Medical Physics Practice Guidelines

March 18, 2013
Spring AAPM Clinical Meeting

Jonas Fontenot

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Outline of Session

- Medical Physics Practice Guidelines (Fontenot)
  - Rationale
  - Vision
  - Process
- Overview of MPPG#1 (Fontenot)
  - Evaluation and quality assurance of x-ray based image guided radiotherapy systems
- Overview of MPPG#2 (Cody)
  - CT protocol management and review

Outline - MPPGs

- Background and rationale
  - AAPM task group reports
  - ACR Technical Standards & Practice Guidelines
  - Focus on medical errors and role of regulations
  - Requirements for clinic accreditation
  - Multiple accrediting entities
- Medical Physics Practice Guidelines
  - Vision and scope
  - Process

AAPM Task Groups

- Significant volunteer activity by domain experts to develop technical reference documents
- Often developed by the “premier centers” in the country
- Purpose is to create useful technical reference documents for practicing medical physicists; frequently contain recommendations for commissioning quality assurance practice

ACR documents

- Developed through a consensus-focused process with broad representation by different practice environments
- Aim to define a minimum practice standard
- Significant physician influence
- Devoid of much specificity

MIPPA

- Medicare Improvements for Patients and Providers Act of 2008:
  - Signed into law in July 2008
  - Requires practice accreditation for the “advanced imaging” modalities which includes CT, MR, and Nuclear Medicine
  - Does not include x-ray, fluoroscopy, sonography, or anything in radiation oncology
  - Does not apply to hospitals

Accrediting bodies under MIPPA:

- American College of Radiology
- Intersocietal Accreditation Commission
- The Joint Commission
- *The Problem/Concern*
  - All have different requirements for personnel and practice - AAPM is on record indicating concern with not requiring board certification for medical physicists

ASTRO's position:

Launching a significantly enhanced practice accreditation program and beginning the development of additional accreditation modules specifically addressing new, advanced technologies such as IMRT, SBRT and brachytherapy.

ACR's position:

The ACR believes Congress should expand the current MIPPA accreditation requirements for advanced imaging to include radiation therapy. In addition, the accreditation mandate should apply to all facilities, including hospital settings. Furthermore, the accrediting of these imaging and radiation therapy procedures should only be conducted by those accrediting bodies with experience and expertise in the area for which they are accrediting.

ASTRO-AAPM: Patient safety

Practical Radiation Oncology (2011) 1, 16–21

practical radiation oncology
pro
www.practicalradonc.org

Special Article

Improving patient safety in radiation oncology

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Received 5 November 2010; accepted 12 November 2010

Abstract Beginning in the 1990s, and emphasized in 2000 with the release of an Institute of Medicine report, health care providers and institutions have dedicated time and resources to reducing errors that impact the safety and well-being of patients. However, in January 2010, the first of a series of articles appeared in *The New York Times* that described errors in radiation oncology that grievously impacted patients. In response, the American Association of Physicists in Medicine and the American Society for Radiation Oncology sponsored a working meeting entitled "Safety in Radiation Therapy: A Call to Action." The meeting attracted 400 attendees, including medical physicists, radiation oncologists, medical dosimetrists, radiation therapists, hospital administrators, regulators, and representatives of equipment manufacturers. The meeting was co-hosted by 14 organizations in the United States and Canada. The meeting yielded 20 recommendations that provided a pathway to reducing errors and

- **Staffing levels**
- **FMEA**
- **Error reporting**
- **Accreditation**
- **Standardization**
- **Checklists**

ASTRO White Papers

Practical Radiation Oncology (2011) 1, 190–195

practical radiation oncology pro www.practicalradonc.org

Special Article

Safety considerations for IMRT: Executive summary

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Received 19 April 2011; accepted 27 April 2011

- **Checklists / Time-outs**
- **Adequate time**
- **Training / credentialing**
- **Error reporting**
- **Accreditation**

ASRT White Paper

- **Staffing levels – min 2 / linac**
- **Training / credentialing**
- **Error reporting**
- **Accreditation**
- **Checklists / Time-outs**

Possible result:

- Multitude of accrediting entities, each defining their own QC/safety standards
- State regulations continue to reference Task Group reports, which may not have been written with that use in mind

Proposed solution:

- AAPM develops practice guidelines for medical physics, defining a minimum practice standard for a given scope of clinical service
- Accreditation programs (and state regulators) incorporate the AAPM practice guidelines rather than defining their own

