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Big Data: How VHA Can Be Your Friend

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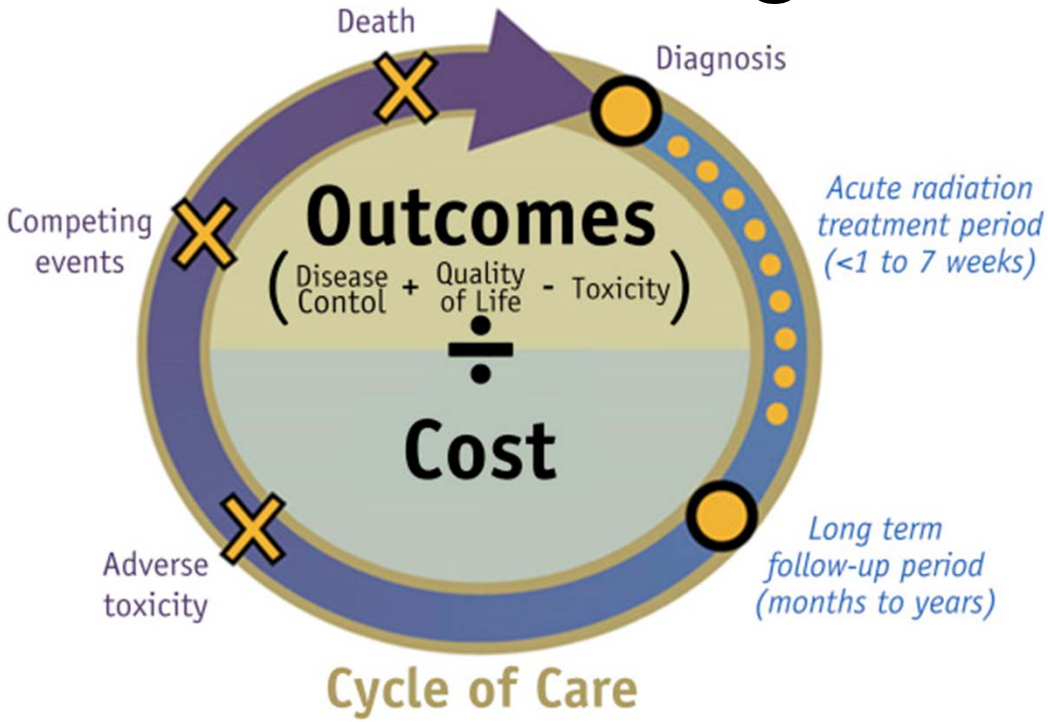
Disclosure

- Vice President, Center for the Assessment of Radiological Sciences (CARS)
  - A non-profit organization dedicated to improving quality and safety of radiotherapy and radiological imaging.

Objectives

- Discuss value proposition in radiation oncology,
- Discuss why VHA is a good test laboratory for determining value in radiation oncology,
- Describe VHAs Radiation Oncology Practice Assessment (ROPA) initiative,
- Discuss how ROPA can potentially become a model for quality and outcome assessment in radiation oncology.

Value in care defined for the radiation oncologist



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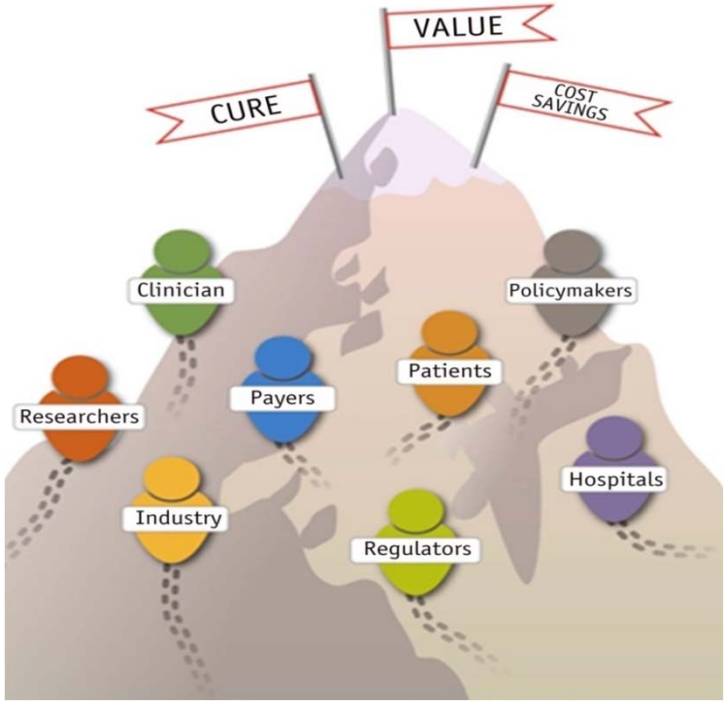
Stakeholder in the discussion of value in oncology



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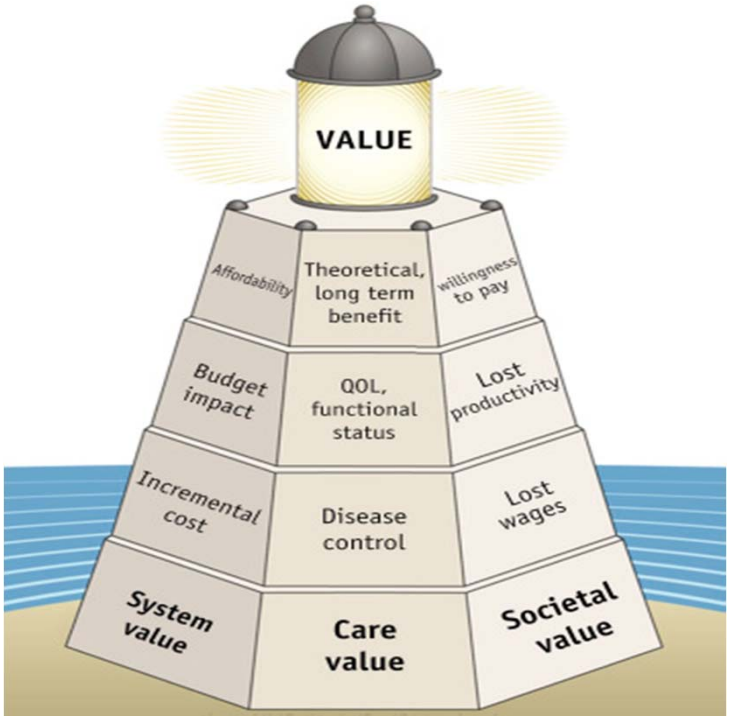


What is big data?

