

SAS® End-to-End solutions in Clinical Trial

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ABSTRACT

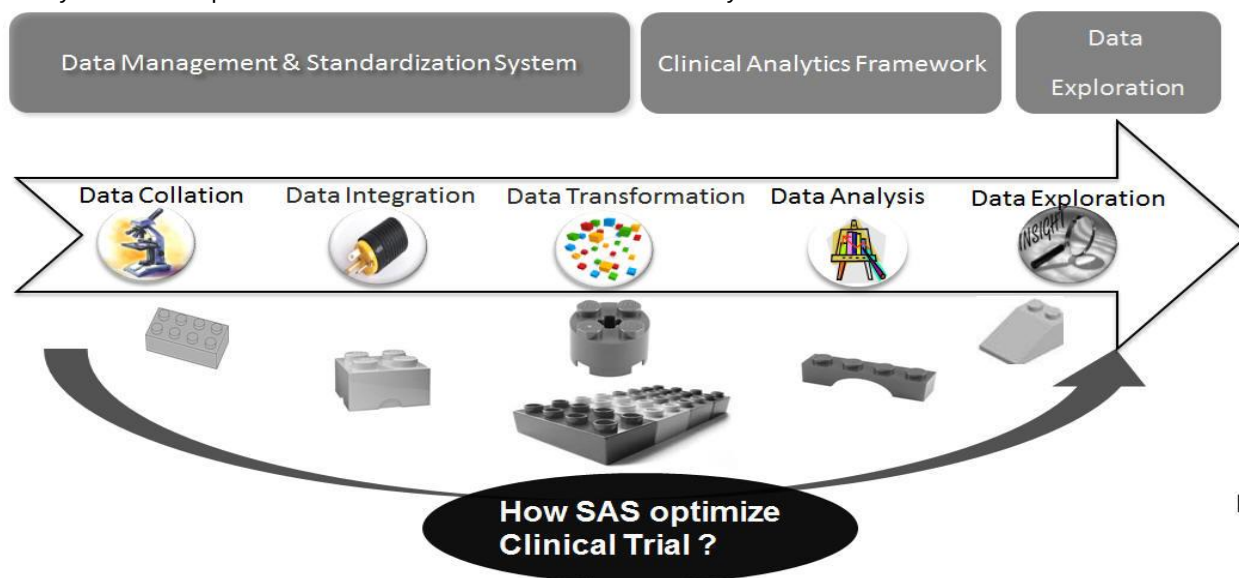
Are you in trouble with executing timely queries against historical or ongoing clinical trials data? Is there confusion of retrieving data from particular trials beyond generating standard reports and analysis across different systems? Are you looking to build a robust integration routine to bring diverse sources of clinical data together repeatedly for different trials? How do you build up a fluent collaboration model with external clinical data management partners? If you answered 'YES' to any of these questions, then you need to look at the SAS End-to-End solutions in Clinical Trial.

INTRODUCTION

LEGO toys are popular because they are flexible, reusable and combinable. Similarly, in this presentation we will discuss how SAS End-to-End solutions resolve above business concerns in Clinical Trial; we would also like to represent it as "SAS LEGO toys" in term of playing specific roles in the Clinical Trial with Data Collation, Data Integration, Data Transformation, Data Analytics and Data Exploration. And with a combination of these "SAS LEGO toys" to SAS End-to-End solutions, we will see:

- How to reuse integrated standards over different components of the clinical data flow.
- How to build up collaboration modules which can be outsourced or split up along different departments according to the business processes.
- How SAS optimize and streamline Clinical Trials from the beginning to the end of working out high-quality submissions to regulatory.

And everything of these can be reached in a security and regulatory compliance SAS development environment to save your time on operational data activities and focus more on analytics of the data.

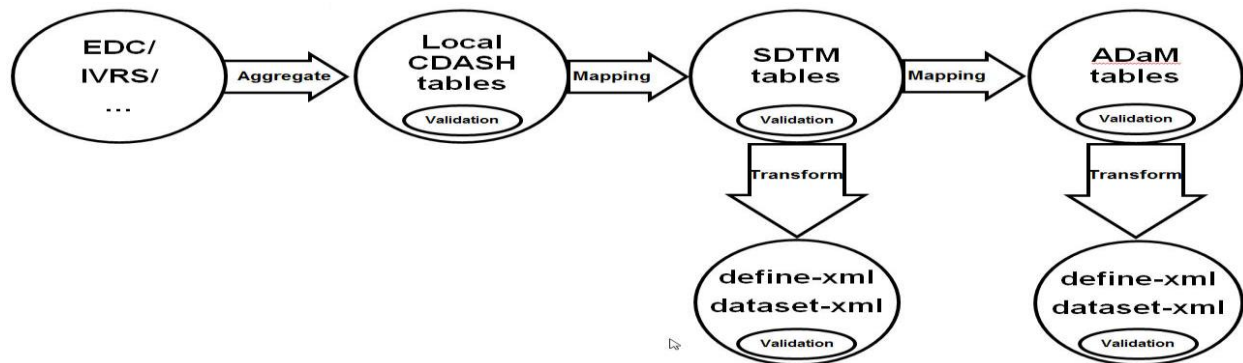


DATA MANAGEMENT AND STANDARDIZATION SYSTEM

Currently most EDC tools available allow for extracting data in variety of format, but not all support the Clinical Data Interchange Standards Consortium (CDISC) or ODM formats, or the specific versions... Further, many of them come from disparate systems, making it hard to build up a robust integration routine to aggregate diverse sources of clinical data for different trials. In this section, I will introduce one of "SAS LEGO toy"-- SAS® CDI- Clinical Data Integration to handle above concerns.

SAS® CDI- CLINICAL DATA INTEGRATION

SAS® CDI- a desktop application and the client portion of SAS® DIS - Data Integration Studio, is a tool designed for supporting the pharmaceutical-industry needs for data standardization of creation industry-mandated data standards- CDISC in data aggregating, transforming, managing, and validation (See [Display 1](#)). By building up in a reusable data structure, SAS® CDI helps you perform clinically oriented tasks such as importing data standards, creating studies and submissions, and adding specialized transformations for mapping clinical data into a standard data model. Throughout the whole process, it produces standards-based data – from the point when the primary clinical data is captured all the way to the point when the standardize data is generated out and ready for the following data analysis report in the hands of regulatory authorities and the pharmaceutical sponsor.



Display 1. Data Standardization Process

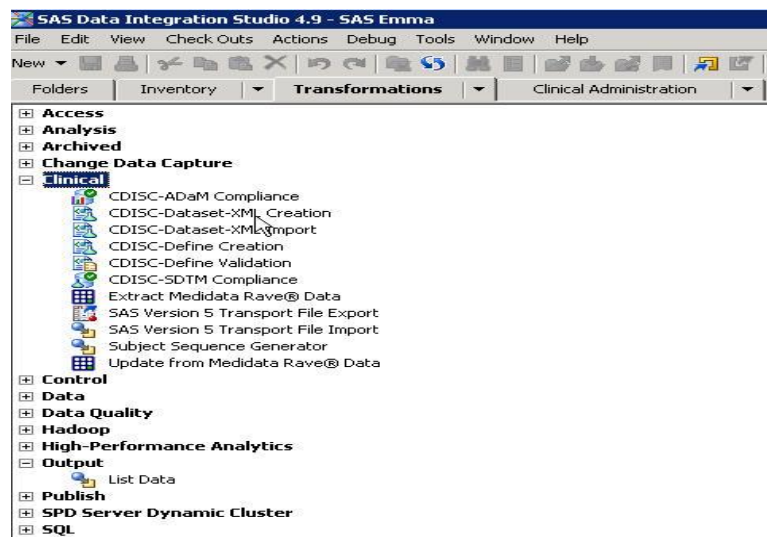
BUSINESS MODULES IN SAS® CDI

This section demonstrates 5 business modules in SAS® CDI:

- Module 1-Build up Clinical Study integrate with CDISC standard
- Module 2-Aggregating data from multiple sources
- Module 3-Mapping disparate data to a uniform
- Module 4-Compliance Standard Data validation
- Module 5-Data Transformation

Pre Knowledge 1-Transformations

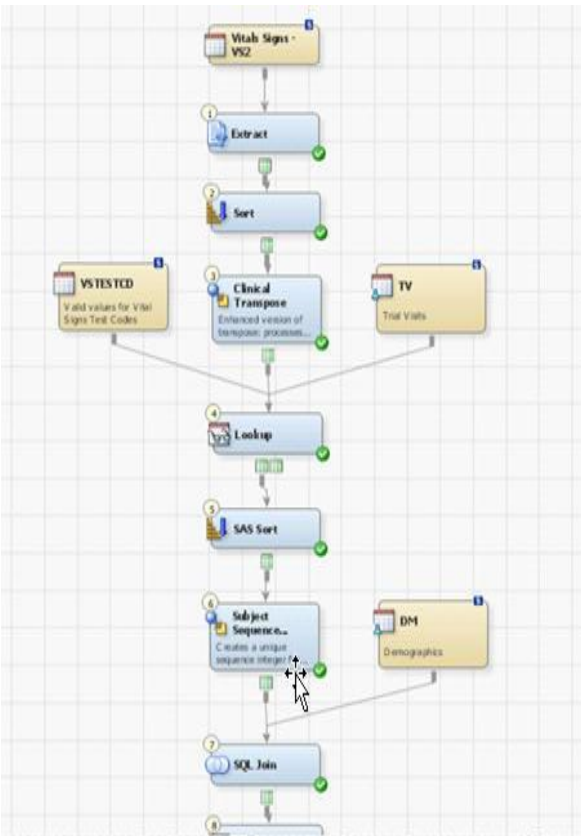
SAS® CDI provides some Transformations automatizing your data standardization work (See [Display 2](#)). Those Transformations include data management & standardization work such as importing EDC data, mapping data, transforming data, and validating data.



