Medical Imaging data standards, automation and analysis

Data Science

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Introduction

- Data is the lifeblood to organizations.
- Insights from data are the key to success.
- Basic data analytics can be straightforward, but companies can be overwhelmed as they progress.
- Building a data driven culture and trust around data analysis is essential for long term success.

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Data standards – Medical Imaging

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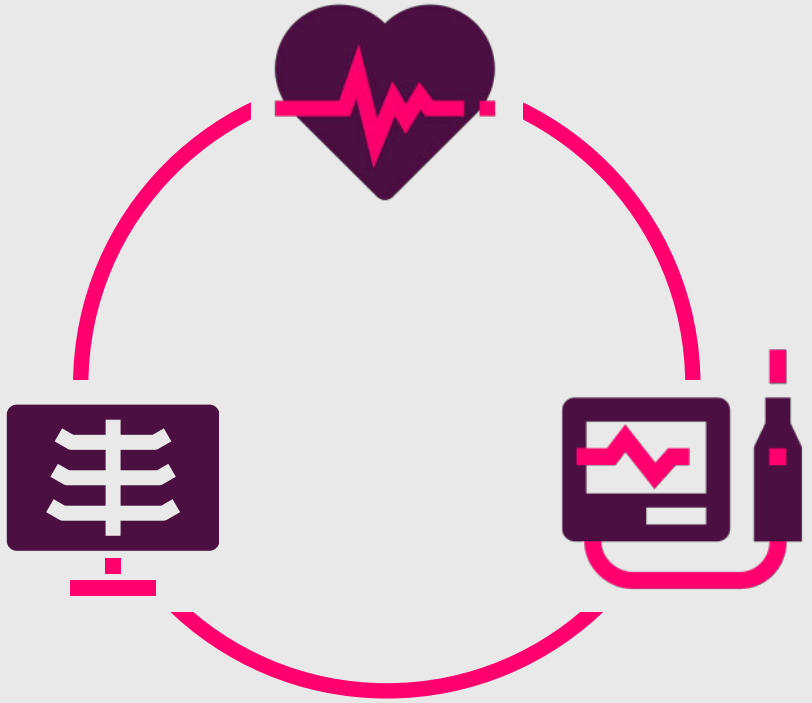
Medical Imaging

- Medical Imaging forms a significant part of most clinical trials.
- Used to generate study endpoints
  - primary, secondary or exploratory study endpoints
- Help determine the safety and efficacy of the treatment.
- Typically, imaging is assessed by using established response criteria like RECIST 1.1.



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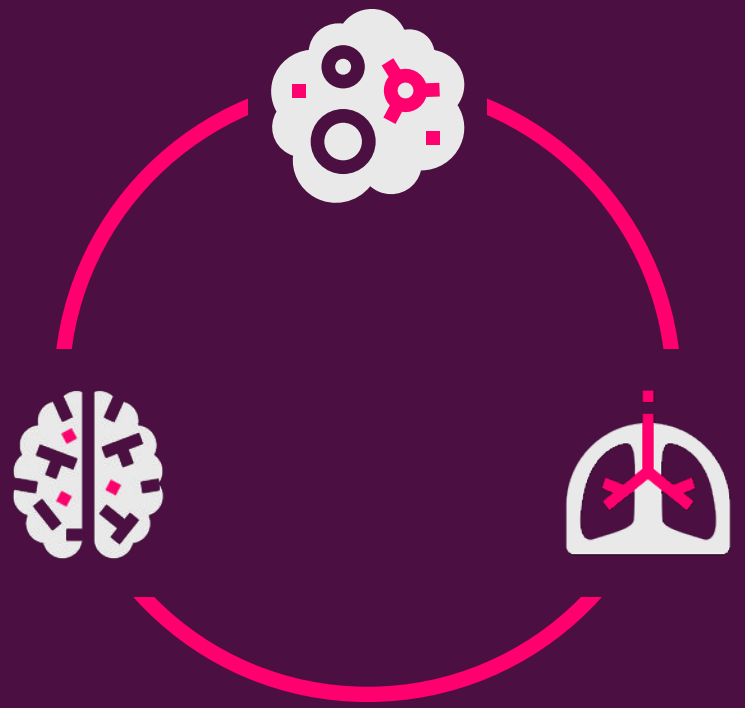
Medical Imaging data standards

