Pushing the Frontier of Automation: Applications & Safe Incorporation into Clinical Care
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Outline
- Motivation
- Value of automation
- Automation at different process steps
- Department workflow
- Summary and conclusions
Example Safety Reports

- ASTRO Safety White Paper Series – 2011-2016 on different topics

United Kingdom Report - 2008

Example Safety Reports

Swiss Cheese Model

Marks et al, The challenge of maximizing safety in radiation oncology, PRO, 2011

Hierarchy of Effectiveness

Marks et al, The challenge of maximizing safety in radiation oncology, PRO, 2011
Challenges in Radiation Oncology

Our processes are complex.

Marks et al. PRO, 2012

With RO-ILS – we know where events happen and where discovered

We find events with pre-tx QA review but would prefer to prevent errors or to identify them sooner.

From TG113:
- Physics Practice Standards for Clinical Trials
- Executive Summary JACMP (June 2018)

Incident Reporting related to Imaging: Multiple Pathways

To 2016-Q3: 2544 events with 396 were high priority and reviewed again.

A fault tree analysis was performed:
1. "problematic plan approved for treatment."
2. "wrong shift instructions given to therapists."
3. "wrong shift performed at treatment."

Fault trees were created showing how different errors:

Ezzell et al, PRQI, 2018

QA of Organs at Risk – Leveraging Standardization & Automation

QA of OARs based on historical contours: computers first, then people.

Hui et al, Med Phys, 2018

Manual Delineation:
Tool identified 96% of the simulated errors
Improved the ability of individuals to identify errors.

Hui et al, Med Phys, 2018
Automation to Fabricate Custom Immobilization

Gensheimer et al, PRO 2017

Automation for Treatment Decisions in Precision Medicine

Which modality is best?
How do clinicians incorporate and balance different data sources?
An analytical pipeline approach
Cheng et al, Radiother Oncol, 2016

Mitigating Incidents at the Planning Stage

• Automation of 19 of 33 initial checks led to a 60% decrease in delays at the treatment unit compared to prior to release
• Automation saved 488.8 hours
• Results automatically uploaded to EMR
• Improves quality and efficiency; decreases treatment delays
Covington et al, Plan Checker, JACMP 17, 2016
Mitigating Incidents at the Planning Stage

Data pulled from different systems with automation to highlight information for users.

Holadi and Lu, JACMP, 2014

Safety, efficiency, etc can affect patient outcomes

Ohri et al evaluated patient compliance and found that missed treatments resulted in lower rates of recurrence-free survival.

Ohri et al, IJROBP, 2015

SBRT Planning – Automation to Improve Dose Metrics

↓ Variability with autoplanning
Better target coverage for similar normal tissue sparing.

Galbi et al, Physica Medica, 2018
Knowledge-based planning (KBP) – Automation to improve plan quality

Younge et al, PRO 2018

Pushing the Frontier: Automation enables MLC Tracking

Automation is needed for guiding treatment decisions (beam on/beam off) and for computational analysis

Keall et al, IJROBP 2018

Automation: Delivery of precision medicine in RT

Keall et al, IJROBP 2018

Monitoring toxicity

Does automation deliver a better treatment?
• Identify key data to track
• Look for outliers
• Agree on actions when something is out of tolerance
• Are the tests effective?

Rethinking the QA Paradigm: Improving Efficiency

Automated QA – Standard tests & Automated Analysis

Some tests recommended by AAPM TG42 Klein et al
13 minutes to deliver test suite
1 minute to analyze
Initial consortium was 8 institutions in the US and Australia

Automated QA – Trends & Analysis for Exceptions

• A framework has been built to support different QA procedures, drag and drop functionality and automated analysis

Estimate of Current Linac QA Efforts

Future States for Linac QA Efforts

Performing tests
Assigning tests
Learning and improving tests
Time for other work

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Automation for Linac QA

Mean, upper and lower control limits
Enable ongoing quantitative evaluation of QA test results

Automation for Workflow & Process Improvements

We want real-time quality control...if the system cannot be designed to prevent certain incorrect tasks by a user.
Automate communication, testing


Automation cannot do it all – Kapur et al

- Effort targeted an overprocessing and safety defect.
  - Suboptimal systems integration of a patient collision detection system...leading to spurious alerts and thus a need for an override by the therapist.
- Alert and override fatigue resulted in a therapist missing a true alert that caused a collision. Annually, performing these overrides...an estimated 2.6 weeks per machine.
- The proposed solution was to turn off the collision detection system in lieu of a peer-reviewed dry run...rather than overreliance on automation to eliminate this defect. No collisions have been reported since this change was made.

Kapur et al, PRO 2017
Summary and Conclusions

- Automation can be applied to any part of the radiation therapy process.
- Incident reporting systems, such as RO-ILS, can help us identify processes where automation can support quality.
- The appropriate inspection may steps may be needed to ensure accurate results from automation.
- To push the frontiers of precision medicine, both real-time and offline automation may be of value.
- Automation of quality control steps can enable lead to efficiencies allowing for advances in clinical practice and clinical trials (KBP).

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Other Organizations and References

- DICOM 7 Working Group
- IEC 62083 – manufacturer efforts
- Radiation Oncology – Safety Stakeholders Initiative (RO-SSI) – ongoing discussions on how to encourage more communication between users, manufacturers, and those developing standards
  - Feel free to join! http://info.radonssi.org/about
- ASTRO White Papers on Safety
- ASTRO Safety is No Accident
  - https://www.astro.org/Clinical-Practice/Patient-Safety/Blue-Book/tabid/10795
- RO-ILS quarterly and annual reports