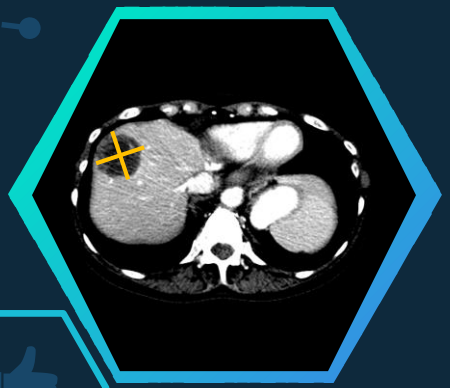


LesionTracker

Open Source Oncology Web Viewer

Funded through NCI ITCR U24 Program

Gordon J. Harris, PhD
Professor of Radiology
Mass General / HMS

ITCR PI Meeting, Boston: June 14, 2016

Tumor Imaging Metrics Core

In 2004, Dana-Farber/Harvard Cancer Center (DF/HCC) investigators were struggling to get reliable, timely, protocol compliant image assessments.

TIMC was created to provide:

Protocol adherence

On time results

Ease of use for staff

Metrics and analytics

Fiscal tracking

Audit support

Overview of TIMC

- Founded in 2004 and co-directed by Drs. Harris and Van den Abbeele at DF/HCC (5 hospitals)
- Approved as NCI Shared Resource in 2006
- Performs over 10,000 clinical image analyses per year
- Manages over 700 active clinical trials
- Self-sustaining through Core chargeback revenue

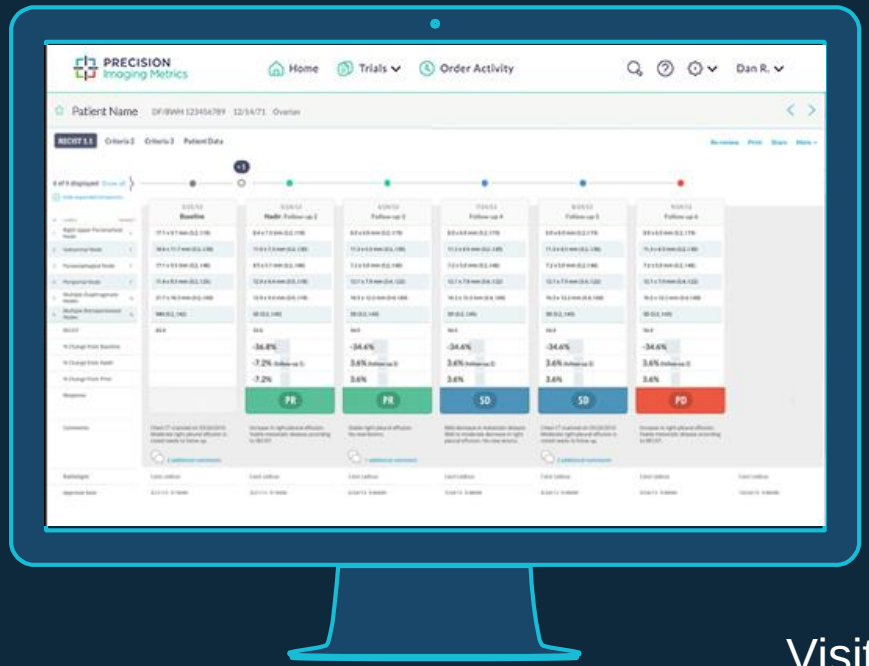
Visit http://www.tumormetrics.org for more information

Need for Clinical Trial Informatics

- Trial requirements are growing in complexity
  - Not just RECIST anymore; over a dozen criteria
  - Modifications to standard criteria are common
- Adequate clinical trial imaging review/reporting tools usually only available to Clinical Research Organizations (CROs)
- Need the ‘right assessment for the right scan at the right time’

Precision Imaging Metrics

System was developed to address the need to manage:



- Trial/patient registration and image assessment requests
- Demanding requirements for turnaround time
- Work lists, results reporting, and protocol compliance
- Communication between radiology and oncology