Medical Physics Practice Guidelines

AMERICAN ASSOCIATION OF PHYSICISTS IN MEDICINE
PROFESSIONAL POLICY:
PROCESS FOR CREATION, APPROVAL, AND REVISION OF
MEDICAL PHYSICS PRACTICE GUIDELINES

INTRODUCTION

The American Association of Physicists in Medicine (AAPM) has long advocated a consistent level of medical physics practice, and has published many guidelines and position statements toward that goal, such as Science Council Task Group reports related to calibration and quality assurance, Education Council and Professional Council Task Group reports related to education, training, and peer review, and Board-approved Position Statements related to the scope of practice, physicist qualifications, and other aspects of medical physics practice. Despite these concerted and enduring efforts, the profession does not have a clear and concise statement of the acceptable practice guidelines for routine clinical medical physics. As accreditation of clinical practices becomes more common, Medical Physics Practice Guidelines (MPPGs) will be crucial to ensuring a consistent benchmark for accreditation programs.

The AAPM will lead the development of MPPGs in collaboration with other professional societies. The MPPGs will be freely available to the general public. Accrediting organizations, regulatory agencies and legislators will be encouraged to reference these

TG reports vs MPPGs

TGs are

- Intended to be technical reference for medical physicists – compendia of the known science on a topic
- Written by a core group of subject-matter experts
- Reviewed by subject-matter committee and approved by one Council

TG reports vs MPPGs

MPPGs are

- Developed following a structured process to become consensus practice guidance documents
- Developed with cross-Council participation
- Open for review/comment by ALL members
- Intended to be adopted by regulatory agencies and accrediting entities
- Updated regularly – sunset dates / revision #
- Freely available to ALL – not just AAPM

MPPG vision/scope

2. Vision

The AAPM will lead the development of MPPGs in collaboration with other professional societies. The MPPGs will be freely available to the general public. Accrediting organizations, regulatory agencies and legislators will be encouraged to reference these MPPGs when defining their respective requirements.

