2019 IMAGING INFORMATICS SUMMIT

October 5, 2019

Update on Regulatory and Reimbursement Challenges with AI:

Fostering Public Private Partnerships to Facilitate AI Development and Deployment in Clinical Practice

Bibb Allen, Jr. MD FACR

Chief Medical Officer, American College of Radiology Data Science Institute

Grandview Medical Center

Birmingham, Alabama

WASHINGTON

OCTOBER 5–6, 2019

Ronald Reagan Building/
International Trade Center
Washington, DC

FDA U.S. FOOD & DRUG ADMINISTRATION

DATA SCIENCE INSTITUTE™
AMERICAN COLLEGE OF RADIOLOGY

Brandon Gallas, PhD
Research Physicist and Mathematician, Division of Imaging, Diagnostics, and Software Reliability, FDA

Jennifer Segui
Lead Medical Device Reviewer
Division of Radiological Health
FDA

No Commercial Conflicts Of Interest

Neither I nor my immediate family have a financial relationship with a commercial organization that may have a direct or indirect interest in the content of this presentation

DATA SCIENCE INSTITUTE™
AMERICAN COLLEGE OF RADIOLOGY

ACR®

Making imaging safe, effective and accessible to those who need it.

36K
members

75+
years

Core Purpose

To serve patients and society by empowering members to advance the practice, science, and professions of radiological care.

© 2017 | DATA SCIENCE INSTITUTE™: AMERICAN COLLEGE OF RADIOLOGY | ALL RIGHTS RESERVED.

© 2017 | DATA SCIENCE INSTITUTE™: AMERICAN COLLEGE OF RADIOLOGY | ALL RIGHTS RESERVED.

ACR Strategic Plan

MISSION

Radiology professionals consistently employ best radiological practices throughout the continuum of disease detection, diagnostic evaluation, and therapeutic care.

Objectives:

1. Establish radiology professionals as stewards of the patient's entire radiological care experience.
2. Increase the range and application of tools available to radiology professionals to facilitate patient centered care.

© 2017 | DATA SCIENCE INSTITUTE™: AMERICAN COLLEGE OF RADIOLOGY | ALL RIGHTS RESERVED.

ACR Strategic Plan

Facilitate future practice innovations through research and education for the benefit of patient care and population health.

Objectives:

1. Foster clinical innovations to advance radiology's value in patient care.
2. Enhance opportunities for IT and informatics innovations.

© 2017 | DATA SCIENCE INSTITUTE™: AMERICAN COLLEGE OF RADIOLOGY | ALL RIGHTS RESERVED.

ACR Strategic Plan

Advance data science as core to clinically relevant, safe and effective radiologic care

Objectives:

1. Establish the ACR as a global leader in advancing appropriate data science solutions.
2. Facilitate the development of AI solutions that are free of unintentional bias.
3. Develop external relationships that support and extend the ACR's data science goals.

© 2017 | DATA SCIENCE INSTITUTE™: AMERICAN COLLEGE OF RADIOLOGY | ALL RIGHTS RESERVED.

© 2017 | DATA SCIENCE INSTITUTE™: AMERICAN COLLEGE OF RADIOLOGY | ALL RIGHTS RESERVED.

Resources

Economics

CPT Coding

Valuation Of Physician Services and Practice Expense

MACRA Metrics And Payment Models

Government Relations

Congress

CMS

FDA

Quality And Safety

Appropriateness Criteria

Technical Standards And Practice Parameters

Accreditation

Informatics

Technology Standards - DICOM

Clinical Decision Support

Computer Assisted Reporting

© 2017 | DATA SCIENCE INSTITUTE™: AMERICAN COLLEGE OF RADIOLOGY | ALL RIGHTS RESERVED.

© 2017 | DATA SCIENCE INSTITUTE™: AMERICAN COLLEGE OF RADIOLOGY | ALL RIGHTS RESERVED.