- Study Data Tabulation Model (SDTM) implementation guide
  - Study data regulatory submission guidelines
  - Provides information on the different domains, variables as well as formats to be used when submitting data.
- Oncology Domains in SDTM
- TU
  - Uniquely identifies tumors, lesions or locations of interest
- TR
  - Represents quantitative measurements and/or qualitative assessments of tumors, lesions or locations of interest
- RS
  - Assessment of disease response to therapy, or clinical classification based on published criteria



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SDTM is the recommended data standard used for submitting clinical trial data to the FDA

TU domain in oncology studies

tu.xpt

Row	STUDYID	DOMAIN	USUBJID	TUSEQ	TULNKID	TUTESTCD	TUTEST	TUORRES	TUSTRESC	TULOC	TULAT	TUMETHOD	TUNAM	TUEVAL	TUEVALID	VISITNUM	VISIT	TUDTC	TUDY
1	ABC	TU	55555	1	R1-T01	TUMIDENT	Tumor Identification	TARGET	TARGET	CERVICAL LYMPH NODE	LEFT	MRI	ACE IMAGING	INDEPENDENT ASSESSOR	RADIOLOGIST 1	10	SCREEN	2010-01-02	-2
2	ABC	TU	55555	2	R1-T02	TUMIDENT	Tumor Identification	TARGET	TARGET	LIVER		CT SCAN	ACE IMAGING	INDEPENDENT ASSESSOR	RADIOLOGIST 1	10	SCREEN	2010-01-01	-3
3	ABC	TU	55555	3	R1-T03	TUMIDENT	Tumor Identification	TARGET	TARGET	THYROID GLAND	RIGHT	CT SCAN	ACE IMAGING	INDEPENDENT ASSESSOR	RADIOLOGIST 1	10	SCREEN	2010-01-01	-3
4	ABC	TU	55555	4	R1-NT01	TUMIDENT	Tumor Identification	NON-TARGET	NON-TARGET	KIDNEY	RIGHT	CT SCAN	ACE IMAGING	INDEPENDENT ASSESSOR	RADIOLOGIST 1	10	SCREEN	2010-01-01	-3
5	ABC	TU	55555	5	R1-NT02	TUMIDENT	Tumor Identification	NON-TARGET	NON-TARGET	CEREBELLUM	RIGHT	MRI	ACE IMAGING	INDEPENDENT ASSESSOR	RADIOLOGIST 1	10	SCREEN	2010-01-02	-2
6	ABC	TU	55555	6	R1-NEW01	TUMIDENT	Tumor Identification	NEW	NEW	LUNG		CT SCAN	ACE IMAGING	INDEPENDENT ASSESSOR	RADIOLOGIST 1	40	WEEK 6	2010-02-20	48
7	ABC	TU	55555	7	R1-NEW02	TUMIDENT	Tumor Identification	NEW	NEW	CEREBELLUM	LEFT	MRI	ACE IMAGING	INDEPENDENT ASSESSOR	RADIOLOGIST 1	60	WEEK 12	2010-04-02	88

In a Recist study, tumors/lesions of interest are categorized as target, non-target and new tumors. The TU domain will capture the:

- Subject identifier
- Role of the evaluator
- LinkID used to identify the tumor
- Location of the tumor
- Method used to identify the tumor
- Type of tumor (target, non-target, new)