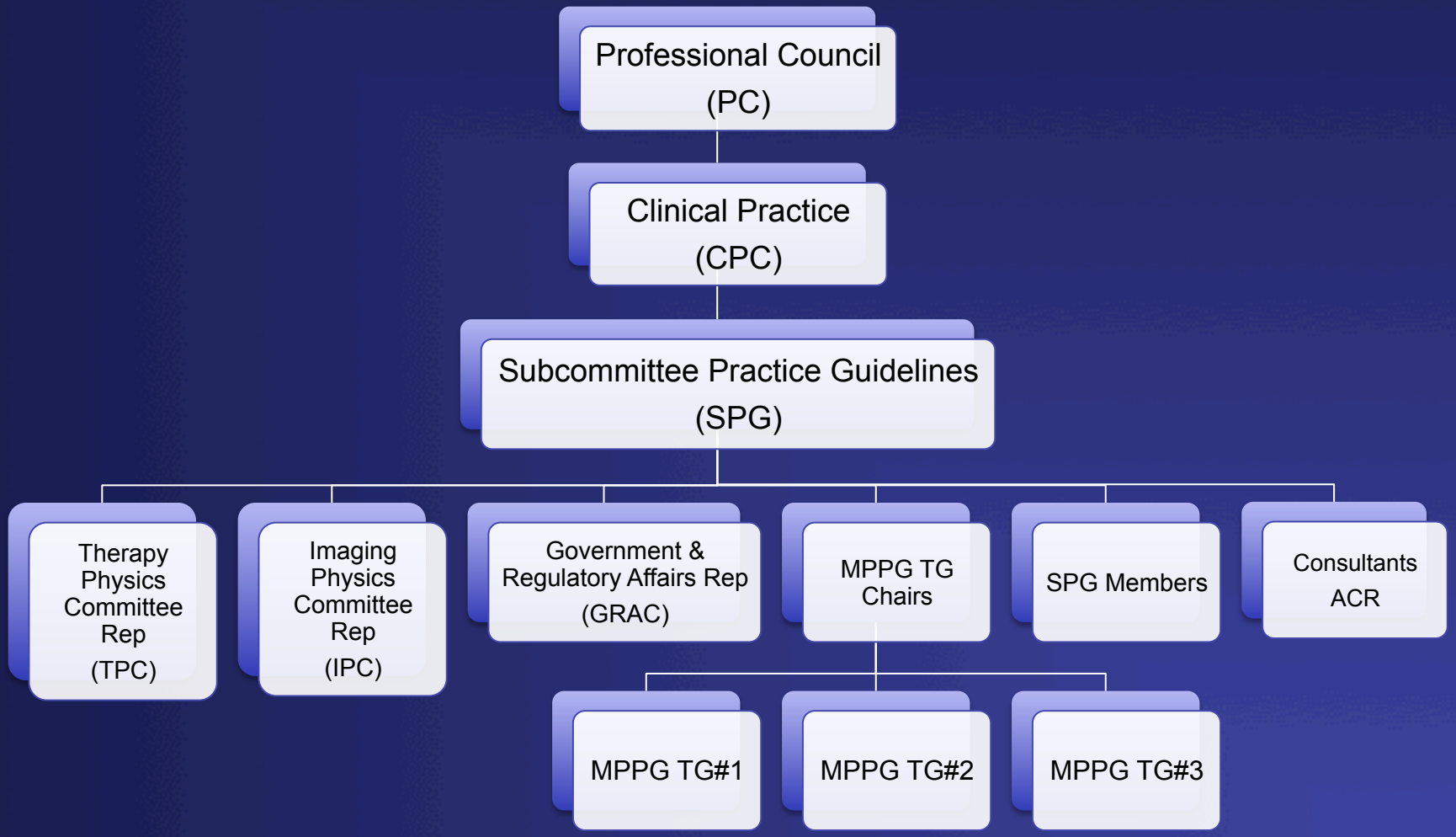
3. Scope

MPPGs are intended to provide the medical community with a clear description of the minimum level of medical physics support that the AAPM would consider prudent in all clinical practice settings. Support includes but is not limited to staffing, equipment, machine access, and training. These MPPGs are not designed to replace extensive Task Group reports or review articles, but rather to describe the recommended minimum level of medical physics support for specific clinical services.

MPPG Initiative

- Medical Physics Practice Guidelines (MPPG)
  - Intended to provide the medical community with a clear description of the minimum level of medical physics support that the AAPM would consider to be prudent in all clinical practice settings.
    - Staffing, equipment, machine access, and training.
  - Not designed to replace extensive Task Group reports or review articles, but rather to describe the recommended *minimum level* of medical physics support for specific clinical services.
  - Subcommittee on Practice Guidelines (SPG) is the parent committee for MPPGs

Structure of SPG



Current SPG Membership

Per Halvorsen, Chair of PC
Daniel Pavord & Martin Fraser, Chair and Co-Chair of CPC

Joann Prisciandaro (Chair, Therapy)	Kristina Huffman
Jeff Shepard (Vice Chair, Imaging, IPC)	David Jordan
Maria Chan (Vice Chair)	Ingrid Marshall
Jessica Clements	Art Olch (TPC)
Dianna Cody (MPPG)	Robert Pizzutiello
Indra Das	Narayan Sahoo
Nicholas Detorie (consultant)	Anthony Siebert (MPPG)
Lynne Fairobent	Jennifer Smilowitz (MPPG)
Vladimir Feygelman	James VanDamme
Luis Fong del los Santos (MPPG)	Gerald White (GRAC)
Jonas Fontenot (MPPG)	Ning Yue
David Gierga	

MPPGs

- Responsibilities
  - SPG is responsible for developing a list and priority of appropriate subject areas in need of MPPGs
  - The Clinical Practice Committee (CPC) is responsible for reviewing the list, the prioritization, and for providing suggested revisions.
  - PC is responsible for final review and approval
- Topics
  - May be submitted by any AAPM member, the AAPM Board of Directors, AAPM Councils, and collaborating societies.
  - The SPG shall review nominations for new topics and suggested revisions in a timely manner, but no less frequently than once per year.

MPPGs

- Process
  - Once MPPG topic is identified, an MPPG chair is chosen
  - MPPG chair, in consultation with SPG, chooses MPPG members
  - The timeline, from start to finish, for every MPPG is one year (not a typo!)
  - Requirements
    - Well-defined scope
    - Clear endpoints
    - Motivated MPPG members
    - Motivated SC and PC members

MPPG Report Template

- Table of Contents, List of Figures, and List of Tables
- Summary of recommendations
- MPPG Task Group members
- Summary of peer review
- Introduction
- Definitions
- Staffing qualifications and responsibilities – key players
- Implementation guidelines
- Recommendations
- Conclusion

- Overview
- Goals and rationale
- Intended users
- Potential limitations and precautions

- Required resources and equipment
- Staff training and validation
- Continuing quality improvement

- Recommendation 1
  - Relevant references
  - Example case scenario
- *Repeated for each recommendation*

MPPGs

- Review
  - Relevant AAPM councils
  - Other professional societies
  - All AAPM members
- Approval
  - Majority vote by MPPG Task Group, SPG, CPC, and PC sequentially
  - At each phase of the approval process, the MPPG Task Group Chair must respond to any concerns voiced. If the document is revised in response to this review process, the revised document must be re-submitted through the same approval sequence.
  - Upon approval by PC, the MPPG document is in effect and is posted to the AAPM webpage on April 1 each year.
  - MPPG document will also be submitted for publication in JACMP
  - Approved MPPGs will be issued a sunset date of 5 years from the date of approval.