Display 2. SAS® CDI Transformations for Clinical

Pre Knowledge 2-Automated Job

In order to assist clinical professions focusing more on Clinical design or data analysis related investigation works rather than data management & standardization, SAS® CDI provides Job function. Job is a collection of SAS tasks that create output to ensure that your clinical data management & standardization work automatically and repeatedly. SAS® CDI Job editor- designed as a graphical user interface with a visual standardization process (See Display 3), enables users to drag different Transformations into Jobs graphical user interface according to their needs, and simply connect the different input and output. And the actual Job background will generate SAS code to execute the job and show logs with exact output results (See Display 4)



Display 3. Job Editor

The interface includes tabs for Diagram, Code, Log, and Output. The Code tab is currently selected, showing the generated SAS code. Below the code, there are tabs for Details, Status, Warnings and Errors, Statistics, and Control Flow. A table with columns 'Order' and 'Name' is visible at the bottom."/>

Display 4. Automatic Code

Module 1-Build up Clinical Study and Submission with CDISC Standard

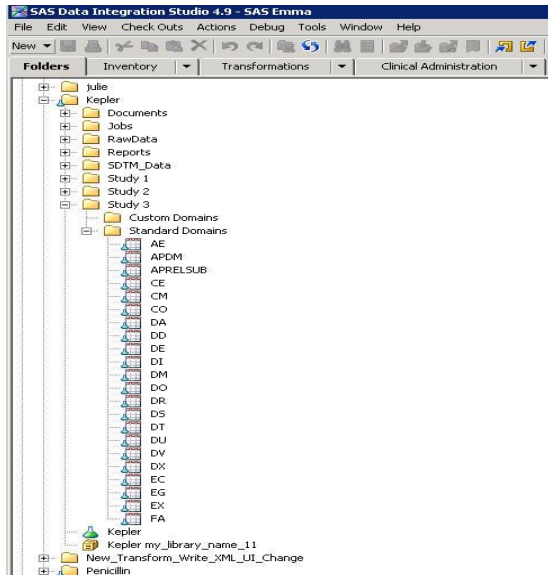
SAS® CDI provides pharmaceutical professionals to design Clinical Study or Submission (See [Display 5](#)) by pre-defined data structure template (See [Display 6](#)) based on different phases among Clinical Trial; which would also be customized by Pharmaceutical professionals for different investigating purpose. This pre-defined data structure integrate with latest version of CDISC standard, and even though old version of CDISC also being included in SAS® CDI, thus creating an efficient operational environment for users to integrate various clinical data from different projects, different sites or different format files into a unique standardized data system.

By integrating with CDISC standard, SAS® CDI supports importing SDTM, CDASH, SEND, ADaM domains with metadata tables to your Study, this metadata data structure is robust and reusable to make your clinical investigation work reproducibly and automatically.

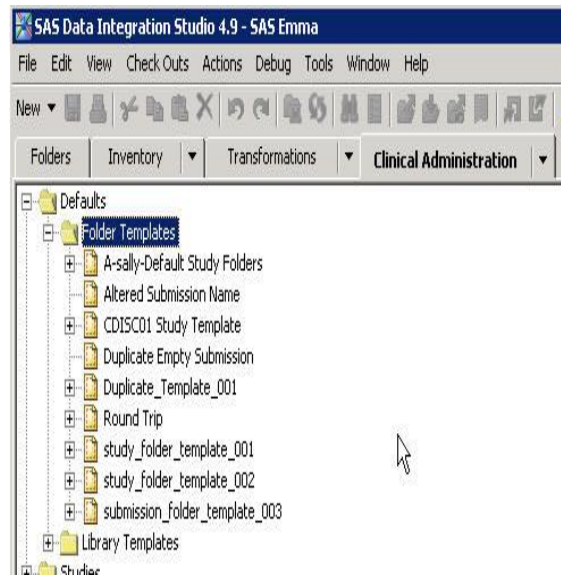
The version of CDISC standard of SDTM, ADaM, SEND, CDASH that SAS® CDI currently supports are shown as below:

- SDTM V3.1.2
- SDTM V3.1.3
- SDTM V3.2
- ADaM V2.1

- CDASH V1.7
- SEND V3.0

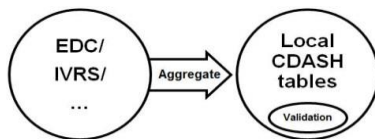


Display 5. Build Clinical Study Structure in CDI



Display 6. Define Data Structure Template

Module 2-Aggregating data from multiple sources



SAS® CDI brings together clinical study data that is scattered among multiple clinical system and stored in multiple formats across multiple operating environments and organizations. Typical data sources include laboratory data, EDC data, IVRS data, patient diary data, pre-clinical data, CDMS data and CTMS data – among others, and SAS® CDI can access all of these data regardless of the source and format. SAS® CDI provides specific Transformation to integrate with Medidata Rave®, and supports to integrate with other leading EDC systems as well. We can also work with a customer to build an adapter for other EDC systems which could provide full extract or incremental form updates.

Here we demonstrated the data aggregating module to exact data from Medidata Rave® and output with CDASH data to your Clinical Study in SAS® CDI. (See [Display 7](#))

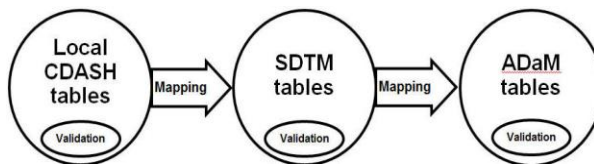
Transformation used by Data Aggregating in SAS® CDI as follows:

- Clinical Update from Medidata Rave® data
- Clinical Exact Medidata Rave® data



Display 7. Aggregating from Medidata Rave®

Module 3-Mapping disparate data to a uniform



In order to accelerate the process of data standardization, SAS® CDI enables mapping disparate data to a uniform consistent data structure by using specific Transformations as follows:

- Mapping CDASH Data to SDTM Data
- Mapping SDTM Data to ADaM Data

Module 2 demonstrated CDASH data has been extracted from Medidata Rave®, here we show an example by running job in SAS® CDI to map CDASH data to SDTM data (See [Display 8](#)).

Transformations used by Data Mapping in SAS® CDI as follows:

- SQL Join
- SQL Extract
- Access Table Loader

The screenshot displays the SAS CDI interface with a data mapping job configuration on the left and the SAS Extract Properties dialog on the right.

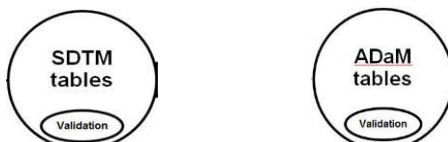
Job Configuration: The workflow starts with three input tables: ADMIN2, REGISTER, and RANDFILE. These are joined using a SQL Join transformation. The result is then processed by an Extract transformation, followed by a Table Loader, and finally loaded into the DM Demographics table.

SAS Extract Properties Dialog: This dialog shows the mapping of source table columns to target table columns. The source table is 'Clinical Transpose (VSDSDM)' and the target table is 'Extract Target (VSDSDM)'. The columns are mapped as follows:

#	Column	Column Description	Type	#	Column	Column Description	Expression
1	STUDYID	PATIENT STUDY ID	Numeric	1	STUDYID	Study Identifier	NDC001
2	DOMAIN	DOMAIN	Numeric	2	DOMAIN	Domain Abbreviation	YS
3	USUBID	Unique Subject ID	Character	3	USUBID	Unique Subject ID	LEFT(UPUTSTU...
4	VSSEQ	Sequence Number	Character	4	VSSEQ	Sequence Number	A
5	VSSEQ	Sequence Number	Character	5	VSSEQ	Sequence Number	A
6	VSSEQ	Sequence Number	Character	6	VSSEQ	Sequence Number	A
7	VSSEQ	Sequence Number	Character	7	VSSEQ	Sequence Number	A
8	VSSEQ	Sequence Number	Character	8	VSSEQ	Sequence Number	A
9	VSSEQ	Sequence Number	Character	9	VSSEQ	Sequence Number	A
10	VSSEQ	Sequence Number	Character	10	VSSEQ	Sequence Number	A
11	VSSEQ	Sequence Number	Character	11	VSSEQ	Sequence Number	A
12	VSSEQ	Sequence Number	Character	12	VSSEQ	Sequence Number	A
13	VSSEQ	Sequence Number	Character	13	VSSEQ	Sequence Number	A
14	VSSEQ	Sequence Number	Character	14	VSSEQ	Sequence Number	A
15	VSSEQ	Sequence Number	Character	15	VSSEQ	Sequence Number	A
16	VSSEQ	Sequence Number	Character	16	VSSEQ	Sequence Number	A
17	VSSEQ	Sequence Number	Character	17	VSSEQ	Sequence Number	A
18	VSSEQ	Sequence Number	Character	18	VSSEQ	Sequence Number	A
19	VSSEQ	Sequence Number	Character	19	VSSEQ	Sequence Number	A
20	VSSEQ	Sequence Number	Character	20	VSSEQ	Sequence Number	A
21	VSSEQ	Sequence Number	Character	21	VSSEQ	Sequence Number	A
22	VSSEQ	Sequence Number	Character	22	VSSEQ	Sequence Number	A
23	VSSEQ	Sequence Number	Character	23	VSSEQ	Sequence Number	A
24	VSSEQ	Sequence Number	Character	24	VSSEQ	Sequence Number	A
25	VSSEQ	Sequence Number	Character	25	VSSEQ	Sequence Number	A
26	VSSEQ	Sequence Number	Character	26	VSSEQ	Sequence Number	A
27	VSSEQ	Sequence Number	Character	27	VSSEQ	Sequence Number	A
28	VSSEQ	Sequence Number	Character	28	VSSEQ	Sequence Number	A
29	VSSEQ	Sequence Number	Character	29	VSSEQ	Sequence Number	A
30	VSSEQ	Sequence Number	Character	30	VSSEQ	Sequence Number	A