- Big data is a term for data sets that are so **large** or **complex** that traditional data processing application softwares are inadequate to deal with them. **(Wiki)**
- Big data is a term that describes the large volume of data – both **structured** and **unstructured.** Big data can be analyzed for insights that lead to better decisions and strategic business moves. **(SAS)**
- Extremely large data sets that may be analyzed computationally to **reveal patterns, trends, and associations**. **(Dictionary)**

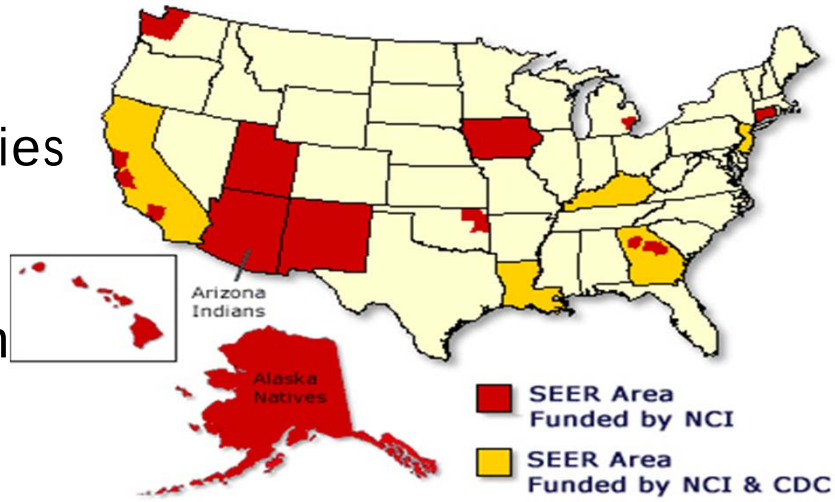
"5 V"; Volume, Velocity, Variety, Veracity, and Value

The Surveillance, Epidemiology, & End Results (SEER) Registries

- Includes approximately 28% of US Population
- Representative sample of all ethnicities and socio-economic backgrounds

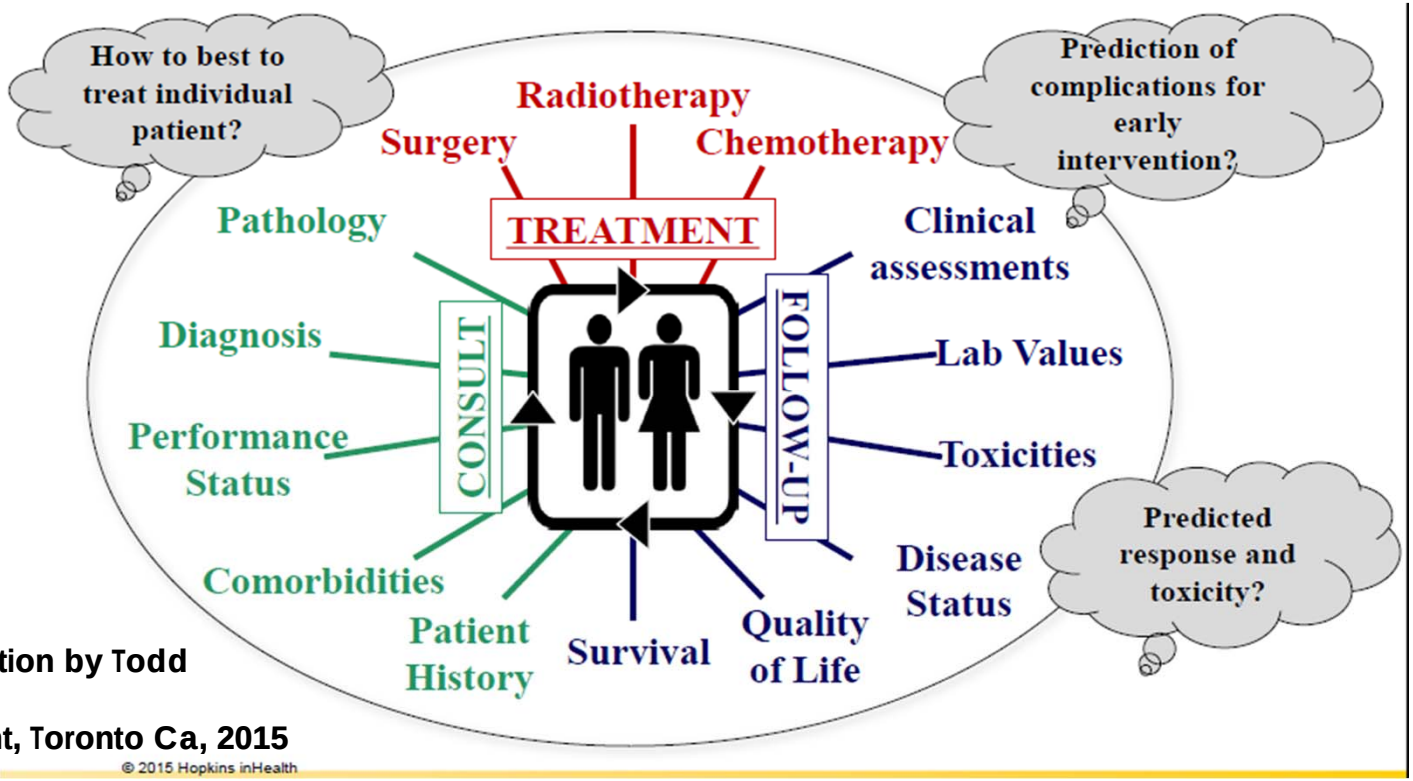
Limitations

- Limited information about key health factors
- Inaccuracy; such as under ascertainment of outpatient treatments,
- Migration/loss to follow-up
- Sparse to no RT data



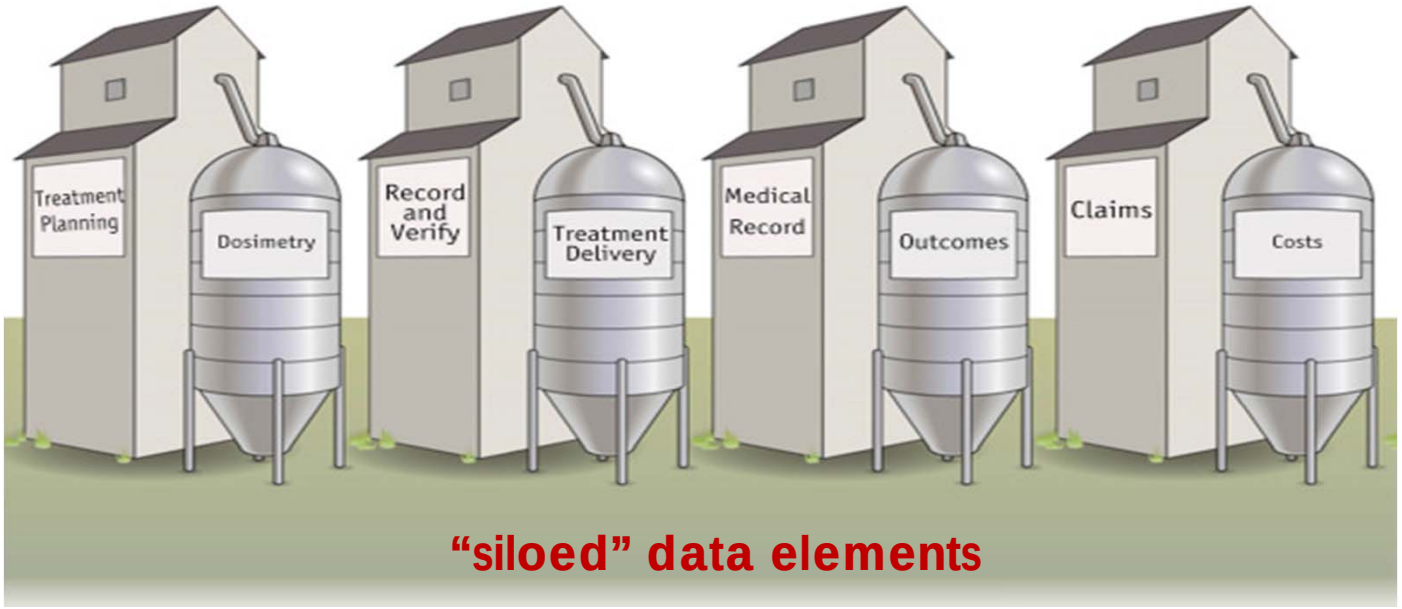
States included in SEER Registries; SEER 9, 13 &18