Process for MPPG

Current MPPG Task Groups

- Evaluation and QA of x-ray based image guided radiotherapy systems
- CT protocol management and review
- Development, implementation, use and maintenance of safety checklists for radiation oncology
- Treatment planning system commissioning and QA
- Definition of Supervision

Overview of TG225 - Medical Physics Practice Guideline #1

Evaluation and quality assurance of x-ray based image guided radiotherapy systems

Jonas Fontenot, Ph.D.

MPPG #1

Evaluation and Quality Assurance of X-ray Based Image Guided Radiotherapy Systems

Committee Members:

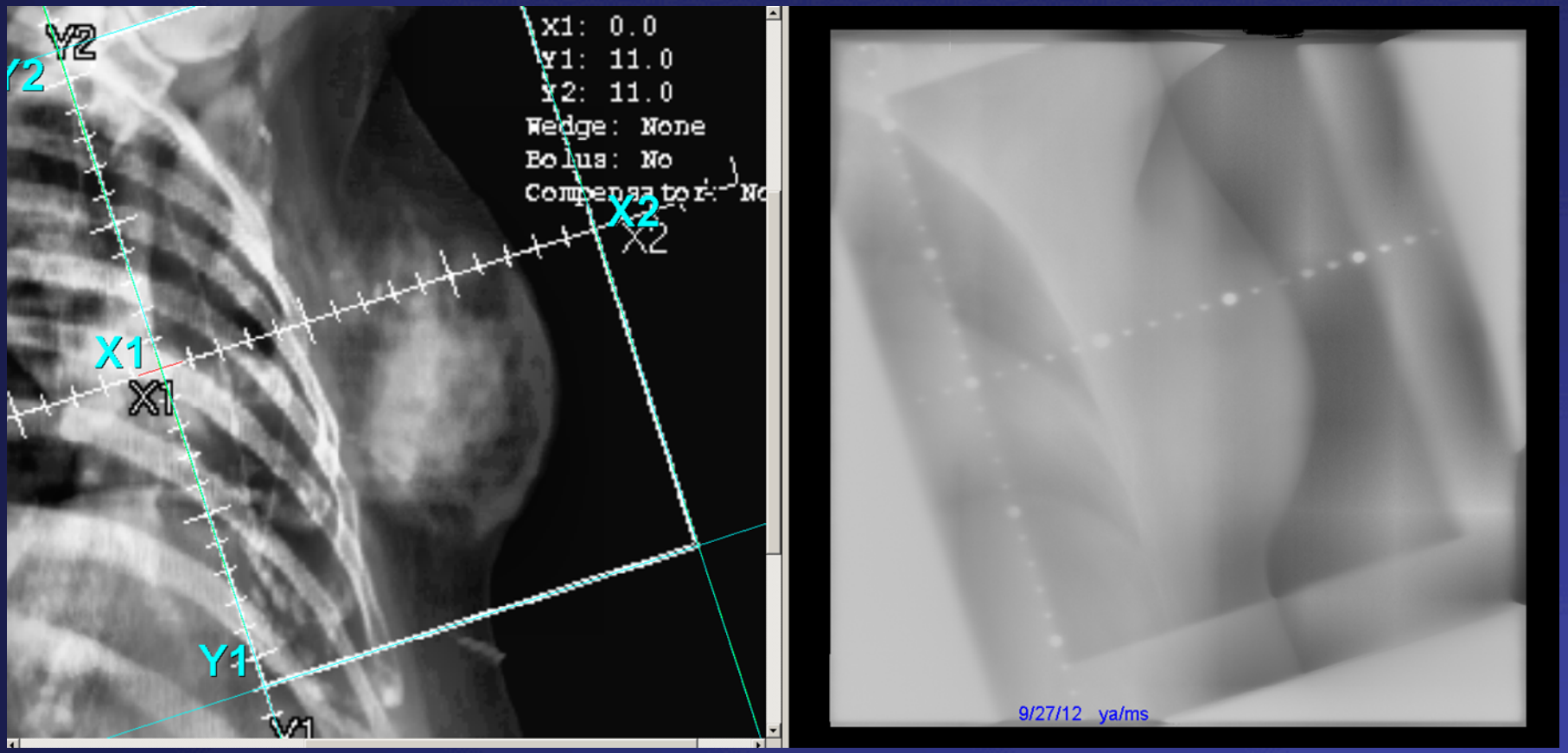
- Jonas Fontenot (chair) – Mary Bird Perkins Cancer Center
- Andrew Jensen – Mayo Clinic (now US Oncology)
- Jack Yang – Monmouth Medical Center
- Hassaan Alkhatib – Richland Memorial Hospital
- Jeff Garrett – Mississippi Baptist Medical Center
- Steve McCullough – Methodist Richardson Cancer Center
- Brent Parker – University of Texas Medical Branch at Galveston
- Art Olch (TPC rep) – Children's Hospital of LA

