Using Open Source Approaches to Automate Research Data Management

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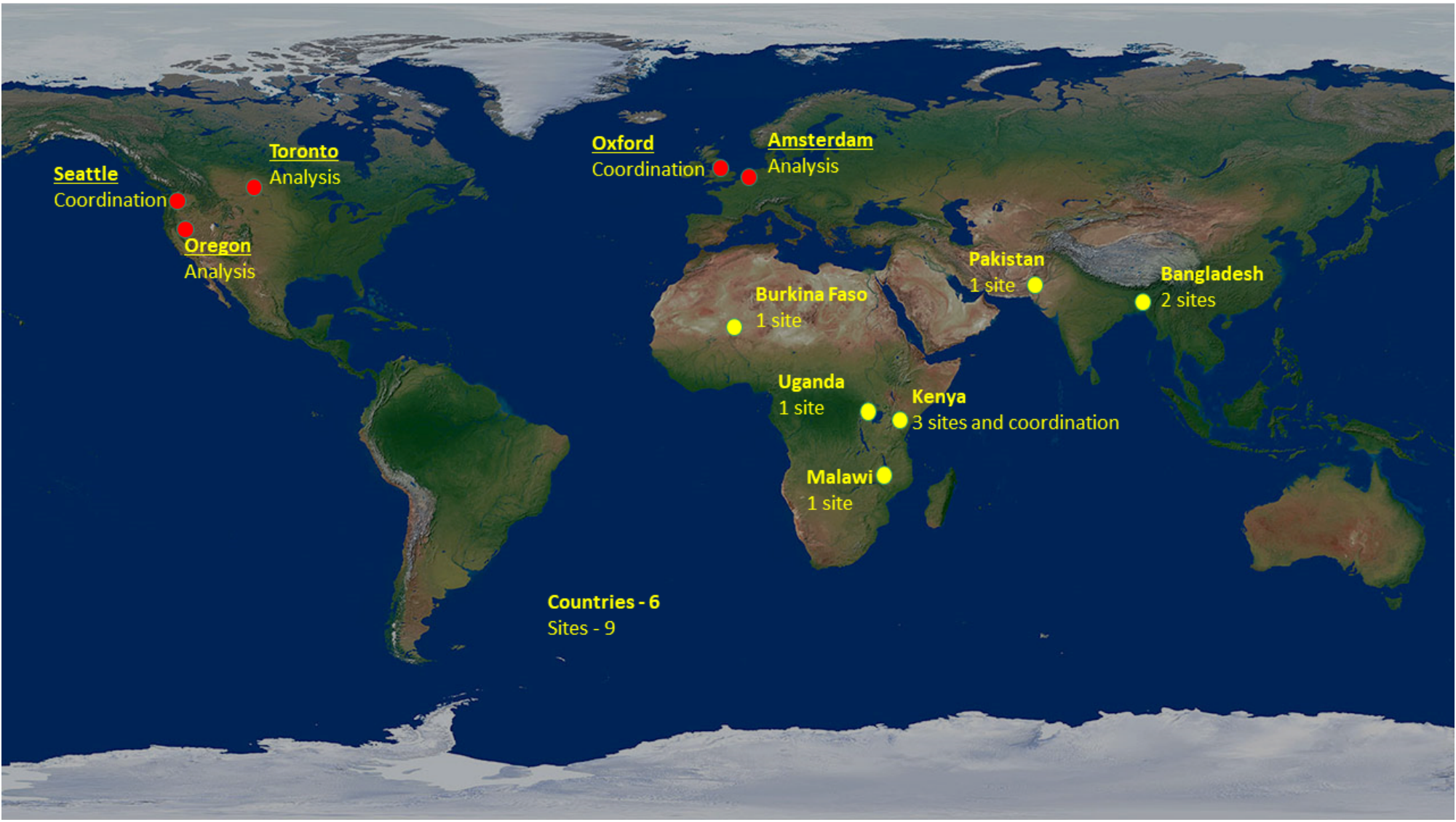
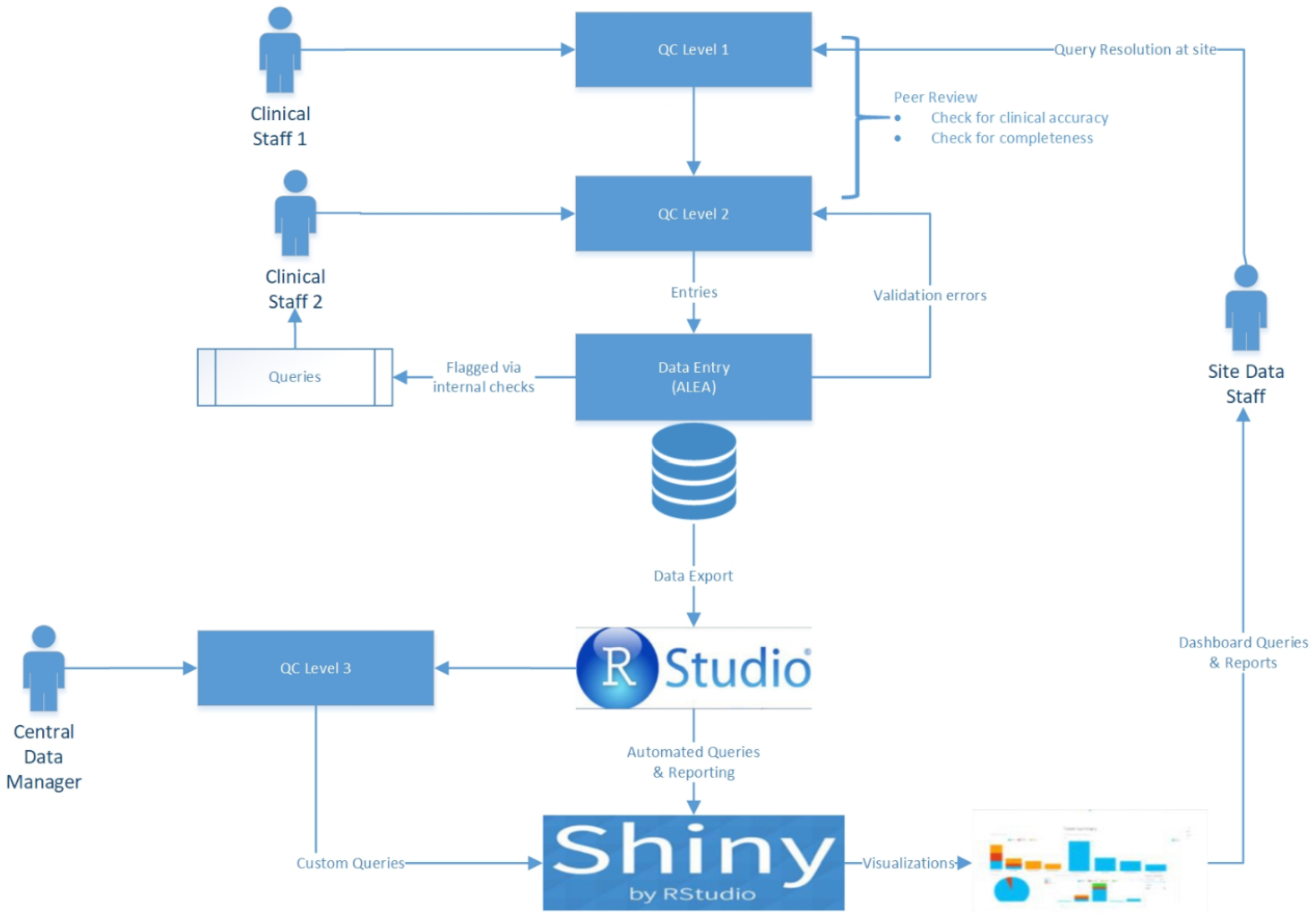
Contents

