New Developments in Knowledge Based Planning and Automation

Setting the Stage for Incorporation of Toxicity Measures in Treatment Plan Assessments

WE-F-BRB-0
Wednesday July 15, 2015 2:45 PM – 3:45 PM
AAPM Annual Meeting – 2015 Anaheim, CA

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University of Michigan

Disclosures: Unrelated grant support from Varian Medical Systems

Thanks to my collaborators at Mayo:
Tom Pisansky MD, Ivy Petersen MD, Elizabeth Yan MD, Brian Davis MD, Scott Stafford MD, Yolanda Garces MD, Robert Miller MD, James Martenson MD, Robert Mutter MD, Richard Choo MD, Chris Hallemeier MD, Nadia Laack MD, Sean Park MD, Daniel Ma MD, Kenneth Olivier MD, Sameer Keole MD, Mirek Fatyga PhD, Robert Foote MD, Michael Haddock MD

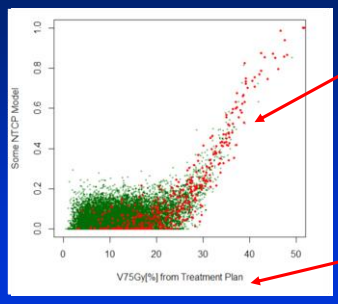
- What is normal?
- How did we do in treating our patients?

- Periodic Cleveland Clinic report (~83 pages) provided to physicians to give detailed data on outcomes for **all** disease sites.
- Example of how routine collection of data can be incorporated into clinician discussions of evidence based medicine and used as a baseline to better inform patients.
- Requires a commitment to "follow the data"

Courtesy of John Suh MD and Ping Xia PhD

The world that we're working toward living in

NTCP Metrics would be routinely calculated and analyzed



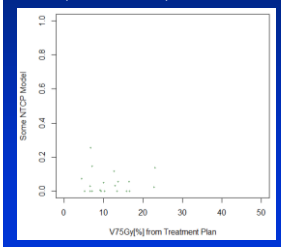
Toxicities would be routinely measured and compared to DVH and NTCP metrics

DVH Metrics would be routinely aggregated and analyzed for all patients

Simulated dataset of **20,000** patients – multiple institutions

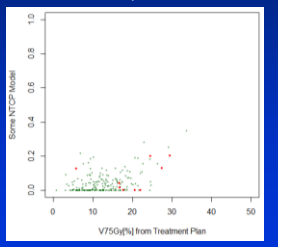
The world that we're really living in

The clinic is busy, tools are limited, so try out comparison for a small group of patients. Intensely manual!



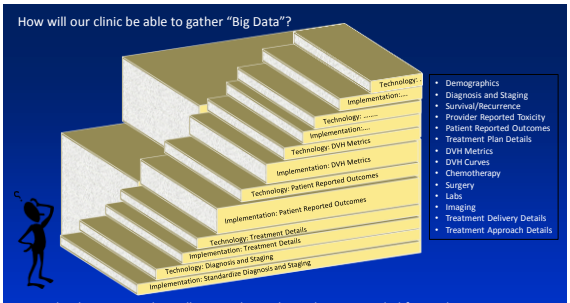
Simulated dataset of 20 patients

More serious about the question, mount a research study. Again tools are limited so intensely manual.



Simulated dataset of 200 patients

How will our clinic be able to gather "Big Data"?



- Technology is a much smaller step than culture changes needed for implementation: consensus (inter and intra institutional), process, changes in work duties, QA
- Can do a lot with existing treatment planning and radiation oncology information systems
- Think through what data elements you want /need in the long run, how they are related and then develop a strategy of small, manageable steps.

How to get there ?

Technology

- Software/database systems for aggregating information
- Software systems for analytics
- Integration with other systems

A few options here

- DIY – Use in house staff with expertise or train
- Use consultants to help build
- Purchase from current vendor (ROIS,TPS)
- Purchase from 3rd party vendor

Culture

- Need to shift thinking about data related to treating our patients.
- Thinking about the data not just for treatment of the patient before us , but for systematic aggregation to help all the patients yet to come.
- Implication is accepting limitations in options, standardizations
- Potentially more work to quantify data – "free text" is hard to use

This… only you can do

Assume you have the technology, what do you have to change about your practice to enable the technology to get the data?

