

RTOG
RADIATION THERAPY
ONCOLOGY GROUP



Data Integration and Data Mining
- RTOG Bioinformatics
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ACR
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**Evidence Based
Radiation Oncology**

Radiation Therapy Oncology Group (RTOG)

- Improve The Survival Outcome And Quality Of Life
- Evaluate New Forms Of Radiotherapy Delivery
- Test New Systemic Therapies In Conjunction With Radiotherapy
- Employ Translational Research Strategies

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2

RTOG Bioinformatics Mission

To facilitate the development and to develop personalized predictive models for radiation therapy guidance from specific characteristics of patients and treatments with integrated clinical trial databases, bridging clinical science, physics, biology, information technology and mathematics

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3

BIOINFORMATICS ELEMENTS AND PROCEDURES Available to BioWG

Database
 RT Dose/Images/Clinical Data
 Genomic/Proteomic
 Biomarker

Data Analysis
 Protocol development/Protocol operation support/Trial Outcome-Secondary Analysis
 Validation/Development/Research

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**DATA/
DATA Integration**

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RTOG DATA for BioWG Investigation

Protocol	N	Endpoints
0022 oropharyngeal cancer	60	Salivary function
0117 lung	73	Pneumonitis and esophagitis
0126 prostate	~1500	Erectile dysfunction; rectal bleeding Fecal incontinence vs dose
0225 nasopharyngeal	60	Salivary function
0232 prostate brachytherapy		
0234 head and neck	230	TCP? Ongoing, not recruiting
0236 lung SBRT	52	Ongoing: TCP, toxicity
0321 prostate HDR brachy	110	Late/Acute GU/GI
0522 head and neck		Local control
0529 IMRT anal canal cancer	59	GI/GU acute
9311 lung	~150	NIH R01 (Deasy). Toxicity: esophagitis; pneumonitis
9406 EBRT prostate	800	NIH R01 (Tucker) toxicity
9803 3DCRT GBM	40	Brain toxicity

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Rapid Learning CAT (Computer Assisted Theragnostics) MAASTRO/RTOG Collaboration

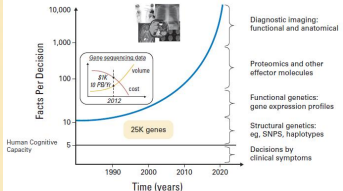
Andre Dekker, PhD
MAASTRO Knowledge Engineering



7

Why Rapid Learning/CAT?


Personalized medicine improves survival and quality of life.



Personalized medicine

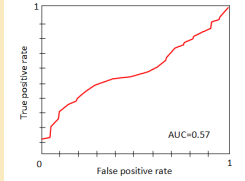
- “ Explosion of data
- “ Explosion of decisions
- “ Decision support
- “ Evidence base

[.] rapid learning [.] where we can learn from each patient to guide practice, is [.] crucial to guide rational health policy and to contain costs [..].
Lancet Oncol 2011;12:933




8

Prediction by MDs?



É Non Small Cell Lung Cancer
 É 2 year survival
 É 30 patients
 É 8 MDs
 É AUC: 0.57
 É Retrospective

Figure 3: Average receiver-operating curve of 8 radiation oncologists predicting two-year survival in 30 non-small cell lung cancer patients (AUC 0.57). Area-Under-the-Curve is an indicator of model prediction performance with 0.5 indicating random predictions, 1.0 a perfect model and >0.85-0.90 clinically acceptable.



9

**How To Get
Data For Rapid Learning**

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Challenges to Share Data

[...] the problem is not really technical [1]. Rather, the problems are ethical, political, and administrative. Lancet Oncol 2011;12:933

1. Administrative (time)
2. Political (value, authorship)
3. Ethical (privacy)
4. Technical

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CAT Approach

CAT is a research project in which

we develop an IT infrastructure -> *technical*

to make radiotherapy centers

semantic interoperable (SIOp*) -> *administrative*

while the data stays inside your hospital -> *ethical*

under your full control -> *political*

* SIOp level 3 = Machine Readable -> Data in common syntax and with common meaning

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Key Features

- " No sharing of data, truly federated
- " Machine learning (retro.) & clinical trials (prosp.)
- " NCI Thesaurus with formal additions
- " 5 languages, 5 countries & 5 legal systems
- " Focus on radiotherapy
- " Inclusion of non-academic centers
- " Industry involvement

13

Network 11/2011

Map from cgaadvertising.com

● Active or funded CAT partners (10)
● Prospective centers (4)

14

Laryngeal Carcinoma Model

- " 994 MAASTRO patients
- " 1990-2005
- " www.predictcancer.org
- " Input parameters
 - . Age
 - . Hemoglobin
 - . T-stage
 - . EDQ2T(Gy)
 - . Gender
 - . N+
 - . Tumor location
- " Output parameters
 - . Overall survival

