Adoption & Evolution of a Fully Electronic Medical Record System:

The Cambridge University Hospitals NHS Foundation Trust Experience

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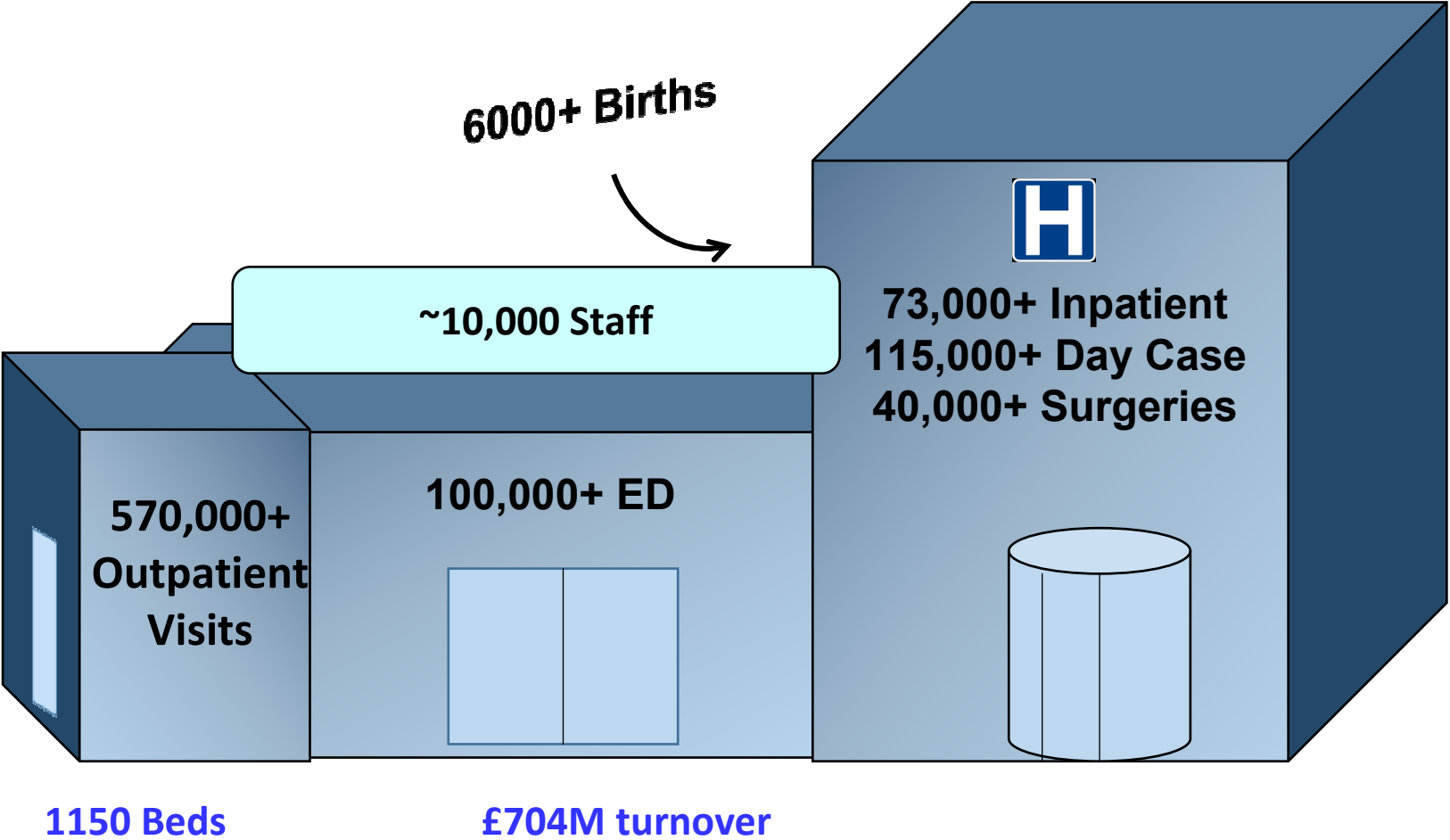NHS Foundation Trust