- Consensus in your practice
- Standardize practice
- Change who does what

Baby Steps – a lot of them

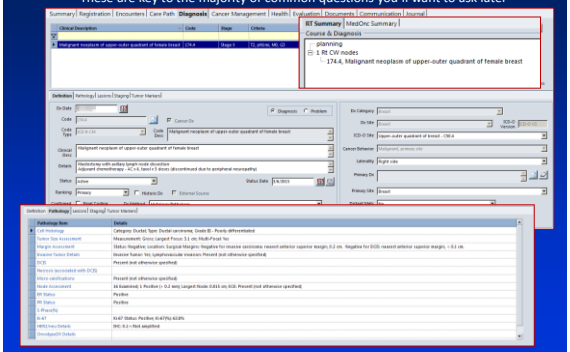
To move a group you have to help them believe in the vision.
As you create working examples that show it is real and doable, then they will lead the way.

Pick working examples that can positively impact work flow in clinic and add value to current practice

Identify and tackle the "enabling" steps one by one. This positions you to grow your effort.

Be sure to fully enter and curate your diagnosis and staging data, primary and metastatic.

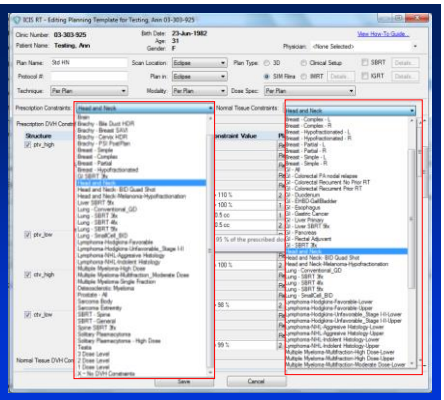
These are key to the majority of common questions you'll want to ask later



Application becomes our standard prescription.

Also serves as documentation tool for image setup, notes, IMRT justification, etc.

Physician groups define consensus for DVH metrics for all treatment sites; what to measure and default values for constraints and prioritizations.



Several groups are coordinating efforts to address nomenclature for radiation oncology

NRG Oncology

BRIEF REPORT AND OPINION

Radiation Therapy Digital Data Submission Process for National Clinical Trials Network

AAPM Task Group No. 263 - Standardizing Nomenclature for Radiation Therapy

Members represent multiplicity of stake holders – institutions, vendors, national regions and international, academic/non-academic, physicians, physics, AAPM/ASTRO

Left Optic Nerve(12): Lt Optic Nerve, OPTICN_L, OPTNRV_L, optic_nrv_L, L_optic_nerve, OPTIC_NRV_L, OpticNerve_L, LOPTIC, OpticNerve_L (3), Lef Optic Nerve

Left Lung(12): Lt Lung, Lung_L(4), LUNG_L(3), lung_L, L_lung, LLUNG, LLung

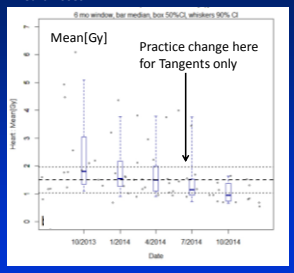
Both Lungs(12): Lungs(2), LUNGs, LUNG_TOTAL, lung_total, combined_lung, LUNG, LUNGS(2), Lung Bilatlung, Lung_Both

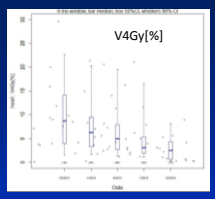
8th cranial nerve(7): CN_VIII(5), cn_viii(2)

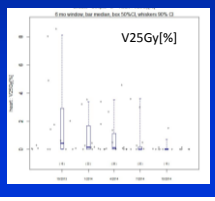
Right External Iliac Artery(2): A_ILLIAC_E_R, a_illiac_e_r

What is normal?

Simple Tangents
Heart Doses

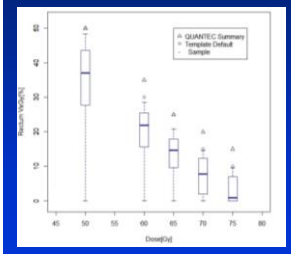


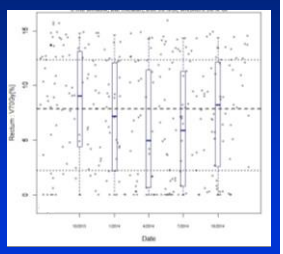




What is normal?