1. Introduction
2. Proposed QC model
3. Implementation
4. Fitting the pieces together
5. The Gains
6. The reality check
7. The Challenges
8. Future thoughts

- All health research involves collecting, managing and processing of study data.
- Data management can be costly and unaffordable in developing countries.
- Good data management is important and beneficial to the success of any study.
- Potential data management issues.
  - Data from different sources
  - Complex study designs (longitudinal)
  - Multiple individuals conducting data entry
- Open source technologies can be used to monitor real time data quality checks and up-to-minute study progress.


Seattle
Coordination
Toronto
Analysis
Oregon
Analysis
Oxford
Coordination
Amsterdam
Analysis
Pakistan
1 site
Bangladesh
2 sites
Burkina Faso
1 site
Uganda
1 site
Kenya
3 sites and coordination
Malawi
1 site
Countries - 6
Sites - 9

- Main cohort (4,714 records, 1,563 variables over 23 unique eCRFs)
- Over seven sub-studies (2,658 records, 1,985 variables over 46 unique eCRFs)
- Variables on demographics, clinical features, mental health, socio-economic phenotyping etc.
- Lab meta-data and patients' test results (long data), approx. 0.95 million records on more than 80 non-processed variables.
- 48 hour turn-around time for data base update (KIDMS for lab data and REDCap for clinical data)


Clinical Staff 1
QC Level 1
Query Resolution at site
Peer Review
Check for clinical accuracy
Check for completeness
Clinical Staff 2
QC Level 2
Entries
Validation errors
Site Data Staff
Queries
Flagged via internal checks
Data Entry (ALEA)
Data Export
Dashboard Queries & Reports
Central Data Manager
QC Level 3
RStudio
Automated Queries & Reporting
Custom Queries
Shiny by RStudio
Visualizations

- A sub-set of risk based approaches to data management.
- Real-time check on both item and variable missingness.
- Up-to-minute capturing of data inconsistency and anomaly detection.
- Standardized yet interactive study progress reports (accrual curves, lost to follow up and missed visits summaries).
- Customized utility reports for planning future events and tracking follow up trajectories by sites.

- REDCap is a mature, secure web application for building and managing online surveys and databases.

- Kilifi Integrated Database Management System. Primary storage for laboratory meta data and test results.

- Rstudio and Shiny: Great combination of both packages & frameworks to produce a dashboard.

