little about WashU Brachytherapy center…

siteman.wustl.edu

Brachytherapy Center

- AU (RO) performs HDR implants
  - In RO dept (most common)
    - Nursing & RTT assistance
  - OR (sarcoma, prostate)
- Sim RTTs image (CT or MRI)
- Dosimetrist plans
- Physicist (AMP) checks
- Therapists setup, connect, & treat with AMP and AU present

Brachytherapy

- ~4000/yr (implants + procedures + treatments)
- Radiopharmaceutical therapy
- LDR therapy
- HDR therapy (2 RAUs)
  - Highest volume services:
    - GYN intracavitary– “template” plans —all HDR AMPs
    - Breast interstitial/SAVI-- customized plans (more experienced team)
    - Prostate interstitial-- customized plans (more experienced team)

Aims of Our Work with API Scripting

- Design QA tools for automated plan checking with API-based programming (or scripting) in a commercially available TPS
- Test clinical implementation of these QA tools for SAVI breast and HDR prostate
  - High volumes (1-2 week) in an already busy clinic
  - Customized planning (more experienced teams)
  - Established planning criteria (rules -- scripted)
- Design an observer study to
  - Validate QA tools
  - Evaluate gain (if any) in efficiency

Cai et al., ABS, Brachytherapy 2016: 15: S28-S29
Cai et al., Brachytherapy 2019, 108e114.

Methods: “Plan QA”

- Plan QA was divided into 2 major categories:
  - Plan quality (PQ) evaluations
  - Plan integrity (PI) checks

- PQ: focuses on dosimetric information and checks plan meets D-V constraints, and also performs a manual verification of dwell time
- PI: checks plan parameters against tolerances/specs of the RAU and applicator
- Perform by physicists, dosimetrists and physicians

Mooney et al, Brachytherapy, 15, 616-624, 2016.
NSABP B-39/ROTG 0413 protocol
RTOG 0321 protocol

Plan QA Checklist

- Sample plan QA checklist for HDR prostate (manual process)
  - ❑ Items need to be checked
  - ❑ Items need to be reported
- Goal: to automatically pull information from TPS and mimic human checking process -- scripting

  As much as possible

HDR Prostate Checklist:	Checked?	Comments
Correct image sets (Series?, # of images?)		
Plan Properties:		
Rx Dose (ARIA vs Plan)		
ARIA Rx linked? Ref pt created? MONO or BOOST entered?		
Correct CT for planning		
Check all contours		
Channel:		
Channel numbering		
Digitization		
Correct machine assigned to applicators		
Catheter Lengths		
Step size = 0.5 cm?		
Offset >= 0.3 cm?		
Dwell Times:		
Distribution of dwell times reasonable?		
No 0.1s dwells		
No empty channels		
Isodoses		
Prostate DVH:		
V100≥ 90% (Min V100 > 85%)		
Urethra:		
V125 < 1cc		
V150 = 0%		
Bladder & Rectum:		
V75 < 1cc		
V150 = 0%		
Implant DVH:		
HI = (1- V150/V100) ≥ 0.5		
'P-P' Calc within 15%?		

Scripting in TPS

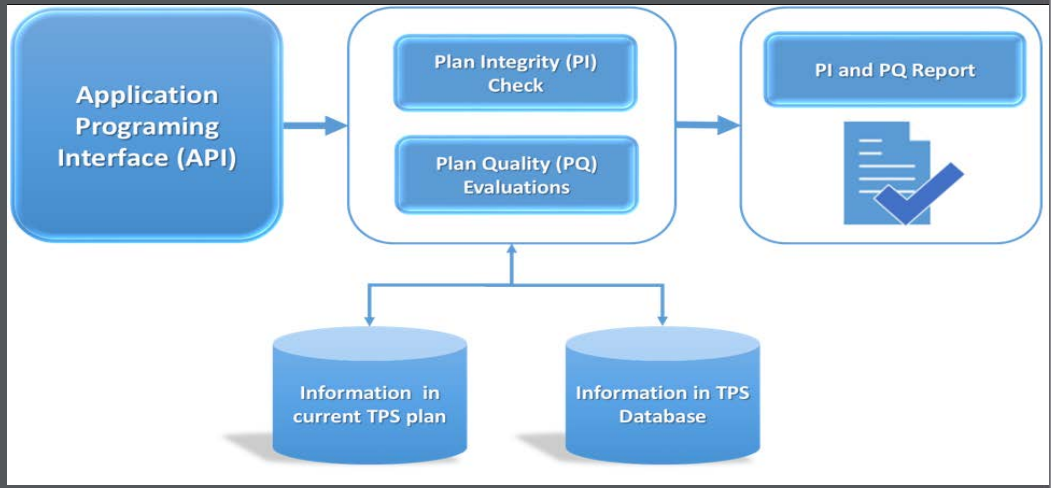
- Programing via a vendor supported format or interface to access treatment planning information from Treatment Planning System.
- ❑ Scripting is supported by several major TPS (Eclipse, Pinnacle, RayStation, etc.)

