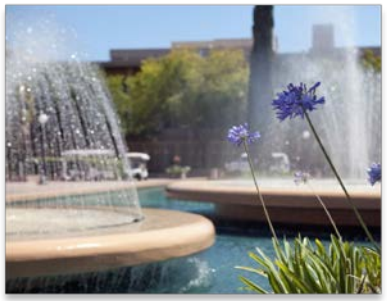
Successes and Lessons Learned in Stanford Medical Center's Transition to the Beaker LIS



Brent Tan, MD, PhD
Director of Laboratory Informatics
Stanford Department of Pathology

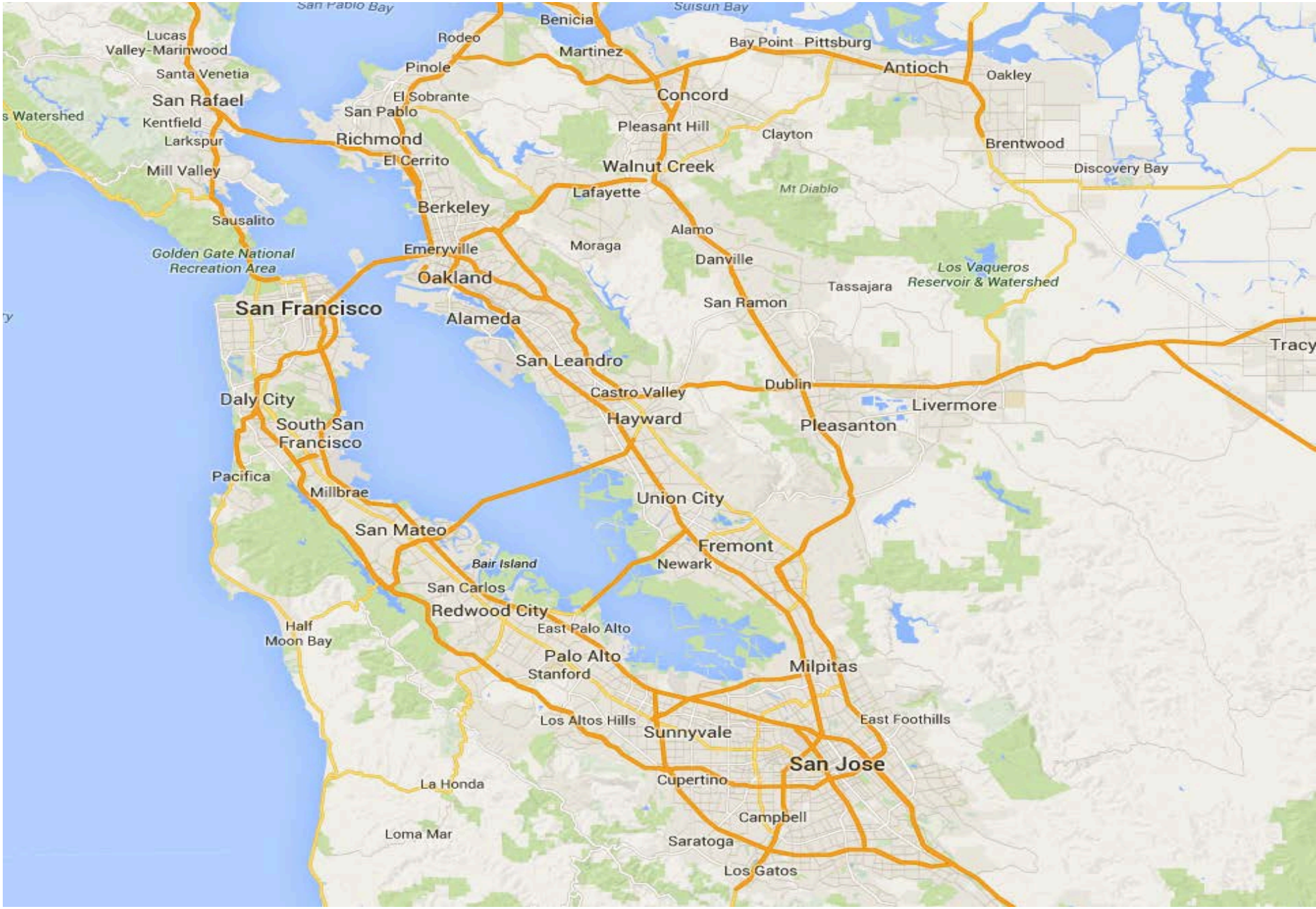
May 5, 2015

Goals

- Review the laboratory information system (LIS) selection process at Stanford
- Review the EPIC Beaker implementation process
- Provide keys to a successful implementation
- Review results of implementation, including key performance indicators

Lecture outline

- Background
  - Stanford Health Care
  - Stanford Children's Hospital
  - Stanford Department of Pathology
  - Pre-Beaker IT landscape
  - New LIS selection process
- Implementation
  - Planning (Epic phase 0)
  - Design (Epic phases 1-2)
  - Build (Epic phase 3)
  - Testing (Epic phase 4)
  - Training (Epic phase 4)
  - Go live (Epic phase 5)
    - Cut over plan
    - Support plan
- Results
  - Key performance indicators (KPIs)
  - Other metrics
- Managerial lessons
  - *Things we did well*
  - *Things we could have been done better*


San Pablo Bay
Suisun Bay
Benicia
Rodeo
Martinez
Bay Point
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Antioch
Oakley
Lucas Valley-Marinwood
Santa Venetia
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San Rafael
El Sobrante
Concord
San Pablo
Kentfield
Pleasant Hill
Clayton
Brentwood
Larkspur
Richmond
El Cerrito
Walnut Creek
Discovery Bay
Mill Valley
Lafayette
Mt Diablo
Berkeley
Sausalito
Alamo
Moraga
Emeryville
Golden Gate National Recreation Area
Danville
Los Vaqueros Reservoir & Watershed
Oakland
Tassajara
San Ramon
San Francisco
Alameda
Tracy
San Leandro
Dublin
Castro Valley
Daly City
Livermore
Hayward
South San Francisco
Pleasanton
Pacifica
Millbrae
Union City
San Mateo
Fremont
Bair Island
Newark
San Carlos
Redwood City
Half Moon Bay
East Palo Alto
Palo Alto
Milpitas
Stanford
Los Altos Hills
East Foothills
Sunnyvale
San Jose
La Honda
Cupertino
Campbell
Loma Mar
Saratoga
Los Gatos

Stanford Hospital & Clinics

Mission

- To CARE for the patient, each other, and about what we do
- To EDUCATE patients and families, and other customers; and to advance our own knowledge
- To DISCOVER new treatments and technologies, and new ways of improving care

Vision

Healing humanity through science and compassion, one patient at a time.

Summary

- Licensed Beds – 613 Beds
- Adult Acute Care – 466 Active Beds
  - 59 Intensive Care
  - 8 Coronary Care
  - 369 General Medical/Surgery
  - 30 Acute Psychiatric
- Surgical Services
  - 33 Operating Suites
    - 21 Main OR
    - 12 Ambulatory Surgery
  - 14 Cath-Angio Suites
  - 6 Outpatient Surgery Units at Redwood City
- Transplant Center, Level 1 Trauma Center, Comprehensive Cancer Center
- EMR: EPIC since 2008

Renewal Project: Expansion of SHC

- **Renewal Project - Broke ground May 1, 2013**
  - To assure adequate capacity
  - To meet State-mandated earthquake safety standards
  - To provide modern, technologically-advanced hospital facilities
  - To replace outdated lab facilities at the School of Medicine and other areas (e.g. Hoover Pavilion, roads)
- **Stanford Hospital – to be completed 2018**
  - Individual patient rooms
  - Enlarged Level-1 trauma center and Emergency Department serving both hospitals
  - New surgical, diagnostic, and treatment rooms
  - Additional 144 patient beds at Stanford Hospital & Clinics

View of the New Stanford Hospital from Welch Road

Arcade at New Stanford Hospital

Lucile Packard Children's Hospital

Mission

To serve our communities as an internationally recognized pediatric & obstetric hospital that

- Advances family-centered care
- Fosters innovation
- Translates discoveries
- Educates health care providers and leaders
- Advocates on behalf of children and expectant mothers

Vision

To drive innovation in the most challenging areas of pediatrics & obstetrics to improve the quality of life for children & expectant mothers and those who love and care for them.

Summary

- 311 Total Licensed Beds
  - 111 Pediatric Services
  - 89 Intensive Care Newborn Nursery
  - 44 Intensive Care
  - 32 Perinatal Services
  - 35 Unspecified General Acute Care
- Surgical Services
  - 7 Operating Suites
  - 3 Cesarean Section OR Suites
  - 3 Ambulatory Procedure Rooms
- EMR:
  - EPIC 2013 (CERNER prior)

Renewal Project: Expansion of LPCH

- **Lucile Packard Children's Hospital**
  - Launched in Fall 2012; to be completed Winter 2016
  - Compliance with seismic safety regulations and other code requirements
  - Additional 104 patient beds
  - Improved patient safety, privacy, and comfort through individual patient rooms
  - Increased space for families to be with their children during treatment and recovery
  - New surgical, diagnostic, and treatment rooms at both hospitals

Artist's view of the new hospital entrance at Lucile Packard Children's Hospital

Artist's view of the new Welcome Desk at Lucile Packard Children's Hospital

Anatomic Pathology and Clinical Laboratories

Anatomic Pathology

- Autopsy
- Cytopathology
- Dermatopathology
- Electron Microscopy/ Immunofluorescence
- Immunohistochemistry
- Hematopathology
- Neuropathology
- Renal Pathology
- Surgical Pathology

Clinical Laboratories

- Chemistry/Special Chemistry
- Biochemical Genetics
- Hematology/Urinalysis
- Flow Cytometry
- RBC Special Studies
- Coagulation/Special Coag
- Microbiology
- Virology
- Transfusion Services
- Cytogenetics
- Molecular Genetic Pathology
- Point of Care Testing
- Send Out Testing
- Phlebotomy Services
- Preanalytic Processing