Visit http://www.precisionmetrics.org

Precision Imaging Metrics:
Participating Sites

DF/HCC
DANA-FARBER / HARVARD CANCER CENTER

Activated Aug 2004

Yale CANCER CENTER

Activated Sept 2013

FRED HUTCHINSON
CANCER RESEARCH CENTER
A LIFE OF SCIENCE

Activated Sept 2014

HUNTSMAN
CANCER INSTITUTE
UNIVERSITY OF UTAH

Activated June 2015

MASSEY
CANCER CENTER

Activated Sept 2015

Metrics Manager

Integrated image application built on open-source PC platform
In use for ~5 years but starting to show its age

Pros

- **Replaced manual measurement entry**
- **Improved efficiencies**
- **Implemented response criteria conformance checks**

Cons

- **Deployment is challenging**
  - **All clients need to be updated for each release**
  - **IT involvement to install software, configure DICOM connections and firewall exceptions**
- **Only compatible with Windows**
- **Must be on hospital network**

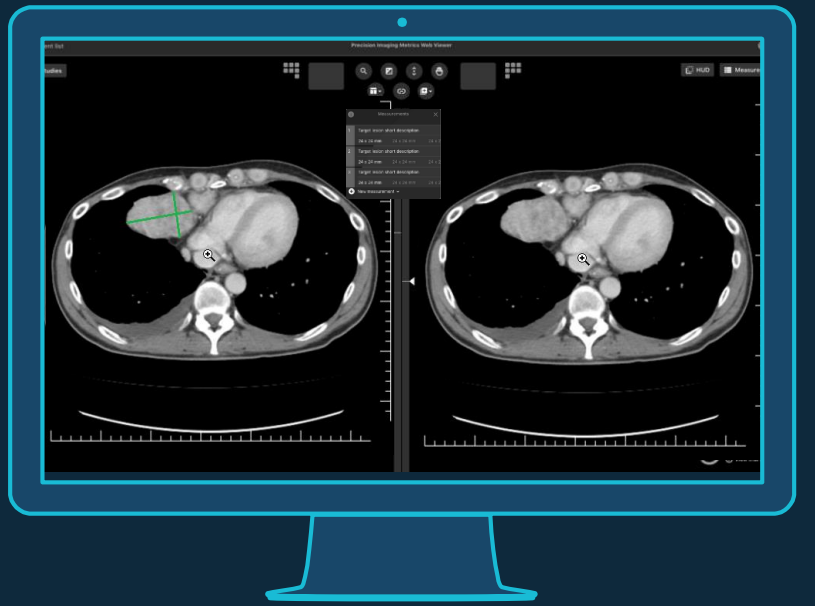
Open Health Imaging Foundation (OHIF)

- Established ~1 year ago as US 501(c)3 non-profit foundation
- Aims to produce enterprise-grade, open-source medical imaging software

Visit http://ohif.org/

LesionTracker

- Quantitative imaging package optimized for oncology clinical trials workflow
- Funded by PAR-13-294 grant for Advanced Development of Informatics Technology (U24)
  - NCI Cooperative Agreement



Visit http://lesiontracker.ohif.org

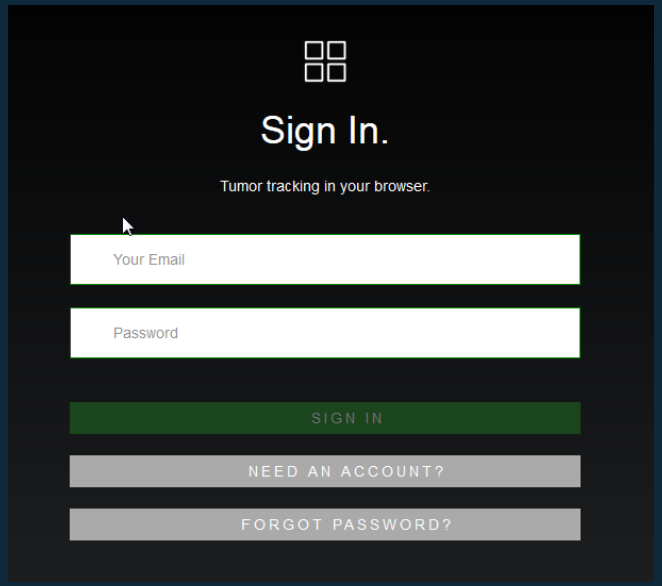
Goals for LesionTracker Grant

Create a vendor-neutral, extensible zero-footprint image viewer for display and oncology analysis of DICOM images