Big Data in Cancer Care



From Presentation by Todd McNutt, JHU
@Target-Insight, Toronto Ca, 2015

Big data Challenges in Radiation Oncology



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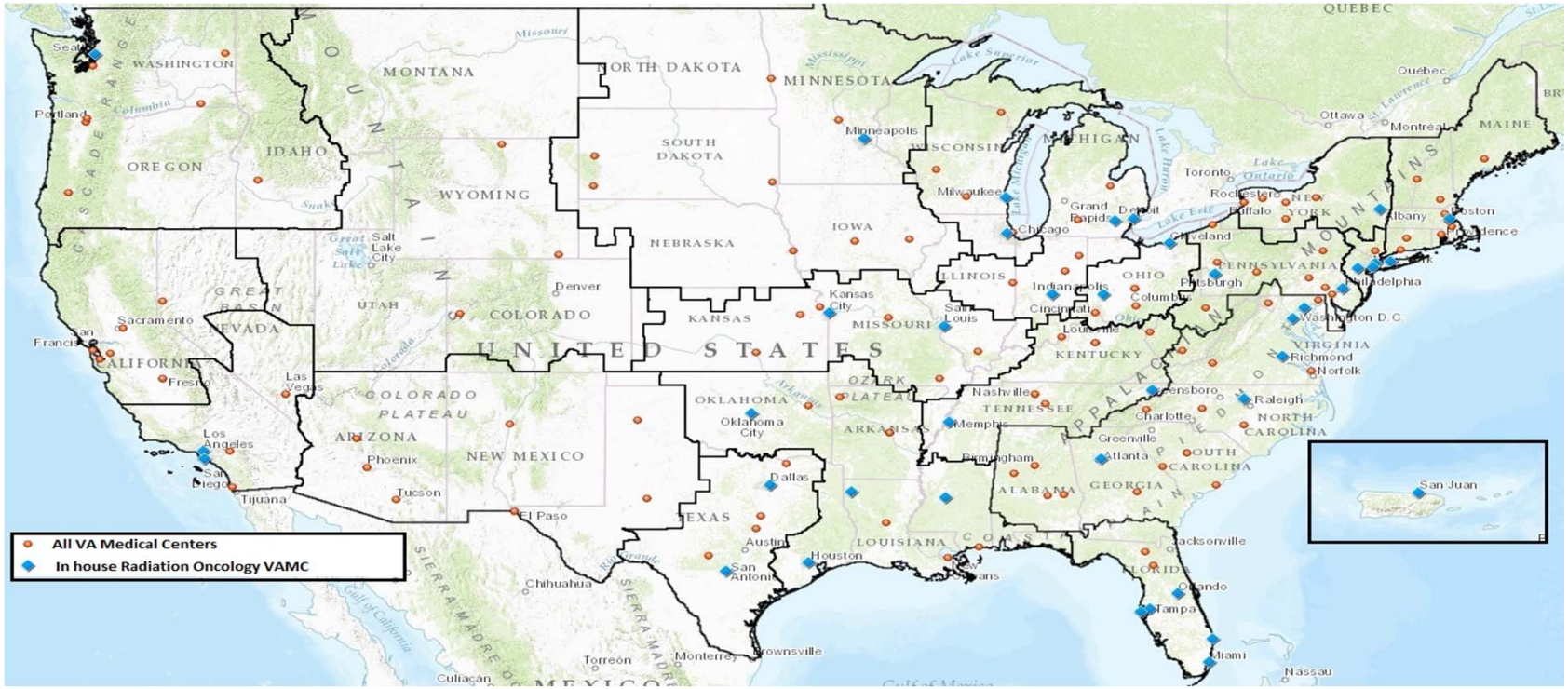
Veteran Health Administration

- Largest Integrated Health care system in United States.
  - 1,233 health care facilities
  - Incl. 168 VA Medical Centers
  - 1,053 outpatient clinics
- Serving more than 8.9 million Veteran each year.
- Annual budget: $69 billion (2017)
- **Single interconnected electronic medical record system (VISTA – CPRS) since 1983**

VHA Radiation Oncology Centers

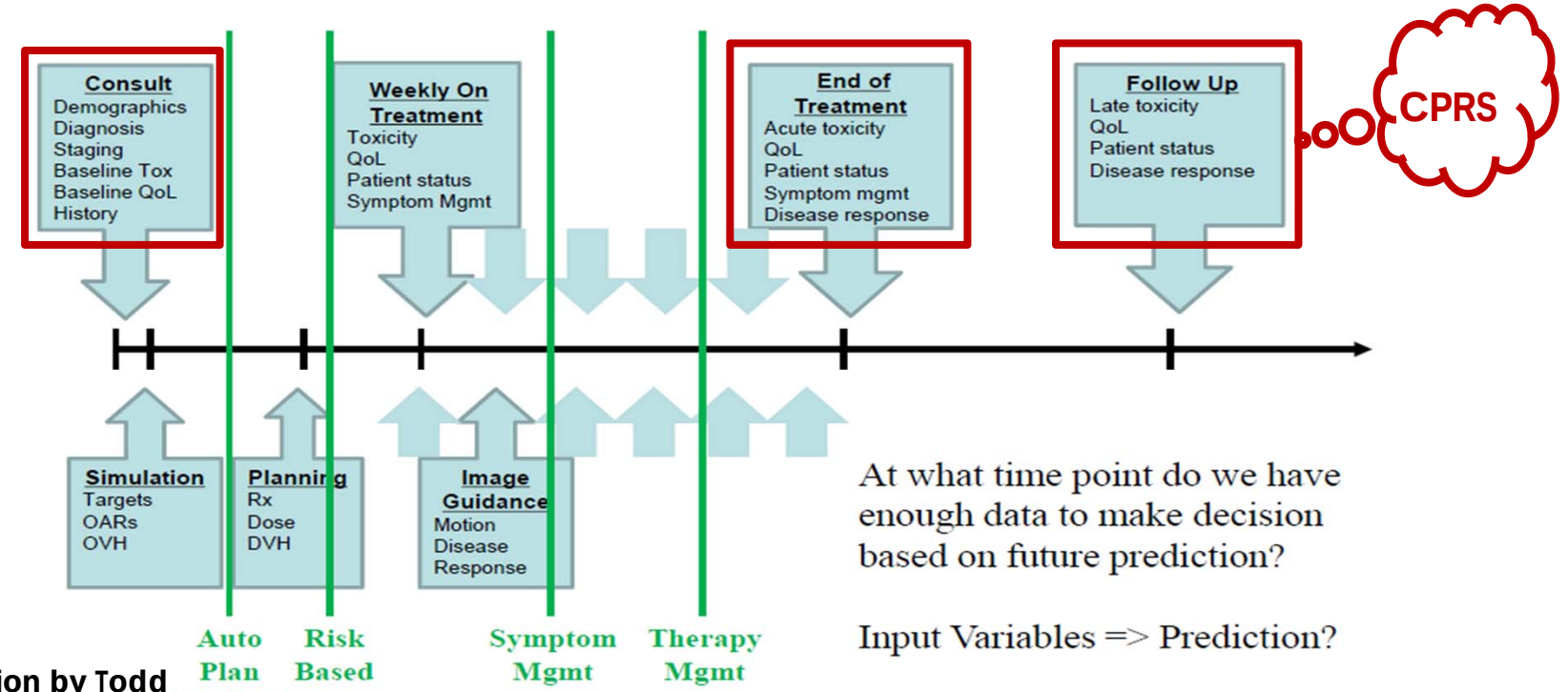


40 Centers in 18 regions across the U.S.

Radiation Oncology in VHA

- 40 Radiation Oncology VA clinics
  - 15,000 patients treated in-house
  - 25,000 patient sent outside for RT.
  - 70+ treating radiation oncologists
  - 70+ therapeutic medical physicists
  - 72 linear accelerators
- **Longitudinal history of patients RT episode in Vista/CPRS.**