Administrative Departments

- Business and Finance
- Customer Service
- Laboratory Education
- Quality Management

SHC - IT

- Lab Systems & Services

Satellite Laboratories

- Bass Lab (SCH)
- Mary Johnson Lab (SCH)
- MOHS Lab
- Redwood City Lab
- San Jose South Campus (August 2015)

Laboratory Campuses

Stanford HEALTH CARE

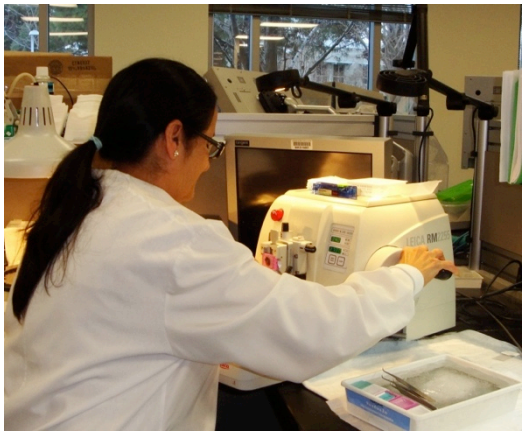
To Redwood City Satellites:
e.g. MOHS Lab

SHC & LPCH Core Clinical, Transfusion, & Anatomic Pathology Labs

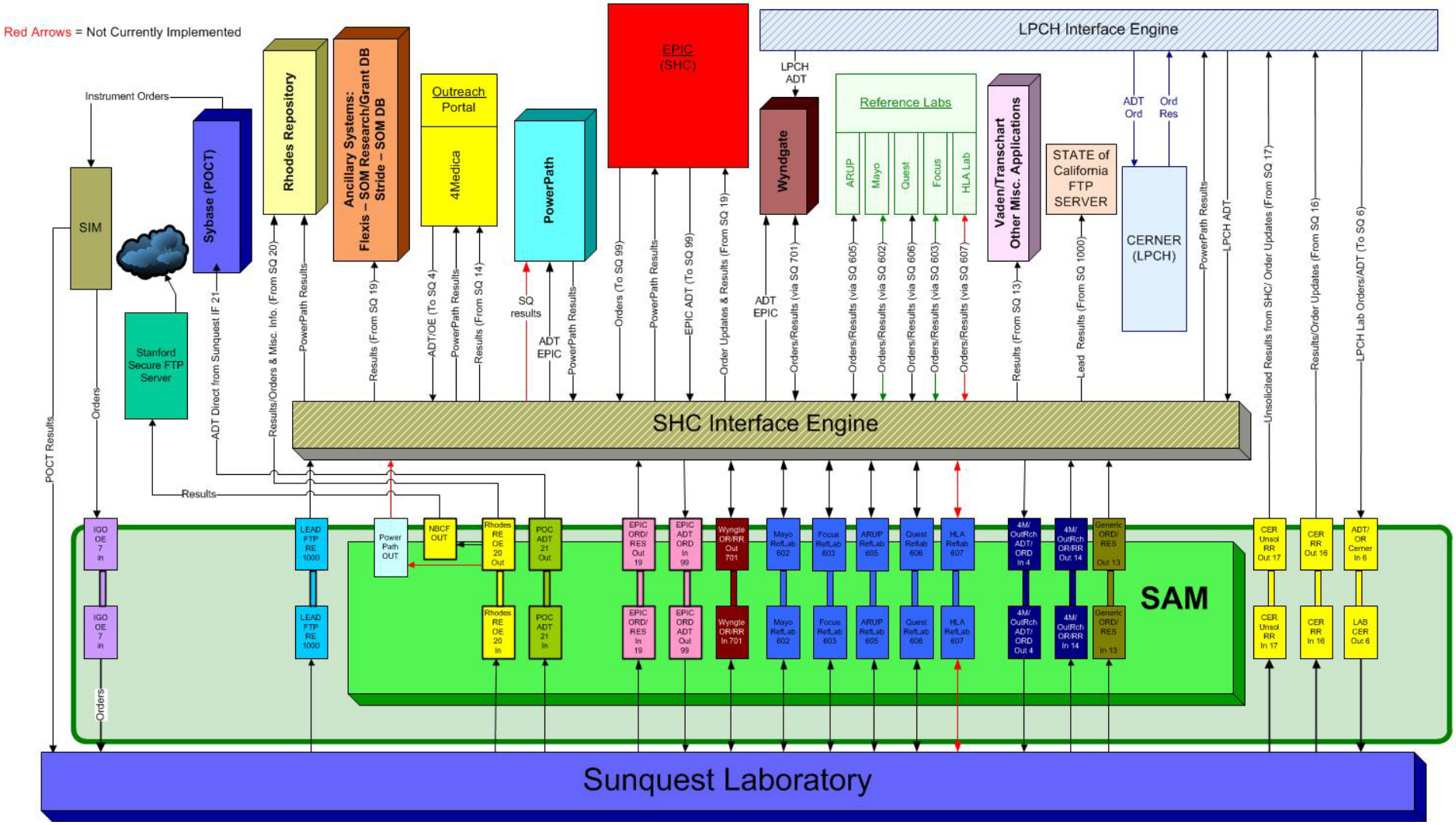
Hillview Labs

Anatomic Pathology and Clinical Laboratories Statistics

- Shared service: Stanford Health Care, Stanford Children's Health, Clinics, and Referred Clients
- Over 5.3 Million Billable Tests in FY2012
- Locations
  - Core Laboratory (SHC)
  - Transfusion Service (SHC)
  - Anatomic Pathology (SHC & Hillview)
  - Specialty Laboratories (Hillview)
  - 12 Patient Service Centers
- Over $1.0 Billion Gross Charges in FY2012
  - 41% SHC Inpatient
  - 59% LPCH, SHC Outpatient & Referral Testing
- $142 Million Expenses
- 22 sections
- 544 Paid FTE's
- 53 Faculty, 17 Clinical Fellows, 36 Residents



Sunquest within IT landscape



Strategic Business Drivers for new LIS

- Planning for the New Hospital
  - Need technology to sustain the Stanford Clinical Laboratory, Stanford Health Care, Stanford Children's Hospital well beyond 2018
    - Based on competing projects, an optimal implementation window is 2012 – 2015
    - Desire for positive-patient identification (PPID)
      - Sunquest required specific hardware for PPID
      - Nurses currently used incompatible hardware for administration of medication.

- Implementing Integrated Systems is an organization al goal
  - Common user interface across functionality
  - Minimize complexity and support costs

Vendor selection governance

- **Steering committee - Final approval of recommended vendor**
  - Laboratory Medical Director
  - Laboratory Administrative Director
  - Director Laboratory Informatics
  - Director of laboratory IT
  - Vice Presidents of Clinical Services (SHC and SCH)
  - CIO (SHC and SCH)

- **Core Team – working group**
  - Laboratory Administrative Director, Director Laboratory Informatics
  - Section Medical Directors, Laboratory Managers, IT personnel (SHC and SCH)
  - Functional requirements development
  - RFP development and response analysis
  - Participation in vendor demonstrations and reference calls
  - Participation in site visits (subset of 4 physicians, 4 lab admin, 3 lab informatics, 2 hospital IT)

High Level Timeline

Activity	Completion Date
Kick off Meeting	June 28, 2011
Requirements	August 12, 2011
RFP Submitted	August 19, 2011
RFPs Received	September 19, 2011
Vendor Demos	November 4, 2011
Technology Calls	November 11, 2011
Reference Calls	December 9, 2011
Site Visits	January 27, 2012
Selection Decision	February 28, 2012
Selection Validation	May 4, 2012

1. *RFPs were sent to a variety of vendors, including Sunquest and EPIC.*
2. *Based on RFP responses, 3 candidate vendors were selected for DEMOS.*
3. *The RFP scores and DEMO scores for the 3 vendors were not significantly different.*

- Request for proposal (RFP):
  - 53 pages
  - 370 questions
    - General (67)
    - PPID (27)
    - Pre analytic (8)
    - Micro/viro (18)
    - Anatomic pathology (26)
    - Molecular pathology (8)
    - Immunostaining (4)
    - Cytogenetics (13)
    - Flow cytometry (10)
    - Blood transfusion services (37)
    - Biochemical genetics (9)
    - Special chemistry (7)
    - Biomed (5)
    - Finance and billing (44)
    - Business intelligence/reporting (12)
    - Technology (75)

Demos and site visits

- Vendor Demonstrations
  - 3 Vendor demos scheduled
  - 127 Scripted scenarios created
- Site visits
  - 1 for Epic, 2 for Vendor 2, 2 for Vendor 3.
    - 5 cities in 5 days!
  - Team: 4 physicians, 4 lab admin, 3 lab informatics, 2 hospital IT.