Our Vision

"Clinical informaticians transform health care by analyzing, designing, implementing, and evaluating information and communication systems that enhance individual and population health outcomes, improve patient care, and strengthen the clinician-patient relationship."
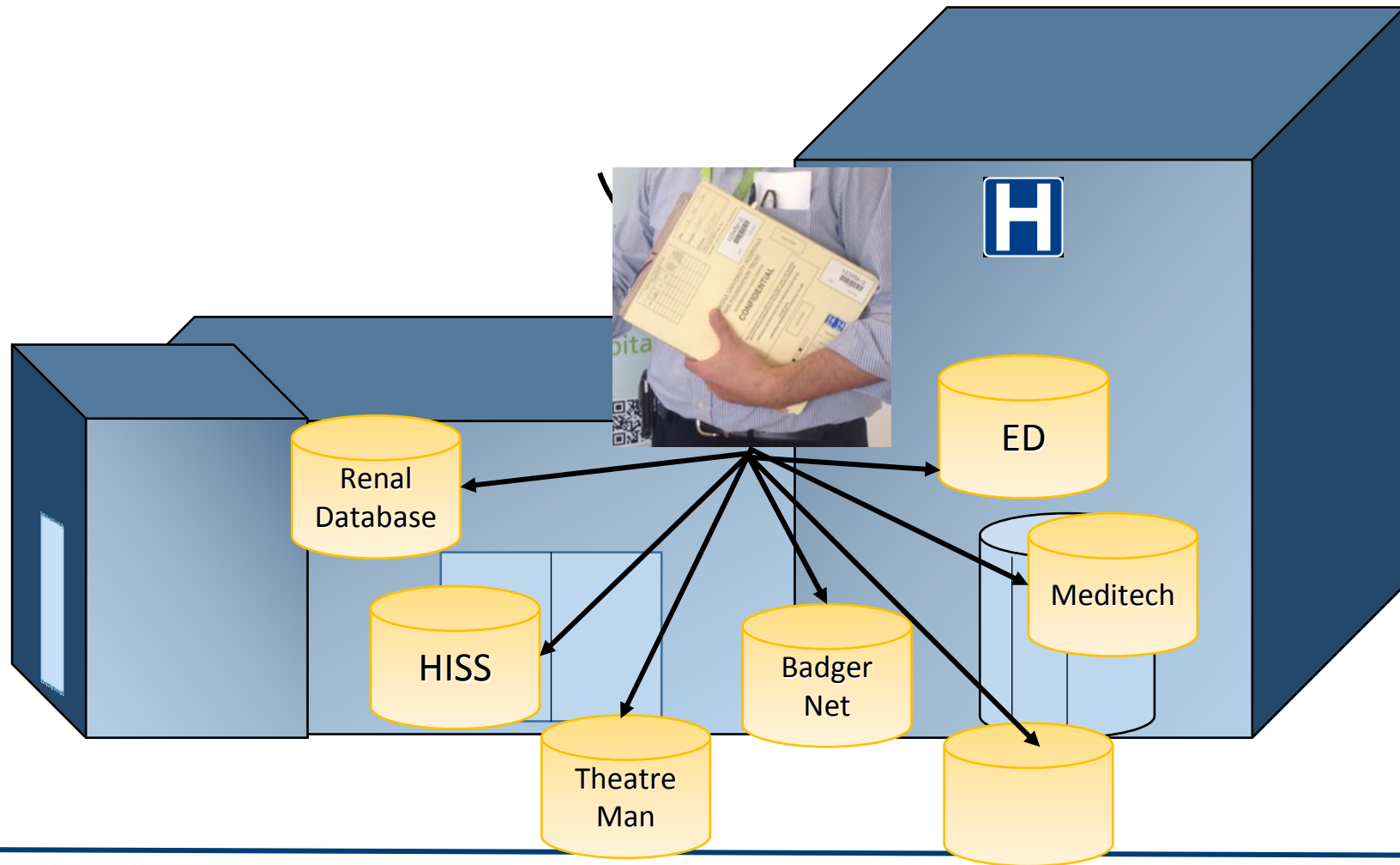
J Am Med Inform Assoc. 2009 Mar-Apr;16(2):153-7

- State of the Art Medical Records System that could:
  - Provide all data on a patient, in one location, in real-time
  - Support high-quality documentation and standardisation of care
  - Bring together research & medicine to
    - Enable new electronic interventions & tools to advance medicine
    - Increase patient safety

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6000+ Births

~10,000 Staff

73,000+ Inpatient
115,000+ Day Case
40,000+ Surgeries

570,000+ Outpatient Visits

100,000+ ED

1150 Beds

£704M turnover

Cambridge University Hospitals NHS Foundation Trust Pre-eHospital

The Journey

2010

Strategic case outline "Towards an EPR"

2011/2012

Invitation to tender

Competitive Dialogue

2012

Select preferred bidders:

Epic & Hewlett Packard

Hardware Transformation

Before
- No wireless network
- Ageing PC / infrastructure
- Low resilience
- Limited remote access

After
- 'Infrastructure as a service'
- Network refresh & wireless
- Desktop refresh and new devices (6750, 395 WoWs*)
- Remote access & 'bring your own device'
- Handheld devices