INFRASTRUCTURE

TRIAD® ACR IMAGE AND INFORMATION EXCHANGE

ACRdart™

ACRcommon™

ACRselect

ACRassist™

NRDR™ NATIONAL RADIOLOGY DATA REGISTRY AMERICAN COLLEGE OF RADIOLOGY

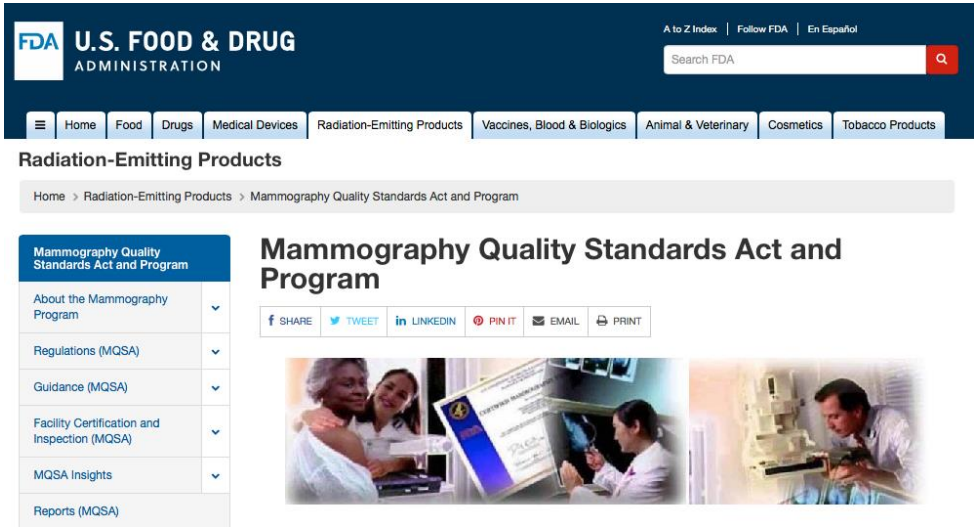
ACR CRI CENTER for RESEARCH and INNOVATION®

© 2017 | DATA SCIENCE INSTITUTE™: AMERICAN COLLEGE OF RADIOLOGY | ALL RIGHTS RESERVED.

Trusted Relationships
Public Private Partnerships

© 2017 | DATA SCIENCE INSTITUTE™: AMERICAN COLLEGE OF RADIOLOGY | ALL RIGHTS RESERVED.

ACR – FDA And Governmental Agency Collaborations To Benefit Patients And The Public



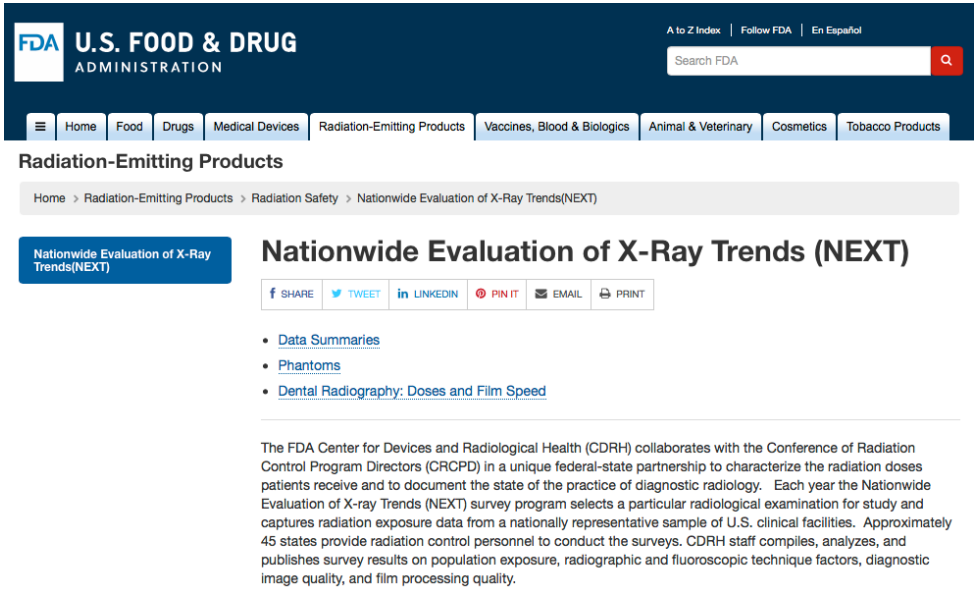
MAMMOGRAPHY QUALITY STANDARDS ACT OF 1992:

- Implemented in 1994
- Ensures safe practice of mammography
- Built on the ACR Mammography Accreditation program
- ACR still the only accrediting body for the FDA

The Mammography Quality Standards Act requires mammography facilities across the nation to meet uniform quality standards. Congress passed this law in 1992 to assure high-quality mammography for early breast cancer detection, which can lead to early treatment, a range of treatment options leading to an increased chance of survival. Under the law, **all mammography facilities must: 1) be accredited by an FDA-approved accreditation body, 2) be certified by FDA, or its State, as meeting the standards, 3) undergo an annual MQSA inspection, and 4) prominently display the certificate issued by the agency**

© 2017 | DATA SCIENCE INSTITUTE™: AMERICAN COLLEGE OF RADIOLOGY | ALL RIGHTS RESERVED.

ACR – FDA And Governmental Agency Collaborations To Benefit Patients And The Public



RADIATION SAFETY

- Educational workshops with the FDA
- Member education through dissemination of FDA information
- Support for NEXT

image gently®

IMAGE WISELY®
Radiation Safety in Adult Medical Imaging

NRDR DIR™
Dose Index Registry
American College of Radiology

© 2017 | DATA SCIENCE INSTITUTE™: AMERICAN COLLEGE OF RADIOLOGY | ALL RIGHTS RESERVED.