1. *Site visits were the most informative aspect of the vendor selection process.*
2. *EPIC was the most transparent vendor*
    1. *Functionality at installed systems matched demos.*
    1. *Exhibited the least “salesmanship”.*

High Priority Items

- ✓Integration of Anatomic Pathology and Clinical Pathology.
- ✓Positive Patient ID: specimen collection, blood product administration, medications.
- ✓Specimen tracking through all modules
- ✓Integration with the EMR(s)
- ✓Professional and Technical billing from all modules/applications

Vendor Evaluation

	Epic	Ven 2	Ven 3	Comments
Strategic Partnership	●	◔	◔	Epic: Current SHC partner; Is rapidly developing the Lab system and will be a leader in Lab systems within a few years Gartner: Strong industry trend towards one system for entire hospital, thus "best of breed" vendors are at risk
High Priority items	●	◑	◔	Integration of Clinical Lab and Pathology, Positive Patient ID, Specimen tracking through modules, External Web Portal, Integration with EMR, Professional and Technical billing
Lab Specialty areas	◑	●	●	Epic: Lab module is young, Pathology module is very young, and there not yet separate modules for Cytogenetics, Flow Cytometry, and Molecular Ven 2 and Ven 3: More developed products
Technical	●	◔	◔	Epic: Infrastructure is currently in place; Existing UI and portal is familiar to users; Only vendor moving in direction of HTML5; also touch screen devices
Financial	●	○	◔	Epic: SHC owns Clinical Lab (Beaker) and PPID (Mobile/Rover) so no cost; Pathology module is a relatively modest cost; Esoteric modules will be included in Pathology when developed
References	●	◑	◔	Epic: References said they are good to work with and are customer focused

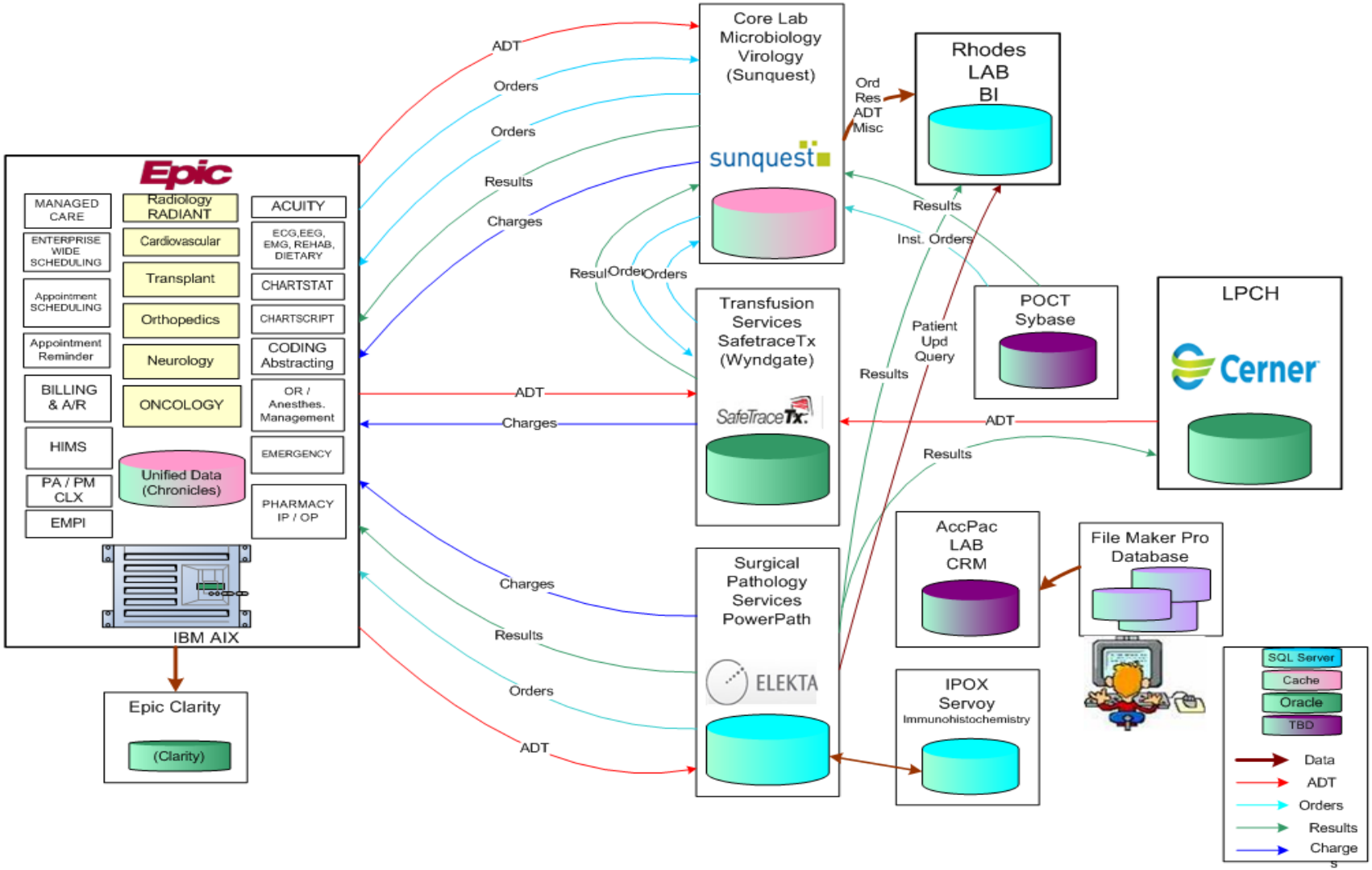
Selection Summary

"Epic is recommended as the best long term solution for the hospital" – decision by formal vote of the site visit team, February 28, 2012.

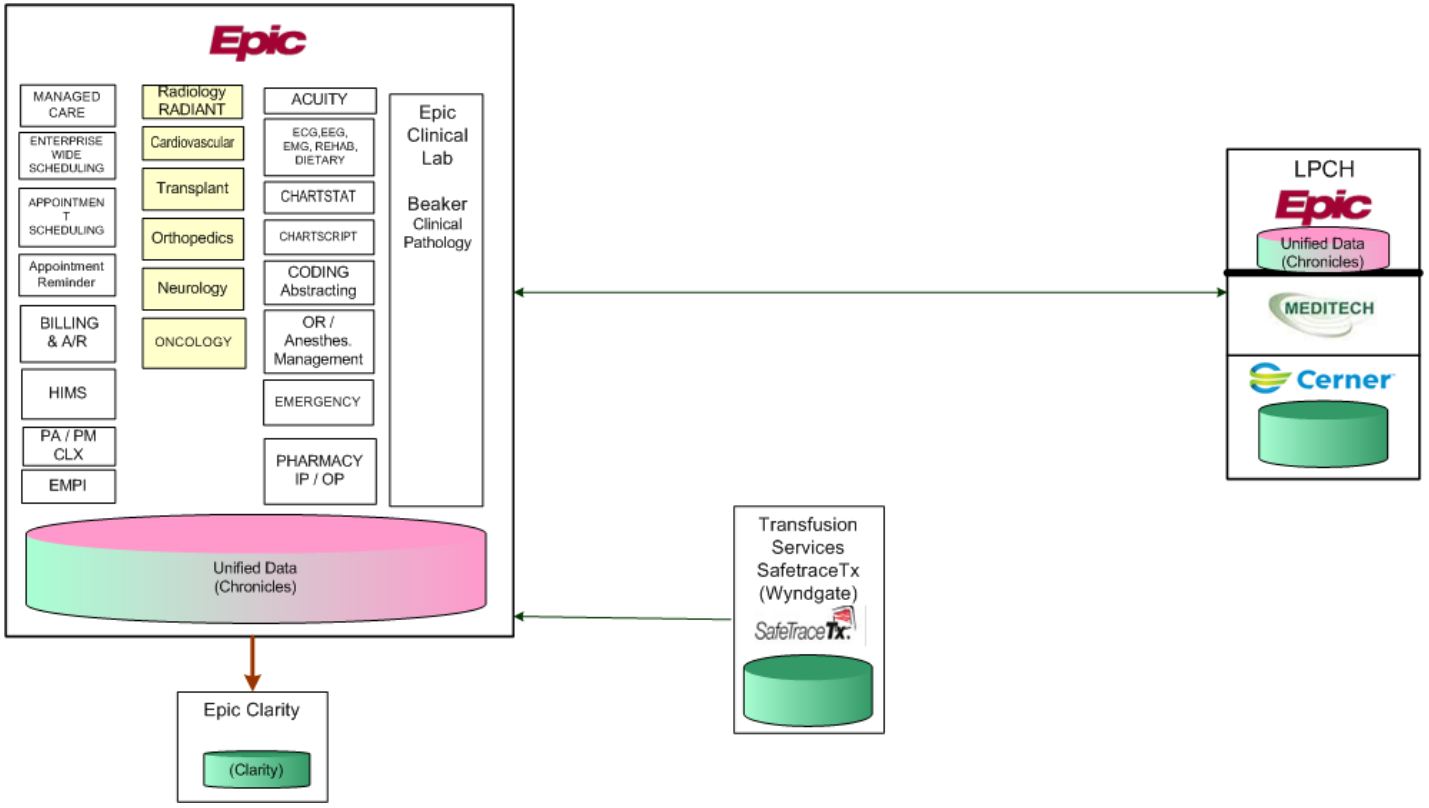
- Presented and finalized by Lab Governance council on May 4, 2012
  - CEO, Chair of Pathology, Chief Information Officer, Chief Operations Officer
  - Medical Director of Pathology and Clinical Services, Administrative Director of Pathology and Clinical Services
- Approved by the Board of directors in May 2012

The 2-month interval between the decision and formal acceptance was valuable time and more work could have been accomplished during this interval.

Current Lab Interfaces



Epic Lab


Epic
MANAGED CARE
ENTERPRISE WIDE SCHEDULING
APPOINTMENT SCHEDULING
Appointment Reminder
BILLING & A/R
HIMS
PA / PM CLX
EMPI
Radiology RADIANT
Cardiovascular
Transplant
Orthopedics
Neurology
ONCOLOGY
ACUITY
ECG,EEG, EMG, REHAB, DIETARY
CHARTSTAT
CHARTSCRIPT
CODING Abstracting
OR / Anesthes. Management
EMERGENCY
PHARMACY IP / OP
Epic Clinical Lab
Beaker Clinical Pathology
Unified Data (Chronicles)
Epic Clarity
(Clarity)
Transfusion Services SafetraceTx (Wyndgate)
SafeTraceTx
LPCH
Epic
Unified Data (Chronicles)
MEDITECH
Cerner

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EPIC implementation phases

- Phase 0
  - Project planning and analysis
  - Project team identified
- Phase 1
  - Scope defined
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  - Go-live
- Phase 5
  - System is live and optimized
  - Epic team completes post-live visits
  - Evaluation of future scope

Phase 0

- Project planning and analysis – *EPIC Flight Plan*.
  - The Implementation coordinator (IC) and Implementation manager (IM) from EPIC help leadership understand the implementation process.
  - "Good install" takes advantage of lessons learned from previous implementations
    - A fully staffed and certified project team who understand Epic software.
    - Well-prepared users who can be productive at go-live.
    - An infrastructure to support your staff members in their use of Epic.
- Project team identified
  - Program director for planning phase
  - Team members are introduced to basic components of Epic architecture.