Elements of Guidelines

- Introduction
  - Goals and rationale
  - Intended users
- Definitions/abbreviations
- Staff Responsibilities
- Implementation Guidelines
  - Required resources
    - Staffing
    - Equipment
  - Staff training
  - Process descriptions
- Recommended minimum requirements
- Conclusions

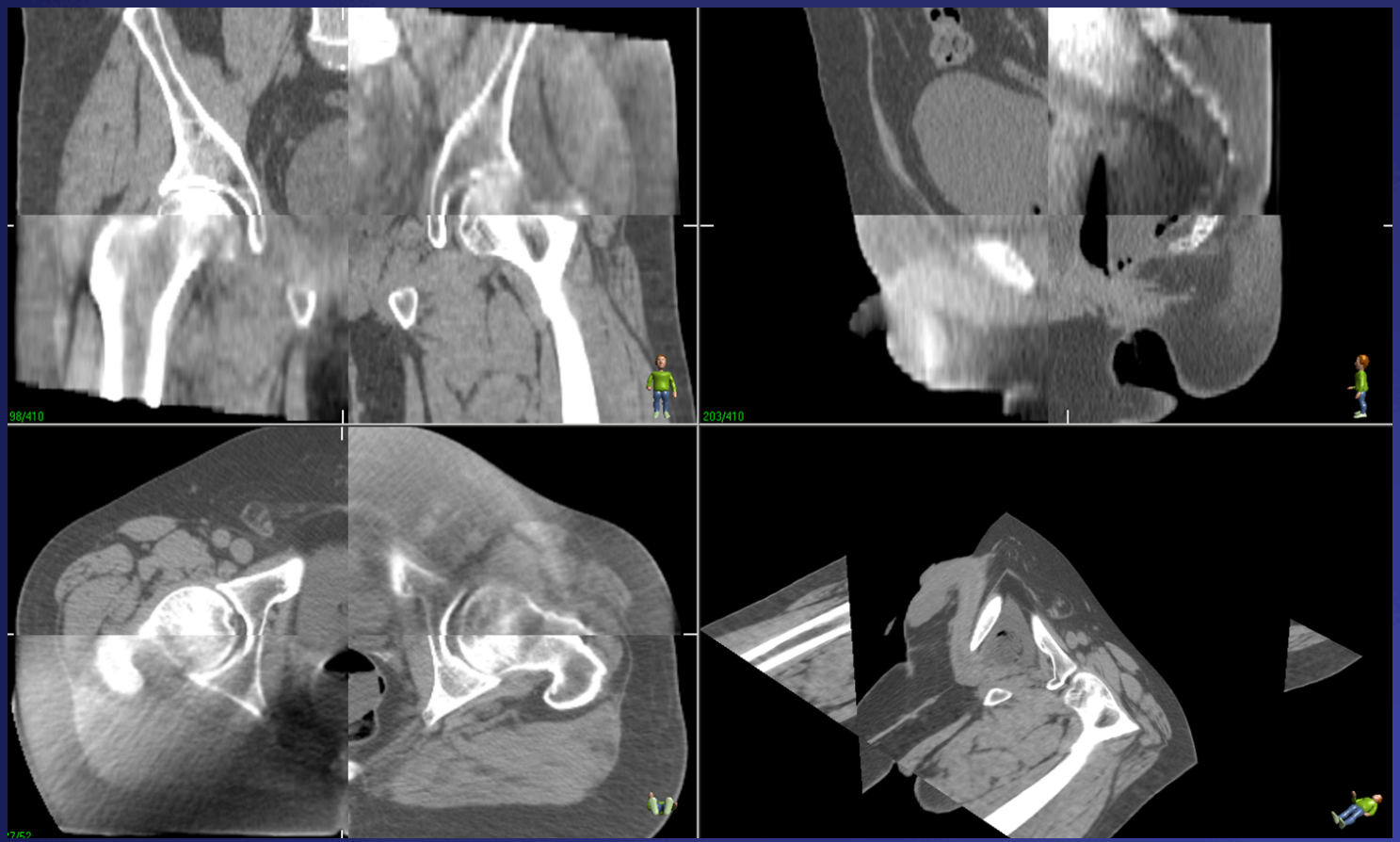
Background

- IGRT is not a new concept



Background

- IGRT is now more complex and heavily-utilized than ever before



Background

- IGRT is now more complex and heavily-utilized than ever before
  - In our clinic
    - Pre-2008
      - No OBI
      - SSD checks were primary metric for localization quality
    - Current
      - All linacs have OBI
      - Frequency of SSD checks > 1 cm has increased
    - Conclusions
      - IGRT has changed the way we align our patients
      - We have de-emphasized traditional localization methods

Background

- Use of imaging systems for daily alignment and localization in radiation therapy IGRT is expanding rapidly
- Challenges for the therapy physicist
  - New technology
  - Not traditionally associated with clinical therapy physics

Rationale

- IGRT systems come in many flavors
  - Megavoltage imaging systems
    - Two-dimensional
    - Three-dimensional
  - Kilovoltage imaging systems
    - Two-dimensional
      - Gantry-mounted
      - Room-mounted
    - Three-dimensional
      - Gantry-mounted
      - Room-mounted

Rationale

- Guidance documents are available
  - TG-58
  - TG-75
  - TG-101
  - TG-104
  - TG-135
  - TG-142
  - TG-148
  - TG-179
- Obstacles to successful implementation of an IGRT program
  - Unfamiliarity with technology
  - Variety/complexity of guidance documents
  - Few process descriptions
  - What is required?

Rationale

Task Group 142 report: Quality assurance of medical accelerators

TABLE VI. Imaging.

Procedure	Application-type tolerance: non-SRS/SBRT	Application-type tolerance: SRS/SBRT
Daily[a]		
Planar kV and MV (EPID) imaging		
Collision interlocks	Functional	Functional
Positioning/repositioning	≤2 mm	≤1 mm
Imaging and treatment coordinate coincidence (single gantry angle)	≤2 mm	≤1 mm
Cone-beam CT (kV and MV)		
Collision interlocks	Functional	Functional
Imaging and treatment coordinate coincidence	≤2 mm	≤1 mm