NIH NATIONAL CANCER INSTITUTE
DCTD Division of Cancer Treatment & Diagnosis

ACR CRI CENTER for RESEARCH and INNOVATION™

ECOG-ACRIN cancer research group
Reshaping the future of patient care

IROC™
IMAGING AND RADIATION ONCOLOGY CORE
Global Leaders in Clinical Trial Quality Assurance

NRG ONCOLOGY
Advancing Research. Improving Lives.™

ACR Coordination Of Multicenter Clinical Research

- **Spans almost 50 years**
  - Over 500 clinical trials
  - 2 million images processed annually
- **Established research infrastructure in Philadelphia**
  - > 130 full time researchers on staff
  - Distributed staff and technology
  - Central and decentralized [on prem] interpretation and analysis

© 2017 | DATA SCIENCE INSTITUTE™: AMERICAN COLLEGE OF RADIOLOGY | ALL RIGHTS RESERVED.

ACR Assets For Public Private Partnerships

The ACR "Research to Clinical Practice" Value Chain

© 2017 | DATA SCIENCE INSTITUTE™: AMERICAN COLLEGE OF RADIOLOGY | ALL RIGHTS RESERVED.

FDA Discussion Paper on Continuously Learning Algorithms and the FDA Software Precertification Program

DATA SCIENCE INSTITUTE™
AMERICAN COLLEGE OF RADIOLOGY

Define-AI

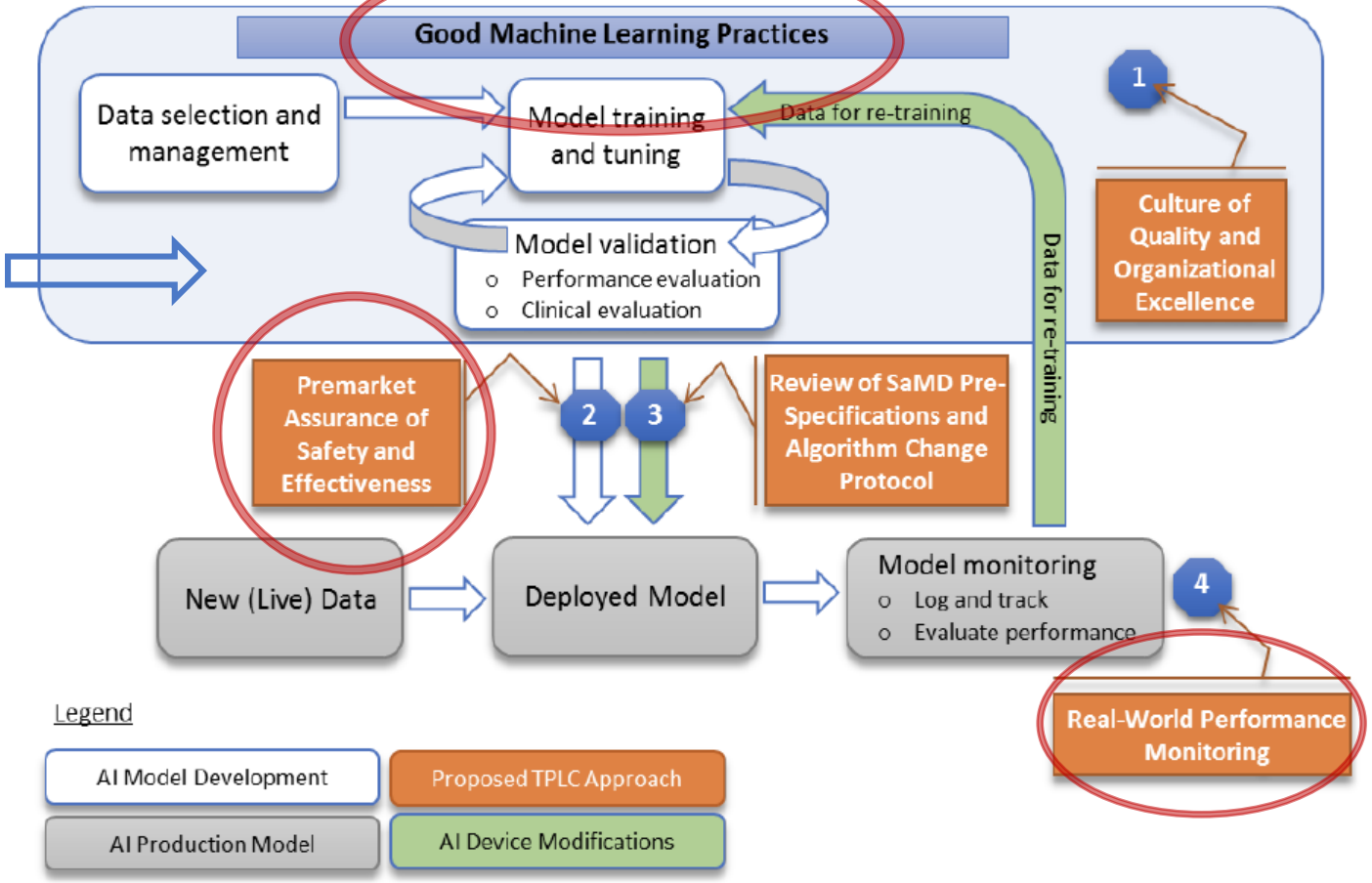


Figure 2: Overlay of FDA's TPLC approach on AI/ML workflow

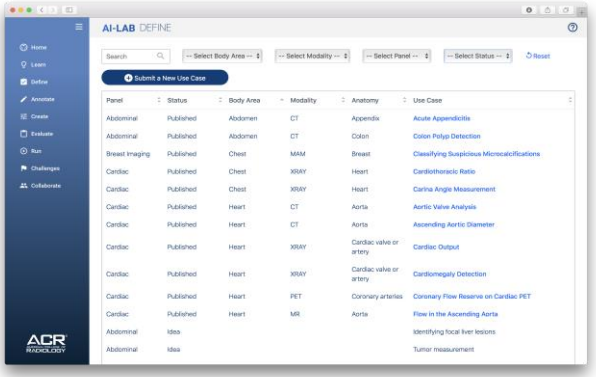
“Good Machine Learning Practices”

Structured AI Use Cases

- Standardized inputs and outputs
- Common data elements
- Defined pathways for clinical integration

DATA SCIENCE INSTITUTE™
AMERICAN COLLEGE OF RADIOLOGY

Define-AI



© 2017 | DATA SCIENCE INSTITUTE™: AMERICAN COLLEGE OF RADIOLOGY | ALL RIGHTS RESERVED.

FDA Discussion Paper on Continuously Learning Algorithms and the FDA Software Precertification Program