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Phase 1 - Scope Summary

- Stanford Health Care
  - Beaker CP (phase 1)
  - Beaker AP (phase 2)
  - EPIC Blood administration module
  - PPID
    - Rover
- Stanford Children's Health
  - Separate instance of EPIC EMR
    - Beaker not installed
    - Required a custom EPIC-to-EPIC interface
  - PPID
    - Specimen information through the interface is not as robust as an integrated system
    - Rover not available

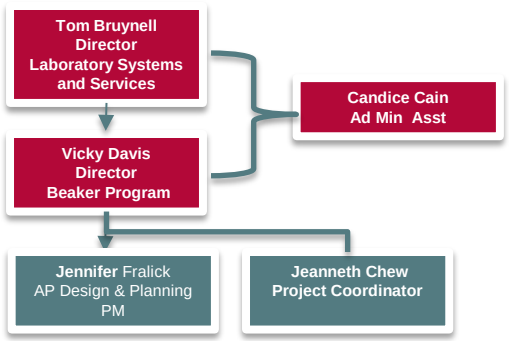
The EPIC-to-EPIC interface was a custom first time application and introduced significant technical and workflow issues

- Interfaces
  - Instruments (75)
  - Systems and FTPs (62)
  - Reference labs
- Reporting
  - Archived Sunquest data
  - Rhodes SQL database
  - Meaningful use
- Integrated Billing
- Technology
  - Hardware
  - Software
- Training
  - 650 laboratory staff
    - 50 phlebotomists
  - 2800 nursing/clinical staff

New Hardware

Item	Qty	Model	Description
Barcode scanners	722	Gryphon GD 4400-B	PPID scanners
Rover handhelds	35	Apple iPod with Captuvo SL22h enterprise sleds	Mobile devices for Phlebotomists
Document scanners	10	Fujitsu fi-7260	Additional scanners for workflow needs
Printers for nursing units and core lab services	231	Intermec PM4i	
Printers for inpatient and outpatient clinics	154	Intermec PC43D	
Wireless printers for Workstations-on-wheels (WOW) and phlebotomy	716	Intermec PB50	Mobile label printers attached/secured to WOWs for Nursing/Clinicians during specimen collection process
Windows workstations	3774	Hewlet Packard	All Beaker Application Workstations

Project Organization



Integration

- Cary Schrandt, SA Integration Engineer
- Manjunath Sanjeevamurthy, SSA-Beaker
- Krish Jasti, Sr. Programmer, Ensemble Cache, Bridges

Build

- Scott Peterson, Beaker Build AL, REQ: 25321
- Cory Spencer, Beaker Build PSA, REQ: 25327
- Ashley Slagle, Beaker Build PSA
- Toan Tran, Beaker Build SSA
- Rob Rae, Beaker Build PSA, REQ:25326
- Christine Chen, Beaker Build/Testing ASA
- Kathy Chepil, Beaker AP Build PSA
- Tommy Kent, Beaker AP Build PSA
- Stephanie Westhoff, Beaker AP Build PSA

Reporting

- Paul Khari, Beaker Reporting Lead
- Lee Osborn, Beaker Reports Analyst/Developer
- Matt Dusanic, Beaker Reports Analyst/Developer
- Mounikareddy Kommuri, SA Reports Analyst-Beaker

Testing

- Caitlin Hanson, Beaker Testing Lead

Training

- Jodie Murrell-Scott, Beaker Training Lead, REQ:25334
- Rechael Garcia, Training Coordinator
- Roberto Loanzon, Credential Trainer (8/11/14)

Partners

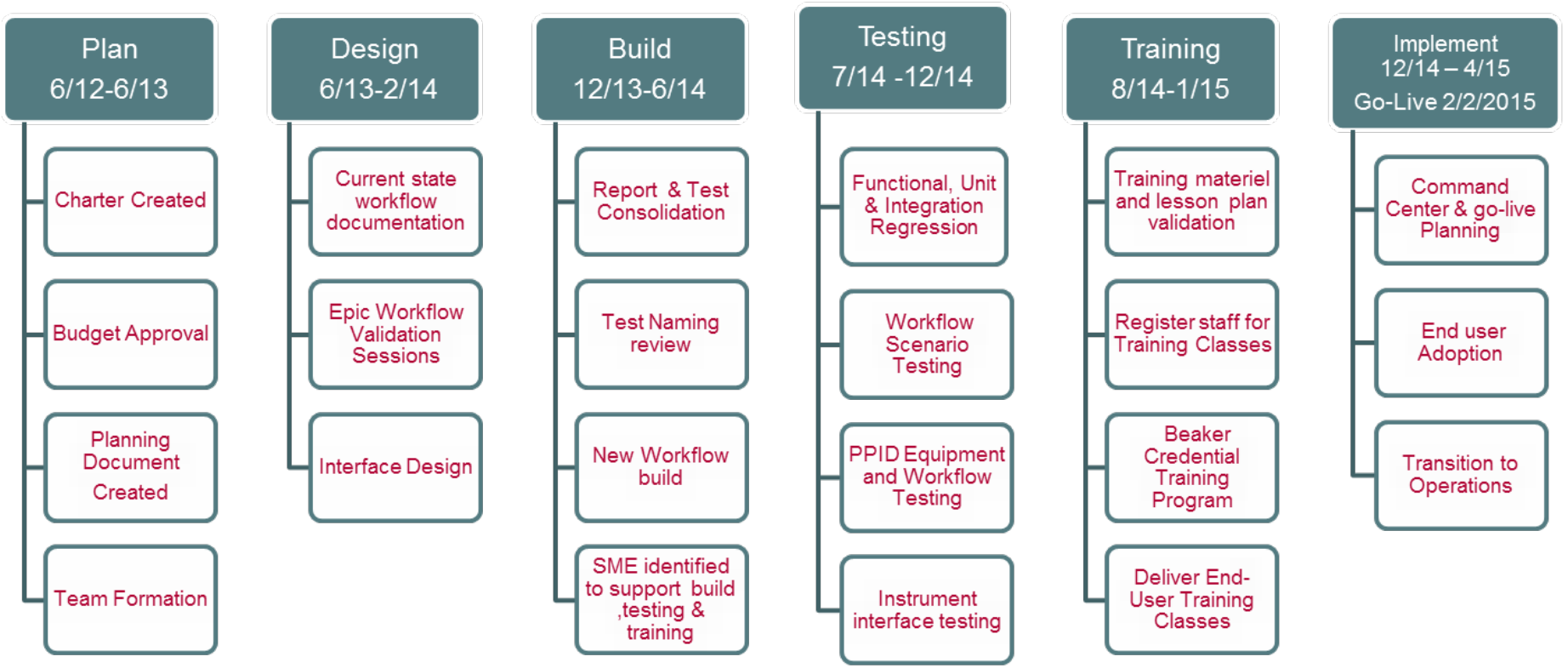
- Rita Brock, LPCH Beaker PM
- Suraj Ramdeo, Infrastructure

Integrated Team Members

- Ramesh Kumar Rajamanickam, SSA Ensemble Cache Technical Services
- Margaret Lee, HB Analyst Revenue Cycle
- Graham Hall, Orders Analyst-Beaker Ambulatory
- Epic App Analyst, &SMEs for Integration Testing
- Credential Trainers from Lab Operations and LS&S staff Leveraging Education Organization,
- Brent Light, IT Project Manager Facilities IT

Lab Upgrades: Beaker Go Live 2015

Stanford HEALTH CARE



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Phase 1

- Site visits completed
  - EPIC team visits and evaluates existing workflows.
- Variation from the Foundation system identified by the EPIC team
- Customer team attends training at EPIC and completes certification
  - Stanford contracted consultants already Beaker certified to perform build.
  - The eventual Stanford IT team that would support Beaker were certified prior to go-live

Consultants were utilized partly because in 2013, the pool of candidates with Beaker certification was limited. The majority of consultants were highly skilled.

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EPIC Phase 2 - Workflow validation

Participant		0%	100%	0%	10%	10%	80%	0%	20%	80%
		0	10	0	1	1	8	0	2	8
#		1) Validation Point			2) Validation Point			3) Validation Point		
		All CLS staff and above will have security to authorize result corrections.			If collection information is missing, the system will trigger a hard hold to prevent verification until the collection date and time are entered.			Only Lab Managers and Lab Supervisors will be able to clear hard holds.		
2	Preanalytic Supervisor	G			G			G		
3	Lab Supervisor	G			R			G		
4	Special chemistry Supervisor	G			NA			NA		
5	Special chemistry Supervisor	G			NA			NA		
6	Operations Manager	G			NA			NA		
7	Micro Supervisor	G			NA			NA		
8	Haematology Supervisor	G			NA			NA		
9	Pre-an Manager	G			NA			NA		
10	Supervisor	G			NA			NA		
11	Operations Manager	G			NA			NA		

- Stoplight evaluation occurred over 2 weeks
- EPIC Beaker team reviews “validation points” with specific lab users
- Lab users indicate a green (agreed), yellow (agreed with reservation), or red (disagree).

Validation points

Stanford HEALTH CARE

Subject (# of validation points)

- Phlebotomist/Rover (6)
- Receiving, resulting, verifying (4)
- Result corrections and holds (3)
- Requisition entry (17)
- Lab follow ups (15)
- Nurse Collection (14)
- Quality control (11)
- Urinalysis (1)
- Chemistry (10)
- Hematology (6)
- Microbiology (11)
- Container storage (5)
- Sendouts (5)

The “green” light. . .

- Very few red decision points
- EPIC resources reviewed laboratory workflows the build team and SMEs remotely, in “pre-validation sessions”.
  - The EPIC team used pre-validation sessions to prepare workflows for the true validation session that would mirror the desired future-state
- Demoed workflows were largely accepted by end-users in attendance during validation
- Each point was discussed until agreement was reached.