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TR domain

tr.xpt

Row	STUDYID	DOMAIN	USUBJID	TRSEQ	TRGRPID	TRLNKGRP	TRLNKID	TRTESTCD	TRTEST	TRORRES	TRORRESU	TRSTRESC	TRSTRESN	TRSTRESU	TRNAM	TRMETHOD	TREVAL	TREVALID	VISITNUM	VISIT	TRDTC	TRDY
1	ABC	TR	55555	1	TARGET	A1	R1-T01	DIAMETER	Diameter	20	mm	20	20	mm	ACE IMAGING	MRI	INDEPENDENT ASSESSOR	RADIOLOGIST 1	10	SCREEN	2010-01-02	-2
2	ABC	TR	55555	2	TARGET	A1	R1-T02	DIAMETER	Diameter	15	mm	15	15	mm	ACE IMAGING	CT SCAN	INDEPENDENT ASSESSOR	RADIOLOGIST 1	10	SCREEN	2010-01-01	-3
3	ABC	TR	55555	3	TARGET	A1	R1-T03	DIAMETER	Diameter	15	mm	15	15	mm	ACE IMAGING	CT SCAN	INDEPENDENT ASSESSOR	RADIOLOGIST 1	10	SCREEN	2010-01-01	-3
4	ABC	TR	55555	4	TARGET	A1		SUMDIAM	Sum of Diameter	50	mm	50	50	mm	ACE IMAGING		INDEPENDENT ASSESSOR	RADIOLOGIST 1	10	SCREEN		
5	ABC	TR	55555	5	TARGET	A1		SUMNLNLD	Sum Diameters of Non Lymph Node Tumors	30	mm	30	30	mm	ACE IMAGING		INDEPENDENT ASSESSOR	RADIOLOGIST 1	10	SCREEN		
6	ABC	TR	55555	6	NON-TARGET	A1	R1-NT01	TUMSTATE	Tumor State	PRESENT		PRESENT			ACE IMAGING	CT SCAN	INDEPENDENT ASSESSOR	RADIOLOGIST 1	10	SCREEN	2010-01-02	-2

The results (quantitative/qualitative) of the tumors/lesions identified in the TU domain are reported within the TR domain. The TR domain will contain:

- Subject identifier
- Role of the evaluator
- LinkID used to link the records to the tumors reported in the TU dataset
- Method used to identify the tumor
- Test used to obtain the measurement or finding
- Results of the test

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RS domain

rs.xpt

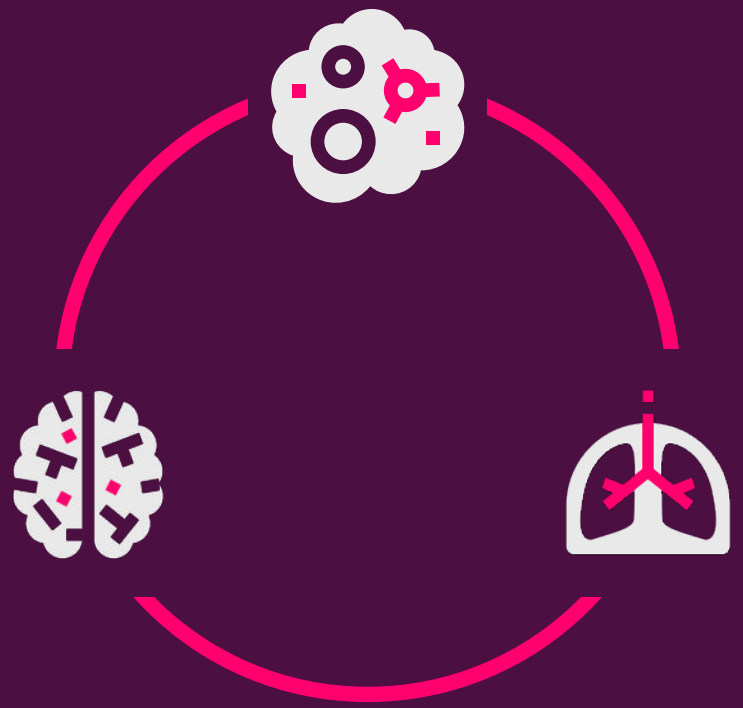
Row	STUDYID	DOMAIN	USUBJID	RSSEQ	RSLNKGRP	RSTESTCD	RSTEST	RSCAT	RSORRES	RSSTRESC	RSEVAL	VISITNUM	VISIT	RSDTC	RSDY
1	ABC	RS	44444	1		TRGRESP	Target Response	RECIST 1.1	PR	PR	INVESTIGATOR	40	WEEK 6	2010-02-18	46
2	ABC	RS	44444	2		NTRGRESP	Non-target Response	RECIST 1.1	SD	SD	INVESTIGATOR	40	WEEK 6	2010-02-18	46
3	ABC	RS	44444	3	A2	OVRLRESP	Overall Response	RECIST 1.1	PR	PR	INVESTIGATOR	40	WEEK 6	2010-02-18	46
4	ABC	RS	44444	4		TRGRESP	Target Response	RECIST 1.1	NE	NE	INVESTIGATOR	60	WEEK 12	2010-04-02	88
5	ABC	RS	44444	5		NTRGRESP	Non-target Response	RECIST 1.1	NE	NE	INVESTIGATOR	60	WEEK 12	2010-04-02	88
6	ABC	RS	44444	6		SYMPTDTR	Symptomatic Deterioration	PROTOCOL DEFINED RESPONSE CRITERIA	Pleural Effusion	PD	INVESTIGATOR	60	WEEK 12	2010-04-02	88
7	ABC	RS	44444	7	A3	OVRLRESP	Overall Response	PROTOCOL DEFINED RESPONSE CRITERIA	PD	PD	INVESTIGATOR	60	WEEK 12	2010-04-02	88