- Zero-footprint: Web-based viewer using HTML5/CSS3/Modern JavaScript
- Secure: Roadmap to be HIPAA and 21CFRPart11 compliant
- Reliable: Implement software best practices and QMS
- State-of-the-art: Performance & functionality expected in modern imaging viewers
- Developer-friendly: Standalone study list and viewer package with API to allow easy integration with third-party sites/software
- Open: Commercially permissive software license (MIT) developed on GitHub with open Jira instance

User Management

Authentication



Audit Trails

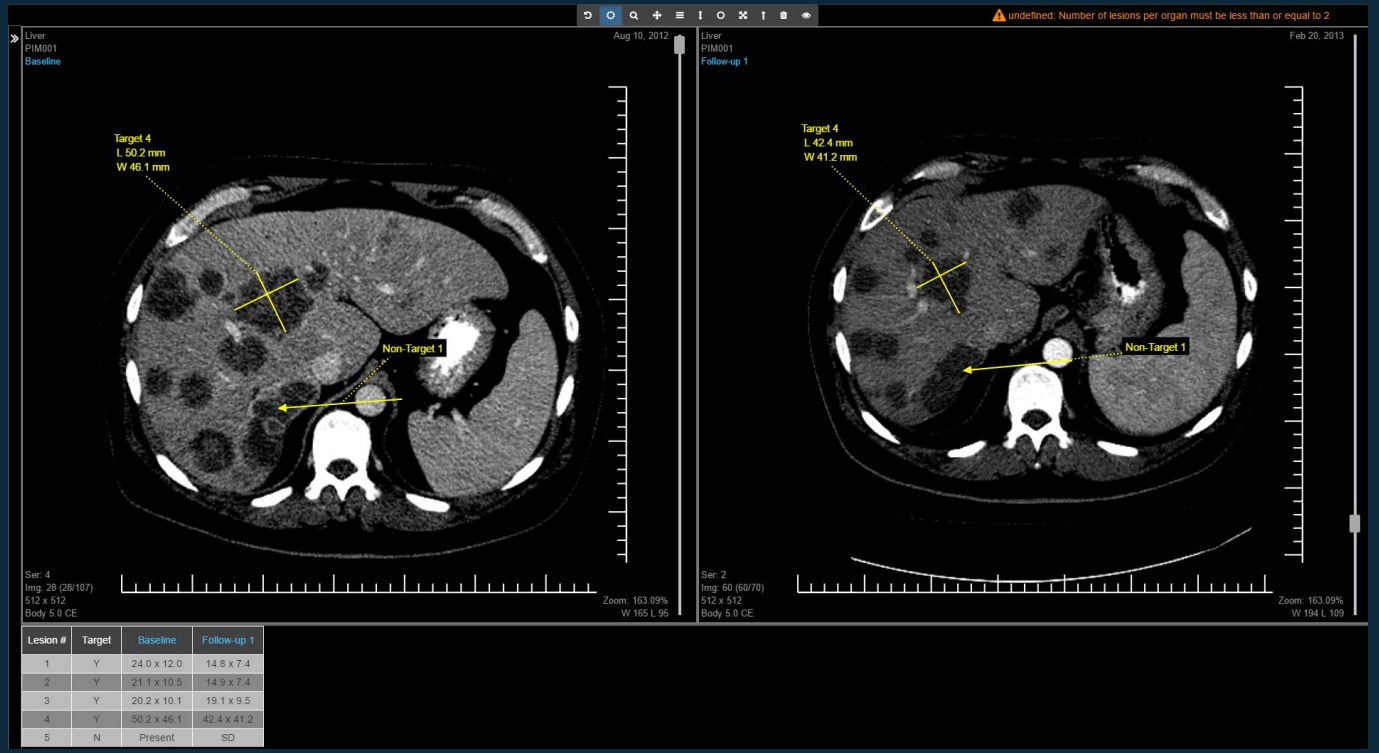
Study List

Study List

Open Health Imaging Foundation

Patient Name	Patient ID	Accession #	Study Date	Modality	Study Description	# Images
Liver	PIM001	3	Aug 10, 2012		6023 CHEST CT W/C	NaN
Liver	PIM001	4	Aug 10, 2012		74177 CT AB/PEL W CON	NaN
Liver	PIM001	5	Feb 20, 2013 (Baseline)		74177 CT AB/PEL W CON	NaN
Liver	PIM001	6	Feb 20, 2013		6023 CHEST CT W/C	NaN
Liver	PIM001	1	Aug 26, 2013		CT005 CT CHEST W CON	NaN
Liver	PIM001	2	Aug 26, 2013		CT192 CT ABD/PEL W/ C	NaN
LiverPelvis	PIM003	3	Oct 1, 2013		74177 CT AB/PEL W CON	NaN
LiverPelvis	PIM003	2	Nov 30, 2013		74177 CT AB/PEL W CON	NaN
Lung	PIM002	1	Nov 28, 2012		CT192 CT ABD/PEL W/ C	NaN
Lung	PIM002	2	Nov 28, 2012		CT005 CT CHEST W CON	NaN
Lung	PIM002	5	Mar 26, 2013		74177 CT AB/PEL W CON	NaN
Lung	PIM002	6	Mar 26, 2013		6023 CHEST CT W/C	NaN
Lung	PIM002	4	Aug 13, 2013		6023 CHEST CT W/C	NaN
Lung	PIM002	3	Aug 13, 2013		74177 CT AB/PEL W CON	NaN
LungLiver	PIM004	1	Aug 17, 2013		Thorax*Chest_Abdomen_Pelvis (Adult)	NaN