Positioning/repositioning	≤1 mm	≤1 mm
Monthly		
Planar MV imaging (EPID)		
Imaging and treatment coordinate coincidence	≤2 mm	≤1 mm

Rationale

Task Group 142 report: Quality assurance of medical accelerators

- Repeated and deliberate use of <u>recommended</u> QA practices
- Institutional deviations from TG-142 QA are <u>expected</u>

Several authors have attempted to develop a systematic approach to developing QA frequencies and action levels.[37–39] More recently the work being performed by Task Group 100[40] of the AAPM. TG 100—A method for evaluating QA needs in radiation therapy [based on "Failure modes and effects analysis (FMEA)"]—promotes individual departments to be responsible for development of unique QA programs based on procedures and resources performed at individual institutions. Institutional deviations from some of these recommendations are expected based upon the institution's policy and procedures; the clinical significance of these deviations may be mitigated by other control methods that are not anticipated in this document. In the case of decreasing the frequency of a particular test, the results of the test must be examined and be validated with an appreciable history of that test and based on sound statistical principles. That decision must also be correlated with the documented analysis of the potential impact of catastrophic results in the event of an occurrence. By FMEA analysis, an institution can estimate the degree of harm due to a failure along with (lack of) detection and occurrence probabilities. We reiterate the recommendations of TG-40[1] that the QA program should be flexible enough to take into account quality, costs, equipment

Goals

- “Clinical recipe” for the solo physicist
- Inform the reader of the needs of this particular technology (time, effort, resources)
- Succinctly state the minimum acceptable standards for using IGRT, similar to ACR-ASTRO technical standards
- Provide necessary references for further investigation

Intended Users

- Medical physicists
  - What is required for safe and effective use?
    - Tools
    - Time/effort
    - Procedures
- Administrators
  - How much will it cost (hard/soft)?
- Accrediting bodies
- Regulatory agencies