The results of the response assessment that might have been collected or calculated based on tumors/lesions identified in the TU domain and their results in the TR domain, are reported within the RS domain. The RS domain will contain:

- Subject identifier
- Role of the evaluator
- Name of the response assessment (target/non-target/new response, date of progression, date of first response, etc.)
- Results of the response assessment

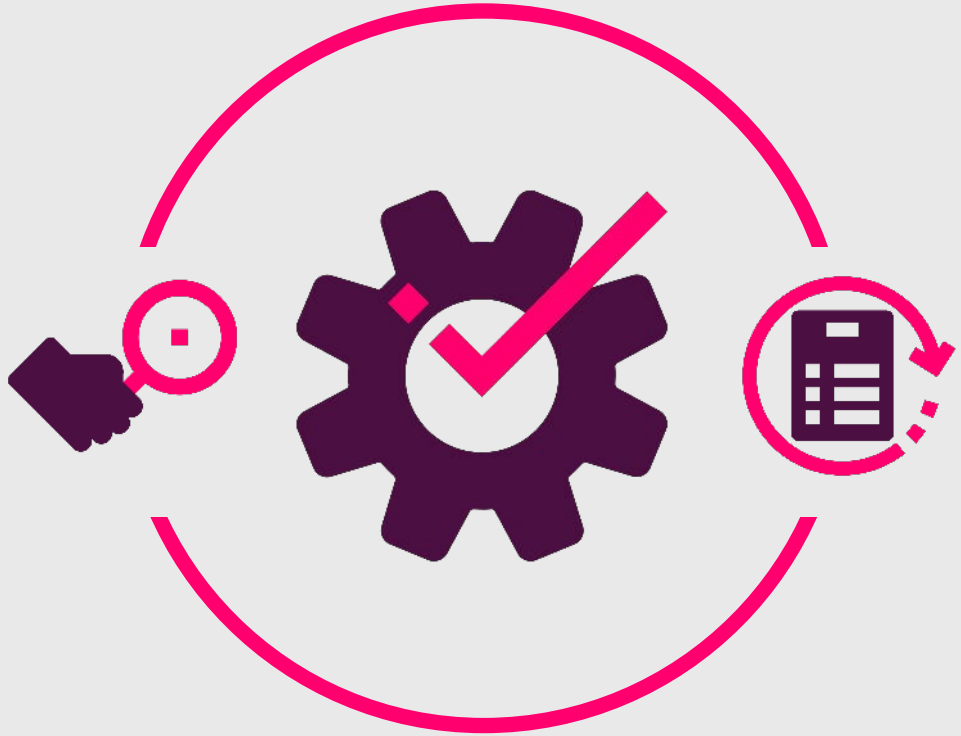
Challenges

- Build databases to fit SDTM format and accommodate trial/criteria specificities
- Collection of data points in tumor evaluations for complex criteria
  - Criteria vary in complexity and protocol requirements may be different
- Multiple flavors of data standards to map to
- Perform data standardization and automation at scale
- Clario is managing the imaging endpoints for more than 500 active oncology studies



Solution overview

- Define a Clario data standard for Imaging RECIST 1.1 studies
  - Based on the SDTM Guidelines.
- Build a system and workflow to standardize all studies
- Automate the entire workflow
  - Automate data cleaning
  - Automate data analysis
  - Enable Predictive analysis



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CDAMS – Clinical Data Automation and Management System