We were fortunate to have Jordan Goslee and Mike Bonn from EPIC

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Phase 3 – “Red lights”

- “Workflows with yellow and red lights are addressed by the EPIC team and re-reviewed with lab users until they are green.
- Some deviations from the model system were not uncovered until Phase 3.
  - The container sharing requirement necessitated building every lab as a section “belonging to” the main Hospital lab, to allow for container sharing across labs.

System build

- Tests (1766 total)
- Interfacing – Data Innovations
- Autoverification and QC
  - Stanford chose to use Beaker functionality
  - Others may chose to do this in DI.
- Critical Calls
  - Routed to customer service
  - EPIC Communication Log
  - Component level comments

CORE FUNCTIONAL AREAS	# TEST RECORDS TO BUILD
Biochemical Genetics	19
Blood Bank	28
Blood Gas	6
Chemistry	172
Coagulation	15
Coagulation-Special	35
Flow Cytometry	16
Hematology	37
HLA	83
Microbiology	76
Molecular Pathology	91
Point of Care	22
Sendouts	867
Special Chemistry	230
Urinalysis	24
Virology	45
OVERALL	1766

1. *The EPIC-to-EPIC interface to SCH did not transmit the communication log data.*
2. *This omission requires dual documentation of critical calls by the lab as a component level comment*

Reporting

- Reporting was accomplished through:
  - Beaker reporting workbench (231)
  - Beaker crystal reports (3)
  - Stanford's existing Rhodes Group (Vernon, CT) structured query language (SQL) data repository
    - Beaker data
    - Historical data from Sunquest
    - Accessed through
      - SAP Web Intelligence (WEBI)
      - Microsoft SQL server reporting services

Rhodes data repository

- Real-time data posting of significant data, based on HL7 interface feeders from source systems.
- Multi-source data integration for multiple LIS and Pathology systems.
- Concept normalization and data flattening to optimize large scale reporting processes
- Federated database environment to support long term online data storage.
- Environment segmented across multiple processor units to optimize performance.
- Cube metrics aggregation to optimize trending and large data metrics.

Components

- SQL Server 2012 Enterprise
- SQL Report Services
- SQL OLA Analysis Services
- Rhodes Clinical Lab Repository
- Rhodes Interface Services
- Rhodes Scholar Clinical Metrics Cubes
- Rhodes Communications and Process Architecture Components

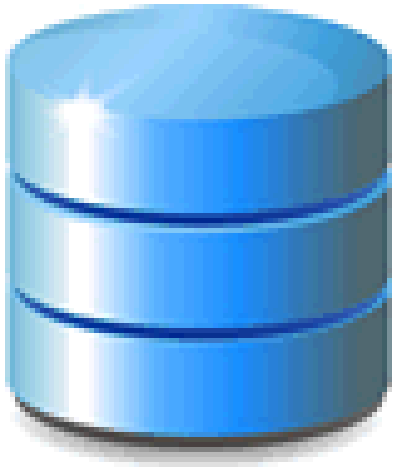
Database Server Architecture

- Significant components are segmented across multiple servers to increase performance and large data handling.
  - Analysis Services (Cubes)
  - Report Rendering Services (SSRS)
  - Interface message storage and processing.
- Disk IO performance bottlenecks optimized with CPU level SSD (Fusion IO)

Database Hardware Architecture

Interface Transaction

Cube Metrics



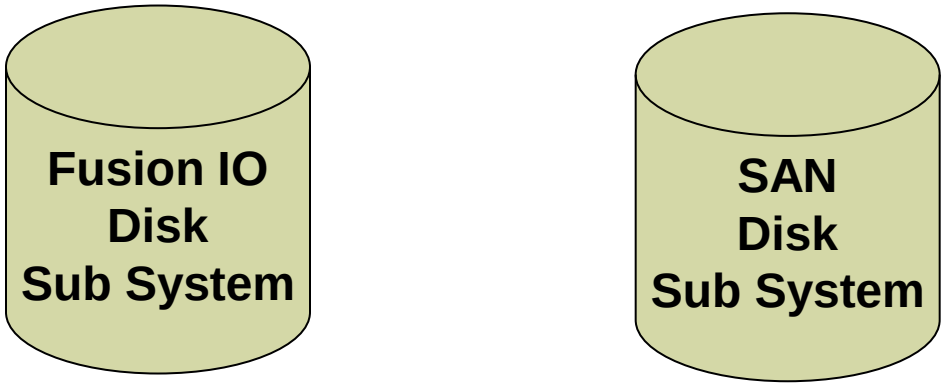
Core DB Server

Report Rendering

Mirror Reporting (Future)

Mirror Adhoc (Future)

Core Database Server Disk IO



- Fusion IO 130K+ IOPS (input output operations /sec)
  - Holds primary member of the data federation
  - Many times faster that typical SAN DB environments
- SAN 6k+ IOPS
  - Holds secondary federation members

Federated Database Schema

- Schema split in to federated data sections based on data age.
  - Primary Last 3-4 years. Located on Fast IO
  - Secondary sections hold previous years
  - Messaging and staging data separated.
- Federation members share schema and queries can access all members simultaneously when needed.

Data sources for Rhodes SQL

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- Epic – Beaker (2015 Forward)
  - Core data through HL7 real-time feeders
  - Ancillary data through extract, transform and load (ETL) procedures
- Power Path (2009 Forward)
  - Core data through HL7 real-time feeders
  - Ancillary data through ETL procedures
- Sunquest LIS (1998-2015)
  - Core data through HL7 real-time feeders
  - Ancillary data through ETL procedures
- Safe trace Blood Bank (2009 Forward)
  - Core data through HL7 real-time feeders
  - Ancillary data through ETL procedures
- Current data statistics:
  - Total Patients: 3,679,966
  - Total Orders: 31,512,080
  - Total Test Results: 396,657,706

EPIC implementation phases

- Phase 0
  - Project planning and analysis
  - Project team identified
- Phase 1
  - Scope defined
  - Site visits completed
  - Variation from the Foundation system identified
  - Customer team attends training at EPIC and completes certification
- Phase 2
  - Workflow validation sessions
  - Stoplight evaluations completed
- Phase 3
  - “Red light” points validation sessions resolved
  - System built
- Phase 4
  - Testing
  - Workflow labs conducted
  - System is finalized and tested
  - End users trained and prepared for go-live
  - Go-live
- Phase 5
  - System is live and optimized
  - Epic team completes post-live visits
  - Evaluation of future scope

Testing

- Application - 100 different workflows spanning across all functions within the lab
- Integrated - Integration with all of Epic modules.
- Interface – validation of data between instruments or systems
- Laboratory
  - Iterative laboratory test testing.
  - Autoverfication testing – by individual sections with actual patient samples
  - Manual QC testing.
  - Iterative charge testing – make sure all charges in the system are occurring as expected
  - Chart Review - by section director MD's
  - Reference Ranges – Quality Department and Director of Laboratory Informatics
  - Result Review - by Director of Laboratory Informatics
- Revenue Cycle – integrated targeting the revenue cycle: ADT (registration), Cadence (scheduling), HIM, HB (hospital billing), and PB (professional billing).
- Technical – Device functionality, integration, and mapping for barcode scanners, label printers, rovers, document printers, and document scanners.

Iterative testing

Procedure (EAP)	Patient Requirements	Procedure (EAP) Name in Order Entry	Confirm that the correct Specimen Source quick buttons display	Confirm that the associated questions are correct and appropriate	Confirm correct container type displays	Confirm that the listed specimen types are applicable	Confirm that the listed specimen sources are applicable	Confirm correct collection instructions	Collection information defaults appropriately after clicking collect	Review tube summary for correct grouping of tests, if applicable	Confirm the correct S&H instructions in the reports panel	Confirm that the correct collection data appears	Confirm that the correct columns appear and display as desired	Confirm that the test appears on the correct outstanding list	Confirm that the correct specimen flags are available	Confirm correct components to result	Confirm correct methods are available for the test	Confirm correct units display	Confirm correct critical/abnormal/reportable flagging is built out	Confirm correct reference ranges display for each result component	Confirm correct number of decimals appear	Confirm that equations calculate correctly	Confirm that correct mnemonic & reflex actions trigger	Confirm that results display correctly in Chart Review	Issues/Defects
FSH [LABFLL]	Sex: Female Age: 9 Years up to 150 Years	Pass	Pass	N/A	Fail	Pass	Pass	Pass	Pass	N/A	Fail	Pass	Pass	Pass	N/A	Pass	Pass	Pass	Fail	Fail	Pass	N/A	Fail	Pass	PLEASE RE-ASSESS RESULTS REVIEW [CH] No reference ranges. Test range is configured but not flagging on this patient. See below. Retested 11/11/14. No check range configured. No reference range. Retested 11/16/14. Passed.

Performed by SMEs

The iterative testing process overwhelmed the SMEs and staff.