15

Larynx Query

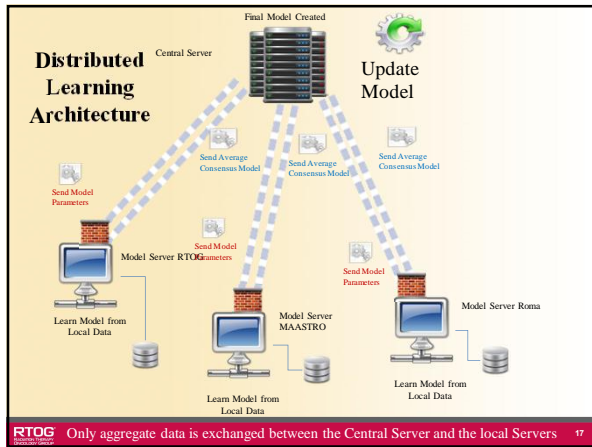
Descendants (Malignant Laryngeal Neoplasm)

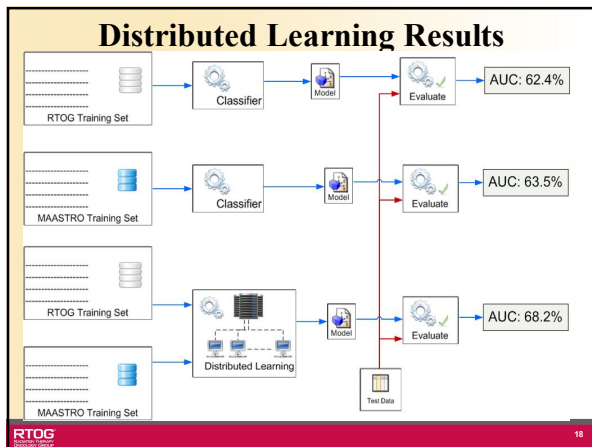
- ▾ Malignant Laryngeal Neoplasm
 - Laryngeal Carcinoma
 - Laryngeal Sarcoma
 - Malignant Glottis Neoplasm
 - Malignant Subglottis Neoplasm
 - ▾ Malignant Supraglottis Neoplasm
 - Malignant Epiglottis Neoplasm



Inclusions:
Delete all
C7484 Malignant Laryngeal Neoplasm -1

Exclusions:
Delete all

16






Web-based Documentation System

with Exchange of DICOM RT for Multicenter Clinical Studies in Particle Therapy




Priv.-Doz. Dr. med. Stephanie E. Combs, DEGRO 2012



19

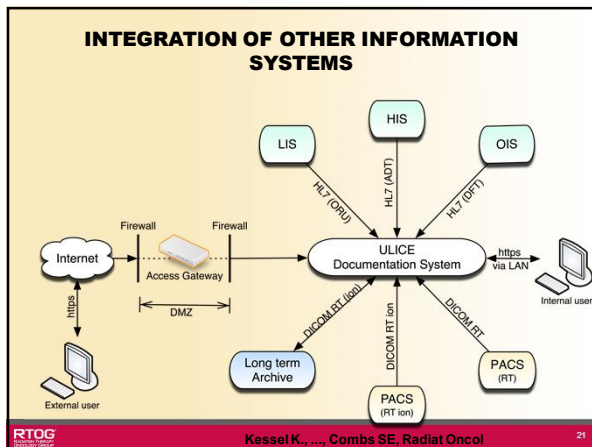
HIT

HEIDELBERG ION-BEAM THERAPY CENTER

- ~ began patient treatment in Nov. 2009
- ~ main focus:
 - clinical studies to evaluate the benefits of ion therapy for several indications
- ~ ULICE project (Union of Light Ions Centers in Europe)
 - development of a database with transnational access
 - platform for international clinical multicenter studies
 - accessible by external/internal oncologists, physicists, researchers


20



More to Integrate

Andre Dekker, PhD
MAASTRO Knowledge Engineering

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More Variables from a Simple CT

23

Biomarkers **General** **Radiomics**

ROC Plot
AUC 0.87

Biomarker: IL6, IL8, CEA
General: Gender, WHO-PS, FEV1, Positive lymph nodes, Tumor Volume
Radiomics: Range, Run Length, Run Percentage