LungLiver	PIM004	2	Jan 3, 2014		CT Abdomen/Pelvis W Contrast	NaN
LungLiver	PIM004	3	Apr 22, 2014		Thorax*Chest_Abdomen_Pelvis (Adult)	NaN
LungLiverPelvis	PIM005	2	Jul 15, 2013		Thorax*Chest_Abd_Pelvis (Adult)	NaN
LungLiverPelvis	PIM005	1	Sep 5, 2013		Thorax*Chest_Abd_Pelvis (Adult)	NaN

Image Viewer



Lesion #	Target	Baseline	Follow-up 1
1	Y	24.0 x 12.0	14.8 x 7.4
2	Y	21.1 x 10.5	14.9 x 7.4
3	Y	20.2 x 10.1	19.1 x 9.5
4	Y	50.2 x 46.1	42.4 x 41.2
5	N	Present	SD

Architecture

- dicomParser (https://github.com/chafey/dicomParser): Lightweight library for parsing DICOM P10 byte streams in modern web browsers
- Cornerstone (https://github.com/chafey/cornerstone): JavaScript library to display interactive medical images including but not limited to DICOM
- Meteor (https://www.meteor.com/)
- Full stack JavaScript (i.e. both client/server)
- Reactive UI rendering
- Flexible MongoDB (https://www.mongodb.com): schema-less database for easy development

Clinical Meteor Collaboration

- Set of packages for User Management, Compliance, Form-based trial features
- 21CFRPart11 and HIPAA Compliance is on roadmap
- Verification/Validation testing

http://clinical.meteor.com/

PACS Connection Protocols

To retrieve metadata:

- DICOMWeb: Query based on ID for DICOM Objects (QIDO)
- DICOM message service element (DIMSE) protocol

To retrieve files:

- DICOMWeb: Web Access to DICOM Objects (WADO)
- Developed against Orthanc (http://www.orthanc-server.com)
- Tested with Orthanc and dcm4che (http://www.dcm4che.org)