Iterative testing patients

Test Patients	MRN	Lab Section	Sex	Age	SCH/SHC	IP/OP
BKRPT, Sly	30000939	Special Chemistry	Male	75 Years	SHC	OP
BKRPT, Sean Special Chemistry	30000699	Special Chemistry	Male	26 Years	SHC	IP
BKRPT, Simon	30000954	Special Chemistry	Male	19 Years	SHC	OP
BKRPT, Stuart	30000962	Special Chemistry	Male	18 Years	SHC	OP
BKRPT, Sam	30000970	Special Chemistry	Male	15 Years	SHC	OP
BKRPT, Slick	30000996	Special Chemistry	Male	7 Years	SHC	OP
BKRPT, Selena	30000749	Special Chemistry	Female	7 Years	SHC	IP
BKRPT, Sarah	30000715	Special Chemistry	Female	15 Years	SHC	IP
BKRPT, Sloan	30000723	Special Chemistry	Female	18 Years	SHC	IP
BKRPT, Sally	30001010	Special Chemistry	Female	56 Years	SHC	OP
BKRPT, Sharon	30000731	Special Chemistry	Male	3 Months	SHC	IP
BKRPT, Scott	30001051	Special Chemistry	Female	3 Months	SHC	OP
BKRPT, Sabrina	30001077	Special Chemistry	Female	1 Month	SHC	OP
BKRPT, Snape	30001101	Special Chemistry	Male	4 Months	SHC	OP
BKRPT, Starlight	30001135	Special Chemistry	Female	8 Months	SHC	OP
BKRPT, Sherlock	30001168	Special Chemistry	Male	1.5 Years	SHC	OP
BKRPT, Stella	30001200	Special Chemistry	Female	2.5 Years	SHC	OP
BKRPT, Skyler	30001234	Special Chemistry	Male	3.5 Years	SHC	OP
BKRPT, Sarisha	30001275	Special Chemistry	Female	4.5 Years	SHC	OP
BKRPT, Sheridan	30001283	Special Chemistry	Male	5.5 Years	SHC	OP
BKRPT, Shoshanna	30001309	Special Chemistry	Female	6.5 Years	SHC	OP
SME to Request when Ready to Test:						
BKRPT, Saxton		Special Chemistry	Male	3 Days	SHC	OP
BKRPT, Sadie	30005292	Special Chemistry	Female	3 Months	SHC	OP
BKRPT, Santiago	30005300	Special Chemistry	Male	3 Months	SHC	OP

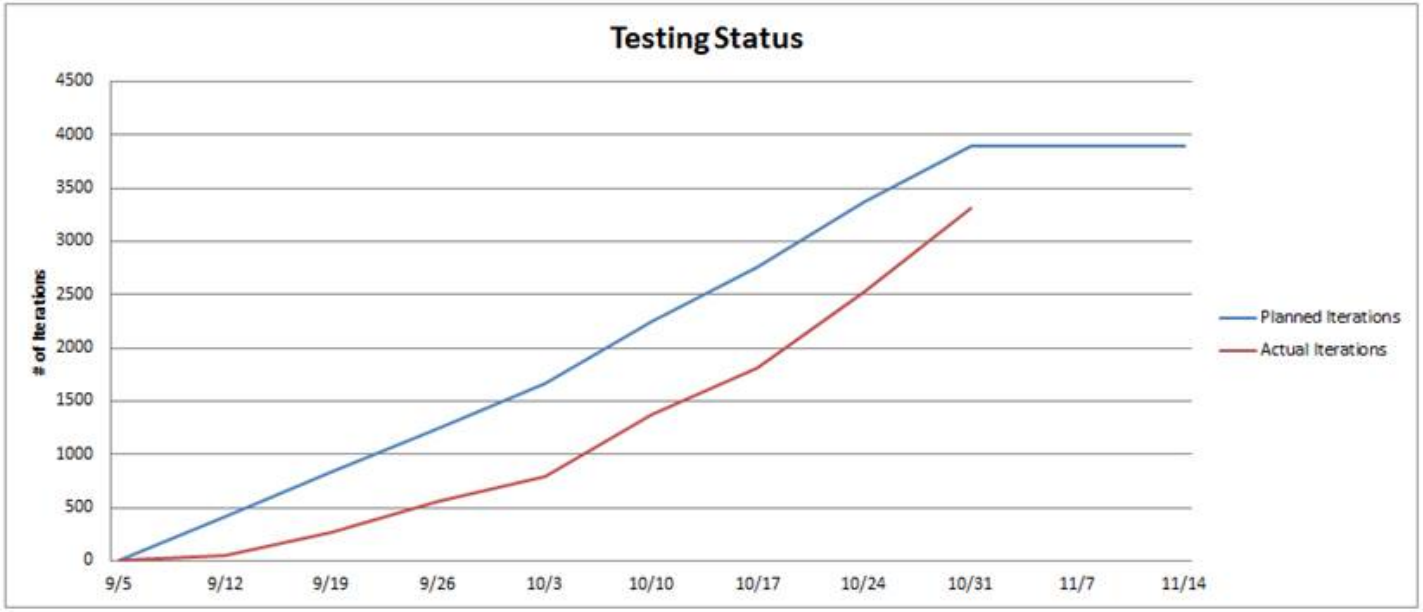
For reference ranges that are setup with sex-specific ranges, trauma patients with "unspecified" sex will NOT flag for abnormalities or critical values

Iterative testing

Iterative Testing Dashboard

Date	9/5	9/12	9/19	9/26	10/3	10/10	10/17	10/24	10/31	11/7	11/14
Planned Iterations	0	421	841	1252	1672	2246	2766	3371	3897	3897	3897
Actual Iterations	0	53	263	554	798	1376	1814	2531	3312		

Iteration Summary	
Passed	2643
Passed - Optimization	208
Failed - Non-test Record	28
Failed - Change Request	72
Failed - Build Incorrect	233
Failed - Separate Testing	42
Ready for Review	86
Untested	585
% Complete	**85%**



- The target date for completion of iterative testing was October 31, 2015. This was not completed until November 26, 2015.

Phase 4

- Workflow labs conducted
  - Workflow “dress rehearsals” occurred January 12 – 30, 2015
- System is finalized and tested
- End users trained and prepared for go-live
  - Credentialed trainers trained Oct 20 – Dec 5, 2014
  - SMEs trained Dec 8-19, 2014
  - End users trained Jan 5-30, 2015
- Go-live, targeted Feb 7, 2015

1. *Workflow labs were the first opportunity for operations to experience the full system build. This process should occur earlier*
2. *Modification of the build at this point would affect training.*

Iterative testing failures

Iteration Metrics

Passed	Passed - Optimization	Failed - Non-test Record	Failed - Change Request	Failed - Build Incorrect	Failed - Separate Testing	Ready for Review	Untested	
10	7	0	16	8	0	9	0	
28	0	16	0	7	2	0	0	
197	22	0	16	54	0	0	70	
12	13	0	5	6	0	0	0	
9	14	0	0	0	25	0	0	
63	8	1	2	8	0	7	93	
1353	17	0	1	0	0	0	140	
236	0	10	6	8	0	0	140	
52	89	0	17	118	15	70	52	
147	15	0	0	0	0	0	0	
37	6	1	9	13	0	0	5	
499	17	0	0	11	0	0	85	
2643	208	28	72	233	42	86	585	3897
80%	17%	1%	2%	7%	1%	3%		

- Many tests failed, requiring multiple rebuilds.

Testing was performed in large part by the SMEs, overburdening them

The tests should have been double-checked by the build team prior to handoff to SMEs

GO versus NO-GO decision: February 5, 2015

- The targeted go-live date of February 7, 2015 was postponed.
- Previous GO vs. NO-GO meetings on 1/22 and 1/28 were GO
- Major issues included:
  - Chemistry autoverification
    - Low visibility into % completion
  - Confidence in operational training
    - Shared specimens
    - Specimen tracking
  - MD sign-off of validation binders

The Critical List

#	Go-Live Ready	Go-live Critical	Section	Reported By	Issue Details/Current Status	Owner	Projected Completion Date	IT Owner(s)	Lab Operation Owner(s)	Medical Director Owner(s)	Subject Matter Expert Owner(s)
1	NO	Yes	Auto Verification	SHC Chemistry	Outstanding instruments, RXLs and EXLs in StreamLab, remains to complete auto-verification testing.	Operations		Cary, Michael, Toan	Phil Cheng / Gay Routh	Raffick Bowen	Ranie Rieta
2	NO	Yes	Auto Verification	HV Special Chem	In Special Chemistry, their autoverification passed but no screen shots were ever sent to Dr. Shi for approval.	Operations		Michael, Cory	Merrie	Dr Shi	
3	NO	Yes	Auto Verification	SHC Hematology	Outstanding Instruments need testing and approval by Medical director	Operations		Angela, Shelley, Scott	Mercy Dones / Gay Routh	Susan Atwater	Xiaoling Lu

- On February 6, a systematic review of “must haves” was composed by the Laboratory Director of Administration, the Medical Director for the Laboratory, and Medical Director of Laboratory Informatics.

1. *The Critical List should have been created ~30 days prior to the targeted go-live.*
2. *There was disconnect between the items on the critical list, which was composed by operations, versus the 30-day clinical readiness evaluation by IT.*

We really are going live. . . February 21, 2015

- A new sense of urgency occurred between the missed go-live date of February 7 and the actual go-live date of February 21, 2015.
  - The Beaker build team moved onsite
  - Increased collaboration between operations and IT
  - Additional training sessions
    - Add-on workflow
    - Critical call workflow
  - Increased operational resources dedicated to chemistry autoverfication
- By February 11, IT and the lab collectively made a firm commitment to go-live on February 21
  - The scope of autoverification in chemisry was limited to mission critical tests
  - Non-critical tests were addressed post go-live

Moving IT onsite into a the future home of the "command center" was vital to accelerating the pace of the project. This move should have occurred earlier.

Cutover

- On Sat 01:00 AM on 2/21/15 EPIC orders will held / queued and not processed until 3:35 AM
- From 1 AM to 3:35 AM, orders are only processed directly from Sunquest
  - Lab only processing standard downtime paper orders
  - Results will flow into EPIC
- Cutover required no EPIC system downtime
  - Providers still be able to document on patients' charts
  - Results still file back to the Epic system for all other systems (eg. Radiology)
- Beaker's planned go live on Sat 03:35 AM on 2/21/2015

End User Support Plan

- We expected 3 phases as Beaker goes live.
  - Phase 1 – SHC and SCH Labs go live with Beaker, PPID, and Rover affecting inpatient lab orders first
  - Phase 2 – 7 AM Saturday ITA will be the first outpatient center affected with other limited AMB clinics affected on Sat morning
  - Phase 3 – 7 AM Monday all ambulatory clinics will begin to use Beaker

At 4 am. . .