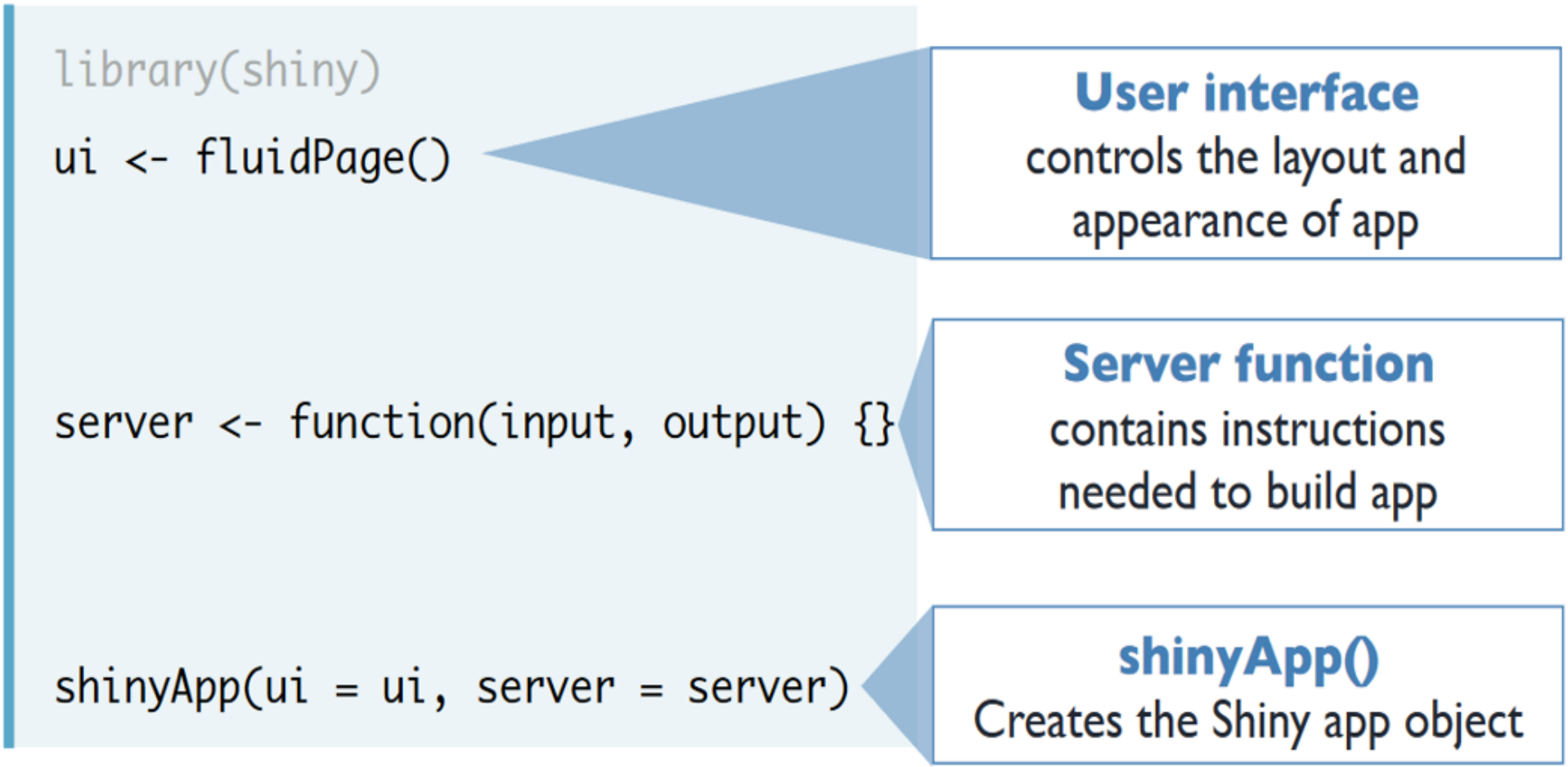
REDCap
Research Electronic