Display 8. Mapping CDASH to SDTM in SAS® CDI

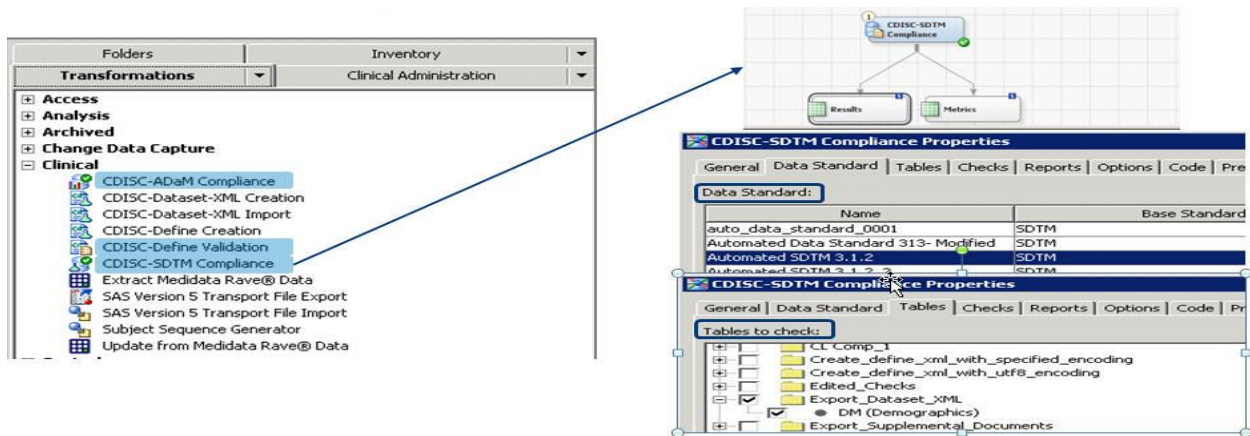
Module 4-Compliance Standard Data validation



Module 3 shows us CDASH data has been mapped to SDTM data, we then need to ensure that the data is reliable for future data analysis, and such task could be done with Clinical Programmer by writing massive SAS code in traditional ways. SAS® CDI provides SDTM, ADaM compliance check per different version of CDISC standard which include metadata element compliance check and data value compliance check. User can select domain tables and standard version to specify the data standardize settings. (See [Display 9](#))

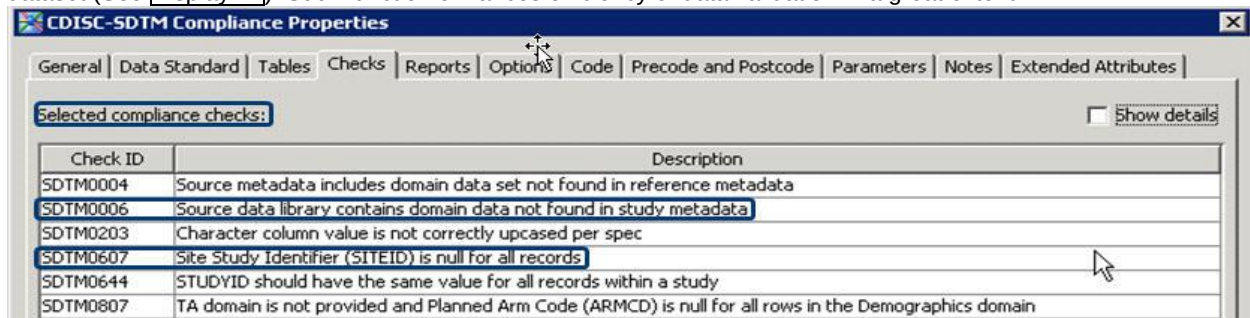
Transformations used by Data Validation in SAS® CDI as follows:

- CDISC – AdAM Compliance
- CDISC – SDTM Compliance
- CDISC - Define Validation SQL Join



Display 9. Specify Transformation, Standard version, Domain tables for Data Validation in SAS® CDI

This module demonstrates with the support of various Compliance Check Rules (See [Display 10](#)) rely on CDISC standard, professionals are able to output with dataset listing all the illegal problems occurred in your input domain dataset (See [Display 11](#)). Such function enhances efficiency of data validation in a great extent.



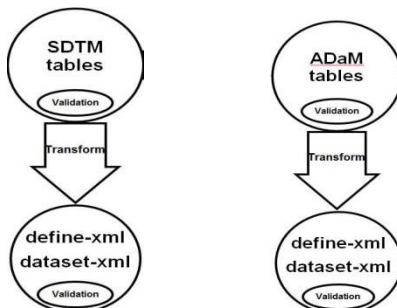
Display 10. Specify Compliance Check Rules in SAS® CDI

View Data: Results (38 rows)

#	checkid	resultid	resultseq	seqno	srcdata	message	resultseverity
1	SDTM0807	SDTM0807	1	2	libr_10.DM ...	ARMCD missing in DM	Error
2	SDTM0644	SDTM0644	1	1	LIBR_10.DM ...	Inconsistency detected for column STUDYID - 1 inconsistencies were detected	Error
3	SDTM0607	SDTM0607	1	2	libr_10.DM ...	SITEID missing for all DM records	Error
4	SDTM0203	SDTM0203	1	1	libr_10.DM ...	Character column value not upcased	Note
5	SDTM0203	SDTM0203	1	3	libr_10.DM ...	Character column value not upcased	Note
6	SDTM0203	SDTM0203	1	2	libr_10.DM ...	Character column value not upcased	Note
7	SDTM0203	SDTM0203	1	4	libr_10.DM ...	Character column value not upcased	Note
8	SDTM0006	CST0100	1	1	WORK_...CST...	No errors detected in source data	Info
9	SDTM0004	CST0100	1	1	WORK_...CST...	No errors detected in source data	Info

Display 11. Output with dataset listing all the illegal problems per Compliance Check Rules

Module 5-Data Transformation



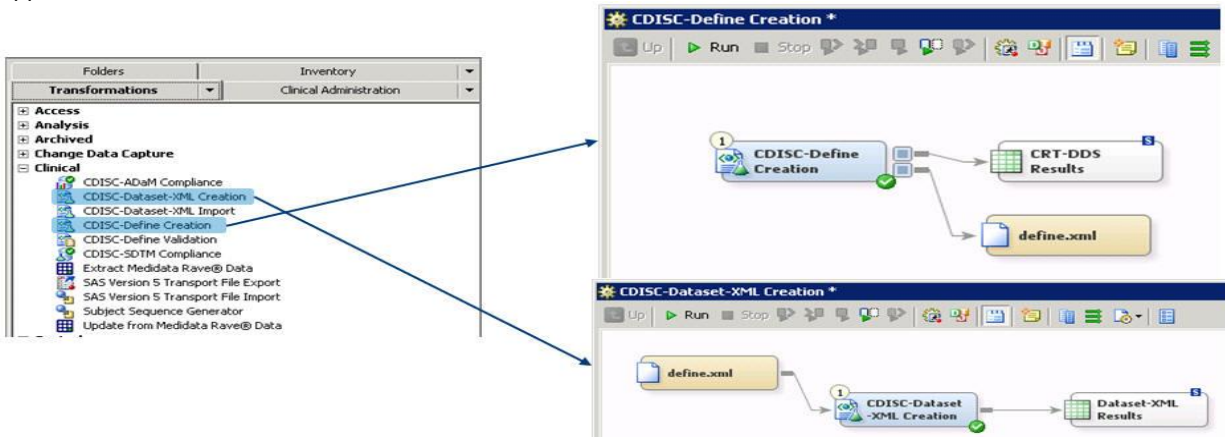
SAS® CDI also supports specific Transformations which create Define.xml and Dataset.xml in delivery of regulatory authorities review package or the pharmaceutical sponsor & CRO data transformation co-work. (See [Display 12](#))

Transformations used by Data Transformation in SAS® CDI as bellows:

- CDISC – Dataset-XML-Creation
- CDISC – Define – Creation
- CDISC – Dataset-XML- Import

The CDISC-Dataset-XML Creation Transformation creates a separate Dataset-XML file for each domain or data table in a study or submission. Each Dataset-XML file is named based on the domain or data table name. For example, the DM domain creates the dm.xml file.