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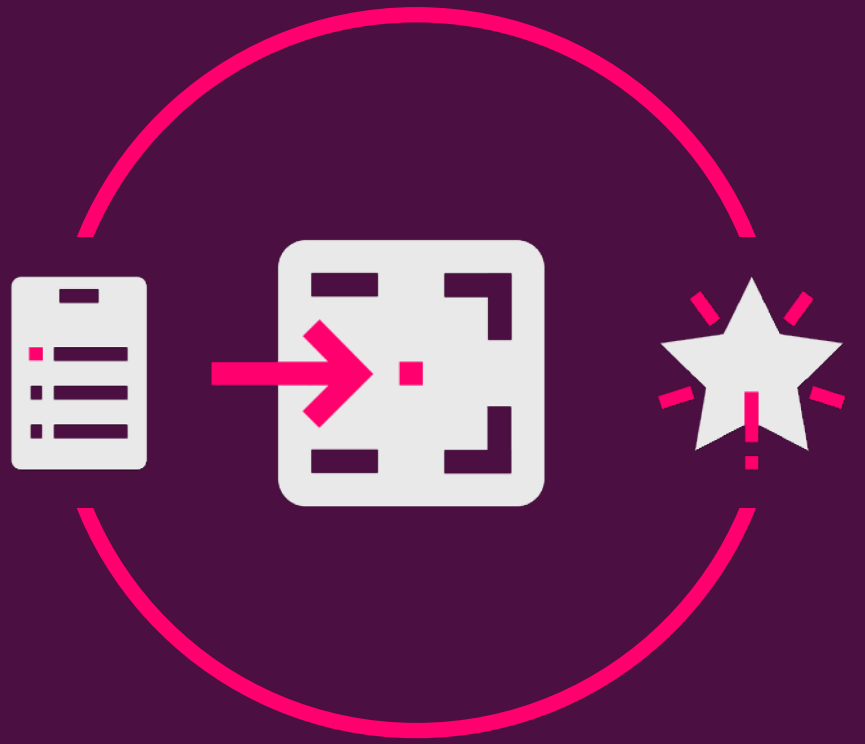
CDAMS – Clinical Data Automation and Management System

Define and publish Clario Imaging Data Standards

- Enable Clario to map all studies into a common set of standards
- Automate the workflow and the data cleaning process
- Enable real time data sharing
- Enable real time data analysis
- Enable Machine Learning and Predictive applications



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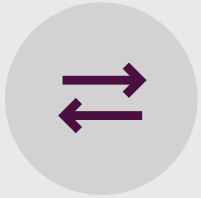
CDAMS objectives

Source system independent

Data quality improvement

Time/cost savings



Backward compatible

Enable the creation of a “Clario Data Standard”

Regulatory/compliance - audit ready system

Enhanced patient reporting

Real time data sharing capabilities

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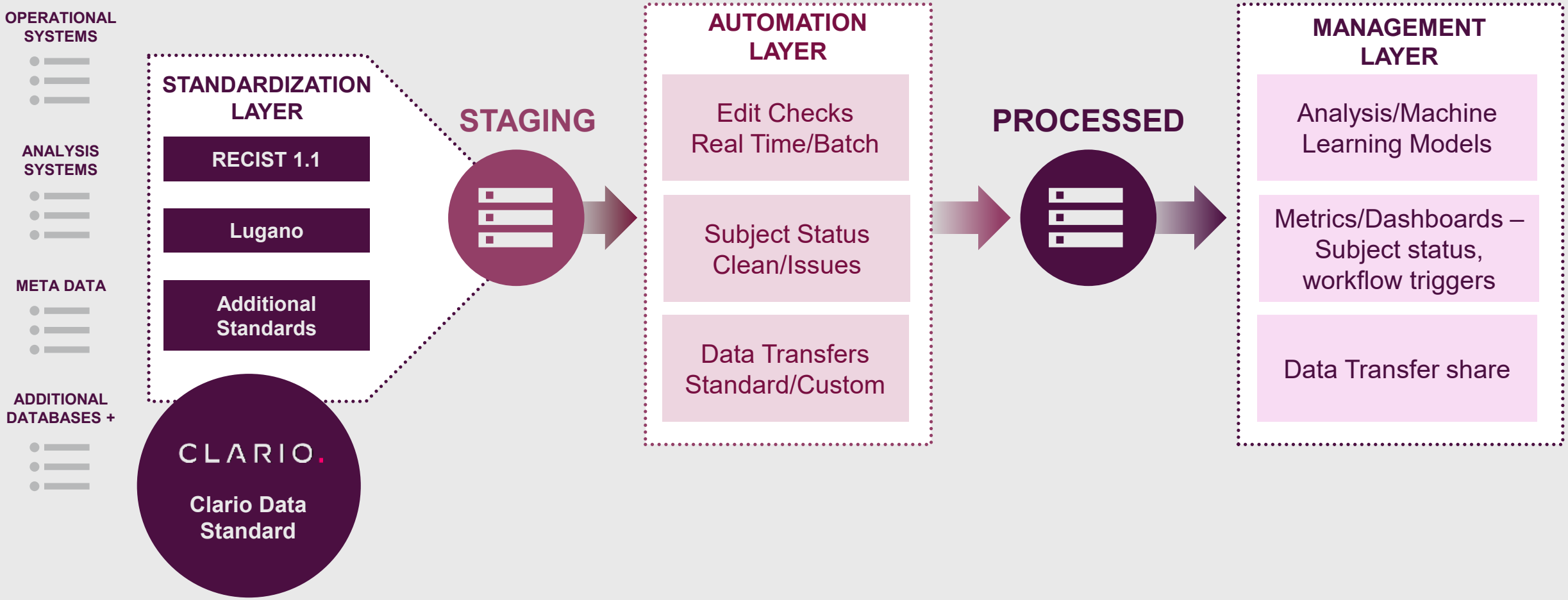
Application architecture