n = 131

DATA ANALYSIS

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25

DATA ANALYSIS
**- Evidence Based Radiation
Therapy Quality Assurance**

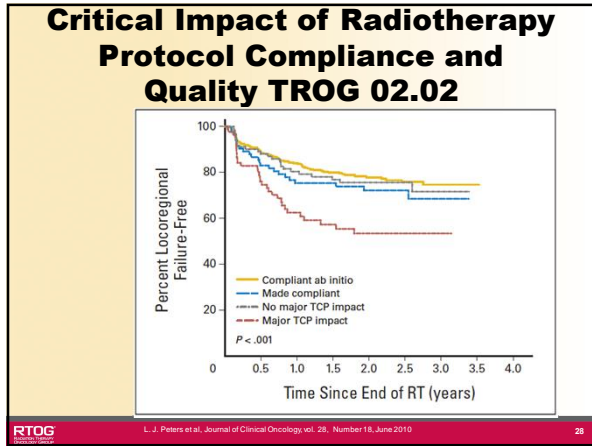
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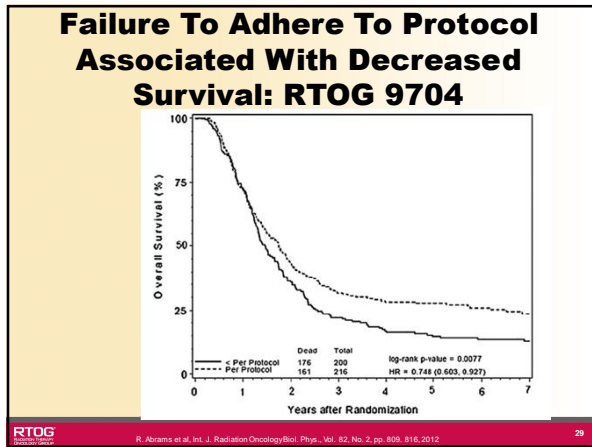
26

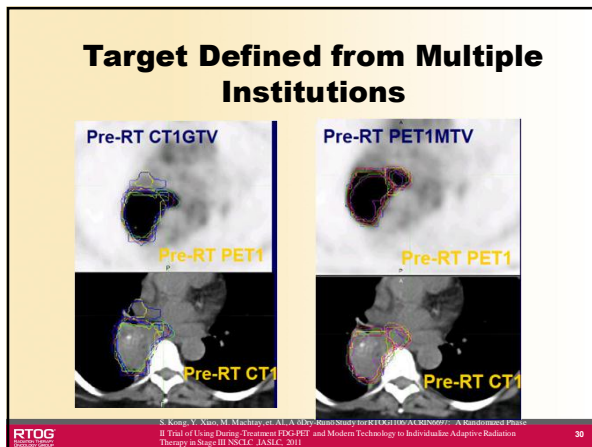
DATA ANALYSIS
**- Evidence Based Radiation
Therapy Quality Assurance
(Structure Definition)**

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27







IGRT Credentialing for RTOG Protocols

Protocol # (disease site)	Number of datasets	Absolute value of difference of shifts (mm); mean±SD (range)		
		Left-Right	Superior-Inferior	Anterior-Posterior
0813 (Lung)	71	1.8 ± 1.2 (0.0 - 6.4)	2.0 ± 1.1 (0.0 - 6.9)	2.0 ± 0.9 (0.0 - 5.0)
0813 (Lung)	21	1.7 ± 0.8 (0.1 - 5.1)	2.2 ± 1.0 (0.3 - 5.0)	2.0 ± 1.1 (0.1 - 4.8)
0631 (Spine)	6	0.7 ± 0.6 (0.1 - 1.5)	2.9 ± 3.8 (0.0 - 7.0)	0.4 ± 0.1 (0.1 - 0.9)
0920 (Head&Neck)	35	1.5 ± 1.0 (0.1 - 6.7)	2.5 ± 2.2 (0.0 - 8.2)	1.4 ± 1.1 (0.0 - 7.3)
Overall	133	1.7 ± 1.0 (0.0 - 6.7)	2.2 ± 1.5 (0.0 - 8.2)	1.8 ± 1.0 (0.0 - 7.3)

0813 Seamless Phase I/II Study of Stereotactic Lung Radiotherapy (SBRT) for Early

0630 A Phase II Trial of Image Guided Preoperative Radiotherapy for Primary Soft Tissue Sarcomas of the Extremity

0631 Phase II/III Study of Image-Guided Radiotherapy/SBRT for Localized Spine Metastasis--RTOG CCOP Study

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IGRT Variations

Imaging modality	Number of datasets	Absolute value of difference of shifts (mm); mean±SD (range)		
		Left-Right	Superior-Inferior	Anterior-Posterior
kV CBCT	96	1.7 ± 1.1 (0.0 - 6.7)	1.6 ± 0.9 (0.0 - 6.9)	1.7 ± 1.1 (0.0 - 5.0)
MVCT	37	1.5 ± 1.0 (0.1 - 5.1)	3.7 ± 1.7 (0.1 - 8.2)	1.9 ± 0.9 (0.0 - 7.3)
Overall	133	1.7 ± 1.0 (0.0 - 6.7)	2.2 ± 1.5 (0.0 - 8.2)	1.8 ± 1.0 (0.0 - 7.3)

	Left-Right	Superior-Inferior	Anterior-Posterior
Lung	2.33±1.06	4.58±2.96	4.19±2.80
Spine	3.50±4.67	1.25±1.63	2.70±2.40
Head&Neck	2.08±1.55	2.97±2.19	2.02±1.62

Y. Dai (Xiao) et al. Implementation of Remote 3D IGRT QA for RTOG Clinical Trials. Int. J. Radiation Oncology Biol. Phys. - In Press

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DATA ANALYSIS

- Analytical Algorithms

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FUTURE DIRECTIONS

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46