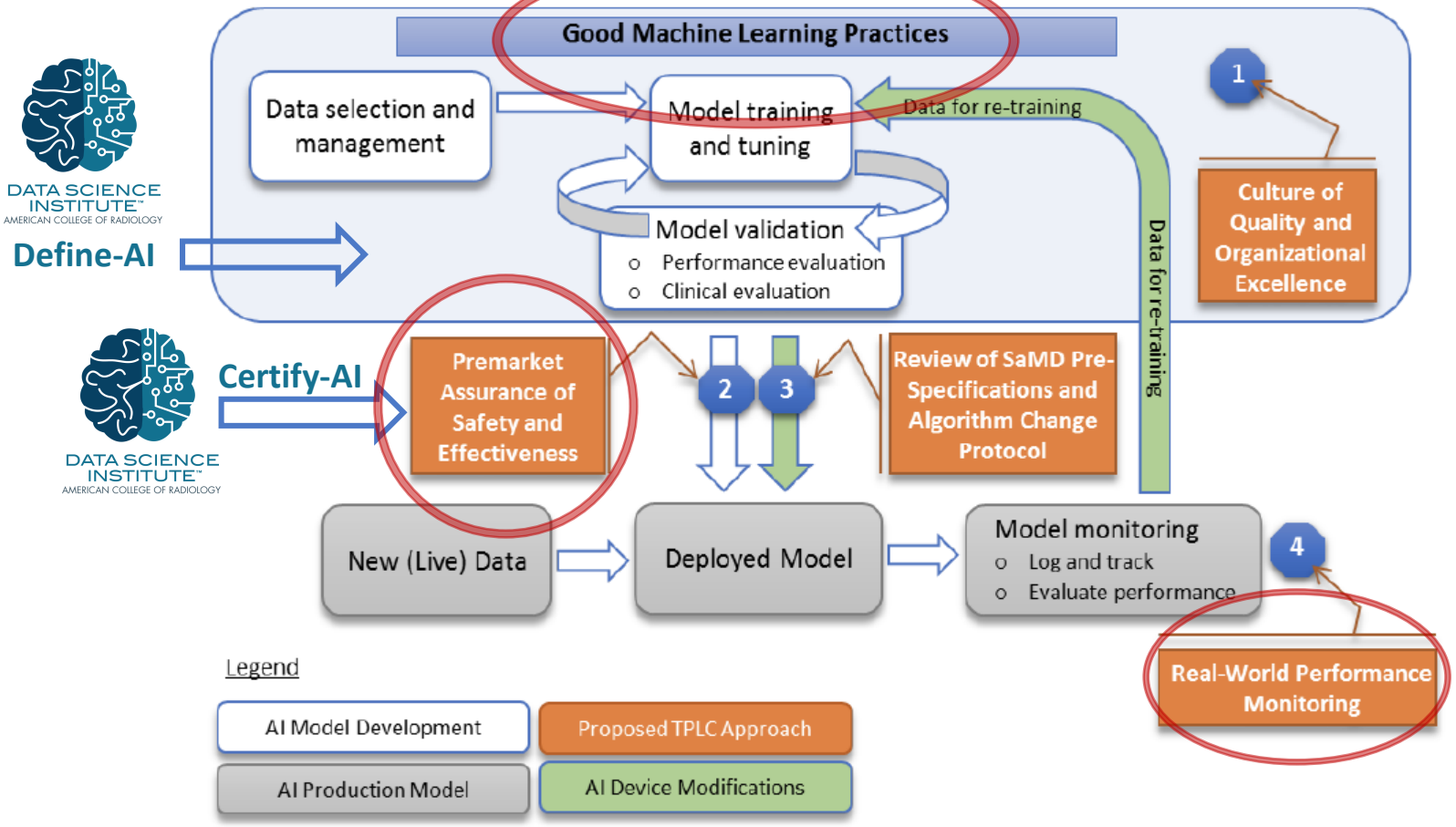


Figure 2: Overlay of FDA's TPLC approach on AI/ML workflow

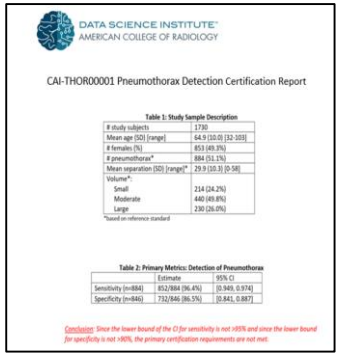
“Premarket Assurance of Safety and Effectiveness”

Algorithm Validation

- Diverse validation data sets
  - Multiple institutions
  - Diverse patient demographics
  - Diverse imaging equipment
- Built according to the use case
- Reasonable costs for developers as compared to reader studies
- Access to diverse data for validation

DATA SCIENCE INSTITUTE™
AMERICAN COLLEGE OF RADIOLOGY

Certify-AI


DATA SCIENCE INSTITUTE™
AMERICAN COLLEGE OF RADIOLOGY

CAI-THOR00001 Pneumothorax Detection Certification Report

Table 1: Study Sample Description

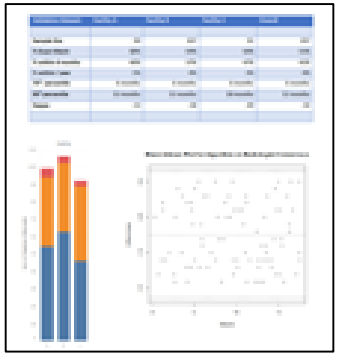
# study subjects	1730
Mean age (SD) [range]	64.9 (10.0) [32-103]
# females (%)	853 (49.3%)
# pneumothorax*	884 (51.1%)
Mean separation (SD) [range]*	29.9 (10.3) [0-58]
Volume*:	
Small	214 (24.2%)
Moderate	440 (49.8%)
Large	230 (26.0%)

*based on reference standard

Table 2: Primary Metrics: Detection of Pneumothorax

	Estimate	95% CI
Sensitivity (n=884)	852/884 (96.4%)	[0.949, 0.974]
Specificity (n=846)	732/846 (86.5%)	[0.841, 0.887]

Conclusion: Since the lower bound of the CI for sensitivity is not >95% and since the lower bound for specificity is not >90%, the primary certification requirements are not met.

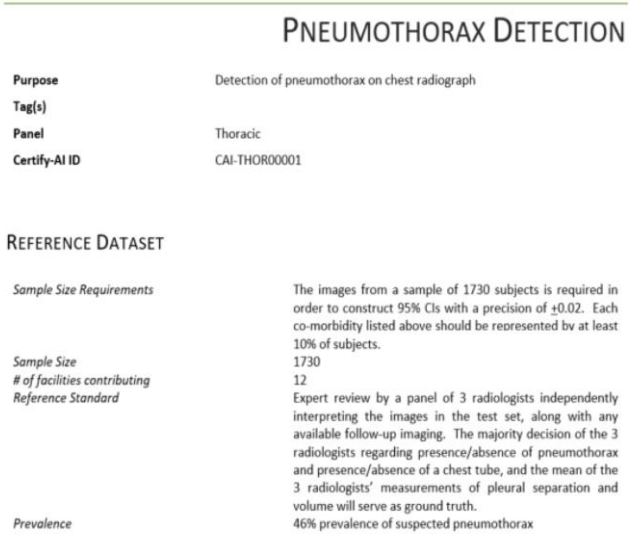


© 2017 | DATA SCIENCE INSTITUTE™: AMERICAN COLLEGE OF RADIOLOGY | ALL RIGHTS RESERVED.