The CDISC-Define- Creation Transformation transforms SDTM domains or ADaM data sets into a define.xml file. The define.xml file complies with the CRT-DDS standard. If the SDTM domain references a value-level metadata table or supplemental documents table, it is included in the define.xml file.



Display 12. Data Transformation to Dataset.xml and Define.xml

SUMMARIZATION- DATA MANAGEMENT AND STANDARDIZATION SYSTEM

Per above 5 SAS® CDI business modules, we can see how SAS® CDI resolves Clinical End-to-End data management and standardization, how SAS® CDI optimizes Clinical Trail various data from different systems to one system integrated with CDISC standard and follow up Regulatory Compliance; and how SAS® CDI reusable modules enable the life sciences industry to truly complement EDC systems by enabling the reuse of already defined study data elements, guarding data quality by executing all-encompassing data to standardized data.

Actually in the background of SAS® CDI, SAS have another hero--**SAS® CST - Clinical Standard Toolkits**. With the components that are installed as part of the SAS Foundation and shared files (SAS macros, JAR files, and so on), and the global standards library. SAS® CST is a free Toolkit which processes a set of predefined SAS macros, JAR files for Clinical Programmer to do data Validation and Transformation related works to follow up CDISC standard. So instead of buying CDI, or writing custom SAS Code, SAS® CST is another good choice for Clinical Trail to save Data Standardization time and optimize your Clinical Study.

Further, we've seen SAS®CDI or SAS® CST output with trusted clinical data which can be leveraged for the next step to do statistical analyses or cross study analysis and advanced safety analysis. Let's see next section that how SAS Solutions in Clinical Analytics.

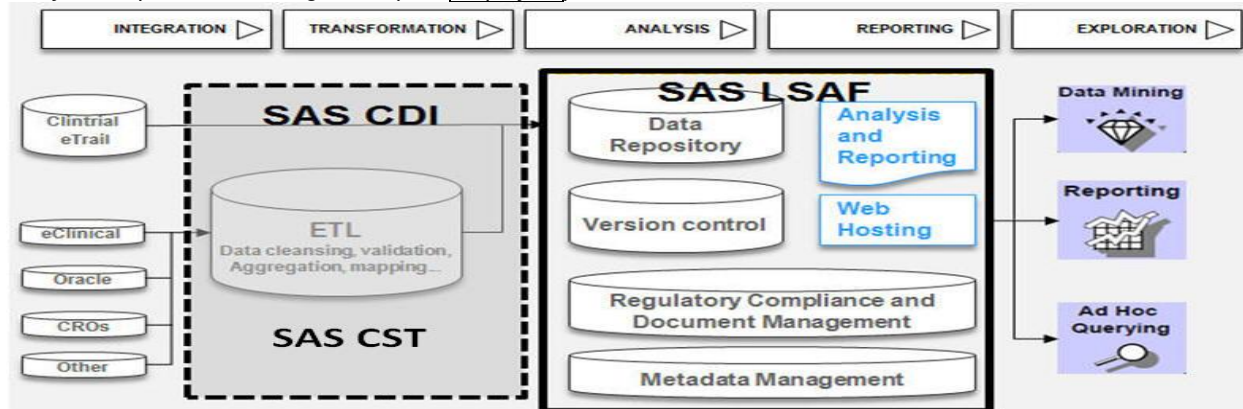
CLINICAL ANALYTICS FRAMEWORK

The final objective of any clinical trial is to determine the safety and efficacy of the new compound, device or biological under development. The gathered, standardized, cleansed and summarized data is ready to be studied from a clinical perspective. Now how could we execute timely queries against historical or ongoing clinical trials data; how could we do analysis and data explore spanning across different phases, different studies, and even different systems; how could we build up collaboration modules which can be outsourced (CRO) or split up along different departments according to the business processes to share the same study data. In this section, I will introduce another "SAS LEGO toy" – SAS® LSAF to handle above concerns.

SAS® LSAF – LIFE SCIENCE ANALYTICS FRAMEWORK

SAS® LSAF - a web based hosted solution which does not require client installation or maintenance, so that it enables the efficient development, execution and management of the analysis and reporting and activities for clinical study with the implement of SAS Foundation development environment.

Continue with above section, after SAS® CDI finish aggregating, mapping, validation, transformation of data standardization related works, we can populate all the trusted data to SAS® LSAF to do further data development, analytics, explore and management (See [Display 13](#)).



Display 13. SAS® LSAF in Clinical Trail Process

BUSINESS MODULES IN SAS® LSAF

In this section, we are going to demonstrate 4 key modules in SAS® LSAF to see how SAS® LSAF resolves pharmaceutical challenges.

Module 1- File Management Security Hierarchy

Security Hierarchy

SAS® LSAF supports file management security hierarchy-Repository. Repository- with the data structure of Origination, Project and Analysis to distribute and integrate data from all relevant sources, stores information related to a clinical research, brings all information together in a standardized, centralized Repository and compiles diverse pharmaceutical industry data to an open analytic framework. All users, department, sites, organization can work in this hierarchy to store and manage their files (See [Display 14](#)).

Private working environment

SAS® LSAF also supports private working environment-Workspace, which available only to you, but not to other users. For pharmaceutical professionals to develop SAS code, investigate study report, or manage their works in a private workshop, they can Check Out public files from Repository to Workspace to proceed their works, and then Check In the files to Repository as new version with the investigation updates; this Version Control feature in SAS® LSAF ensures the traceability for previous versions of the files in the whole drug life cycle could be retrieved (See [Display 14](#)).

Name	Size	Modified By	Date Modified	Signed	RepositoryVersion	Workspace
AE_BODSYS_SORT_PVAL.sas	3.7 KB	Emma Liu	Aug 01, 2015 04:08 P...		1.0	
AE_LISTING.sas	2.33 KB	Emma Liu	Aug 01, 2015 04:08 P...		1.0	
AE_LISTING_dth.sas	2.55 KB	Emma Liu	Aug 01, 2015 04:08 P...		1.0	
AE_NO_DEATH.sas	2.97 KB	Emma Liu	Aug 01, 2015 04:08 P...		1.0	
AE_TOTALS.sas	2.67 KB	Emma Liu	Aug 01, 2015 04:08 P...		1.0	
Create_AE_Reports.sas	1.01 KB	Emma Liu	Jul 31, 2015 03:34 PM		1.0	
Create_DM_Report.sas	1.11 KB	Emma Liu	Aug 01, 2015 04:01 P...		1.0	
de.sas	204 bytes	Emma Liu	Aug 01, 2015 04:01 P...		1.0	
DM_LISTING.sas	1.63 KB	Emma Liu	Aug 01, 2015 04:08 P...		1.0	
DM_LISTING_InputTitle.sas	1.86 KB	Emma Liu	Aug 01, 2015 04:08 P...		1.0	
DM_PATIENT_PROFILES_AGE.sas	1.36 KB	Emma Liu	Aug 01, 2015 04:01 P...		1.0	
DM_PATIENT_PROFILES_GEND...	1.14 KB	Emma Liu	Aug 01, 2015 04:08 P...		1.0	
DM_PATIENT_PROFILES_RACE...	1.12 KB	Emma Liu	Aug 01, 2015 04:08 P...		1.0	
DM_PATIENT_PROFILES_TREAT...	1.11 KB	Emma Liu	Aug 01, 2015 04:09 P...		1.0	
DS_DEATH_LISTING.sas	2.18 KB	Emma Liu	Aug 01, 2015 04:09 P...		1.0	
DS_DROPOUT_GROUP_AND_R...	5.92 KB	Emma Liu	Aug 01, 2015 04:09 P...		1.0	
DS_EVENT_BAR_CHART.sas	546 bytes	Emma Liu	Aug 01, 2015 04:09 P...		1.0	
DS_MORTALITY_TREATMENT_G...	2.06 KB	Emma Liu	Aug 01, 2015 04:09 P...		1.0	

Display 14. Security hierarchy in SAS® LSAF

Cross Clinical Trails Query

Professionals can perform basic and advanced query in Repository specific location to gather all the historical and ongoing demanded clinical trials data for investigation.