Roadmap

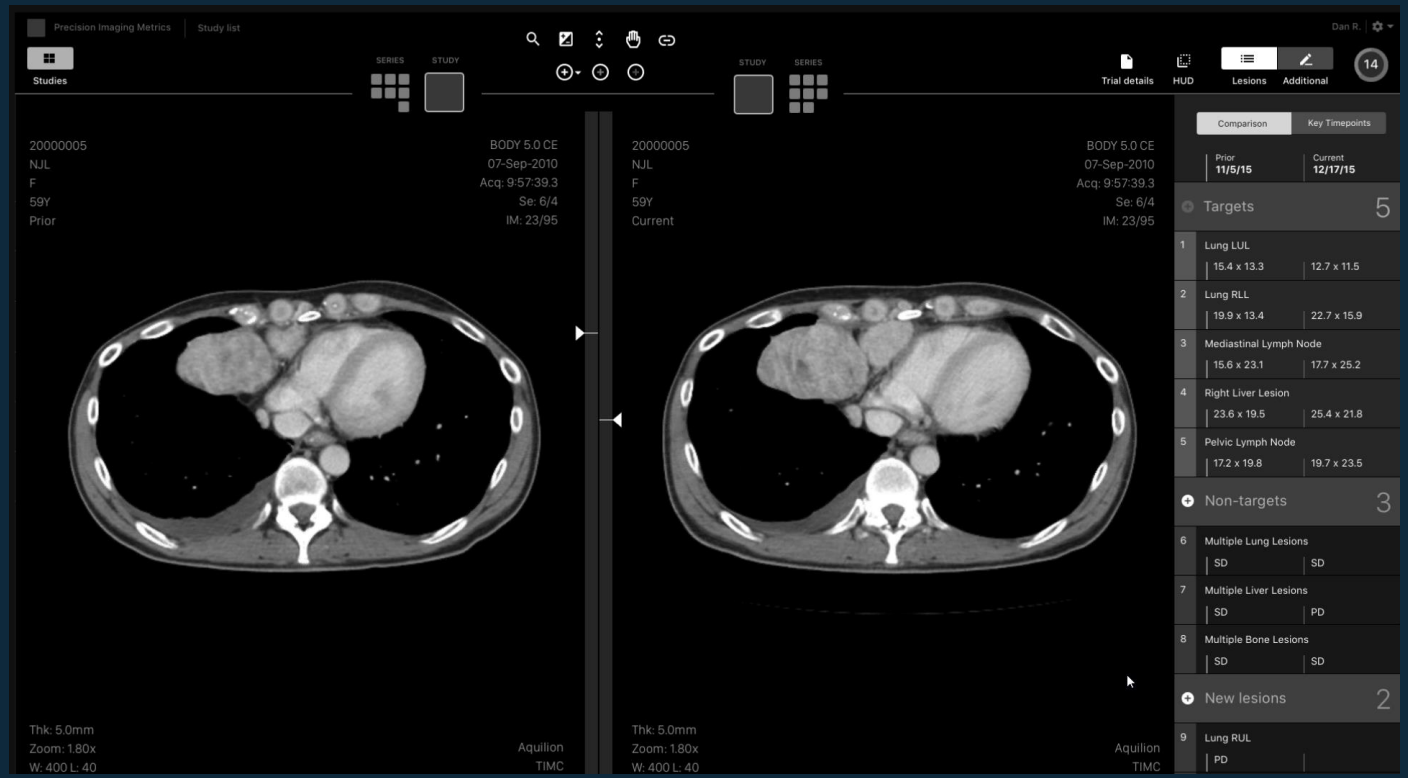
In-Progress

- Hanging Protocol support
- Improved study list
- User Management support

Upcoming

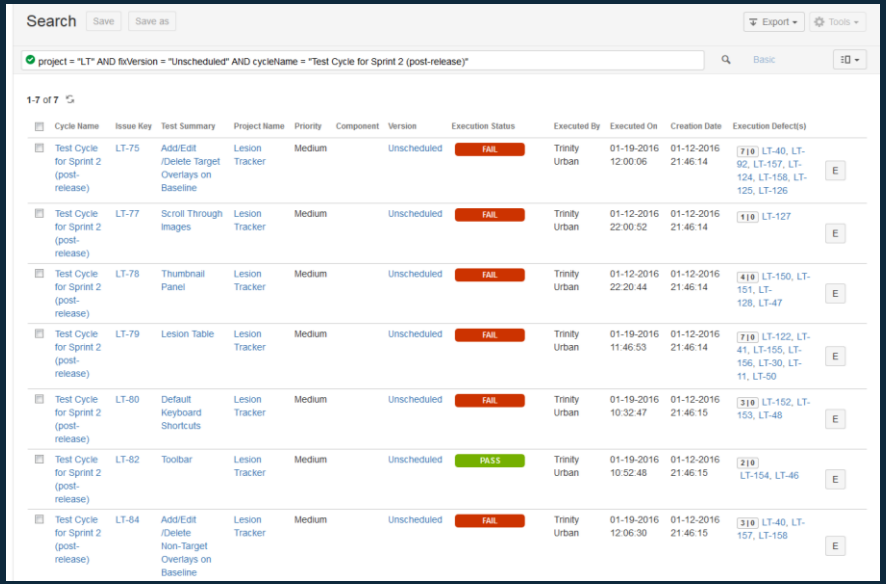
- User Interface Design
- Integration with Slicer
- Improved oncology support
- QMS/Compliance

UI Design


Precision Imaging Metrics
Study list
Dan R.
Studies
SERIES
STUDY
Trial details
HUD
Lesions
Additional
14
20000005
NJL
F
59Y
Prior
BODY 5.0 CE
07-Sep-2010
Acq: 9:57:39.3
Se: 6/4
IM: 23/95
Thk: 5.0mm
Zoom: 1.80x
W: 400 L: 40
Aquilion
TIMC
20000005
NJL
F
59Y
Current
BODY 5.0 CE
07-Sep-2010
Acq: 9:57:39.3
Se: 6/4
IM: 23/95
Thk: 5.0mm
Zoom: 1.80x
W: 400 L: 40
Aquilion
TIMC
Comparison
Key Timepoints
Prior 11/5/15
Current 12/17/15
Targets 5
1 Lung LUL
15.4 x 13.3
12.7 x 11.5
2 Lung RLL
19.9 x 13.4
22.7 x 15.9
3 Mediastinal Lymph Node
15.6 x 23.1
17.7 x 25.2
4 Right Liver Lesion
23.6 x 19.5
25.4 x 21.8
5 Pelvic Lymph Node
17.2 x 19.8
19.7 x 23.5
Non-targets 3