Approach

- Survey existing TG recommendations
- Survey IGRT practices/observations at MPPG members' institutions
  - University clinics
  - Community clinics
- Rank, prioritization of minimally acceptable practice
- Expansion of process descriptions, categorized by IGRT approach
- Address applicable areas of need identified by SPG

Approach

- Timeline of activities
  - 2/13/12: MPPG TG formed
  - 3/19/12: Scope and Timeline submitted to SPG
  - 3/27/12: IGRT program questionnaire submitted to MPPG member institutions (who, what, when, where, how)
  - 5/15/12: IGRT program data collected from MPPG member institutions
  - 7/01/12: Working draft of report submitted to SPG
  - 7/29/12: Face-to-face meeting at AAPM
  - 8/21/12: teleconference
  - 8/28/12: teleconference
  - 9/11/12: teleconference
  - 9/18/12: teleconference
  - 10/2/12: teleconference
  - 10/7/12: Report submitted for internal review
    - SPG, PC, TPC, QASC, EXCM, Chairs of TG 75, 104, 111, 135, 179
  - 11/13/12: Internal review comments received (95)
  - 12/3/12: teleconference
  - 12/7/12: teleconference
  - 12/15/12: Report submitted for public comment
  - 1/28/13: Public review comments received (34)
  - 2/05/13: teleconference
  - 3/11/13: Report approved by MPPG members for formal process approval

Staff Responsibilities

- IGRT implementation requires a team approach
  - Radiation Oncologist
  - Medical Physicist
  - Medical Dosimetrist
  - Radiation Therapist
  - Information Technologist

Staff Responsibilities

- Medical physicist
  - Must be competent to practice independently in the subfield of therapeutic radiological physics. The individual **must** be certified (ABR, ABMP, CCPM).
  - Responsibilities of the qualified medical physicist in an IGRT program include:
    - Performs acceptance testing and commissioning
    - Implements and manages of a quality assurance program
    - Develops and implements standard operating procedures (including imaging protocols and repositioning thresholds)

Staff Responsibilities

- Radiation Oncologist
  - Manages patient positioning procedures
  - Specifies imaging modalities and frequencies
  - Identifies registration targets and repositioning thresholds
  - Performs timely review of clinical IGRT images
  - Conducts regular reviews of the IGRT program

Staff Responsibilities

- Medical Dosimetrist
  - Creates and transfers to the OIS all patient-specific data necessary for IGRT implementation
- Radiation Therapist
  - Understands the use of positioning devices in IGRT
  - Prepares the IGRT system for acquisition of patient-specific positioning verification images
  - Implements the IGRT treatment protocol under the supervision of the radiation oncologist and medical physicist
  - Acquires positioning verification images for review by the radiation oncologist
  - Assists in periodic review of the stability of the IGRT system (e.g., daily QA)

Staff Responsibilities

- Information technologist
  - Provides and maintains resources necessary for storing, archiving and retrieving images generated during IGRT.
  - May be accomplished by a dedicated Information Specialist or duties assigned to another team member.

Implementation Guidelines

- Required resources
  - Staffing/time
    - Two dimensional MV imaging systems
      - Acceptance/Commissioning/Documentation: 18-36 hours
      - Ongoing support: 25-50 hours annually
    - Two dimensional kV imaging systems
      - Acceptance/Commissioning/Documentation: 18-36 hours
      - Ongoing support: 25-50 hours annually
    - Three dimensional MV imaging systems
      - Acceptance/Commissioning/Documentation: 18-36 hours
      - Ongoing support: 100-125 hours annually
    - Three dimensional kV imaging systems
      - Acceptance/Commissioning/Documentation: 18-36 hours
      - Ongoing support: 100-125 hours annually

Implementation Guidelines

- Required resources
  - Equipment
    - Quality tools **must** provide reliable values of the measured parameters.
      - Image quality
      - Spatial accuracy (scaling)
      - Congruence of imaging and treatment isocenters
      - Accuracy of registration/couch movements
      - Imaging dose
    - Phantoms specifically designed for IGRT are available and, when coupled with automated image analysis tools, can improve efficiency.

Implementation Guidelines

- Required resources
  - Training
    - Training for the operation of the IGRT system must be provided
    - Prior to initial use of IGRT, the treatment team should meet to discuss staff responsibilities, clinical goals and process workflows.
    - Physicist should also review the image acquisition procedures with the therapists and radiation oncologists.