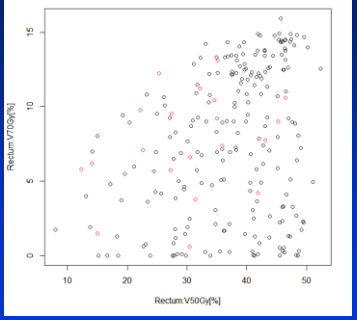
Prostate Treatment : Rectal Doses





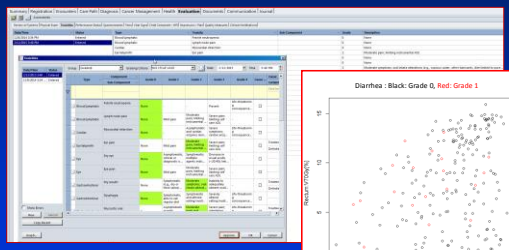
Comparing toxicity to DVH metrics

Diarrhea : Black: Grade 0, Red: Grade 1



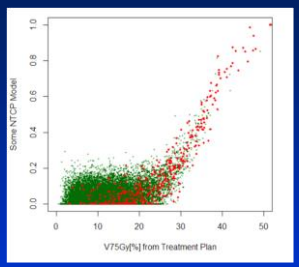
When is no data, data and when is it just no data?

- Almost all of the 0 scores correspond to not entering a value.
- Another iteration on changing culture to think about treatment records as like a scientist as well as like a clinician.



- Need to enter the data, all of it
- Need to perform QA on the data

- Change your culture to think about treatment data as something you will want to aggregate and analyze over the long term, not just what you have to do to treat the patient
- Think in terms of 1000's not 10's of patients. Real knowledge implies real numbers.
- Standardize processes, nomenclatures, etc so that computers can automatically extract the information
- Be sure to use the tools in your planning and record and verify systems to make data extracted reliable for answering clinical and research questions



New Developments in Knowledge-Based Treatment Planning and Automation

P Gabriel[1], C Mayo[2], T McNutt[3], (1) University of Pennsylvania, Philadelphia, PA, (2) Mayo Clinic, Rochester, MN, (3) Johns Hopkins University, Severna Park, MD

Presentations

2:45 PM - ***The Power of Ontologies and Standardized Terminologies for Capturing Clinical Knowledge*** - P Gabriel, Presenting Author

3:05 PM - ***Setting the Stage for Incorporation of Toxicity Measures in Treatment Plan Assessments*** - C Mayo, Presenting Author

3:25 PM - ***Inclusion of Data-Driven Risk Predictions in Radiation Treatment Planning in the Context of a Local Level Learning Health System*** - T McNutt, Presenting Author

WE-F-BRB-0 (Wednesday, July 15, 2015) 2:45 PM - 3:45 PM Room: Ballroom B

Advancements in informatics in radiotherapy are opening up opportunities to improve our ability to assess treatment plans. Models on individualizing patient dose constraints from prior patient data and shape relationships have been extensively researched and are now making their way into commercial products. New developments in knowledge based treatment planning involve understanding the impact of the radiation dosimetry on the patient. Akin to radiobiology models that have driven intensity modulated radiotherapy optimization, toxicity and outcome predictions based on treatment plans and prior patient experiences may be the next step in knowledge based planning. In order to realize these predictions, it is necessary to understand how the clinical information can be captured, structured and organized with ontologies and databases designed for recall. Large databases containing radiation dosimetry and outcomes present the opportunity to evaluate treatment plans against predictions of toxicity and disease response. Such evaluations can be based on dose volume histograms or even the full 3-dimensional dose distribution and its relation to the critical anatomy.

This session will provide an understanding of ontologies and standard terminologies used to capture clinical knowledge into structured databases; How data can be organized and accessed to utilize the knowledge in planning; and examples of research and clinical efforts to incorporate that clinical knowledge into planning for improved care for our patients.

Learning Objectives:
1. Understand the role of standard terminologies, ontologies and data organization in oncology
2. Understand methods to capture clinical toxicity and outcomes in a clinical setting
3. Understand opportunities to learn from clinical data and its application to treatment planning

Funding Support, Disclosures, and Conflict of Interest: Todd McNutt receives funding from Philips, Elekta and Toshiba for some of the work