

LesionTracker

Open Source Oncology Web Viewer

Funded through NCI ITCR U24 Program

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Mass General / HMS

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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

A decorative graphic on the left side of the slide consists of several overlapping hexagons in shades of blue and cyan. One hexagon contains a thumbs-up icon, another contains a computer monitor icon, and a magnifying glass icon is positioned below the monitor icon.

Need for Clinical Trial Informatics

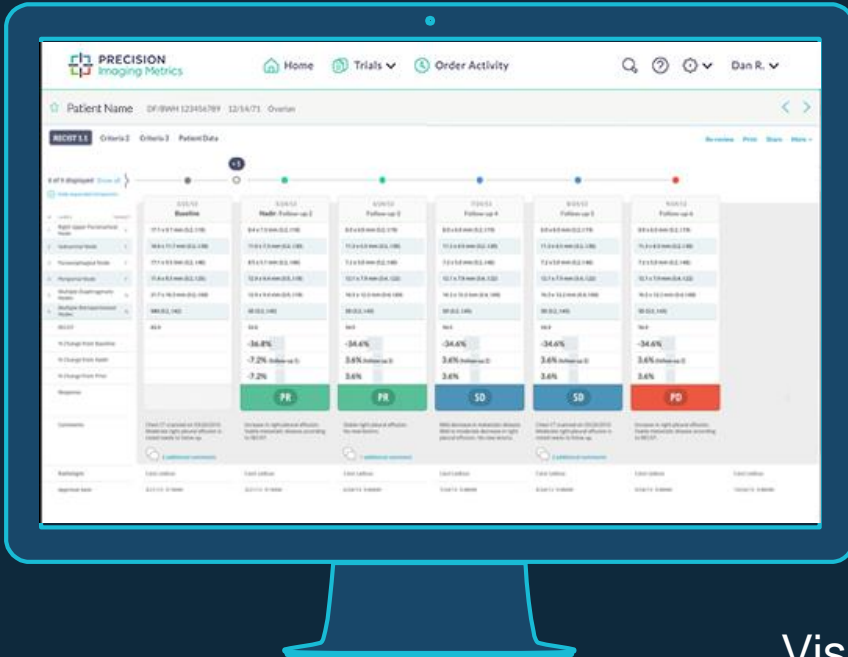
- Trial requirements are growing in complexity
 - Not just RECIST anymore; over a dozen criteria
 - Modifications to standard criteria are common
- Adequate clinical trial imaging review/reporting tools usually only available to Clinical Research Organizations (CROs)
- Need the ‘right assessment for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

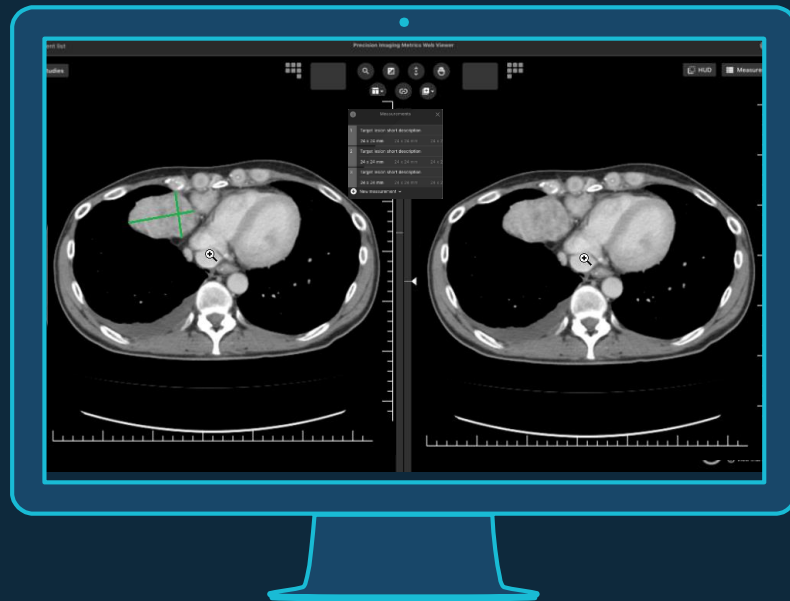
- Established ~1 year ago as US 501(c)3 non-profit foundation
- Aims to produce enterprise-grade, open-source medical imaging software