The Friday night/Saturday morning time is low volume and a good opportunity for cutover

Command Center Summary

Locations

- Stanford Hospital: 1st Floor – Conf Room 1551L & 1551R
- Hillview –1st Floor – Conf Room 1023
- IT (PATC) –Caret Conf Room (Training Room)

Stanford Hospital		Hillview		PATC	
02/20 - 02/24:	24/7	02/20 - 02/24:	24/7	02/20 - 02/24:	24/7
02/25 - 03/02:	7AM - 7PM	02/25 - 03/02:	8AM - 5PM	02/25 - 03/02:	8AM - 5PM

Support “at the elbow”

		Monday, February 23, 15			Tuesday, February 24, 15			Wednesday, February 25, 15		
		CommanD Center Hours: Hospital: 24/7 Hillview: 24/8			Command Center Hours: Hospital: 24/7 Hillview: 24/9			Command Center Hours Hospital: 7AM-7PM Hillview: 8AM-5PM Remote/On-Call: 7PM-7AM		
		12a-9a	8a-5p	4p-1a	12a-9a	8a-5p	4p-1a	7a-3p	11a-7p	OC: 7p-7a
Lab Super Users/SME's	**Location**									
CLIN LAB SCIENTIST - STAFF	Flow Cytometry			HV		HV 3PM	HV 11PM		HV 3PM	HV 11PM
SUPV - LAB	Virology		HV 6-6			HV 6-6		HV 6-6 (?)	HV 6-6 (?)	
MGR-LAB OPERATIONS	Pre-Analytic		HV 7-7			HV 8-8			HV 8-(8?)	
CLIN LAB SCIENTIST SENIOR	Molecular Path		HV 8-4:30			HV 8-4:30				
SUPV - LAB	Microbiology	HV to 7 am		HV 11:00pm	HV to 7 am		HV 11:00pm	HV to 7 am		
SUPV - LAB	Special Chem, BCG		HV 8:30-5			HV 8:30-5		HV 8:30-5		
CLIN LAB SCIENTIST - REF	Flow Cytometry		HV			HV		HV		
SUPV - LAB	Molecular Path		HV 9-7			HV 9-7		HV 9-7		
CLIN LAB SCIENTIST - REF	Special Coag		HV			HV				
CLIN LAB SCIENTIST - STAFF	Microbiology		HV 7:30-4			HV 6-2:30		HV	12:00-8:30pm	
CLIN LAB SCIENTIST - SPLST	BCG		HV 9-5:30			HV 9-5:30		HV 9-5:30		
CLIN LAB SCIENTIST SENIOR	Virology									
CLIN LAB SCIENTIST SENIOR	Microbiology			HV 2:30-11			HV 2:30-11			
CLIN LAB SCIENTIST - REF	Microbiology	HV 04:00 to	HV-12:30					HV 4am-12:30		
SUPV - LAB	Flow and Special Coag		HV			HV		HV		

SME support was critical. The SMEs understand both workflow and Beaker build.

Scenes from go-live!

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6 hours

72 hours

Chemistry Turn-around-times (TAT)

90%tile All Priorities	Chemistry METC Inpatient									
	Receipt to Bench			Bench to Verify			Receipt to Verify			Volume
DATE:	Target	Actual	Gap	Target	Actual	Gap	Target	Actual	Gap	
Feb 16	15	38	23	50	74	24	60	97	37	176
Feb 17	15	23	8	50	80	30	60	93	33	144
Feb 18	15	27	12	50	80	30	60	97	37	159
Feb 19	15	24	9	50	90	40	60	107	47	163
Feb 20	15	n/a	######	50	n/a	######	60	n/a	######	n/a
Feb 21	15	n/a	######	50	n/a	######	60	70	10	126
Feb 22	15	4	-11	50	42	-8	60	78	18	128
Feb 23	15	10	-5	50	236	186	60	272	212	163
Feb 24	15	8	-7	50	133	83	60	158	98	142
Feb 25	15	14	-1	50	96	46	60	104	44	147

- Go-live occurred Saturday, Feb 21.
- Chemistry began to have TAT issues on Monday, February 23.

Ideally, the full autoverification previously built in Sunquest would have been ready for go-live in Beaker

Hematology Turn-around-times (TAT)

90%tile All Priorities	Hematology ABC Inpatient									
	Receipt to Bench			Bench to Verify			Receipt to Verify			Volume
DATE:	Target	Actual	Gap	Target	Actual	Gap	Target	Actual	Gap	
Feb 16	15	43	28	30	25	-5	60	60	0	270
Feb 17	15	21	6	30	20	-10	60	39	-21	254
Feb 18	15	24	9	30	41	11	60	57	-3	263
Feb 19	15	20	5	30	30	0	60	42	-18	280
Feb 20	15	n/a	######	30	n/a	######	60	n/a	######	n/a
Feb 21	15	n/a	######	30	n/a	######	60	62	2	281
Feb 22	15	9	-6	30	15	-15	60	23	-37	214
Feb 23	15	9	-6	30	22	-8	60	30	-30	201
Feb 24	15	9	-6	30	30	0	60	33	-27	212
Feb 25	15	11	-4	30	21	-9	60	33	-27	223

- Hematology had no issues!

Extensive section-specific training with the differential keyboard was beneficial.

EPIC implementation phases

- Phase 0
  - Project planning and analysis
  - Project team identified
- Phase 1
  - Scope defined
  - Site visits completed
  - Variation from the Foundation system identified
  - Customer team attends training at EPIC and completes certification
- Phase 2
  - Workflow validation sessions
  - Stoplight evaluations completed
- Phase 3
  - “Red light” points validation sessions resolved
  - System built
- Phase 4
  - Testing
  - Workflow labs conducted
  - System is finalized and tested
  - End users trained and prepared for go-live
  - Go-live
- Phase 5
  - System is live and optimized
  - Epic team completes post-live visits
  - Evaluation of future scope

Reports

	Original Inventory Assessment			Replacement Reporting Tools Used				
	Total # Reports	Not Needed	Needed	RWB	SSRS/ Other	Crystal	WebI	
Sunquest Report	268	146	122	75	8		39	**122**
SSRS/Rhodes Reports	120	6	114		114			**114**
Other	54	9	45	7	39		1	**47**
New Reports Id'd	141	0	141	131		4	6	**141**
	583	**161**	**422**	**213**	**161**	**4**	**46**	**424**

- RWB – Beaker Reporting workbench (Cache production server)
- Crystal – EPIC Clarity (SQL)
- SSRS – Microsoft SQL reporting services (Rhodes database)
- WEBI – SAP business object intelligence (Rhodes database)

Infection control report (WEBI)

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Lab-IC-Daily Nosocomial

Report Date: 03/26/15

MRN	Patient Name	Location Description	Order level Admit Date	Test Collection DateTime	Test Name/OVT	Specimen Description	Result	Result Flag Code
[redacted]	[redacted] N	B	3/5/15	3/5/2015 9:45:00 PM	.CULTURE, BLOOD (AER/AER)	Peripheral, left antecubital	COAG NEGATIVE STAPHYLOCOCCUS Aerobic bottle: Coag Negative Staphylococcus This isolate is OXACILLIN/NAFCILLIN SUSCEPTIBLE, penicillin resistant. Such staphylococci are also resistant to ampicillin, amoxicillin, and piperacillin, but susceptible to beta-lactamase inhibitor combinations, cephalosporins, imipenem, and meropenem. **ALERT: VANCOMYCIN MAY BE INFERIOR TO BETA LACTAMS FOR TREATMENT OF THIS ISOLATE. NACFCILLIN IS THE DRUG OF CHOICE.	A
[redacted]	[redacted] N	B	3/5/15	3/5/2015 10:31:00 PM	.CULTURE, BLOOD (AER/ANA)	Peripheral, left antecubital	COAG NEGATIVE STAPHYLOCOCCUS Both Aerobic and Anaerobic Bottles: Coag Negative Staphylococcus This isolate is resistant to all penicillins, and all cephalosporins, and all beta-lactamase inhibitor combinations (including AMP/Sulbactam, Amox/Clavulanic acid, and PIP/Tazobactam), and Imipenem/meropenem.	A
[redacted]	[redacted]	B	3/6/15	3/8/2015 5:52:00 AM	.CULTURE, BLOOD (AER/ANA)	Peripheral, right antecubital	ENTEROCOCCUS FAECALIS Both Aerobic and Anaerobic Bottles: Enterococcus faecalis For treatment of serious systemic enterococcal infections, the combination of high-dose penicillin or high-dose ampicillin, or vancomycin, with an appropriate aminoglycoside is indicated for bactericidal action. Vancomycin is usually reserved for penicillin allergic patients. If isolate does not demonstrate high level aminoglycoside resistance to Gentamicin, synergistic killing may be obtained with Gentamicin, Tobramycin, Kanamycin, Amikacin or (usually) Streptomycin. ("SYNER" = synergy. "NOSYN"	A
[redacted]	[redacted]	B	3/6/15	3/8/2015 6:01:00 AM	.CULTURE, BLOOD (AER/AER)	Peripheral, other: specify	GRAM POSITIVE COCCI Both Aerobic bottles: Gram Positive Cocci in pairs and short chains (morphology suggestive of enterococci/ streptococci) for identification and susceptibility testing, see BLOOD CULTURE collected SAME DAY: - 15S-067MI0038, IDENTIFIED AS E.FAECALIS	A

CULTURE, AFB; CULTURE, AFB BLOOD; CULTURE, ANAEROBIC; CULTURE, ANAEROBIC SHORT BATTERY; CULTURE, AUTOPSY BLOOD; CULTURE, AUTOPSY BX/TISS/GEN; CULTURE, BLOOD (AER/AER); CULTURE, BLOOD (AER/ANA); CULTURE, BLOOD – CATHETER; CULTURE, BLOOD – PHLEB; CULTURE, BONE MARROW; CULTURE, BONE MARROW TRANS; CULTURE, CSF WITH STAIN; CULTURE, CYSTIC FIBROSIS; CULTURE, DIAL MAC/OTHER WATER; .CULTURE, ENVIRONMENTAL; .CULTURE, FLUID STERILITY; .CULTURE, FLUID WITH STAIN; CULTURE, FUNG, SKIN/HAIR/NAIL; .CULTURE, FUNGAL; .CULTURE, FUNGAL & KOH; .CULTURE, FUNGAL BLOOD; .CULTURE, GC SCREEN; .CULTURE, GENITAL; .CULTURE, LEGIONELLA; .CULTURE, MISCELLANEOUS