Data Capture

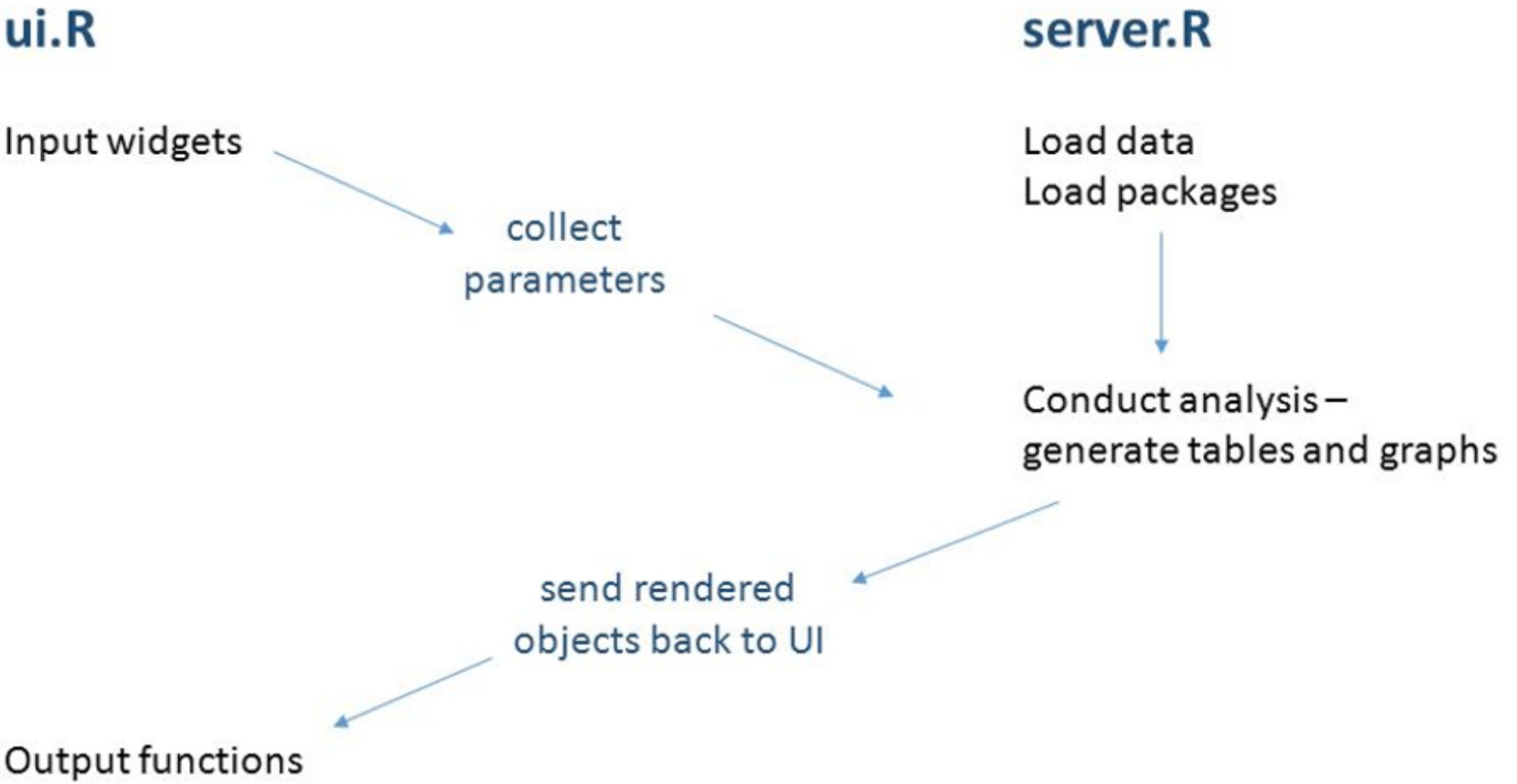
RDBMS (KIDMS)