6 Multiple Lung Lesions
SD
SD
7 Multiple Liver Lesions
SD
PD
8 Multiple Bone Lesions
SD
SD
New lesions 2
9 Lung RUL
PD

Compliance

- Jira: Issue Tracking
- Zephyr: Test Management
- Qualio: QMS Software to manage SOPs, approvals, training, etc.
- Risk Management



Integration with 3D Slicer

Benefits:

- Slicer has an extensible plug-in architecture
- Support for vast repository of tools
- Active developer community

Goals:

- Roundtrip Client-Server segmentation
- Server-side 3D rendering

https://www.slicer.org

ITCR / QIN potential collaborations

- QIICR / ePad: DICOM-SR, DICOM-SEG, AIM (Fedorov / Rubin)
- 3D Slicer (Pieper)
- Radiomics (Aerts)
- Pathology (Saltz)
- TCIA (Pryor)
- Challenges (Jayashree)
- XNAT (Marcus)

Team

MGH

- Gordon Harris
- Olga Kulay
- Matt Leary
- Trinity Urban

Collaborators

- Aysel Afsar
- Chris Hafey
- Rob Lewis
- Evren Ozkan
- WeiWei Wu
- Erik Ziegler

Thanks!

Any questions?

You can contact me at gjharris@partners.org