"Premarket Assurance of Safety and Effectiveness"

FDA MDDT Program

- "The FDA's Medical Device Development Tools (MDDT) program is a way for the FDA to qualify tools that medical device sponsors can use in the development and evaluation of medical devices"
- "Qualification means that the FDA has evaluated the tool and concurs with available supporting evidence that the tool produces scientifically-plausible measurements and works as intended within the specified context of use"



PNEUMOTHORAX DETECTION

Purpose	Detection of pneumothorax on chest radiograph
Tag(s)	
Panel	Thoracic
Certify-AI ID	CAI-THOR00001

REFERENCE DATASET

Sample Size Requirements	The images from a sample of 1730 subjects is required in order to construct 95% CIs with a precision of ±0.02. Each co-morbidity listed above should be represented by at least 10% of subjects.
Sample Size	1730
# of facilities contributing	12
Reference Standard	Expert review by a panel of 3 radiologists independently interpreting the images in the test set, along with any available follow-up imaging. The majority decision of the 3 radiologists regarding presence/absence of pneumothorax and presence/absence of a chest tube, and the mean of the 3 radiologists' measurements of pleural separation and volume will serve as ground truth.
Prevalence	46% prevalence of suspected pneumothorax

FDA – ACR MDDT Demonstration

© 2017 | DATA SCIENCE INSTITUTE™: AMERICAN COLLEGE OF RADIOLOGY | ALL RIGHTS RESERVED.