RStudio

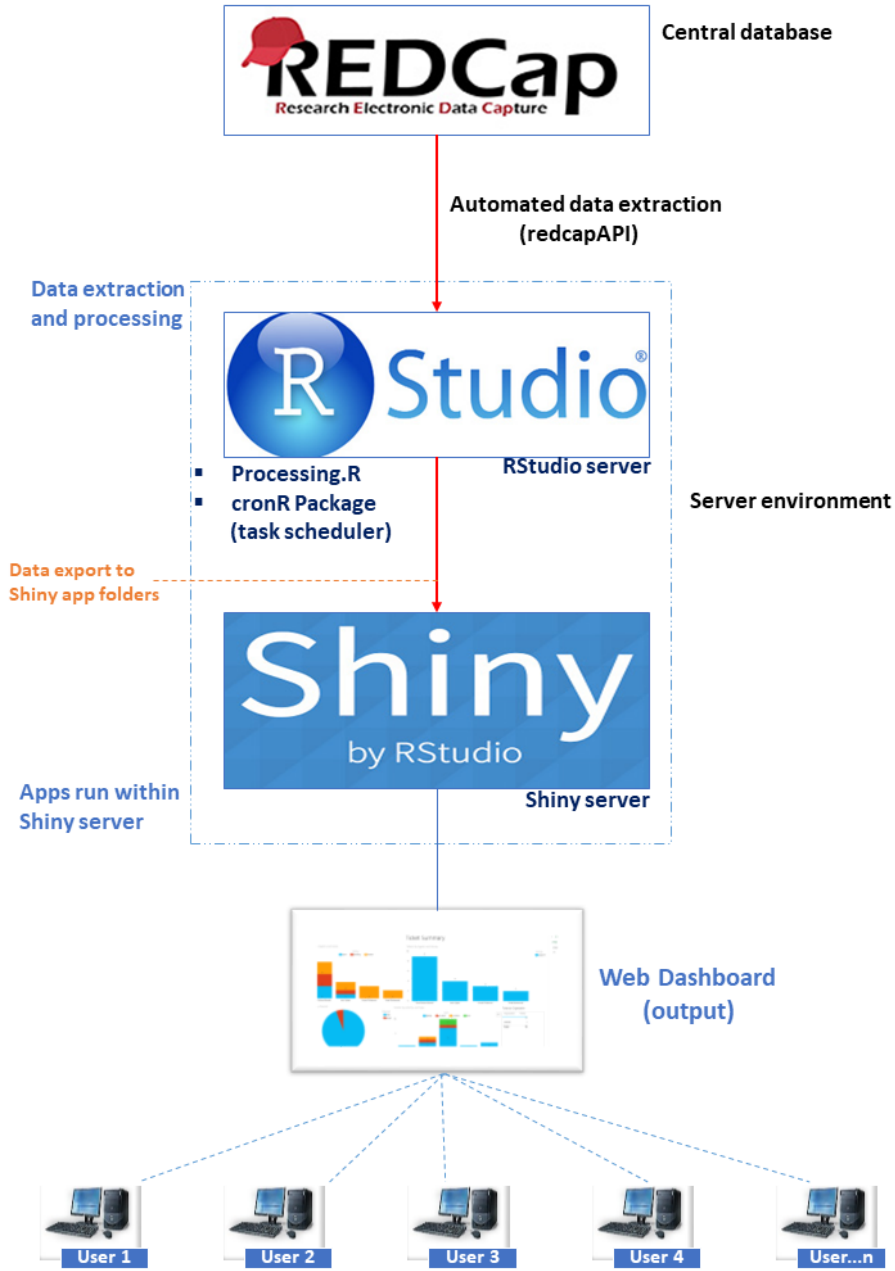
Shiny

The anatomy of a shiny application consist of user interface(ui) and the server section.




ui.R
server.R
Input widgets
collect parameters
Load data
Load packages
Conduct analysis – generate tables and graphs
send rendered objects back to UI
Output functions

- REDCap and KIDMS
  - Central data storage
  - Longitudinal design
  - KIDMS for lab data
- RStudio server
  - Task scheduling
  - Extraction
  - Processing
- Shiny server
  - Cleaning scripts
  - Reports authoring
- The Dashboard
  - Web-based
  - Reports and queries



CHAIN Network Reports Dashboard
Home
Banfora Samples
My Profile
Admin
Hi cmaronga, (Logout)
Clinical Reports (After 31-Jan-2019)
Launch
Clinical Reports (On/before 31-Jan-2019)
Launch
Laboratory Reports
Launch
Laboratory Storage Data
Launch
Clinical QC Reports
Laboratory QC Reports

Clinical Reports | Enrollment summaries | Follow up status | Survival curves | Study visits | Data completeness | Visualizations | About Dashboard