Rules: [?](#)

Location:

☐ Search from current location: /SAS

☐ Search all locations in the repository

Rules:

Name: (none) Search text Case sensitive

Owner: (none)

Created by: (none)

Modified by: (none)

Created: From: To:

Modified: From: To:

Object type: Select an object type

Search results must match: All of the Rules

Number of results per page: 25

Display 15: Search historical or ongoing clinical trials data in SAS® LSAF

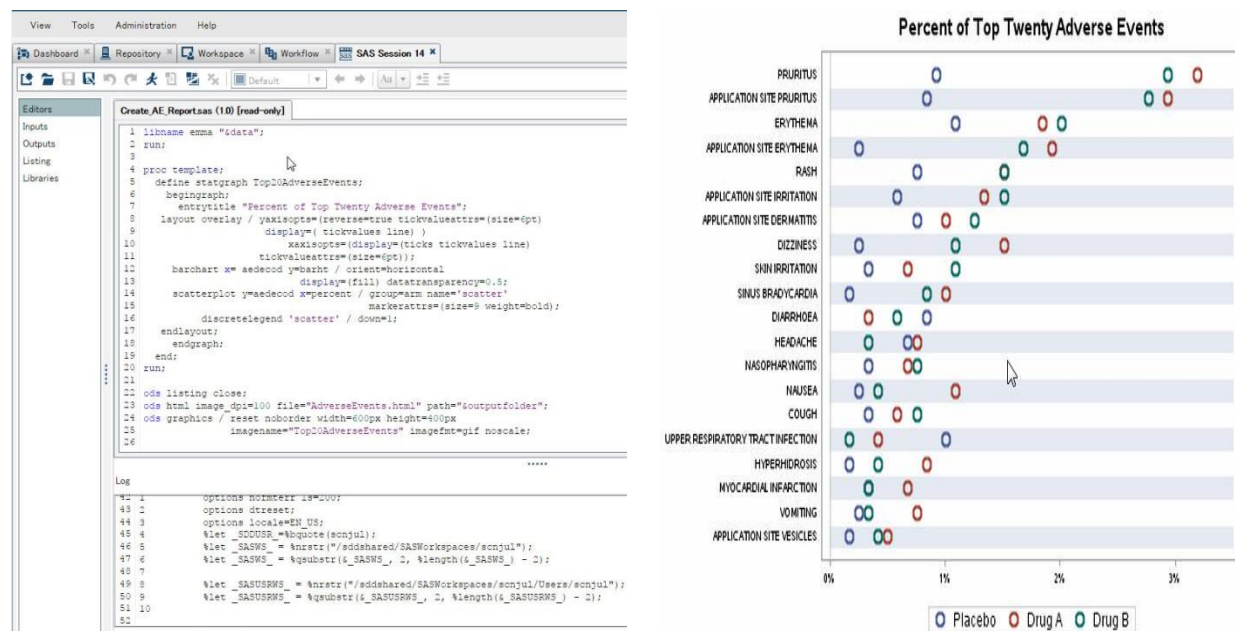
Module 2- Automating Development Environment

SAS Code Development Environment

SAS Session Editor - a component of SAS® LSAF, integrates with SAS development environment, enables Clinical Programmer to use SAS Foundation to develop SAS programs, review log files, and test existing program functionality inside SAS® LSAF (See [Display 16](#)). And it directly generates output files to SAS® LSAF Workspace which could be checked in to Repository for further Clinical investigation. This is the ability to make more confident decisions and analyze data from a single Repository.

Several SAS macro variables are created automatically when a SAS program is run. SAS Programmer can reference these macro variables in your SAS program:

- **_SDDUSR_** specifies the user ID of the user who is running the SAS program.
- **_SASWS_** specifies the location of the root-level folder for the workspace.
- **_SASUSRWS_** specifies the location of the user's folder in the workspace.
- **_SASFILEPATH_** specifies the path of the SAS program that was most recently submitted in a SAS session.

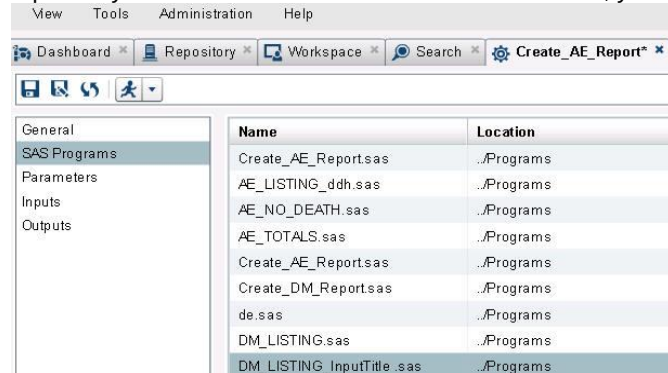


Display 16. Using SAS® LSAF Code Editor Run SAS Code with generating AE Bubble Plot

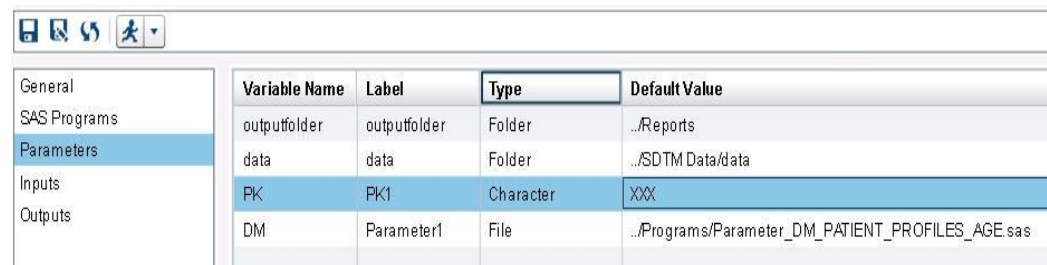
Automated Job

SAS® LSAF also supports to create Job files which specify one or more SAS programs (See [Display 17](#)) and Parameters (See [Display 18](#)), assign the inputs that are required to run the SAS programs, and indicate the locations in which to store the outputs of the SAS programs.

For maximum flexibility, professionals can specify Relative Paths for files that are associated with a job. This feature enables you to copy a Job from one study to another study due to the similar structure. So the job can then be reused with minimal changes or no changes, to build up the robust routine to bring diverse codes of clinical data together repeatedly for different trials. With SAS® LSAF Job files, you don't need to rebuild your code span different trails.



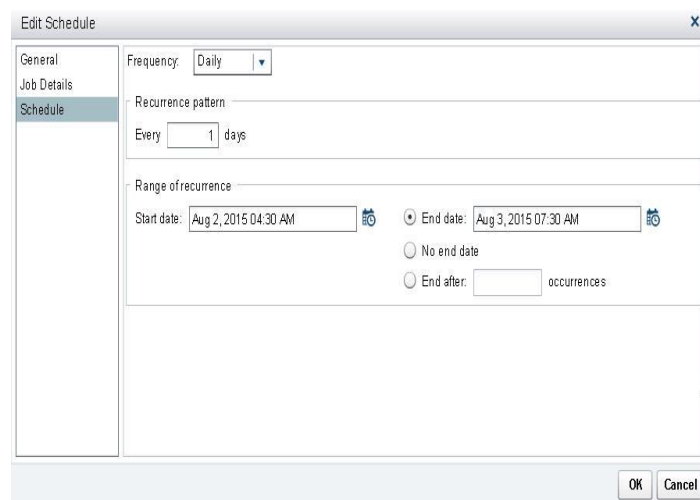
Display 17. Create Job specify batches SAS programs with Relative Path



Display 18. Add Parameter to Job file with Relative path

Schedule Job

SAS® LSAF also supports Schedule Job (See [Display 19](#)) which enables you to specify any time to run your Job file automatically. Here is the scenario when Data Manger specifies time range to load the Patient Data from Hospital or laboratory in the early morning of the day; however, Data Manger need not be in the office since everything could be done automatically by Schedule Job.



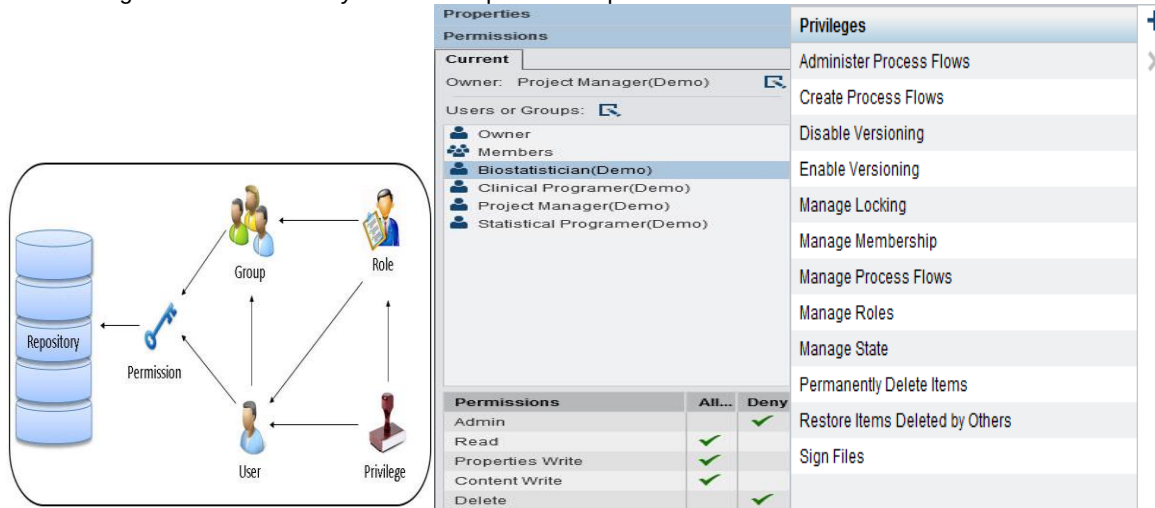
Display 19. Schedule Job file

Module 3-Collaboration works

Security Collaboration

The target users of SAS® LSAF serve all kinds of roles in a Pharmaceutical industry, which could Clinical Programmers, Biostatisticians, Medical Writer, Laboratory Technicians, Trail Designer, Data Manager, Project Manager, QA, IT... Those roles may come from sponsor or CRO or different investigation sites or LAB or Hospital, SAS® LSAF responses to ensure security for those roles work together in the same framework with two key features as follows: (See [Display 21](#))