"Premarket Assurance of Safety and Effectiveness"

SENSITIVITY:

Sensitivity will be estimated as the proportion of images classified by the AI device as 1=Pneumothorax present or 2=Undetermined among all cases determined as having suspicious pneumothorax by the expert panel. A 95% CI will be constructed for sensitivity. Sensitivity will also be estimated, and 95% CIs constructed, for all subgroups of patients.

ACCEPTANCE CRITERIA:

Lower bound for the 95% CI for sensitivity must be ≥0.95

SPECIFICITY:

Specificity will be estimated as the proportion of images classified by the AI device as 0=Pneumothorax absent among all cases determined as having no suspicious pneumothorax by the expert panel. A 95% CI will be constructed for specificity. Specificity will also be estimated, and 95% CIs constructed, for all subgroups of patients.

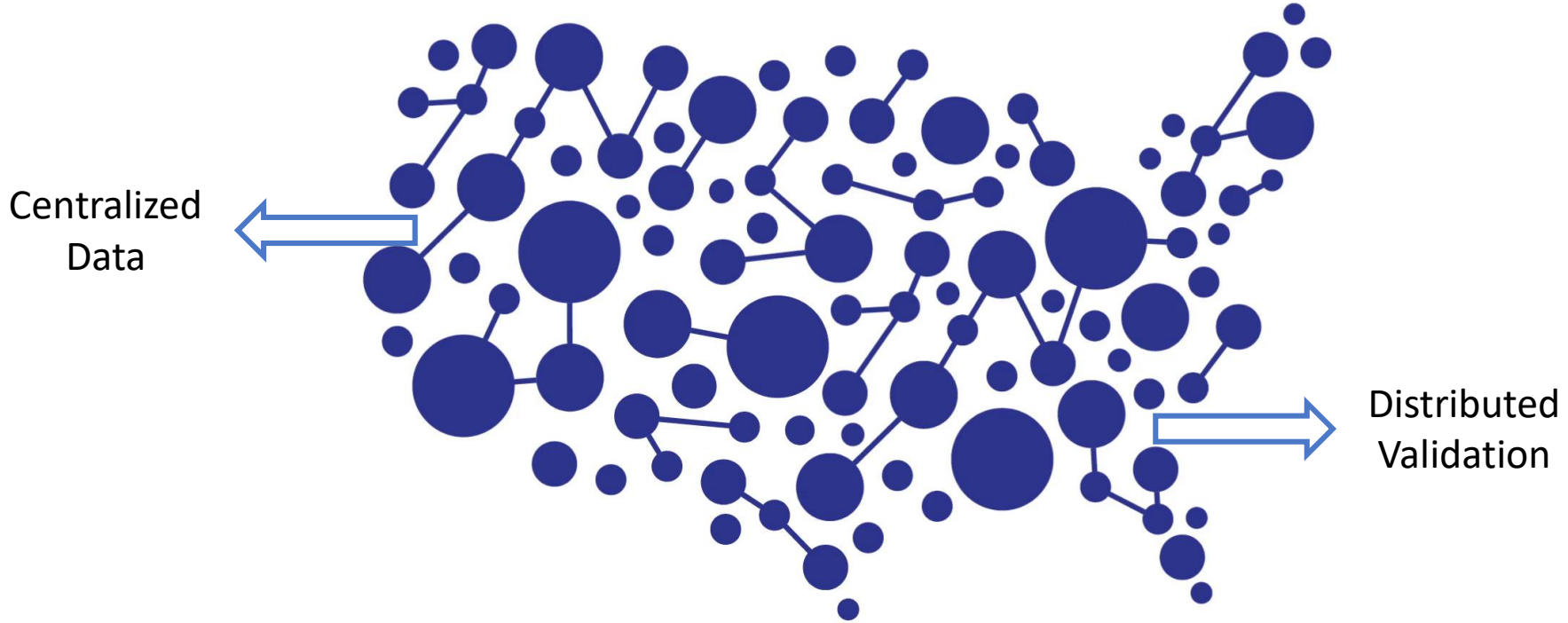
ACCEPTANCE CRITERIA:

Lower bound for the 95% CI for specificity must be ≥0.90

Sources of Variability:

Female Sex at Birth	45%
Age	[35, 87]
Chest Trauma	15%
pleural fluid	13%
lung disease	14%
pneumomediastinum	10%
other extrapleural	14%
Lung Tissue Involvement	15%
Chest Tube	10%
Tension Pneumothorax	20%
Shadow	15%

© 2017 | DATA SCIENCE INSTITUTE™: AMERICAN COLLEGE OF RA



© 2017 | DATA SCIENCE INSTITUTE™: AMERI

GEOGRAPHIC AND TECHNICAL DIVERSITY IN VALIDATION DATASETS

Reader Studies To Distributed Validation

FDA – ACR MDDT Demonstration

© 2017 | DATA SCIENCE INSTITUTE™: AMERICAN COLLEGE OF RADIOLOGY | ALL RIGHTS RESERVED.