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Sponsor and subject reporting

Data transfer:

- Automate transfer
- Data Share Capabilities

Reporting:

- Patient Data Reporting
- Near real time view with controlled user access

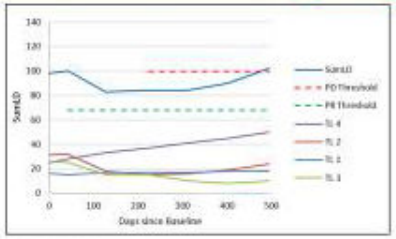
Clinical impact:

- Adjudication Monitoring
- Reader selection model
- Reader variability assessment automation

Response Evaluation as per RECIST 1.1

	Organ	Location	Time Point	Time Point	Time Point	Time Point	Time Point	Time Point	Time Point
Visit Date			23. Nov 12	24. Jan 13	18. Apr 13	25. Jul 13	21. Okt 13	20. Jan 14	22. Apr 14
Day			-21	42	126	224	312	403	495
			baseline						
			size (mm) /status	size (mm) /status	size (mm) /status	size (mm) /status	size (mm) /status	size (mm) /status	size (mm) /status
Target Lesion									
TL 1	Breast	nodule	17	15	17	17	17	18	18
TL 2	Lung	mass lingula	31	32	18	15	16	19	24
TL 3	Lung	right lower lobe mass	26	25	15	15	10	8	10
TL 4	Brain	prefrontal left	23	28	38	37	41	45	50
SumLD			97	100	88	84	84	90	102
PR Threshold				67.9	67.9	67.9	67.9	67.9	67.9
PD Threshold				116.4	116.4	99.6	99.6	99.6	99.6
Response				SD	SD	SD	SD	SD	PD
Non Target Lesion									
nonTL 1	Lung	disseminated	Present	Present	Present	Present	Present	Present	Present
nonTL 2	Bone	disseminated vertebral lesions	Present	Present	Present	Present	Present	Present	Present
Response				Non CR/Non PD	Non CR/Non PD	Non CR/Non PD	Non CR/Non PD	Non CR/Non PD	Non CR/Non PD
New Lesions									
NewL 1	Adrenal	adrenal							present
Overall Response				SD	SD	SD	SD	SD	PD

- **At each follow-up time point**
  - TL: measure and grade for response (PD, SD, PR, CR)
  - nonTL: visually evaluate and grade for response (PD, nonCR/nonPD, CR)
  - new lesions: check for new appearance
  - overall response (OR)
    - appearance of new lesions = PD
    - otherwise = TL response (CR also requires nonTL CR)
    - note that nonTL PD should not trump a TL SD unless massive growth of nonTL



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Data Analysis

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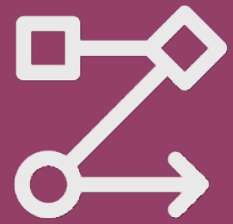
Data analysis

Standard reporting

Predictive analysis

Identifying predictors to influence outcome



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Thank you for your time

If you have any questions, please contact us at:

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