- Many groups have studied and developed scripting tools for RT
- ❑ Auto planning, plan QA, DVH generation, data mining, .etc.
- ❑ Mainly for EBRT

- Education materials and resources.
- ❑ Reference guide, vendor white paper, online discussion group, courses, webinar, code share website.

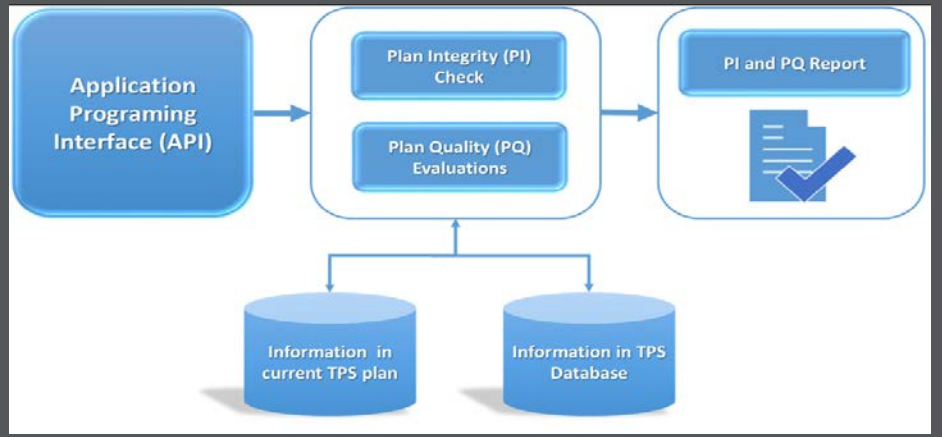
Script Design in Eclipse (ESAPI)

- The Eclipse Scripting Application Programming Interface (Eclipse Scripting API or ESAPI): a programming interface and a software library for Eclipse.
- The scripts can be integrated into the Eclipse user interface, or they can be run as standalone executables.
- User designed C# programs (“scripts”) were created and executed through the API to access planning information in TPS (V13.7)



- Two quality control reports were generated on
  - PI report specific to the applicator
  - PQ report designed to be site dependent (SAVI-Breast, HDR Prostate)

- Information for PI checks & PQ evaluations retrieved mainly from two places: the current plan and the TPS database.
- Dynamic information, e.g., individual plan's planning parameters, retrieved from information and data structure within current plan
- Static information, e.g., the source, is retrieved from the TPS database.




BTSim1, BTSimError1 (2017051) - External Beam Planning
QuickLinks
BTSim1, BTSimError1 (2017051)
Worklist
Bin Cai
File Edit View Insert Planning Tools Window
2017051
C1
Research
Research - Unapproved - Transversal - CT_2
Isodoses (%)
100.0
Dose is imported
Y: 32.88 cm
Research - Unapproved - Model View - CT_2
Isodoses (%)
Dose is imported
IEC 61217
Head First-Supine
Research - Unapproved - Frontal - CT_2
Dose is imported
Z: -14.05 cm
Research - Unapproved - Sagittal - CT_2
Dose is imported
X: -0.05 cm
Research
CT_2
Registered Images
CT_1
CT_2
3mm Skin Rind
Air
BODY
Implant
Invaginated Tiss
Lung
Normal tissue
PTV
PTV_EVAL
Ribs
Savi
SAVI+1
Skin Max
Reference Line
Reference Line1
Match points
User Origin
Reference Points
PTV
Dose
Fields
Fields
Dose Prescription
Field Alignments
Plan Objectives
Optimization Objectives
Dose Statistics
Calculation Models
Plan Sum
Group
Field ID
Technique
Machine/Energy
MLC
Field Weight
Scale
GantryRtn [deg]
CollRtn [deg]
PatientSupportAngle [deg]
Wedge
X [cm]
Y [cm]
Z [cm]
Calculated SSD [cm]
Ready
User: bxc1767
Group: Physicist