Recommendations

Procedure	Tolerance
Acceptance/Commissioning	
Customer acceptance procedures	-
TPS integration	-
OIS integration	-
Establish routine QA baselines	-
Documentation	-
Daily	
Safety/interlocks	Functional
Imaging-treatment isocenter coincidence (SRS only)	1 mm
Positioning/repositioning (SRS only)	1 mm
Imaging-treatment isocenter coincidence (SBRT only)	2 mm
Positioning/repositioning (SBRT only)	2 mm
Weekly	
Imaging-treatment isocenter coincidence (non-SRS/SBRT)	2 mm
Positioning/repositioning (non-SRS/SBRT)	2 mm

Recommendations

Semi-Annually	
Image scaling	2 mm
Annually	
Imaging dose	
2D MV	± 1 cGy of acceptance value
2D kV (static imaging mode)	± 3.0 mGy of acceptance value
2D kV (fluoroscopy mode)	± 1 cGy/min of acceptance value
All 3D imaging modes	± 1 cGy of acceptance value
Image quality	
2D (spatial resolution, contrast)	Acceptance value
3D (uniformity, spatial resolution, contrast)	
Upgrade/Repair/Service	
Verify / Re-establish QA baselines (as appropriate)	-

450 Abbreviations: SRS = stereotactic radiosurgery, SBRT = stereotactic body radiation therapy

Recommendations

- "Acceptance value"
  - refers to the IGRT system manufacturer's minimum performance standard stated in the customer acceptance procedure documentation.
  - If unavailable or not specified, then "acceptance value" can be taken as the value measured at the time of commissioning.
    - Most IGRT system manufacturers have stated performance specifications for image quality and, in such cases; those may serve as the tolerance values for routine QA measurements of image quality.
    - Some IGRT system manufacturers do not have stated performance specifications for imaging dose and, in such cases, the imaging dose measured at the time of commissioning may serve as the baseline value to which future measurements are compared.

Recommendations

- In general, the frequency of routine QA tests is proportional to the importance of their performance for the purpose of patient alignment
  - imaging-treatment isocenter coincidence, positioning/repositioning are considered critical
  - daily checks of these parameters are preferred, but weekly checks are considered acceptable for IGRT save SRS/SBRT
- Imaging dose
  - measured for at least one (conservative) acquisition technique of each mode of clinical operation.
- Augmented with procedures required by state regulation
- IGRT systems with known recurring problems should be subjected to more frequent QA at the discretion of the QMP.

Process Descriptions

- Sample process description for each required QA task

xxi. Imaging dose (2D kV systems)

Imaging dose from 2D kV systems is most typically characterized using entrance surface air kerma (skin exposure). Measurement equipment used to measure the entrance air kerma includes a calibrated ionization chamber and a phantom. The ionization chamber is placed between the source and the phantom in such a way as to minimize scatter radiation to the ionization chamber. The field size is set to cover the detector. A clinically relevant beam is delivered, and the air kerma rate is calculated for static and fluoroscopic imaging modes, respectively.

Measured imaging dose **should** be documented and its management **should** be approached with the goal of keeping it as low as necessary to achieve clinically useful images. (Time: 15-60 minutes, depending on the number of techniques measured)

Conclusions

- IGRT implementation and QA is challenging
- There are QA elements common to all x-ray based IGRT systems
  - Safety
  - Image quality
  - Geometric fidelity
    - Scaling
    - Treatment-imaging isocenter coincidence
    - Registration/table shifts
  - Dose
- A successful MPPG1 will improve the quality of clinical support for various IGRT strategies

References

- AAPM TG-179: Quality assurance for image-guided therapy utilizing CT-based technologies
- AAPM TG-75: The management of imaging dose during image-guided radiotherapy
- AAPM TG-104: The role of in-room kV X-ray imaging for patient setup and target localization
- AAPM TG-148: QA for helical tomotherapy
- AAPM TG-58: Clinical use of electronic portal imaging
- AAPM TG-135: Quality assurance for robotic radiosurgery
- AAPM TG-142: Quality assurance of medical accelerators
- AAPM TG-111: Comprehensive methodology for the evaluation of radiation dose in x-ray computed tomography
- ACR-ASTRO Practice guideline for image-guided radiation therapy
- AAMD Scope of Practice for a Medical Dosimetrist link: http://www.medicaldosimetry.org/generalinformation/scope.cfm
- ASRT *Radiation Therapy Practice Standards*; Link: http://www.asrt.org/docs/practice-standards/GR11_RT_PS.pdf

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Thank You