Recruitment summaries

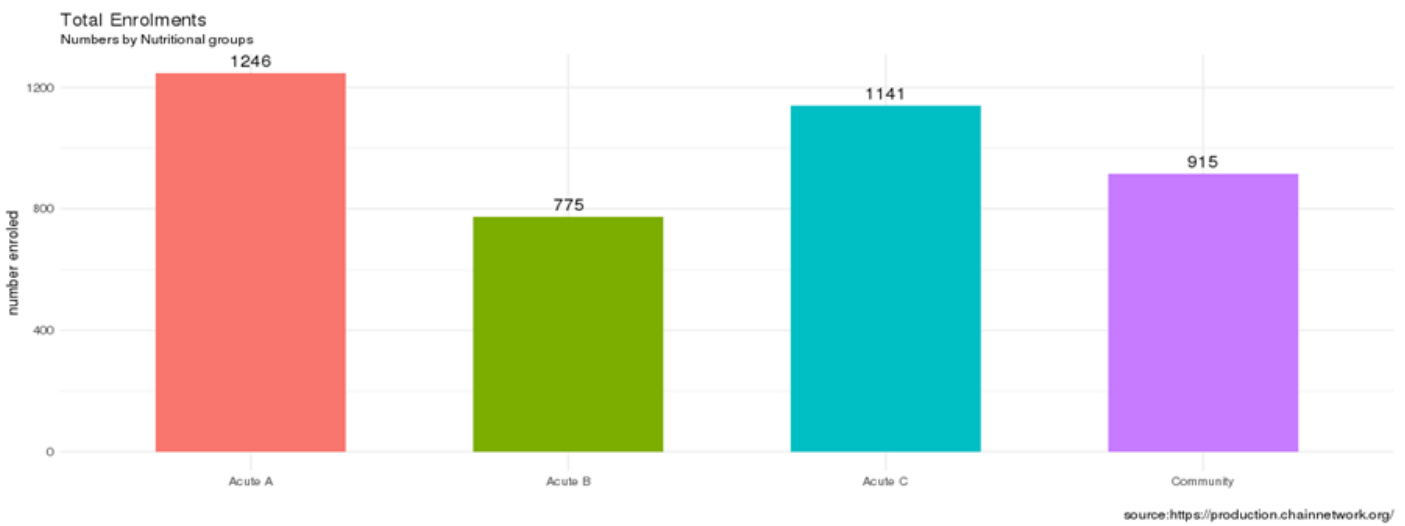
Select Date ranges

2016-11-01 up to 2019-02-11

Select site to view

All sites

Summary | ABC Groups | Enrolment targets | Age distribution | Monthly Enrollments



Missing CBC Results

Show 10 entries Search:

record_id	site	Date	event	test
No data available in table				

Participant discharge Queries | Verbal autopsy queries

Wrong discharge date and/or discharge date left hospital

Show 10 entries

record_id	site	disch_date	disch_date_left_hosp
No data available in table			

Showing 0 to 0 of 0 entries

Absconded patients with MISSING date of absconding(kindly populate Date observations done in the database)

Daily Reviews | Discharge & V.A | Follow up | Home Visits | Screening log | Missed visits | About Dashboard

Study Conclusion | Day 45 Follow Up | Day 90 Follow Up | Day 180 Follow Up

Day 180 follow up date must be before or same as study end

Show 10 entries Search:

record_id	site	Day 180 date	Study end date	comment
30001312	Blantyre	2019-05-17	2019-05-16	Study end happened before day 180
30001328	Blantyre	2019-06-19	2016-06-19	Study end happened before day 180