Treatment Plan Pre-Check Report

Patient and Plan Information

Patient Name	
Patient ROC #	
Course	C1
Plan Name	aprv120715
Plan Time Stamp	2015-12-07 12:03 PM
Plan Type	Brachy

CT Scan Parameters & Patient Setup

Image Device Model	Brilliance Big Bore
Patient Orientation	HFS
Study ID	26291
No. Of Slices	56
Date Created	12/7/2015

Dose Calculation Parameters

Dose Grid	0.25x0.25x0.20 (cm)
Source Treatment Activity(mCi)	8048.50
Total Air Kerma Strength(cGy m*m)	4021.09
Total Curie Secondes (s)	3592.04
Total Treatment Time (s)	446.30

Dose Prescription

Name	Prescribe cGy/Fx	Number of Fraction	Total Dose (cGy)	Target Volume	Prescribed Percentage [%]	Normalization Value
F1	1500.00	1	1500.00	Prostate	100 %	Unknown

Contour Parameters

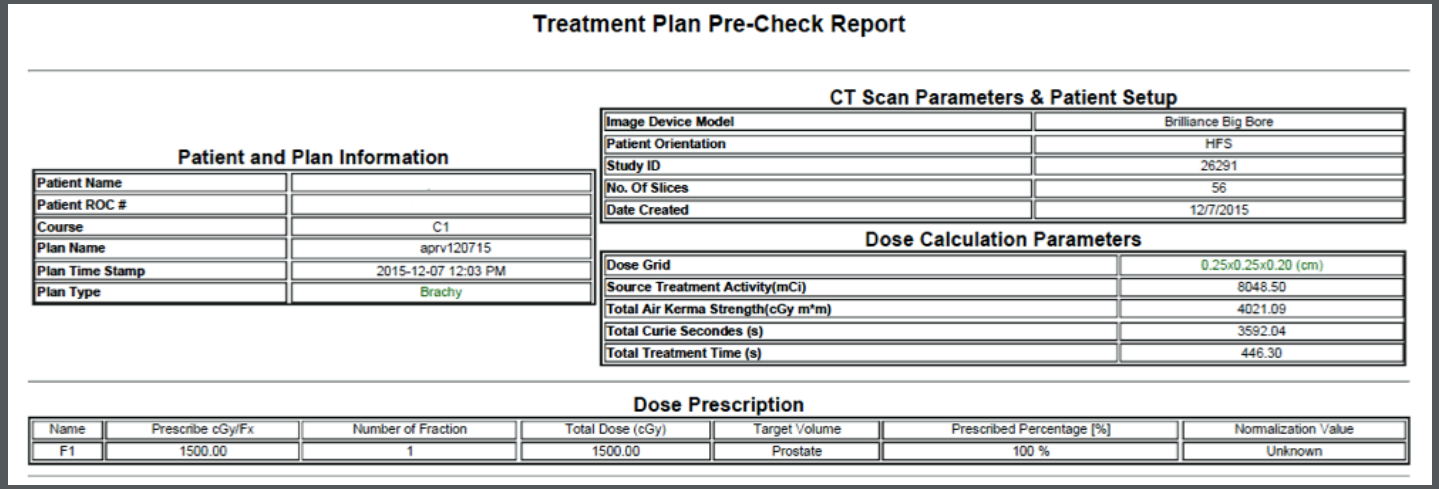
#	ROI Name	Volume (cc)	Density O/R	Gaps
1	Bladder	82.49	No	No
2	Body	13379.37	No	No
3	Implant	866.24	No	No
4	Normal tissue	28.22	No	No
5	NS_implant	866.24	No	No
6	Prostate	26.60	No	No
7	Rectum	29.63	No	No
8	Urethra	2.00	No	No