Time Points for Data Collection



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VHA Radiation Oncology Practice Assessment(ROPA)

Purpose: Assessment of radiation delivery and cancer related outcomes for the VHA radiation oncology practices

Background: Disease-site expert panels of the American Society for Radiation Oncology (ASTRO) have identified clinical measures and associated data fields to assess the quality of radiation treatments

- These clinical measures will be used by the VHA to monitor the quality of radiation oncology and outcome assessment
  - **Pilot: Prostate and Lung Cancer**

Scope of Data Acquisition

- **Manual abstraction** by visit to 40 VA Radiation Oncology Centers.
- Comprehensive evaluation of 50 cases from each center, 20-30 ASTRO vetted metrics per case
  - **20 cases** - prostate cancer: T1c – T3, NX0M0 (Intermediate or high risk per NCCN criteria)
  - **20 cases** – Non-Small Cell Lung Cancer (NSCLC): Stages IIIA and IIIB
  - **10 cases** – Small Cell Lung Cancer (SCLC): Limited Stage.
- Most recent, serial cases in each category who have completed post-treatment follow-up examination

Data Collection for ROPA

Data Sources

- Clinical data
  - Abstracted from physicians clinical note templates in CPRS used by clinicians in their routine process of care
- Radiation treatment management data
  - Abstracted from RT-EMR (e.g. ARIA, MOSAIQ)
- Treatment Planning Data
  - DICOM/DICOM-RT data abstracted from treatment planning systems (e.g. Eclipse, Pinnacle, XiO, Hi-ART…)

Data Abstraction Requirements

- No Protected Health Information (PHI) will be recorded.
- Treatment dates to be recorded as elapsed time from offset.

Clinical Measures

Defined by ASTRO Disease Site Expert Panels

- **Quality Measures**
  - Measures with published data that will be utilized for the practice assessment.
- **Aspirational Measures**
  - VA asked the panels to also provide ambitious goals or items not currently in common practice that reflect high quality.
  - Examples: Quality of life assessment prior to treatment completion, Survivorship Care Plans.
- **Surveillance Measures**
  - Measures that either do not yet have enough published data to demonstrate a link to quality (i.e. collection of molecular information) or are focused on population health (enrollment on clinical trials).

MEASURE #3: Imaging/Staging for High Risk	
Numerator Statement	Patients with imaging for staging, prior to the initiation of treatment, that includes: 1. CT or MRI, **AND** 2. Bone scan (T^{99} or NaF PET).
Denominator Statement	All patients, regardless of age, with a diagnosis of prostate cancer, at high **OR** very high risk as defined by NCCN guidelines, receiving radiation therapy
Denominator Exclusions/Exceptions	• Patients treated post prostatectomy
Notes	• Consensus Survey Results: 100%
Expected Performance Rate	• Higher = better • Panel Vote: 95% • CMS PQRS Measure #102 (Avoidance of Overuse of Bone Scan for Staging Low-Risk Prostate Cancer Patients). Average Performance Rate in 2011: 95.4%. in 2012: 92.9%; in 2013: 90.6%
Timeframe	Prior to first treatment

DVH Metric Types

- **Constraint**
  - Metric will be used to evaluate the plan and provider's performance
- **Informational**
  - For the purposes of data collection
  - Not to be used to judge the appropriateness of a plan
- **DVH Metric Scale**
  - Most DVH Constraints and DVH Informational Metrics were divided into a 3 tiered system
  - Green: Pass
  - Yellow: Warning
  - Red: Fail

Lung Quality Measures

Spinal Cord Dmax* Metrics

Varying Fractionation

Limit	Green	Yellow	Red	Mandatory Constraint vs. Informational	Source	Fractionation
50 Gy	<= 45 Gy	>45 Gy <= 50 Gy	> 50 Gy	**Constraint**	QUANTEC	Standard
41 Gy	<=36.9 Gy	>36.9 Gy <= 41 Gy	> 41 Gy	**Constraint**	Turrisi, NEJM 1998, RTOG 0538	Hyper
37 Gy	<=33.3 Gy	>33.3 Gy <= 37 Gy	> 37 Gy	**Constraint**	BED calc (aB = 3, EQD2 = 49.6 Gy)	Hypo - 10
42 Gy	<= 37.8 Gy	>37.8 Gy <= 42 Gy	> 42 Gy	**Constraint**	Timmerman / USC, confirmed w/BED (aB = 3, EQD2 = 48.7 Gy)	Hypo - 15

***Dose to <0.035 cc**

Various Lung Metrics

Standard Fractionation

Metric	Limit	Green	Yellow	Red	Mandatory Constraint vs. Informational	Source	Note*
V20 Gy	37%	<= 33%	> 33% <= 37%	> 37%	**Constraint**	QUANTEC	2 lungs
V5 Gy	60%	<= 54%	> 54% <= 60%	> 60%	Informational	RTOG 1308	2 lungs
Dmean	20 Gy	<= 18 Gy	> 18 Gy <= 20 Gy	> 20 Gy	Informational	QUANTEC	2 lungs
V20 Gy	7%	<= 6.3%	> 6.3% <= 7%	> 7%	**Constraint**	Rice et al, IJROBP 2007	1 lung
V5 Gy	60%	<= 54%	> 54% <= 60%	> 60%	Informational	Allen et al, IJROBP 2007	1 lung
Dmean	8.5 Gy	<= 7.7 Gy	> 7.7 Gy <= 8.5 Gy	> 8.5 Gy	**Constraint**	Rice et al, IJROBP 2007	1 lung

*Total Lung - XXX. In order of availability, GTV>ITV>CTV>PTV

Esophagus Metrics

Standard Fractionation

Metric	Limit	Green	Yellow	Red	Mandatory Constraint vs. Informational	Source
V60 Gy	17%	<= 15.3 %	> 15.3% <= 17 %	> 17%	Informational	Palma et al, IJROBP 2014
Dmean	34 Gy	<= 30.6 Gy	> 30.6 Gy <= 34 Gy	> 34 Gy	Informational	QUANTEC
Dmax*	74 Gy	<= 66.6 Gy	> 66.6 Gy <= 74 Gy	> 74 Gy	Informational	RTOG 1308

*** Dose to <0.035 cc**

Other Metrics

Standard Fractionation

OAR	Metric	Limit	Green	Yellow	Red	Mandatory Constraint vs. Informational	Source
Brachial Plexus	Dmax*	66 Gy	<= 59.4 Gy	> 59.4 Gy <= 66 Gy	> 66 Gy	**Constraint**	QUANTEC
Heart	V45Gy	35%	<= 31.5%	> 31.5% <= 35%	> 35 %	Informational	RTOG 1308
PTV	D95%	100% Rx	100%	>= 95% < 100%	< 95%	**Constraint**	RTOG 1308
PTV	Dmin*	85% Rx	>85%	>= 75% < 85%	< 75%	Informational	RTOG 1308