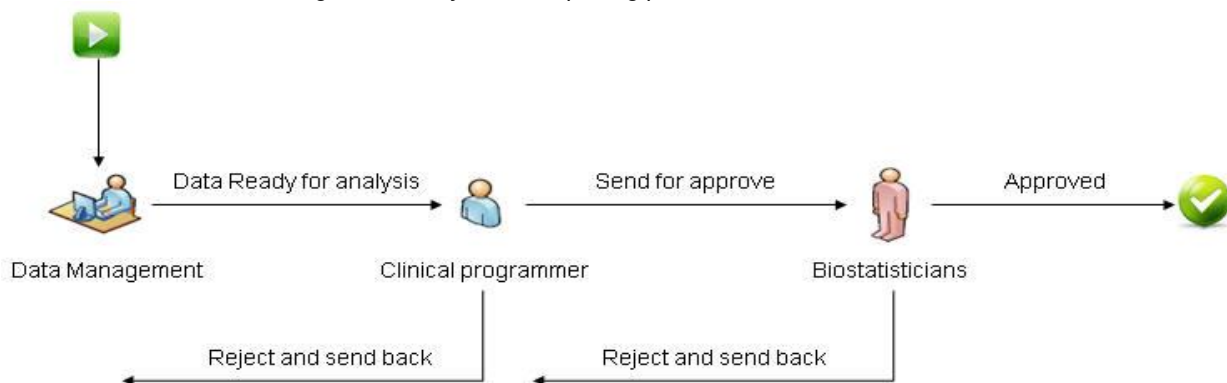
- Permission - Control allocates access rights to specific Project, Analysis, Studies, Folder, Files
- Privilege - Control the ability of a user to perform a specific task



Display 21. Protect Work Collaboration Security with Permission & Privilege

Workflow Process Collaboration

Tables, Displays, listings and data transformations could be delivered in SAS® LSAF by - Workflow. A Workflow contains one or more tasks workflow capabilities that aid organization and oversight for analysis and reporting activities. With System Job task, Notification Task and User task being integrated to Workflow, Workflow capabilities help to provide immediate and ongoing insight to project progress. Also Workflow enables all kinds of Roles in pharmaceutical organization to do collaborative works together in the same process, thus enabling better control and deployment of resources as well as the streamlining of clinical R&D processes (See [Display 20](#)). Together these lead to more efficient and better organized analysis and reporting processes.

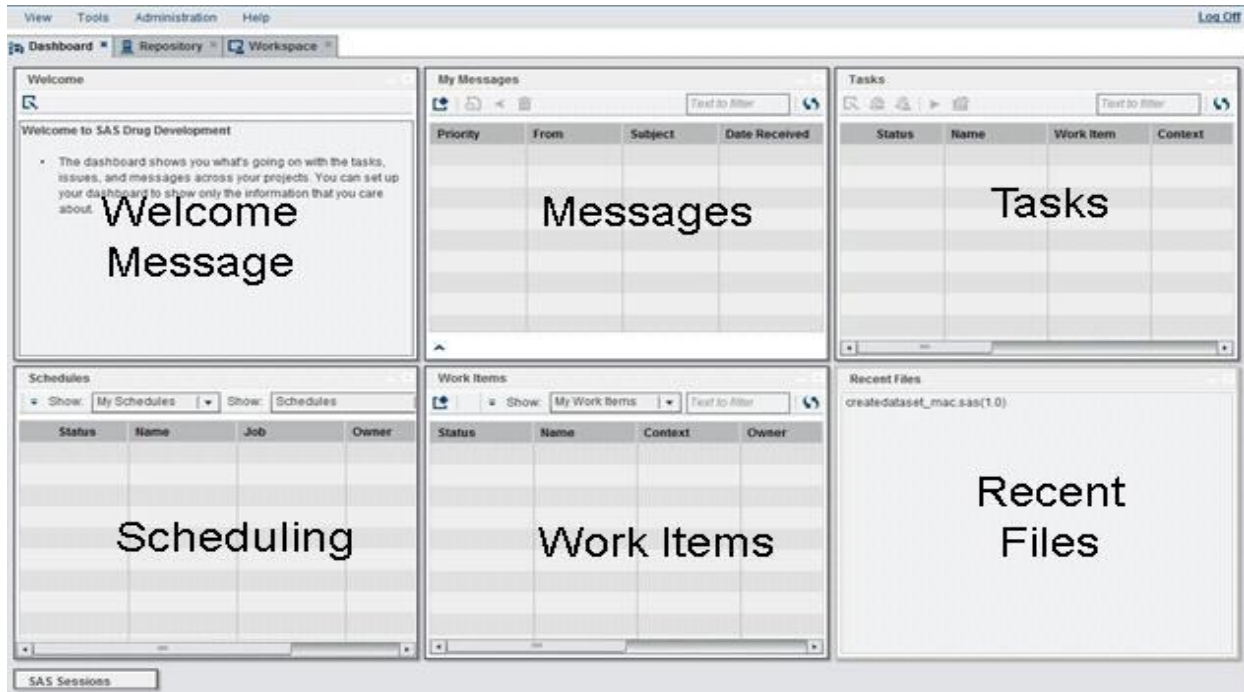


Display 20. A Workflow example demonstrates collaboration module in SAS® LSAF, which involves Data Manager, Clinical Programmer and Biostatisticians to work together to optimize and streamline Clinical Trail process.

Dashboard Collaboration

Under the build-up security collaboration, SAS® LSAF also supports Dashboard Collaboration module which contains the capabilities that all the status in the system activities are presented through the LSAF dashboard. Dashboard

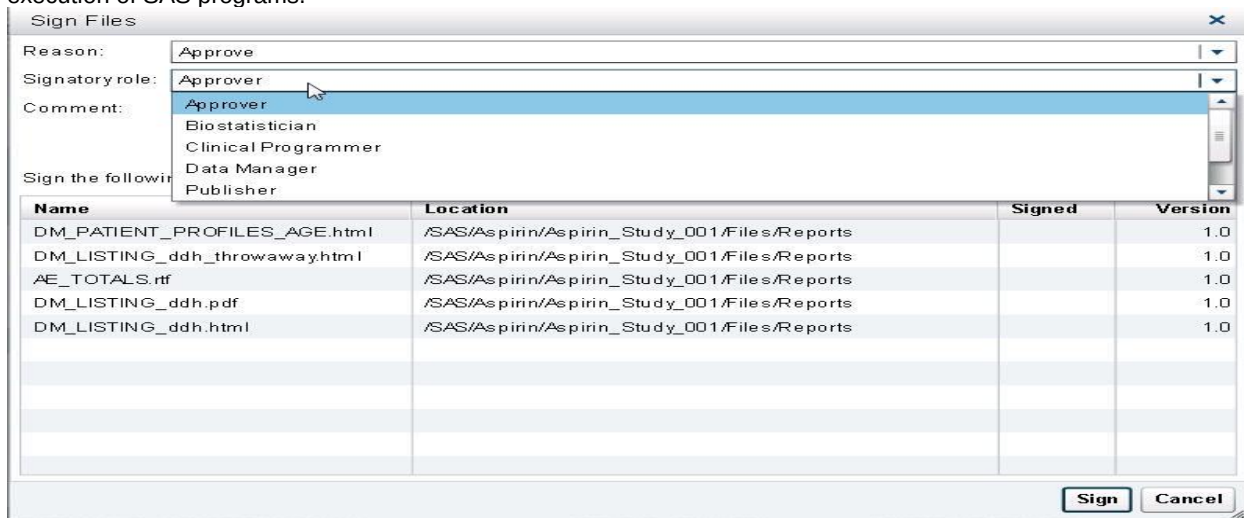
content will vary based upon user privileges, permissions, and personal preferences to make all kinds of roles in pharmaceutical industry works together. Professionals with Dashboard can send message to other user in LSAF, create and manage personal and others' schedule, Workflow, Task and view personal Recent Files. This feature optimizes work collaboration process between Manager and team members for work assignment and delivers high efficiency result, enables Manager handle project status and quality clearly. Obviously, SAS® LSAF collaboration modules make pharmaceutical organization collaboration work more smoothly. (See [Display 22](#))



Display 22. Dashboard Collaboration Module in SAS

Module 4-Regulatory Compliance

Finally the data stored in SAS® LSAF can be processed to generate FDA submission package because of SAS® LSAF is a regulation compliance framework which conforms with 21 CFR Part11 and GxP. The electronic records and signatures are trustworthy, reliable, and generally equivalent to paper record (See [Display 23](#)). The solution provides a secure repository for analyzing and reporting on clinical research information and gives organizations confidence and peace of mind by incorporating compliance and control capabilities with the development and execution of SAS programs.