Catheter Parameters

#	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Catheter ID	Channel_1	Channel_2	Channel_3	Channel_4	Channel_5	Channel_6	Channel_7	Channel_8	Channel_9	Channel_10	Channel_11	Channel_12	Channel_13	Channel_14	Channel_15
Machine	VariSource_5	VariSource_5	VariSource_5	VariSource_5	VariSource_5	VariSource_5	VariSource_5	VariSource_5	VariSource_5	VariSource_5	VariSource_5	VariSource_5	VariSource_5	VariSource_5	VariSource_5
After Loader	VariSource1-SN436	VariSource1-SN436	VariSource1-SN436	VariSource1-SN436	VariSource1-SN436	VariSource1-SN436	VariSource1-SN436	VariSource1-SN436	VariSource1-SN436	VariSource1-SN436	VariSource1-SN436	VariSource1-SN436	VariSource1-SN436	VariSource1-SN436	VariSource1-SN436
Applicator Length	112.40	112.20	112.30	112.30	112.30	112.20	112.30	112.30	112.40	112.20	112.30	112.30	112.30	112.30	112.30
FirstSource Postion	0.80	0.30	0.30	0.30	0.60	0.30	1.00	0.00	0.50	0.60	0.30	0.30	0.80	0.30	0.50
LastSource Postion	4.80	3.80	3.80	3.30	5.10	4.30	5.00	3.80	4.50	5.10	3.80	3.80	4.80	4.30	5.00
Step Size	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Is Equal Space	True	True	True	True	True	True	True	True	True	True	True	True	True	True	True
Minimum Time in Catheter(s)	1.00	2.00	2.10	1.50	0.80	0.90	1.00	3.80	2.10	2.70	2.60	3.20	2.10	0.80	2.00
Total Actual Time (scconds)	62.40	28.00	10.40	20.50	20.50	4.90	24.90	34.70	31.10	43.50	23.80	28.10	21.00	31.90	33.40
Percentage Of Total Time	13.98 %	6.27 %	2.33 %	4.59 %	4.59 %	1.10 %	5.58 %	7.78 %	6.97 %	9.75 %	5.33 %	6.30 %	4.71 %	7.15 %	7.48 %
Summary	Catheters' Pre-Check Passed														

Legend* Black - Not checked Green - Pre-check pass Red - Pre-check fail Orange - Warning

Results: PI Report = “Precheck Report”



Treatment Plan Pre-Check Report

Patient and Plan Information

Patient Name	
Patient ROC #	
Course	C1
Plan Name	aprv120715
Plan Time Stamp	2015-12-07 12:03 PM
Plan Type	Brachy

CT Scan Parameters & Patient Setup

Image Device Model	Brilliance Big Bore
Patient Orientation	HFS
Study ID	26291
No. Of Slices	56
Date Created	12/7/2015

Dose Calculation Parameters

Dose Grid	0.25x0.25x0.20 (cm)
Source Treatment Activity(mCi)	8048.50
Total Air Kerma Strength(cGy m*m)	4021.09
Total Curie Secondes (s)	3592.04
Total Treatment Time (s)	446.30

Dose Prescription

Name	Prescribe cGy/Fx	Number of Fraction	Total Dose (cGy)	Target Volume	Prescribed Percentage [%]	Normalization Value
F1	1500.00	1	1500.00	Prostate	100 %	Unknown

- Used as a “precheck” & “final check” tool (e.g., after opt)
- Some information simply reported (black)
- Other information compared against predetermined QA metrics with color-coded pass (green) or fail (red) or warning (yellow) indicators
- Forty-one parameters reported/checked

Treatment Plan Pre-Check Report

Patient and Plan Information

Patient Name	BTSIm4,BTSImError4
Patient ROC #	2017054
Course	C1
Plan Name	Research(BOOst)
Plan Time Stamp	2017-04-14 15:00 PM
Plan Type	Brachy