*** Dose to <0.035 cc**

Prostate Quality Measures

Rectum Metrics

External Beam, Varying Fractionation

Metric	Limit	Green	Yellow	Red	Mandatory Constraint vs. Informational	Source	Fractionation
V70 Gy*	25%	<=25%		>25%	**Constraint**	RTOG 0126, 0415, 0815	Standard
V69 Gy	25%	<=25%		>25%	Informational	RTOG 0415	Hypo
V70 Gy	15%	<=15%		>15%	Informational	Michalski et al, IJROBP 2013	Standard
V75 Gy	10%	<=10%		>10%	Informational	Michalski et al, IJROBP 2013	Standard
V50 Gy	50%	<=50%		>50%	**Constraint**	QUANTEC	Standard

*Should be met in >= 90% of cases

Bladder, Femurs Metrics

External Beam, Standard Fractionation

OAR	Metric	Limit	Green	Yellow	Red	Mandatory Constraint vs. Informational	Source
Bladder*	V70 Gy	35%	<=35%		>35%	Informational	QUANTEC, RTOG 0126, 0415, 0815
Bladder	V65 Gy	50%	<=50%		>50%	Informational	QUANTEC, RTOG 0126, 0415, 0816
Femurs	V50 Gy	10%	<=10%		>10%	Informational	RTOG 0534

*Should be met in >= 90% of cases

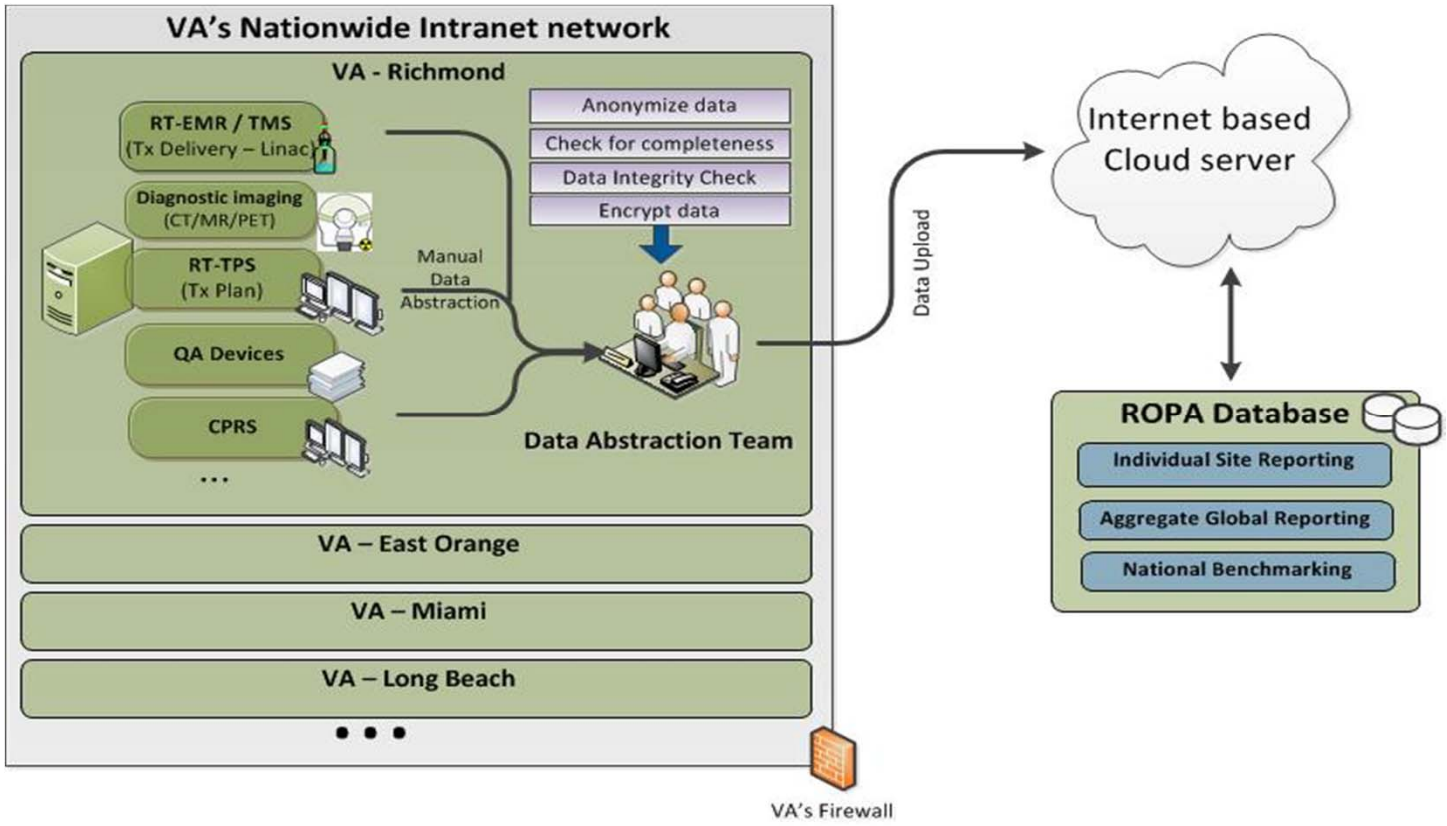
Bowel Metrics

External Beam, Standard Fractionation

OAR	Metric	Limit	Green	Yellow	Red	Mandatory Constraint vs. Informational	Source
Bladder	V70 Gy	35%	<=35%		>35%	Informational	QUANTEC, RTOG 0126, 0415, 0815
Bladder	V65 Gy	50%	<=50%		>50%	Informational	QUANTEC, RTOG 0126, 0415, 0816
Femurs	V50 Gy	10%	<=10%		>10%	Informational	RTOG 0534

*Volume is Bladder minus CTV

VHA ROPA Workflow



VHA ROPA

Deliverables

- **Facility reports**: detailed radiation delivery parameters and outcomes, nationally benchmarked for 50 cases
- **VHA global report**: examines variability within VHA

- Benefit to the VHA enterprise: Roadmap for continuous improvement for each in-house radiation oncology practice
- Identification of metrics for future internal, remote evaluations using VA's EMR (CPRS)

Parallel Effort

Electronic abstraction of data fields for clinical measures directly from different data sources and performing periodic remote electronic re-assessment.