Process for Establishing Performance of an AI Algorithm

Step	Description	MDDT Tool	Pneumothorax Example
1	Define the use case, specifying the trigger, the measure and, and the clinical context	Define-AI	Presence or absence of Pneumothorax
2	Identify sources of variability in the algorithm's measurements	Define-AI	TAI-THOR0000118
3	Determine the performance metrics critical to the specific clinical role	Certify-AI	CIs for sensitivity and specificity
4	Identify the reference data set for evaluation	Certify-AI	CAI- THOR00001
5	Define the minimum acceptance criteria for the metrics identified in step 3	Certify-AI	Lower bound for sensitivity is >0.95 and the lower bound for specificity is >0.90
6	Test the algorithm's performance using criteria defined in step 5	Certify-AI Report	See example

© 2017 | DATA SCIENCE INSTITUTE™: AMERICAN

Validation Metrics Developed As Part Of Each Use Case

FDA Discussion Paper on Continuously Learning Algorithms and the FDA Software Precertification Program

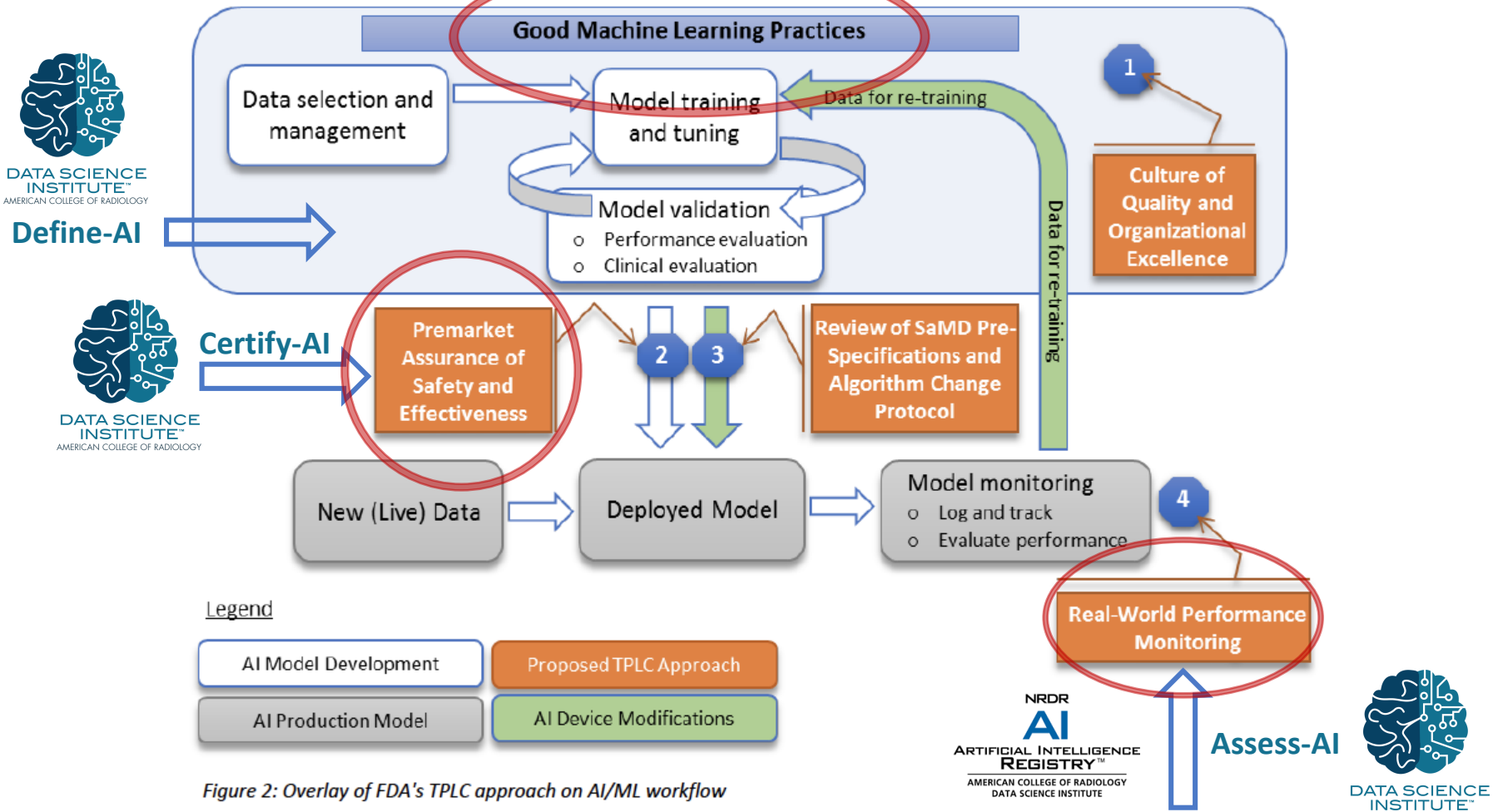
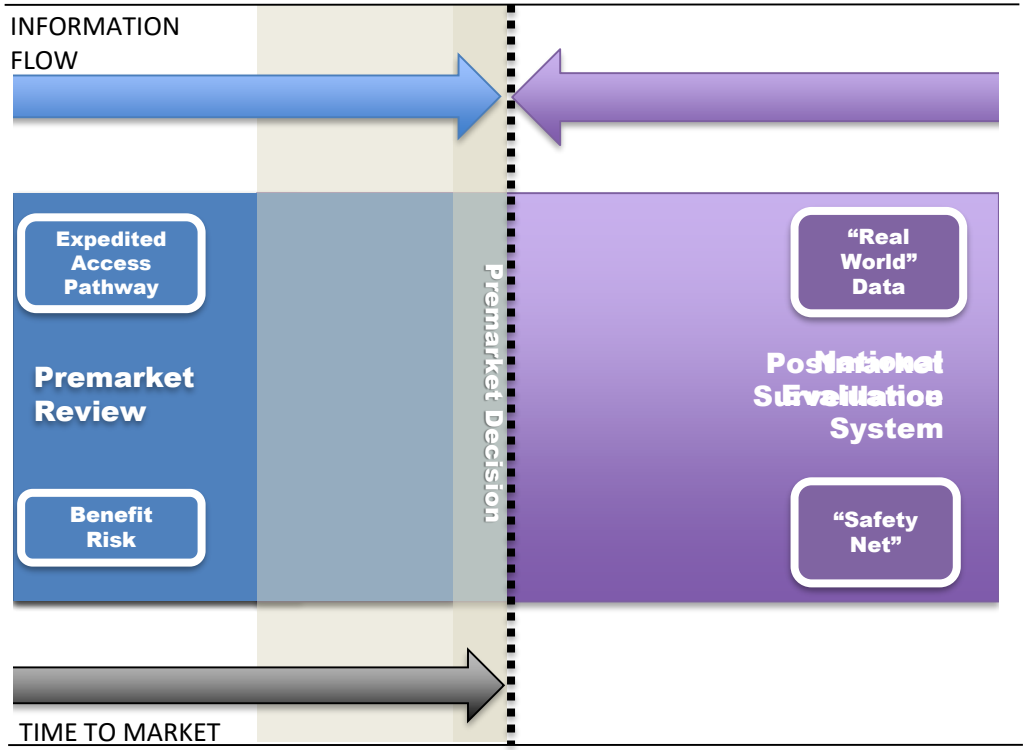