Display 23. Electronic Signature

Also for a modern clinical IT solutions to conform with regulation policy 21 CFR Part11, each action from the even preliminary metadata-level to the ultimate submission must be traceable in electronic by SAS LSAF Audit. (See [Display 24](#))

Object	Name	Location	Action	Acted On By (User Name)	Mode	Date Acted On
File	DM_PATIENT_PROFILES_AGE.ht...	/SAS/Aspirin/Aspirin_Study_001.F...	Uploaded	scnjul (Emma Liu)		Aug 01, 2015 09:54:28 PM GMT+08...
File	DM_PATIENT_PROFILES_AGE.ht...	/SAS/Aspirin/Aspirin_Study_001.F...	Versioning enabled	scnjul (Emma Liu)		Aug 01, 2015 09:54:28 PM GMT+08...
File	DM_PATIENT_PROFILES_AGE.ht...	/SAS/Aspirin/Aspirin_Study_001.F...	Owner changed	scnjul (Emma Liu)		Aug 01, 2015 09:54:28 PM GMT+08...
File	DM_PATIENT_PROFILES_AGE.ht...	/SAS/Aspirin/Aspirin_Study_001.F...	Permissions created	scnjul (Emma Liu)		Aug 01, 2015 09:54:28 PM GMT+08...
Folder	Reports	/SAS/Aspirin/Aspirin_Study_001.F...	File added	scnjul (Emma Liu)		Aug 01, 2015 09:54:28 PM GMT+08...
File	DM_PATIENT_PROFILES_AGE.ht...	/SAS/Aspirin/Aspirin_Study_001.F...	Associated	scnjul (Emma Liu)		Aug 01, 2015 09:54:28 PM GMT+08...
File	DM_PATIENT_PROFILES_AGE.ht...	/SAS/Aspirin/Aspirin_Study_001.F...	Created	scnjul (Emma Liu)		Aug 01, 2015 09:54:28 PM GMT+08...
File	DM_LISTING_InputTitle.rtf	/SAS/Aspirin/Aspirin_Study_001.F...	Uploaded	scnjul (Emma Liu)		Aug 01, 2015 09:54:28 PM GMT+08...

Attribute	From	To
Version		1.0

Display 24. Audit History

SUMMARIZATION- CLINICAL ANALYTICS FRAMEWORK

Per above modules, we can see how SAS® LSAF resolves Clinical data analytics and collaboration related works that by saving time on operational data activities and focus more on analysis of the data. We can also see that with the implementation of security collaboration model, time and resources in the clinical Trial could be saved to make more effort in Analytics.

Actually besides publishing Standardize data from SAS® CDI to SAS® LSAF, SAS® LSAF also supports to call **SAS® CST – Clinical Standard Toolkit** macros in the implemented SAS development environment with running SAS Code to do data validation and data transformation related works, this making SAS® LSAF as an independently frameworks which could handle all the Clinical works even without purchasing SAS® CDI.

Further, when professionals need Data Exploration with the Analytics result, we see that Clinical Programmers in SAS® LSAF still need to design custom SAS Code with SAS/GRAPH produces to generate Visualized Report. Now let's leverage to the next step to see how SAS Solutions works in Data Exploration.

DATA EXPLORATION

When there is standardized, trusted, high-quality Clinical data ready for analysis and exploration; We need a better way for Data Visualization instead of writing a lot of custom SAS code to generate graphic. Suppose there are some business situations: for a business analyst to compare clinical trial spend versus similar past trials; for a clinical research associate to easily see which research sites require more Risk based monitoring; for a data scientist to quickly and easily explore adverse event data for outliers; for a medical writer to attain graphical lab results and patient profiles; for Fraud Detection when submit data to Regulatory; for a CEO to immediately gets high-level dashboards of operational performance. In this section, I will demonstrate another “SAS LEGO toy” – SAS® JMP Clinical to meet all above situations.

SAS® JMP CLINICAL

SAS® JMP Clinical – software designed to streamline the drug development process. This customized tool provides sophisticated analysis of safety review data collected during clinical trials of new prescription drugs. SAS® JMP Clinical possesses data visualization capabilities and a user-friendly environment; so that medical reviewers – many of whom are physicians with little training in statistics or code design experience– are able to easily discover patterns and hidden trends in data on adverse events, concomitant medications, lab results and patient profiles.

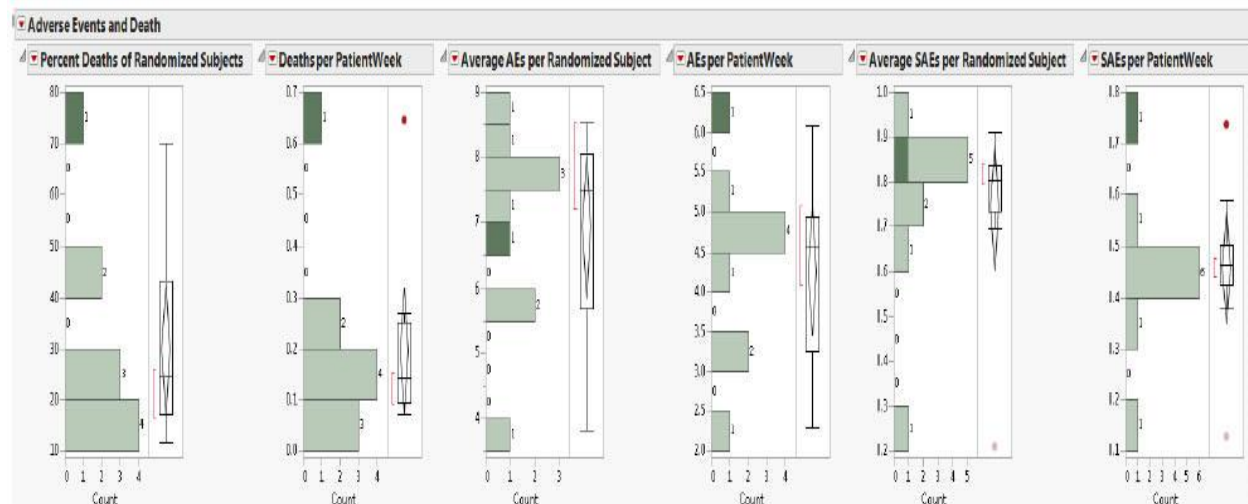
Risk-Based Monitoring and Fraud Detection in Data Quality

As current on-site monitor practice are frequency based to provide generalized quality control at investigational sites.

JMP Clinical provides Risk Based Monitoring modules to monitor important study parameters historically and uses adaptive on-side monitoring to further support site process, subject safety, and data quality. (See [Display 25 & 26](#)). JMP Clinical also provide Fraud Detection module to monitor the fake data to control data quality (See [Display 27](#)).

Study Site Identifier	Country	City	State or...	Monitor	Overall Risk Indicator...	Overall Risk Indicator...	Overall Risk Indicator...	Overall Risk Indicator...	Overall Risk Indicator...
1 01	USA	New York	NY	Monitor G	0.518	0.441	0.056	0.607	0.603
2 02	USA	Orlando	FL	Monitor F	0.257	0.637	0.448	0.218	0.047
3 03	USA	Indianapolis	IN	Monitor E	0.127	0.205	0.497	0.000	0.069
4 04	FRA	Paris	Ile-de	Monitor I	0.522	0.535	0.027	0.000	0.773
5 05	ITA	Milano	Lomb...	Monitor H	1.729	1.288	3.660	2.120	1.498
6 06	USA	Philadelphia	PA	Monitor G	1.443	2.481	1.289	0.000	1.431
7 07	CHN	Guangzhou	Guang	Monitor K	1.367	1.682	1.107	0.000	1.709
8 08	GBR	Birmingham	Birmi	Monitor J	0.593	1.149	1.052	0.000	0.435
9 09	CAN	Montreal	Queb	Monitor A	0.301	0.400	0.629	0.356	0.178
10 10	USA	Baltimore	MD	Monitor G	0.287	0.687	0.432	0.000	0.158
11 12	DEU	Berlin	Berlin	Monitor H	0.483	0.881	1.346	0.008	0.299
12 14	CAN	Toronto	Ontar	Monitor A	0.437	0.552	0.850	1.368	0.000
13 16	USA	Seattle	WA	Monitor B	0.662	0.597	1.282	0.669	0.589
14 17	USA	Los Angeles	CA	Monitor C	0.370	1.072	0.327	0.000	0.151
15 18	JPN	Osaka	Osaka	Monitor L	0.529	0.548	1.155	0.109	0.556
16 19	CAN	Ottawa	Ontar	Monitor A	0.721	0.368	0.682	1.178	0.752
17 20	FRA	Marseille	Prove	Monitor I	0.152	0.286	0.382	0.027	0.088
18 21	ESP	Barcelona	Catal	Monitor I	0.379	0.420	0.169	0.000	0.520
19 22	CAN	Calgary	Alber	Monitor B	0.508	1.209	0.058	0.067	0.381
20 23	USA	Chicago	IL	Monitor E	0.174	0.136	0.095	0.225	0.188