VHA ROPA

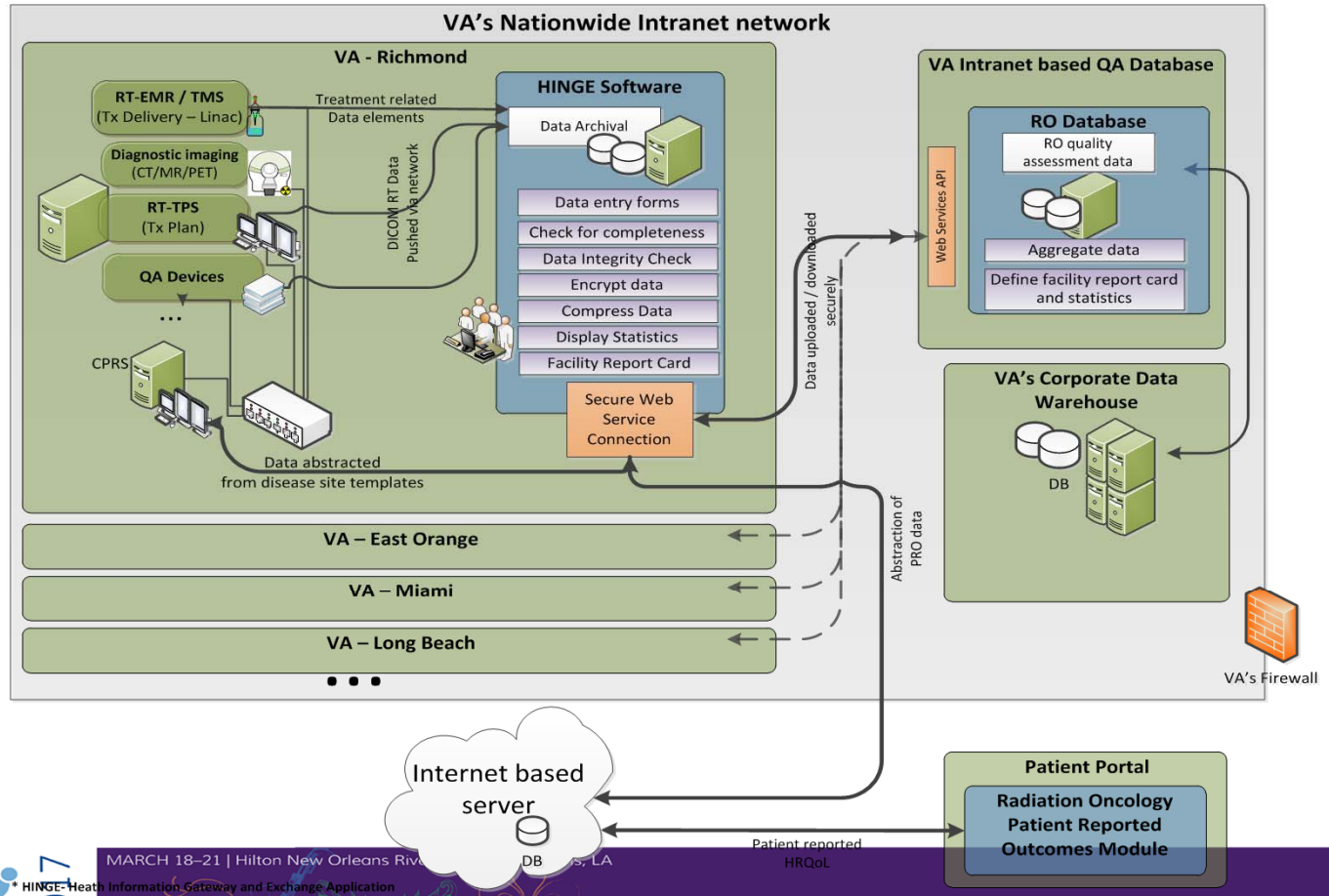
Data Sources

- Clinical data
  - Abstracted from disease-site specific clinical note templates in CPRS used by clinicians in their routine process of care
- Radiation treatment management
  - Abstracted from RT-EMR (e.g. ARIA, MOSAIQ)
- Treatment Planning Data
  - DICOM/DICOM-RT data abstracted from treatment planning systems
- Patient Reported Outcome data from Patient Portals

Electronic Data Abstraction

- Deployment of the data aggregation software at the local facility
  - Aggregation of data at various time points in the treatment process
  - Data integrity, completeness and validation check
- Deployment of the Enterprise Central QA Database
  - Aggregate data from all VA facilities.
  - Tools for data analysis, national benchmarking and analysis of variability within VHA

Abstraction of Patient Specific Data elements for Practice Assessment [IT Infrastructure]