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>





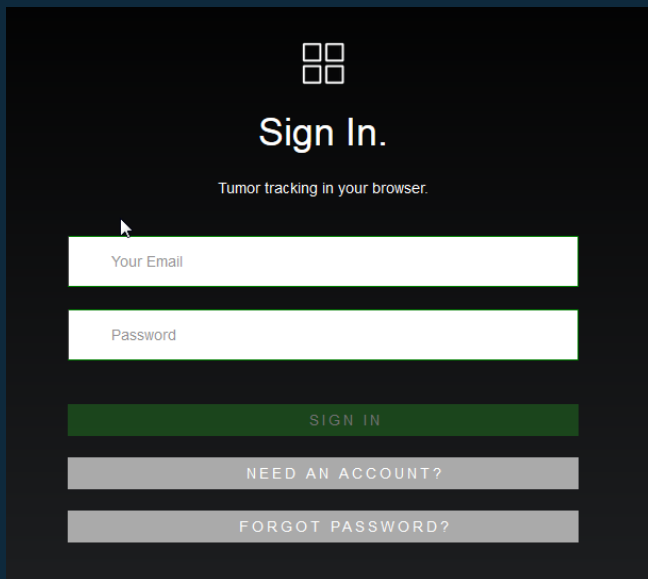
Goals for LesionTracker Grant

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



The sign-in form features a logo at the top, a heading, a sub-heading, two input fields, and three buttons.


Sign In.
Tumor tracking in your browser.

Your Email

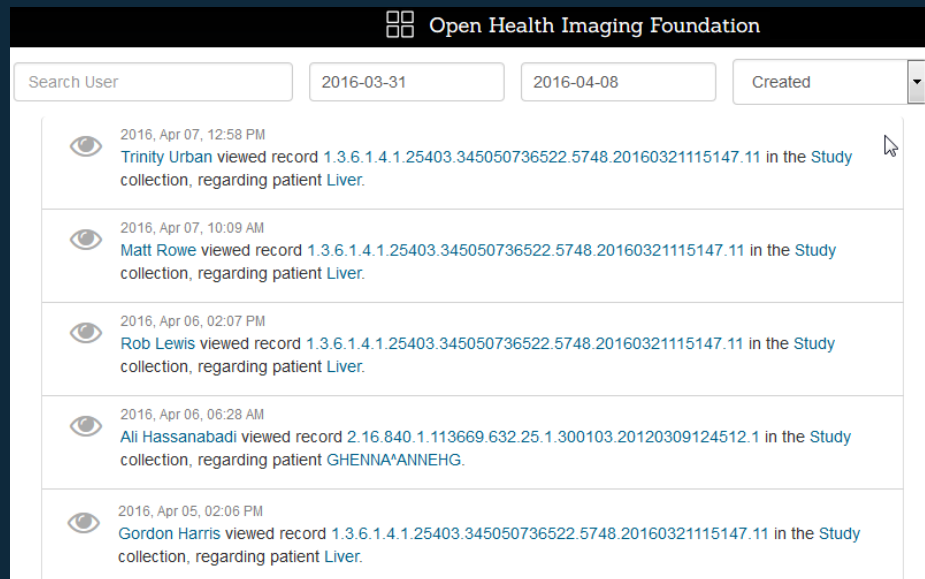
Password

SIGN IN






NEED AN ACCOUNT?

FORGOT PASSWORD?

Audit Trails



The audit trails table displays user activity with columns for search, date range, and creation time. It lists five entries of record views.

Search User	2016-03-31	2016-04-08	Created
 2016, Apr 07, 12:58 PM Trinity Urban viewed record 1.3.6.1.4.1.25403.345050736522.5748.20160321115147.11 in the Study collection, regarding patient Liver.			
 2016, Apr 07, 10:09 AM Matt Rowe viewed record 1.3.6.1.4.1.25403.345050736522.5748.20160321115147.11 in the Study collection, regarding patient Liver.			
 2016, Apr 06, 02:07 PM Rob Lewis viewed record 1.3.6.1.4.1.25403.345050736522.5748.20160321115147.11 in the Study collection, regarding patient Liver.			
 2016, Apr 06, 06:28 AM Ali Hassanabadi viewed record 2.16.840.1.113669.632.25.1.300103.20120309124512.1 in the Study collection, regarding patient GHENNA*ANNEHG.			
 2016, Apr 05, 02:06 PM Gordon Harris viewed record 1.3.6.1.4.1.25403.345050736522.5748.20160321115147.11 in the Study collection, regarding patient Liver.			

