(Regulatory) Science and the Medical Physicist

Joint Council Symposium: Science and the Medical Physicist

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Office of Science and Engineering Laboratories
Center for Devices and Radiological Health
US Food and Drug Administration
Outline

1. Regulatory science at FDA
2. Priorities
3. Predicting clinical performance: phantoms for system evaluation
4. Big data: evaluation of AI imaging devices
5. In silico trials: the VICTRE project
6. Standards
Regulatory science at FDA

Development of methods and tools to assess the safety, efficacy, quality, and performance of FDA-regulated products.

1. Identify priorities for new research for continued mission success
2. Prepare for tomorrow’s challenges
3. Ensure decisions are scientifically sound, least-burdensome, and contribute to public health
4. Highly multidisciplinary (engineering, medicine, chemistry, toxicology, statistics and social sciences)
1800 Employees
18k Medical Device Manufacturers
190k Medical Devices On the U.S. Market

22k/year Premarket Submissions includes supplements and amendments
570k Proprietary Brands
1.4 MILLION/year Reports on medical device adverse events and malfunctions
21k Medical Device Facilities Worldwide
Regulatory science and the medical physics (imaging)
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FY 2017 Regulatory Science Priorities

- Big Data
- Biocompatibility
- Real-World Evidence
- Clinical Trial Design
- Digital Health and Cybersecurity
- Computational Modeling
- Infection Control
- Patient Input
- Predicting Clinical Performance
- Precision Medicine and Biomarkers
Big Data
Biocompatibility
Real-World Evidence
Clinical Trial Design
Computational Modeling
Digital Health and Cybersecurity
Infection Control
Patient Input
Predicting Clinical Performance
Precision Medicine and Biomarkers
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1. Regulatory science at FDA
2. Priorities
3. **Predicting clinical performance**: phantoms for system evaluation
4. **Big data**: evaluation of AI imaging devices
5. **In silico trials**: the VICTRE project
6. Standards
Fabricating Anthropomorphic Breast Phantoms Using Inkjet Printing
(Ikejimba et al, Med Phys 2017)

Adapted from talk by Steve Glick.
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Evaluation of AI in imaging devices

Denoising low-dose images - Artifact reduction - k-space interpolation - Faster and sparse recon

It looks good to me.

How confident are you that the enhancement on the image really exists inside the patient?

► Subjective evaluations are meaningless.
► We need to measure how much information images depict about patients.
► How well can human or machine readers diagnose, measure lesion volume, or detect lesions?

Adapted from talk by Frank Samuelson.
Evaluation of AI in imaging devices

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Adapted from talk by Frank Samuelson.
Facilitating training and testing by data augmentation

Augment datasets with insertion of lesions extracted from patient images into normal cases.¹

High-throughput truth annotation of large datasets

eeDap: An evaluation platform for digital and analog pathology evaluation.

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model
FDA viewpoint

“In the future, computer-based modeling may change the way we think about device validation . . . allowing for much smaller clinical trials, or may change the way we think about running trials, in that some ‘clinical’ information may be derived from simulations.”


However, barriers remain . . .

How can we stimulate or speed up adoption of in silico trials while ensuring scientifically sound regulatory decisions?

mdic.org/computer-modeling/.
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How to increase the role of in silico trials?

Why subject humans to clinical trials when we can reach the same regulatory decision with in silico trials?

Note: No actual data was collected to inform this prediction. A TPLC, least-burdensome approach is sought as opposed to increased requirements. The question of whether or not traditional trials will in the future be needed at all is philosophical and beyond the scope of this presentation.
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- How to increase the role of *in silico* trials?
- Why subject humans to clinical trials when we can reach the same regulatory decision with *in silico* trials?
Imaging clinical trials for regulatory evaluation
A premarket imaging clinical study (P140011)

- 400+ women double-exposed
- Some biopsied (follow-up as truth)
- Screening population

- DM/DBT imaging systems

- 30+ radiologists
- 6+ clinical sites
- 6+ years
In silico imaging trial

- Unlimited subjects based on procedural models
- State-of-the-art Monte Carlo x-ray transport
- Computer image interpretation
What is the research program VICTRE?

VICTRE aims at demonstrating that computational modeling can play an increasingly predominant role in the regulatory assessment of imaging products. See talk by Dr. Badal (TU-AB-202-3).

Why?

▶ Expensive and lengthy clinical trials delay regulatory evaluation.

▶ This burden can stifle innovation affecting patient access to novel, high-quality imaging technologies.

How?

Before: incremental development and validation.

VICTRE: *in silico* replication of an existing clinical trial\(^a\) with demonstration of savings and benefits for stakeholders.

\(^a\)P140011: Comparative trial in summary of safety and effectiveness.
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Consensus development

Role of standards

- Actively supports international and national standards
- CDRH liaisons to 29+ IEC/ISO TCs and participates in 400+ WGs in 20+ organizations
- CDRH has 1000+ recognized standards

AAPM leadership participation

- AAPM/TG196: display color
- AAPM/TG270: display QC
- AAPM/TG260: handheld displays
- AAPM/TSC: Tomosynthesis
- AAPM/TG245
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the end