Showing 1 to 2 of 2 entries Previous 1 Next

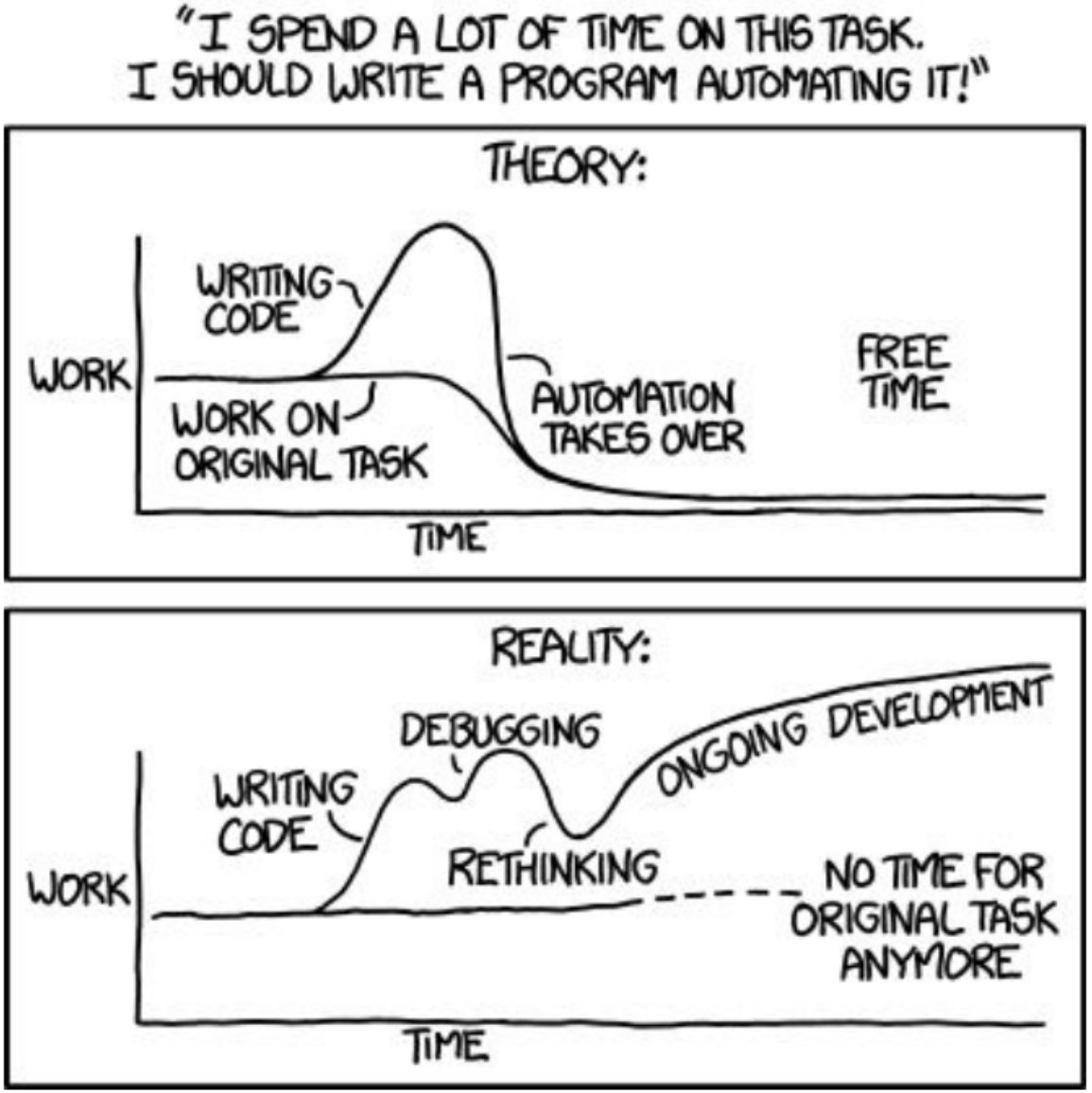
Missing day 180 anthropometry

Show 10 entries Search:

record_id	fu180_visdate	site	fu180_weight	fu180_height1	fu180_height2	fu180_muac1	fu180_muac2	fu
No data available in table								

Showing 0 to 0 of 0 entries Previous Next

- Seamless data extraction and processing with no human intervention.
- Run automated cleaning scripts and monitor data quality checks in real time.
- Up-to-minute access to standardized study reports by sites' PI and study staff.
- Real time study progress reports helped planning of recruitment and other activities.
- Improved productivity of the data team and reduced over-reliance on the CHAIN central team


"I SPEND A LOT OF TIME ON THIS TASK.
I SHOULD WRITE A PROGRAM AUTOMATING IT!"
THEORY:
WORK
WRITING CODE
WORK ON ORIGINAL TASK
AUTOMATION TAKES OVER
FREE TIME
TIME
REALITY:
WORK
WRITING CODE
DEBUGGING
RETHINKING
ONGOING DEVELOPMENT
NO TIME FOR ORIGINAL TASK ANYMORE
TIME

Everything never went smoothly as projected, we faced various challenges

- Dataset grew exceedingly large, slowing down the app. load time.
- Server downtime, making the app. inaccessible sometimes.
- Processing data from different sources concurrently for reporting purposes within the app.

The framework presented here can easily be extended to produce robust and scalable Shiny applications:-

- Spatial data analysis and interactive visualization.
- Data products for statistical analysis and modelling.
- Highly engineered data cleaning and anomaly detection tools

Special thanks to the patients, staff and leadership at our clinical sites.