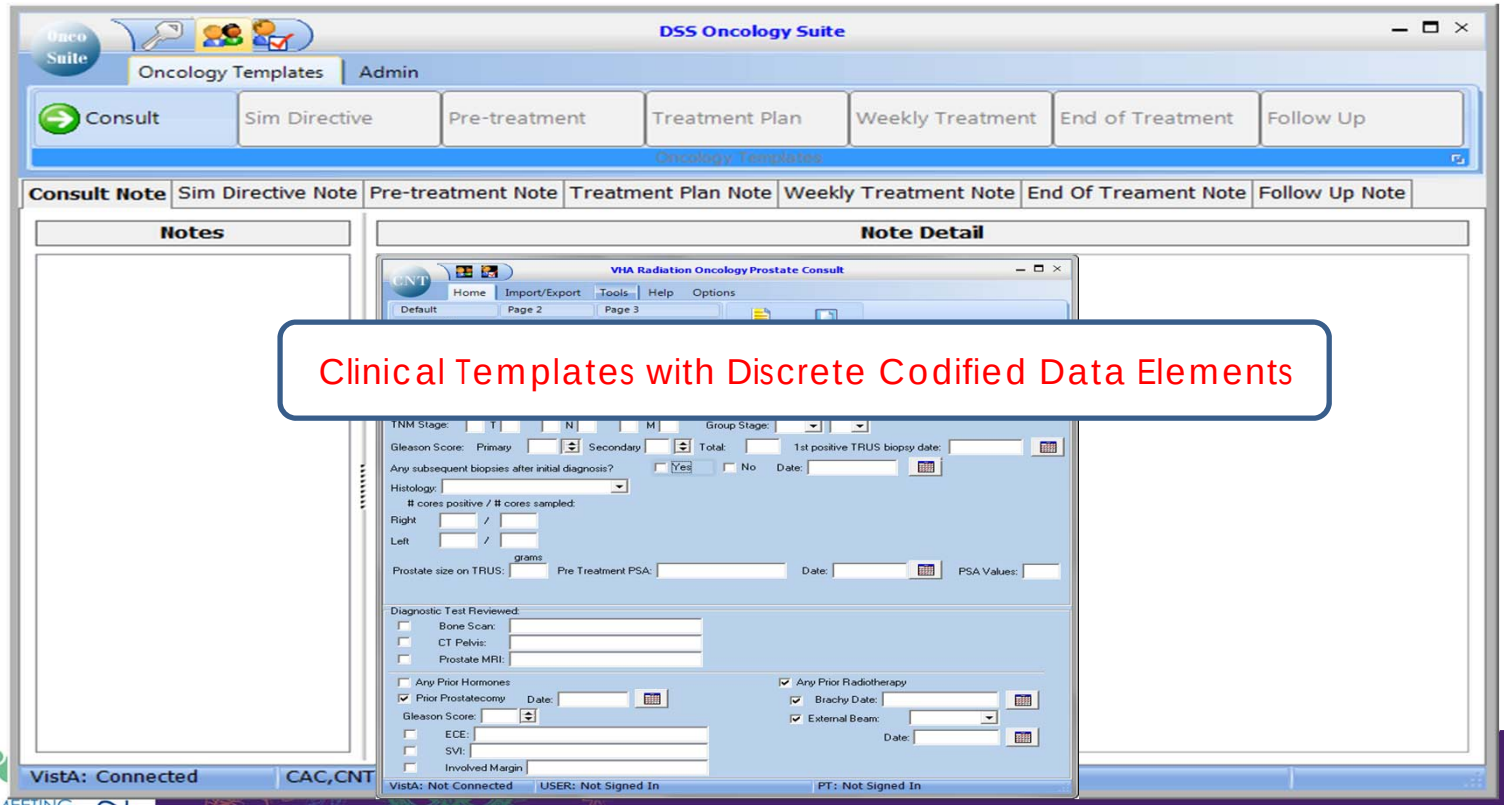


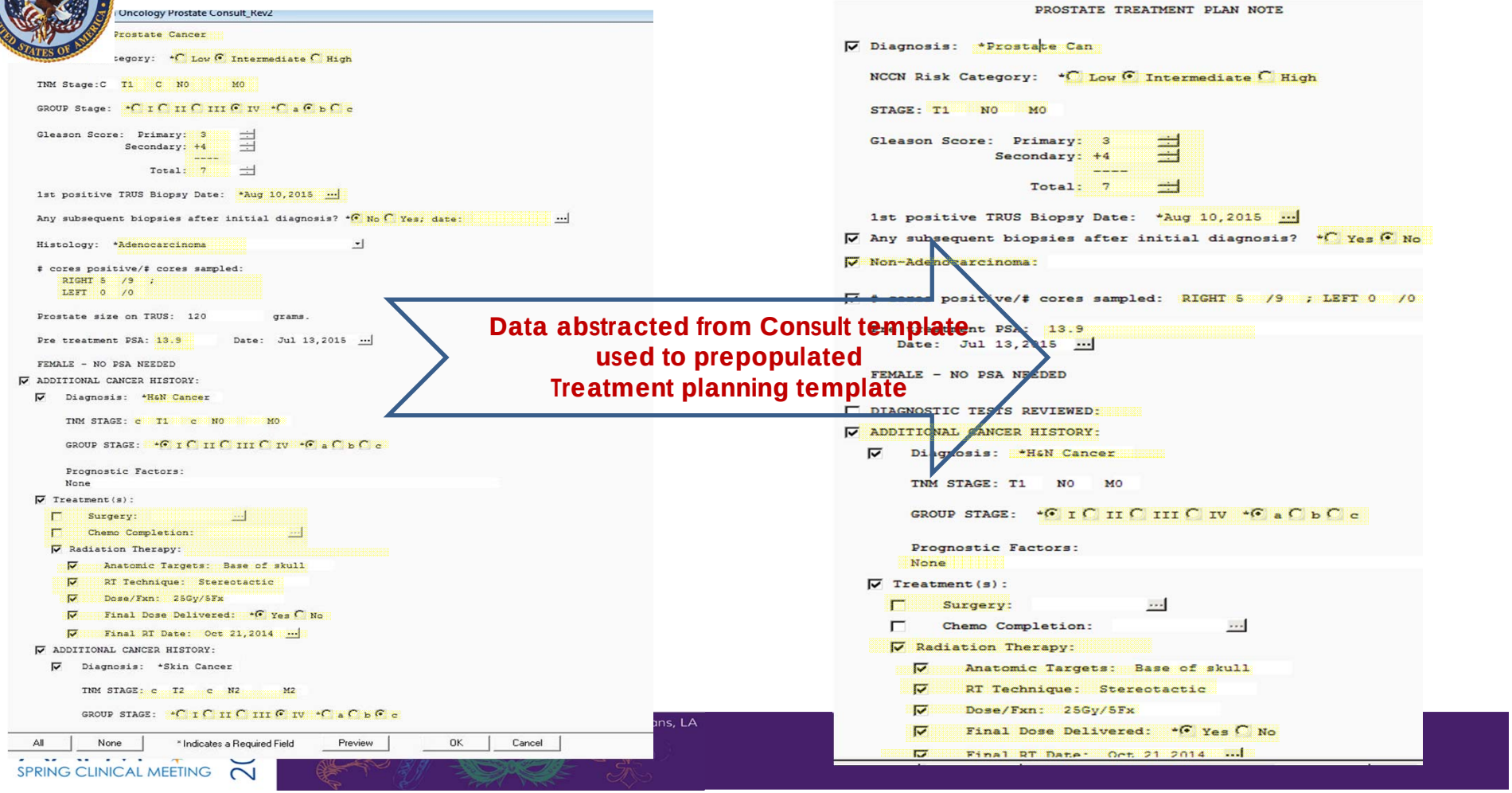
* HINGE- Heath Information Gateway and Exchange Application

Disease Site Specific "Smart" Templates in Radiation Oncology

- Consensus clinical templates for all major disease sites treated with RT,
- Initial consultation, treatment planning, treatment, end of treatment, and follow up notes,
- Designed to prepopulate data from CPRS's patient chart and subsequent notes seamlessly.

