Vendor Provided Data, Tools & Test Procedures
The Linac Vendor Perspective

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Disclosure

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Learning Aim

• What: Understand vendor considerations when providing test tools, data and procedures for a linac.

• Why: Enable vendors and physicists collaboration in developing independent verification tests of closed/black box systems.

• How: Pedagogical approach → case studies.
What Guides Our Thinking?

- Precedents
  - Established practices
  - Documented vs undocumented
  - Regional differences

- Publications
  - Professional society
  - Regulatory bodies and agencies
  - Journals & Books

- Prescience
  - What might the future look like?

Case 1: Product Specifications

- Product specification is a form of vendor-provided data
  - Sets a baseline value at acceptance for future machine QA activities
  - How to define "flatness" for FFF beam if linac only has FFF beams?
    \[
    \text{Flatness} = \frac{\text{Dose}_{\text{max}}}{\text{Dose}_{\text{min}}} - 1
    \]
  - Define the reciprocal of the "flatness" as a product specification called "Off-Axis Intensity"

Case 2: System Self-Test

- Equipment (H/W or S/W) as a vendor-provided tool
  - Hardware: A reproducibly position-able radiopaque phantom
  - Software: Analyzes MV, kV, gantry, couch, isocenter alignment
  - Designed to fit the index features on couch
  - Labeling to show where on the couch to place
  - Notch to accommodate 30 cm x 30 cm slab phantom
  - Used for system self-test; was not designed to be a QA product
    Y. Li et al., JACMP 19(5), Sept 2018, pp 375-382
Case 3: What if I Want to Use It as “QA”?  

- User can choose to validate black-box tool for routine QA  
- Caveats: when a vendor says “This is not QA”  
  - Will my custom Matlab scripts and 3rd party QA S/W always work?  
  - Vendor may change the specification  
  - Output file types may not have been created for 3rd party use  
  - e.g. tag files are generally intended for engineering debug use  
  - e.g. private DICOM tags to support custom functionality  

Y. Li et al., JACMP 19 (5), Sept 2018, pp 375-382

Case 4: What about dose calibration?  

- A vendor-provided absolute dosimetry procedure may be necessary if there is new type of linac.  
  - May be the case if standard reference setup is not feasible  
  - 10 cm x 10 cm square flattened beam  
  - Water phantom doesn’t fit into machine geometry  
- Vendors look to the publications for guidance  
  - May need to build a composite approach using multiple published references  

P. Almond et al., Med Phys 26 (9) Sept 1999, pp 1847-1870

Case 4: What about dose calibration?  

- Example: What if only FFF beam is available on a linac?  
  - Large \( P_{\text{re}} \) recombination factor because of high dose per pulse?  
  - S. Kry et al., JACMP 13 (6) Nov 2012, pp 318-325  
  - Electron contamination in the absence of flattening filter?  
  - S.A.M. Lloyd et al., JACMP 21 May 2018, doi.org/10.1002/acm2.12349  
- Example: What if vendor-defined reference field is “small”?  
  - Small ion chambers with high-Z materials affect the calibration?  
  - M. McEwen et al., Med Phys 41 (4) April 2014, pp 041501-20
Case 5: Linac Beam Data

- Assist in commissioning by providing beam data
- Key information to provide with the data
  - Measurement setup
  - Detector type(s)
  - Scanning protocol
  - Example TPS beam model calculations

Case 6: Sometimes Vendor Has to Provide Procedure

- How to set up water phantom SSD (procedure) in the absence of a front pointer
  - Use the EPID?
  - A first guess: put a radiopaque object at depth of 100 cm - SSD?
  - Vendor recommended procedure
    - Trigonometry reveals that for a particular SSD value, there exists a gantry angle such that, one of the divergent rays from MV x-ray source will exactly graze the water surface, resulting in a sharp edge in the image of the air-water interface

Case 7: IEC 60976

- Vendor provided data per regulatory compliance requirement
  - Regional differences in medical device regulations
  - For some linac characteristics, IEC allows for provision of data that differs from recommended standard value: "should"
  - The Chinese GB standard does not allow for deviations from recommended value
Case 8: Hounsfield Phantom

- Vendor-provided tool per regulatory compliance requirement in India and USA

Case 9: VMAT test trajectory

- Vendor-provided data per precedent & publication*

  * C. Ling et al JROBP 72 (2) 2008 PP 573-581

Case 10: Physics QA Requirements

- How to apply TG-142 for a treatment delivery system that doesn't look like a conventional linac?

  RELEVANT TG142 QA TASKS
  - Daily 6 of 17
  - Weekly 1 of 1
  - Monthly 21 of 38
  - Annual 28 of 52
  - Total 56 of 108 (52%) applicable

- Vendor can get user up to speed quickly by enumerating the relevant aspects of TG-142
Summary

• Precedent
  - Vendors are sensitive to established patterns of practice
  - But also seek opportunities to innovate

• Publications
  - Vendors rely on published standards, codes of practice, guidelines and research articles

• Prescience
  - Need to anticipate what the future will look like
  - Technology, clinical practice, hospital operations & human resources

• Collaboration
  - Keep the lines of communication open between vendors & clinical community
  - Appreciate and recognize the symbiotic relationship between vendors and clinical users

Thank You