Display 25. Traffic-Light System at Site or Country Level



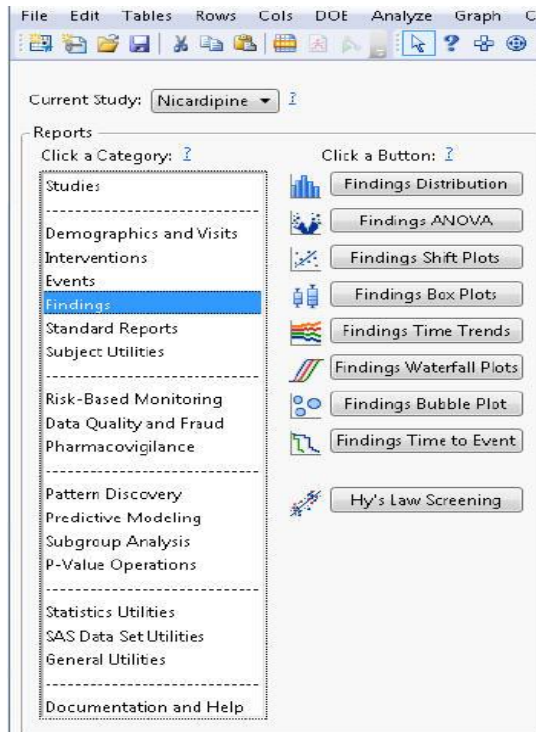
Display 26. Histogram & Box Plot at Site or Country Level

Birthdays and Initials	Holiday	Weekday	Country	Study Site Identifier	Date Label
Cluster Subjects Across Study Sites	No Holiday	Friday	USA	201001	Visit Start Date
Weekdays and Holidays	Christmas	Wednesday		201001	Demography Date
Add Holiday or Event	New Year's Day	Tuesday		201001	Medical History Date
Edit Holiday and Event Data Set	Thanksgiving Friday (USA)	Monday		201001	
Perfect Scheduled Attendance	Good Friday	Thursday		201001	
Constant Findings	Easter Monday	Saturday		201001	
Duplicate Records	Columbus Day (USA)	Sunday		201001	
Digit Preference	President's Day (USA)			201001	
Multivariate Inliers and Outliers	Martin Luther King, Jr. Birthday			201001	
Cluster Subjects Within Study Sites	Easter			201001	
	Veteran/Remembrance Day			201001	
	Christmas (Observed)			201001	
	Independence Day (USA)			201001	
	New Year's Day (Observed)			201001	
	Thanksgiving Day (USA)			201001	
	Memorial Day (USA)			201001	
	Labor Day (USA)			201001	

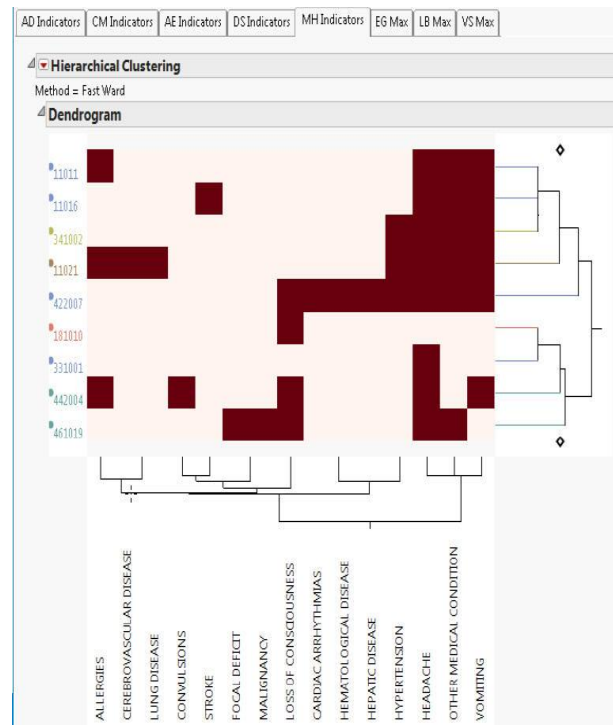
Display 27. Fraud rules reflect Fraud Detection

Automation and Visualization in Data Analysis

SAS® JMP Clinical is implemented with CDISC standard using Study Data Tabulation Model (SDTM) and Analysis Data Model (ADaM) data standard for data analysis in term of automation and visualization, so that many of whom are physicians with little training in statistics or code experience are able to easily discover patterns and hidden trends in data on adverse events, concomitant medications, lab results and patient profiles.



Display 28. Specify Report Condition rules



Display 29. Automatically generate standardization report

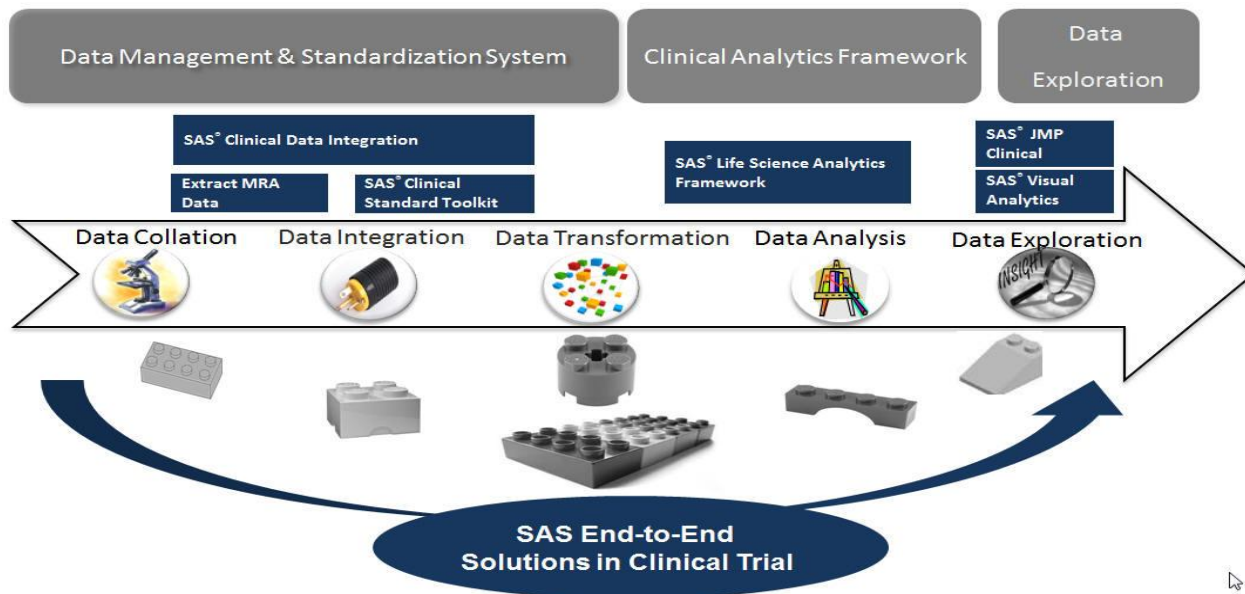
SUMMARIZATION-DATA EXPLORATION

We can see that with SAS® JMP Clinical straightforward user interface and primary reliable graphical summary results, professionals can easily explore data to identify outliers or safety or quality concerns, and everyone from the clinical trial team can speak the “same language”.

Actually besides SAS® JMP Clinical, SAS also provide a Data Exploration solution which is **SAS® VA- Visual Analytics** which provides a robust business intelligence platform embedded with approachable clinical analytics, visual exploration, data discovery, report and SAS Mobile BI in one single solution that meets needs of any big data exploration challenge.

Further, a seamless connection of Data Analytics - SAS® LSAF with Data Exploration -JMP® Clinical and SAS® VA has been launched.

CONCLUSION



See the coming through, SAS provide a seamless connection with each “SAS LEGO toy” through the whole End-to-End process in Clinical Trail. Also each solution plays specific roles in Data Management, Data Standardization, Data Analytics and Data Exploration as bellows:

- **SAS® CDI** - Enables pharmaceutical organization combine various data to the reusable data structure module with integrating of CDISC standard to output with the trusted and standardized data via repeatable Job routines in the Graphic User Interface instead of writing SAS Code to make works automatically.
- **SAS® CST** – Saves Clinical Programmer time of writing larger amounts of SAS Code to achieve data Validation and Transformation related works which complies with CDISC standard to output trustable and standardized data via free toolkit.
- **SAS® LSAF** – Provides a SAS development environment for professionals do data development and analytics in the historical and ongoing Clinical data warehouse, involves all sites all roles of pharmaceutical professionals works together in a security collaboration module with workflow process, and also conforms with the regulatory compliance environment of implementing 21 CFR Part11 to provide the high quality package to shorten FDA data review cycles.
- **SAS® JMP Clinical** -Applies predictive sciences and automatic data visualization in data exploration, to better simulate or predict which compounds are likely to fail, to better monitor which sites have high risk, to better detect fraud problem which will affect data quality, to better visualize clinical data before submission using integrated safety and summary analysis.
- **SAS® Visual Analytics** – Provides Clinical Study Visualization in Demographic Analysis, Adverse Event Analysis, Patient Profile Analysis, Lab Analysis and Clinical Analytics...Provides visual exploration report and SAS Mobile BI that meets needs of any Clinical Data exploration challenge.

In the end, with above “SAS LEGO Toys”, no matter being as single solution or seamlessly integrated as SAS End-to-End solutions in Clinical Trail, pharmaceutical organizations are freed up to start using advanced analytics to derive real insight from clinical data to accelerate drug development process.

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SAS® Drug Development 4.5: User's Guide

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