Figure 2: Overlay of FDA's TPLC approach on AI/ML workflow

Enabling The Post-Market Shift



Graphic courtesy of Greg Pappas, Assistant Director FDA NEST

© 2017 | DATA SCIENCE INSTITUTE™: AMERICAN COLLEGE OF RADIOLOGY | ALL RIGHTS RESERVED.

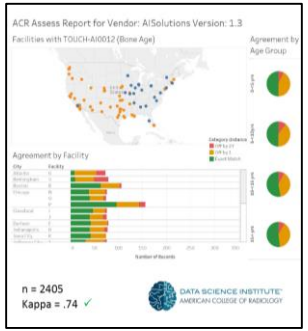
“Real World Performance Monitoring”

Algorithm Monitoring In Clinical Practice

- AI registries
- Capture algorithm performance from practicing radiologists
- Capture meta-data about the examination
- Feedback to developers / FDA
- Working with FDA to capture data

DATA SCIENCE INSTITUTE™
AMERICAN COLLEGE OF RADIOLOGY

Assess-AI



© 2017 | DATA SCIENCE INSTITUTE™: AMERICAN COLLEGE OF RADIOLOGY | ALL RIGHTS RESERVED.

Taking Better Care of Our Patients

© 2017 | DATA SCIENCE INSTITUTE™: AMERICAN COLLEGE OF RADIOLOGY | ALL RIGHTS RESERVED.

DATA SCIENCE INSTITUTE™
AMERICAN COLLEGE OF RADIOLOGY

http://www.acrdsi.org/

Physicians Technologists Industry Data Scientists Informaticists Health Care Execs

Patients

© 2017 | DATA SCIENCE INSTITUTE™: AMERICAN COLLEGE OF RADIOLOGY | ALL RIGHTS RESERVED.