CT Scan Parameters & Patient Setup

Image Device Model	Brilliance Big Bore
Patient Orientation	HFS
Study ID	32257
No. Of Slices	52
Date Created	3/20/2017

Dose Calculation Parameters

Dose Grid	0.25x0.25x0.20 (cm)
Source Treatment Activity(mCi)	7622.30
Total Air Kerma Strength(cGy cm²cm)	3069.23
Total Curie Secondes (s)	2741.74
Total Treatment Time (s)	359.70

Dose Prescription

Name	Prescribe cGy/Fx	Number of Fraction	Total Dose (cGy)	Target Volume	Prescribed Percentage [%]	Normalization Value
F1	1500.00	1	1500.00		100.00 %	Unknown

Contour Parameters

#	ROI Name	Volume (cc)	Density O/R	Gaps
1	Bladder	12.76	No	No
2	CTV	14.98	No	No
3	NS_Implant	1017.86	No	No
4	Prostate	14.98	No	No
5	PTV	14.98	No	No
6	Rectum	30.30	No	No
7	SeminalVesicle	20.85	No	No
8	Urethra	2.11	No	No

Catheter Parameters

Channel Number	1	10	11	12	13	14	15	16	2	3	4	5	6	7	8	9
Catheter ID	Channel_1	Channel_10	Channel_11	Channel_12	Channel_13	Channel_14	Channel_15	Channel_16	Channel_2	Channel_3	Channel_4	Channel_5	Channel_6	Channel_7	Channel_8	Channel_9
Machine	VariSource_5	VariSource_5	VariSource_5	VariSource_5	VariSource_5	VariSource_5	VariSource_5	VariSource_5	VariSource_5	VariSource_5	VariSource_5	VariSource_5	VariSource_5	VariSource_5	VariSource_5	VariSource_5
After Loader	VariSource1-HDR VS 436	VariSource1-HDR VS 436	VariSource1-HDR VS 436	VariSource1-HDR VS 436	VariSource1-HDR VS 436	VariSource1-HDR VS 436	VariSource1-HDR VS 436	VariSource1-HDR VS 436	VariSource1-HDR VS 436	VariSource1-HDR VS 436	VariSource1-HDR VS 436	VariSource1-HDR VS 436	VariSource1-HDR VS 436	VariSource1-HDR VS 436	VariSource1-HDR VS 436	VariSource1-HDR VS 436
Applicator Length	112.20	112.20	112.30	112.30	112.30	112.30	112.20	112.30	112.30	112.20	112.20	112.30	112.30	112.30	112.30	112.30
FirstSource Position	0.30	0.30	0.30	0.30	0.60	1.20	0.30	0.20	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
LastSource Postion	2.80	2.80	1.80	2.30	4.40	4.70	3.30	2.70	2.80	2.30	2.30	2.30	3.30	2.30	2.30	1.80
Step Size	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Is Equal Space	True	True	True	True	True	True	True	True	True	True	True	True	True	True	True	True
Minimum Time in Catheter(s)	2.10	NA	1.20	0.30	0.10	1.50	0.60	0.10	3.30	2.20	0.70	5.10	1.60	0.20	1.40	0.60
Total Actual Time (scconds)	22.70	0.00	1.20	12.50	25.00	26.10	26.30	23.10	42.80	45.30	12.40	43.20	7.00	1.10	46.00	25.00
Percentage Of Total Time	6.31 %	0.00 %	0.33 %	3.48 %	6.95 %	7.26 %	7.31 %	6.42 %	11.90 %	12.59 %	3.45 %	12.01 %	1.95 %	0.31 %	12.79 %	6.95 %
Summary	Channel_10: -Min dwell time in each catheter shold be >0.1s -total actual time for each catheter should be > 0s Channel_13: -Min dwell time in each catheter shold be >0.1s Channel_16: -First dwell position should be > 0.2 cm -Min dwell time in each catheter shold be >0.1s															

Legend* Black - Not checked Green - Pre-check pass Red - Pre-check fail Orange - Warning