Disease Site Specific "Smart" Templates in CPRS




Oncology Prostate Consult_Rev2
Prostate Cancer
TNM Stage:C T1 c N0 M0
GROUP Stage: I II III IV a b c
Gleason Score: Primary: 3
Secondary: +4
Total: 7
1st positive TRUS Biopsy Date: Aug 10,2015
Any subsequent biopsies after initial diagnosis? No Yes; date:
Histology: Adenocarcinoma
cores positive/# cores sampled:
RIGHT 5 /9 ;
LEFT 0 /0
Prostate size on TRUS: 120 grams.
Pre treatment PSA: 13.9 Date: Jul 13,2015
FEMALE - NO PSA NEEDED
ADDITIONAL CANCER HISTORY:
Diagnosis: H&N Cancer
TNM STAGE: c T1 c N0 M0
GROUP STAGE: I II III IV a b c
Prognostic Factors:
None
Treatment(s):
Surgery:
Chemo Completion:
Radiation Therapy:
Anatomic Targets: Base of skull
RT Technique: Stereotactic
Dose/Fxn: 25Gy/5Fx
Final Dose Delivered: Yes No
Final RT Date: Oct 21,2014
ADDITIONAL CANCER HISTORY:
Diagnosis: Skin Cancer
TNM STAGE: c T2 c N2 M2
GROUP STAGE: I II III IV a b c
All
None
* Indicates a Required Field
Preview
OK
Cancel
Data abstracted from Consult template
used to prepopulated
Treatment planning template
PROSTATE TREATMENT PLAN NOTE
Diagnosis: Prostate Can
NCCN Risk Category: Low Intermediate High
STAGE: T1 N0 M0
Gleason Score: Primary: 3
Secondary: +4
Total: 7
1st positive TRUS Biopsy Date: Aug 10,2015
Any subsequent biopsies after initial diagnosis? Yes No
Non-Adenocarcinoma:
cores positive/# cores sampled: RIGHT 5 /9 ; LEFT 0 /0
Pre treatment PSA: 13.9
Date: Jul 13,2015
FEMALE - NO PSA NEEDED
DIAGNOSTIC TESTS REVIEWED:
ADDITIONAL CANCER HISTORY:
Diagnosis: H&N Cancer
TNM STAGE: T1 N0 M0
GROUP STAGE: I II III IV a b c
Prognostic Factors:
None
Treatment(s):
Surgery:
Chemo Completion:
Radiation Therapy:
Anatomic Targets: Base of skull
RT Technique: Stereotactic
Dose/Fxn: 25Gy/5Fx
Final Dose Delivered: Yes No
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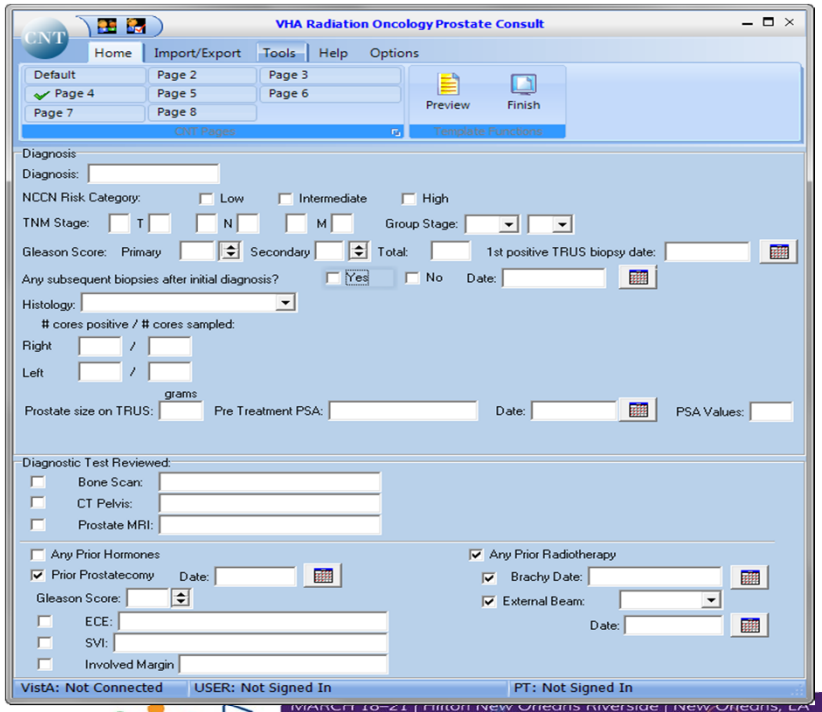
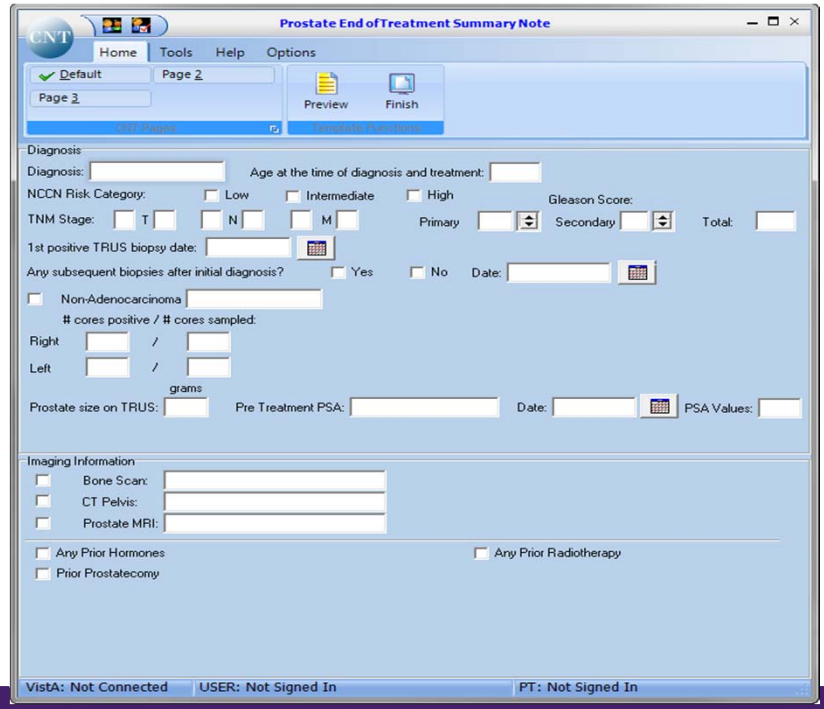
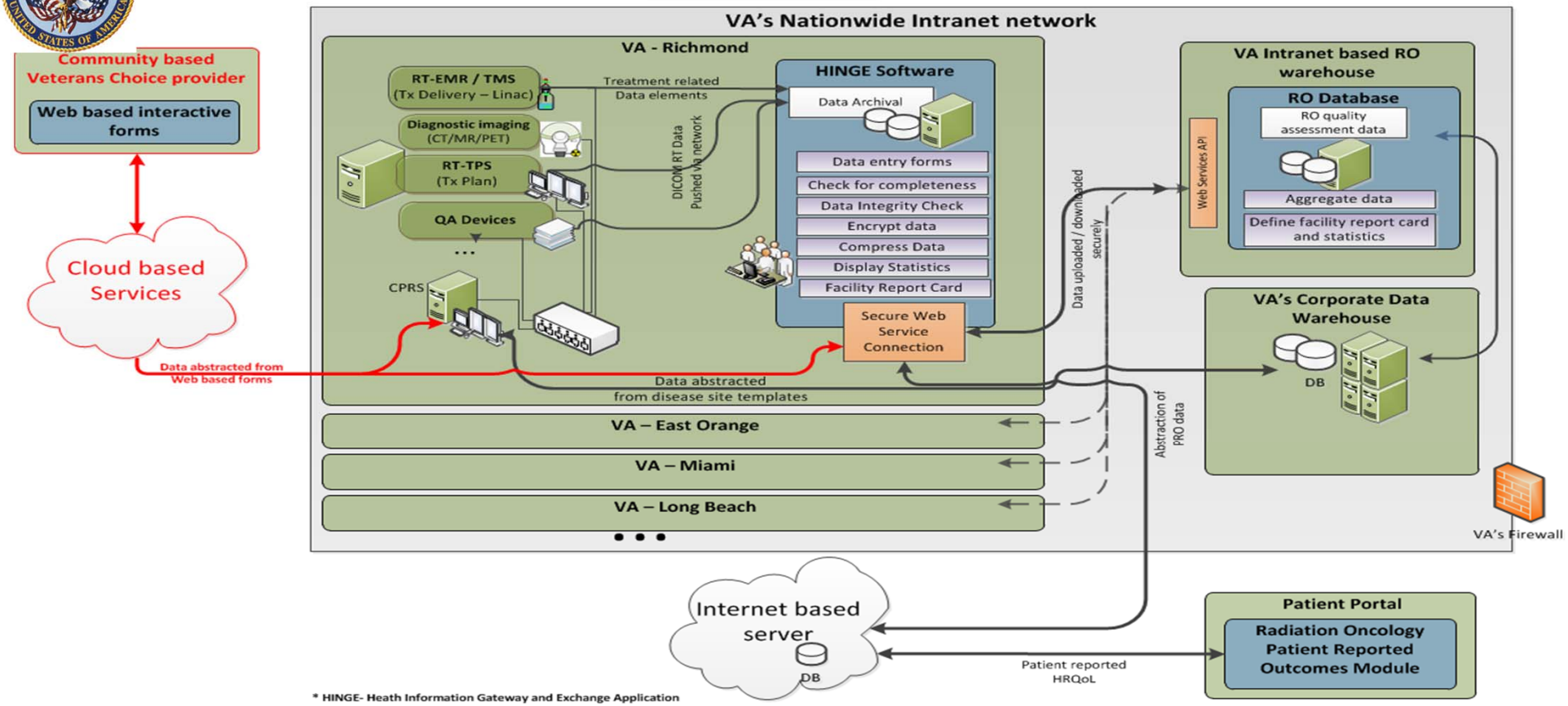
Work Flow Templates in CPRS





Abstraction of Patient Specific Data elements for Practice Assessment [IT Infrastructure]



* HINGE- Heath Information Gateway and Exchange Application

Summary

- Quality care is one of the dominant issues in health care today, especially in radiation oncology,
- Quality care data are most complex in radiation oncology but structured,
- Quality of care is best assessed from the perspective of structure, process, and outcome measures.
- VHA is leading the nation in establishing an electronic infrastructure that will automatically abstract data from clinical workflow templates to assess the quality of radiotherapy and outcomes.