KPI TAT report (SSRS)

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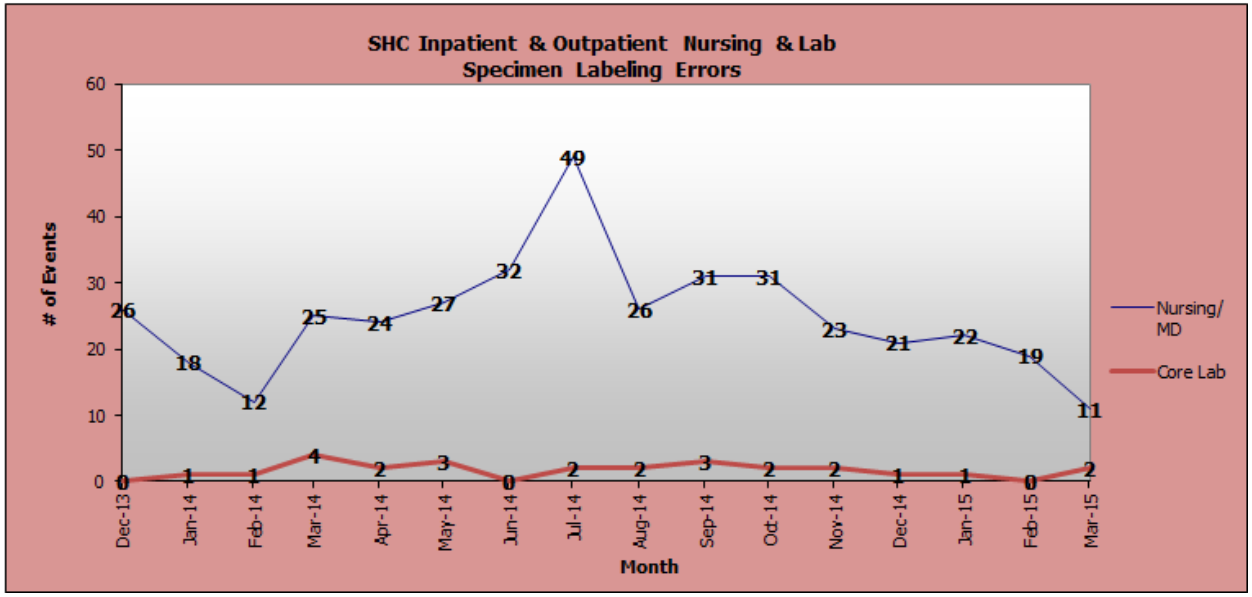
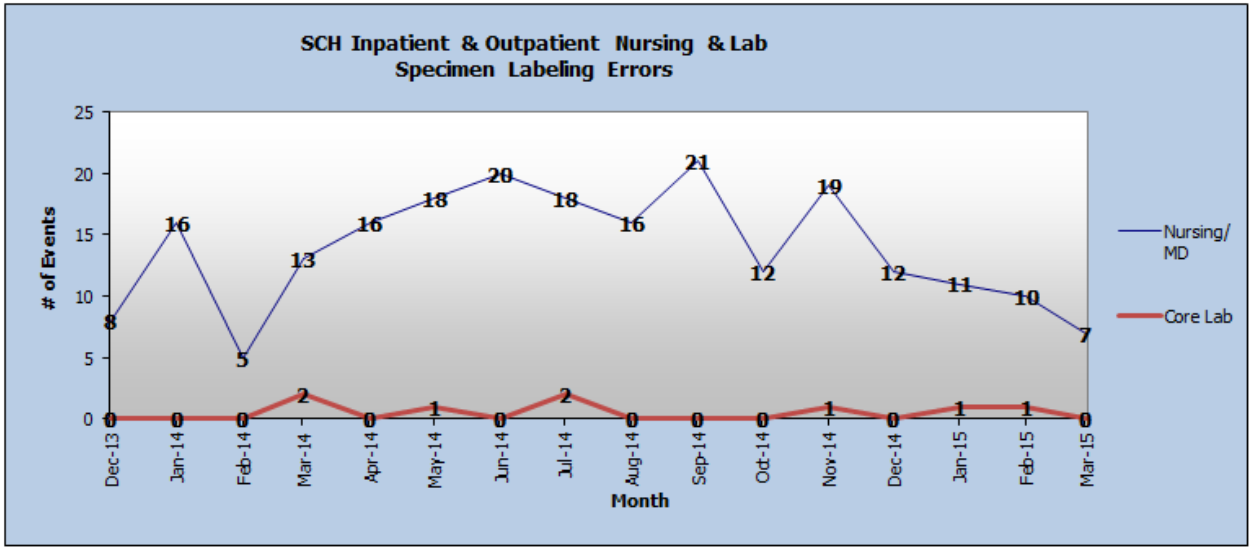
Key Performance Metrics for Major Laboratory Tests Performed at the: Combined (both SHC & SCH) - for Inpatients Only

		TAT Based on Hemogram Result Time			*TAT Based on Final Result Time*					
	Date	LABCBCO (CBC W/O DIFF)	LAB230 (MANUAL DIFFERENTIAL/ SLIDE REVIEW)	LAB234 (CBC with Differential)	LABMETC (METABOLIC PANEL COMPREHENSIVE)	LABMETB (METABOLIC PANEL BASIC)	LABMGN (MAGNESIUM, SERUM/PLASMA)	LABPT (PROTHROMBIN TIME)	LABTBIL (BILIRUBIN TOTAL, SERUM/PLASMA)	LABLACWB (LACTATE WHOLE BLOOD)
	Target (mins)	60	60	60	60	60	60	60	60	60
Receive to Result TAT (90th Percentile) in Min.	Mar 25, 2015	16	78	21	52	55	49	37	55	13
	Delta	44	-18	39	8	5	11	23	5	47
	Mar 24, 2015	23	78	27	48	50	48	45	41	14
	Delta	37	-18	33	12	10	12	15	19	46
	Mar 23, 2015	28	116	31	71	64	68	34	60	18
	Delta	32	-56	29	-11	-4	-8	26	0	42
	Mar 22, 2015	17	73	22	57	69	71	38	39	21
	Delta	43	-13	38	3	-9	-11	22	21	39
	Mar 21, 2015	26	210	43	46	44	45	37	31	14
	Delta	34	-150	17	14	16	15	23	29	46
	Mar 20, 2015	24	93	37	48	50	49	43	65	17
	Delta	36	-33	23	12	10	11	17	-5	43
	Mar 19, 2015	20	167	27	51	54	51	41	47	28
	Delta	40	-107	33	9	6	9	19	13	32
Volume of Tests	Mar 25, 2015	273	12	503	371	347	406	209	22	76
	Mar 24, 2015	257	17	464	325	360	389	216	32	73
	Mar 23, 2015	227	34	526	433	312	388	206	26	66
	Mar 22, 2015	220	12	347	252	319	340	191	21	59
	Mar 21, 2015	249	11	373	243	346	350	184	32	79
	Mar 20, 2015	268	13	459	313	350	380	207	34	87
	Mar 19, 2015	291	13	501	372	381	435	220	35	87

KPI: mislabeled specimens





Results

- EPIC Beaker is a viable system
- Strengths include:
  - Positive patient identification
  - Vertical integration with the EMR
- Weaknesses include:
  - Lack of component level final resulting
  - Critical call workflow
  - Aliquoting/Specimen sharing
  - QC

Things we did well . . .

- Vendor selection process – site visits!
- Cutover
  - Starting on a Saturday morning at 1 AM.
  - Overwhelming support (“at the elbow”) at go-live.
- Extensive testing scripts
  - Beyond EPIC recommendations
- Change management with staff
  - Great excitement and sense of urgency
    - One week prior to the first targeted go-live
    - Two weeks prior to actual go-live.
- Reporting
  - High resource allocation (3-4 analysts)
  - Strong vendor: Rhodes group
- Not implementing Beaker anatomic pathology concurrently with CP

Things we could have done better. . .

- Timeline - the targeted go-live was delayed 2 weeks
  - Start as early as possible on *autoverification*
    - If *autoverification* exists pre-Beaker, it should be in place at go-live
    - Consider *autoverification* as the “critical path” (Critical path or PERT project management)
  - Filling key positions earlier and minimizing turnover
    - Turnover and vacancies with project director, project managers, several key analysts
    - 2-month delay between selecting Beaker and formalization of the project
  - Testing requirements were underestimated
    - EPICs recommendations are less than expected by most laboratories/CAP
  - SMEs were overburdened (design, testing)
  - Implementing the “critical list” for go-live earlier

More things we could have done better. . .

- Address complex workflows early
  - The EPIC Beaker implementation process focuses on generalized workflow and the foundation system in phases 2 (validation) and 3 (build).
  - Complex workflows were addressed late in the process
    - In phases 3-4 (build/workflow laboratories), the following needed changes:
      - Specimen sharing
      - Critical call workflow
      - PPID at SCH (issues with EPIC-to-EPIC interface)
- Review the EPIC Beaker General Facility Setup Form early
  - Examples: Auto Cancel Setup form, Add-on Settings, Default TAT values table

Even more things we could have done better. . .

- Education – too generalized, and needed to supplement with section-specific training.
  - Examples: no training for CBC resulting with differential keyboard,
- EPIC-to-EPIC interface
  - Start work early on any custom or new interface!
  - Difficulties with the EPIC-to-EPIC interface had profound effects on the critical call and SCH PPID workflow
- Better Integration between IT and operations
  - IT worked primarily offsite until the 2 weeks prior to the second go-live
  - Moving onsite increased productivity, collaboration, and led to a heightened sense of urgency

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Questions?