Catheter Parameters

Channel Number	1	10	11	12
Catheter ID	Channel_1	Channel_10	Channel_11	Channel_12
Machine	VariSource_5	VariSource_5	VariSource_5	VariSource_5
After Loader	VariSource1-HDR VS 436	VariSource1-HDR VS 436	VariSource1-HDR VS 436	VariSource1-HDR VS 436
Applicator Length	112.20	112.20	112.30	112.30
FirstSource Position	0.30	0.30	0.30	0.30
LastSource Postion	2.80	2.80	1.80	2.30
Step Size	0.50	0.50	0.50	0.50
Is Equal Space	True	True	True	True
Minimum Time in Catheter(s)	2.10	NA	1.20	0.30
Total Actual Time (scconds)	22.70	0.00	1.20	12.50
Percentage Of Total Time	6.31 %	0.00 %	0.33 %	3.48 %
Summary	Channel_10: -Min dwell time in each catheter shold be >0.1s -total actual time for each catheter should be > 0s Channel_13: -Min dwell time in each catheter shold be >0.1s Channel_16: -First dwell position should be > 0.2 cm -Min dwell time in each catheter shold be >0.1s			

PQ Reports

Some manual inputs required by the PQ report:

- What site? Manually selected
  - SAVI
  - Prostate
- What structures for D-V stats?
  - Script will automatically assign contours in plan to these structures based on a set naming convention, e.g., “PTV_Eval”
  - Otherwise, can be manually assigned

SAVI Report
Treatment Plan Statistics for SAVI Treatments

Structures Match Table

Skin	3mm Skin Rind

PATIENT/PLAN DEMOGRAPHICS

PATIENT NAME: BTSim1,BTSimError1
PHYSICIAN: IZ/MAT
CURRENT USER: Bin Cai
COURSE: C1

Patient ID: 2017051
PLAN DATE: 2017-04-14 13:20 PM
PLAN CREATED BY: jxe8655
PLAN Name: Research

RADIATION PRESCRIPTION(Rx)

Per Fraction Dose: 340.00 cGy/Fx
Total Dose: 340.00 cGy
Dose Prescribed To: PTV_EVAL (74.24 cc)

Number of Fractions: 1
Total Isocenter Dose: NA

TARGET

$V_{90.00\%Rx}$ PTV_Eval =	99.80 %	(>= 98 %) Constraint
$V_{95.00\%Rx}$ PTV_Eval =	99.32 %	(>= 95 %) Goal
$V_{100.00\%Rx}$ PTV_Eval =	98.17 %	(>= 90 %) Goal
$V_{150.00\%Rx}$ PTV_Eval =	39.59 cc	(<= 50.00 cc) Goal
$V_{200.00\%Rx}$ PTV_Eval =	20.18 cc	(<= 20.00 cc) Goal
Volume PTV_Eval =	74.24 cc	
Volume Air =	0.74 cc	
$V_{Air}/V_{PTV\text{-}Eval}$ =	1.00 %	(<10%) Goal

OARs

Max Skin Dose =	104.82 %	(Primary: <90.00%Rx; Second: <100.00%Rx)
Max Ribs Dose =	94.03 %	(< 100.00 %Rx) Constraint
$V_{100.00\%Rx}$ Implant =	119.85 cc	

INDEPENDENT CHECK OF DWELL TIME

Total Treatment Time = 247.10 sec
S_K(cGy*m*m\hr) = 3.664
Estimated Manchester mg-hrs = 327.40
Planned mg-hrs = 348.07
Diff = 6.31 %

PREPARED BY: _____ **REVIEWED BY:** _____

Results: PQ Report

TARGET

$V_{90.00\%Rx}$ PTV_Eval = 99.80 %	(>= 98 %)	Constraint
$V_{95.00\%Rx}$ PTV_Eval = 99.32 %	(>= 95 %)	Goal
$V_{100.00\%Rx}$ PTV_Eval = 98.17 %	(>= 90 %)	Goal
$V_{150.00\%Rx}$ PTV_Eval = 39.59 cc	(<= 50.00 cc)	Goal
$V_{200.00\%Rx}$ PTV_Eval = 20.18 cc	(<= 20.00 cc)	Goal
Volume PTV_Eval = 74.24 cc		
Volume Air = 0.74 cc		
$V_{Air}/V_{PTV\text{-}Eval}$ = 1.00 %	(<10%)	Goal