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

undefined: Number of lesions per organ must be less than or equal to 2

Liver PIM001 Baseline Aug 10, 2012

Liver PIM001 Follow-up 1 Feb 20, 2013

Target 4
L 50.2 mm
W 46.1 mm

Non-Target 1

Ser: 4
Img: 28 (28/107)
512 x 512
Body 5.0 CE
Zoom: 163.09%
W 165 L 95

Target 4
L 42.4 mm
W 41.2 mm

Non-Target 1

Ser: 2
Img: 60 (60/70)
512 x 512
Body 5.0 CE
Zoom: 163.09%
W 194 L 169

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. [Settings]

Series Study

20000005 BODY 5.0 CE 20000005 BODY 5.0 CE
NJL 07-Sep-2010 NJL 07-Sep-2010
F Acq: 9:57:39.3 F Acq: 9:57:39.3
59Y Se: 6/4 59Y Se: 6/4
Prior IM: 23/95 Current IM: 23/95

Thk: 5.0mm Zoom: 1.80x W: 400 L: 40 Aquilion TIMC

Thk: 5.0mm Zoom: 1.80x W: 400 L: 40 Aquilion TIMC

Trial details HUD Lesions Additional 14

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

Search Save Save as Export Tools

project = "LT" AND fixVersion = "Unscheduled" AND cycleName = "Test Cycle for Sprint 2 (post-release)"

1-7 of 7

Cycle Name	Issue Key	Test Summary	Project Name	Priority	Component	Version	Execution Status	Executed By	Executed On	Creation Date	Execution Defects)
Test Cycle for Sprint 2 (post-release)	LT-75	Add/Edit /Delete Target Overlays on Baseline	Lesion Tracker	Medium		Unscheduled	FAIL	Trinity Urban	01-19-2016 12:00:06	01-12-2016 21:46:14	(7) LT-46, LT-92, LT-157, LT-124, LT-158, LT-125, LT-126
Test Cycle for Sprint 2 (post-release)	LT-77	Scroll Through Images	Lesion Tracker	Medium		Unscheduled	FAIL	Trinity Urban	01-12-2016 22:00:52	01-12-2016 21:46:14	(1) LT-127
Test Cycle for Sprint 2 (post-release)	LT-78	Thumbnail Panel	Lesion Tracker	Medium		Unscheduled	FAIL	Trinity Urban	01-12-2016 22:20:44	01-12-2016 21:46:14	(4) LT-150, LT-128, LT-47
Test Cycle for Sprint 2 (post-release)	LT-79	Lesion Table	Lesion Tracker	Medium		Unscheduled	FAIL	Trinity Urban	01-19-2016 11:46:53	01-12-2016 21:46:14	(7) LT-122, LT-41, LT-155, LT-156, LT-30, LT-11, LT-50
Test Cycle for Sprint 2 (post-release)	LT-80	Default Keyboard Shortcuts	Lesion Tracker	Medium		Unscheduled	FAIL	Trinity Urban	01-19-2016 10:32:47	01-12-2016 21:46:15	(3) LT-152, LT-153, LT-48
Test Cycle for Sprint 2 (post-release)	LT-82	Toolbar	Lesion Tracker	Medium		Unscheduled	PASS	Trinity Urban	01-19-2016 10:52:48	01-12-2016 21:46:15	(2) LT-154, LT-46
Test Cycle for Sprint 2 (post-release)	LT-84	Add/Edit /Delete Non-Target Overlays on Baseline	Lesion Tracker	Medium		Unscheduled	FAIL	Trinity Urban	01-19-2016 12:06:30	01-12-2016 21:46:15	(3) LT-40, LT-157, LT-158



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