- Customizable report
  - D-V indices for our clinic
  - Also evaluates % air in PTV_EVAL
  - Could also re-execute report with a different target contour structure—for example PTV_EVAL_air (simply re-assign)
- Report can be re-generated during planning & re-opt (Dos & Phys)

Evaluating the Scripts

- Observer study to validate script, and to quantify improvement in plan review efficiency
- 5 blinded observers
  - 3 experienced authorized medical physicists [AMPs]
  - 2 junior physicists with limited HDR-BT experience
- 4 mock plans (2 SAVIs + 2 HDR Prostates) with added deficiencies

Item	Simulated Errors or Suboptimal Plan Parameters (detected via PI script)	Simulated Deficiencies in Plan Quality (detected via PQ script)
(1)	Wrong prescription	OAR max dose constraints not met
(2)	Wrong planning image dataset	Compromised target coverage
(3)	Wrong step size	Difference of more than 15% in independent dwell time check
(4)	Minimum dwell time < 0.2s	
(5)	Offset of first dwell position < 0.3cm	
(6)	Heavily weighted single channel (> 40%)	

Condensed Checklist

- Check mock plans using a condensed checklist
- Perform 2 rounds:
  - 1st withOUT script,
  - 2nd with script, run it first, and exclude manual check of items included in script
- In-house timing software
  - Track time with pausing
  - To record all detected errors/comments along the way

SAVI Checklist:	Checked?
Plan Properties	
Rx is entered for 1 Fraction?	
Air Volume (<10% of PTV_Eval?)	
Objectives for Vol Opt	
Channel:	
Channel Numbering	
Catheter Lengths	
Step size = 0.5 cm?	
Offset >0.2?	
Dwell times:	
Distribution of Dwell Times Reasonable?	
Channel 1 < 50%?	
No 0.1 Seconds	
No Empty Channels	
DVHs for PTV_EVAL:	
V90 ≥ 98%	
V95 ≥ 95%	
V100 ≥ 90%	
V150 ≤ 50cc	
V200 ≤ 20cc	
DVHs for OARs:	
Skin Dmax < 90% (at least <100%)	
Ribs Dmax < 100% (at least not transecting rib)	
P-P' Calc within 15%?	

Results of Observer Study

Average over all physicists	Plan1			Plan 2*			Plan 3			Plan 4		
	%Errors detected		Time reduction (min)	%Errors detected		Time reduction (min)	%Errors detected		Time reduction (min)	%Errors detected		Time reduction (min)
	Manual	Auto		Manual	Auto		Manual	Auto		Manual	Auto	
	80.0	100	22.1±16.4	100	100	12.8±9.0	90	100	15.7±12	83.3	100	14.3±5.0

*Please note Plan 2 had no simulated errors.

- 100% of simulated errors were detected by the PI scripts
- An average time reduction of 16 mins for plan review observed when using the scripts
- Values failing to meet the planning constraints were red-flagged successfully in the PQ reports
- Appropriate warning messages displayed in the reports

Summary & Conclusions

- Automated API scripting-based plan QA was designed and implemented for HDR SAVI & prostate plans
- Can be helpful in terms of error catching and efficiency improvement
- Scripts have been in use in our clinic since 2015 (for brachy)
- Some notable benefits:
  - 10 s → Comprehensive summary → avoid some manual checking steps → saves time, helps prevent misses
  - Maintain some level of consistency between planners/checkers
  - As a precheck tool—quickly identify problems and identify them all at once & upfront
  - Customizable – can check D-V stats, report other metrics (% air, DHI), quickly verify dwell times
  - Reports saved to pdf, has location for AMP/AU signature and part of patient's chart → concise plan report (happy dosimetrists)

Acknowledgements

- Jacqueline Zoberi
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- Michael Altman
- Francisco Reynoso
- Sasa Mutic
- Sharbacha Edward
- Imran Zoberi
- Maria Thomas
- Hiram Gay

Thank you!