*WoW: Workstation on Wheels

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Software Transformation

Before
- 1994 PAS* system, support ending March 2015
- No ED or critical care systems
- Pathology system upgrade required

After
- Tender process, weighted to clinical quality
- NHS Spine connected system
- Extensible / supported LIMS*
- Epic used Trust-wide
- Bedside device integration

*PAS: Patient Administration System
*LIMS: Laboratory Information Management System

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Preparation

Workflow Validation

1,000+ clinicians validating modules

75% of analyst builders clinicians seconded for 18 months

Training

> 95% of staff trained (12,000 people)

> 175,000 hours of training over 9 weeks

Assessments
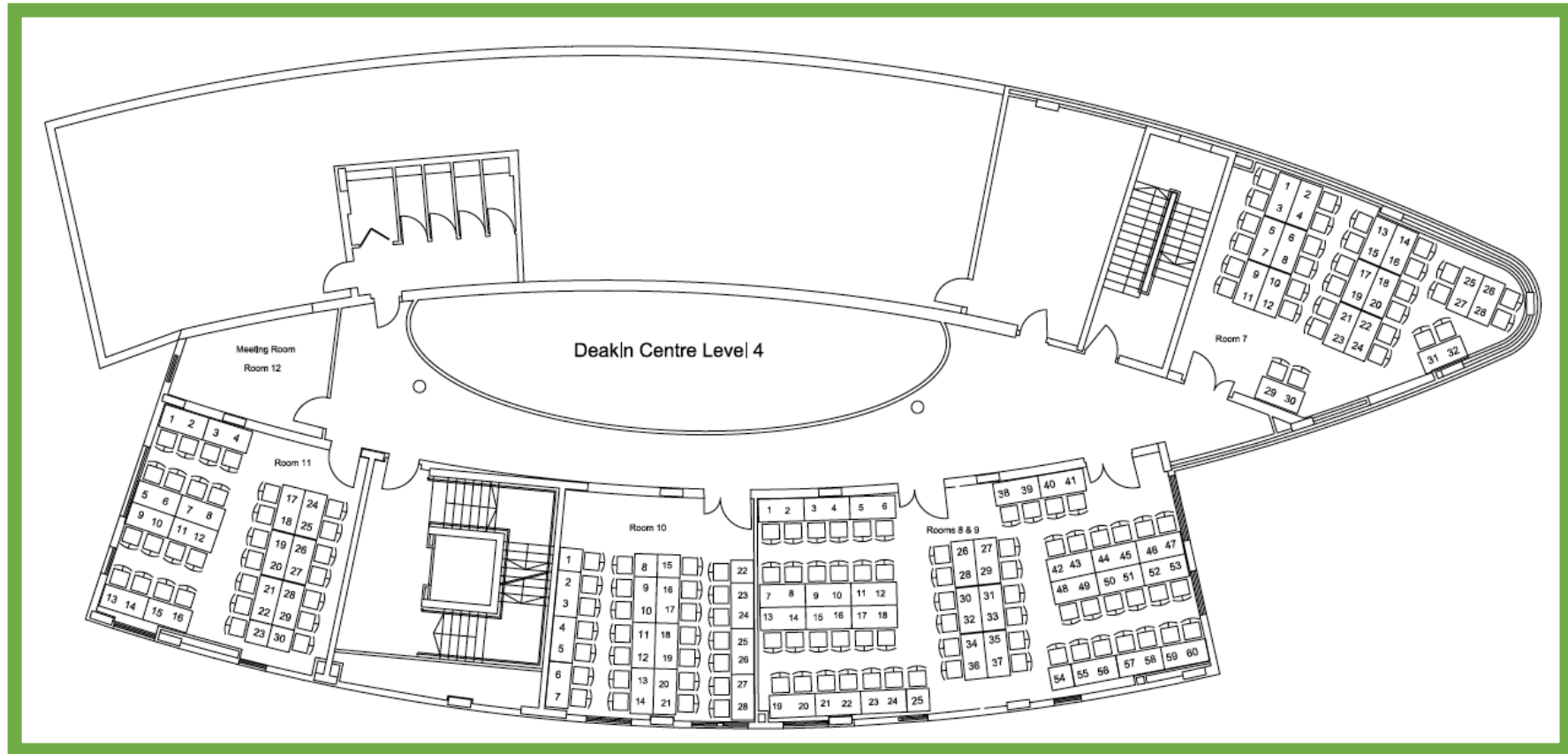
120, 90, 60 & 30-day pre go-live assessments

Parallel divisional operational assessments

Specialty-level risk assessments
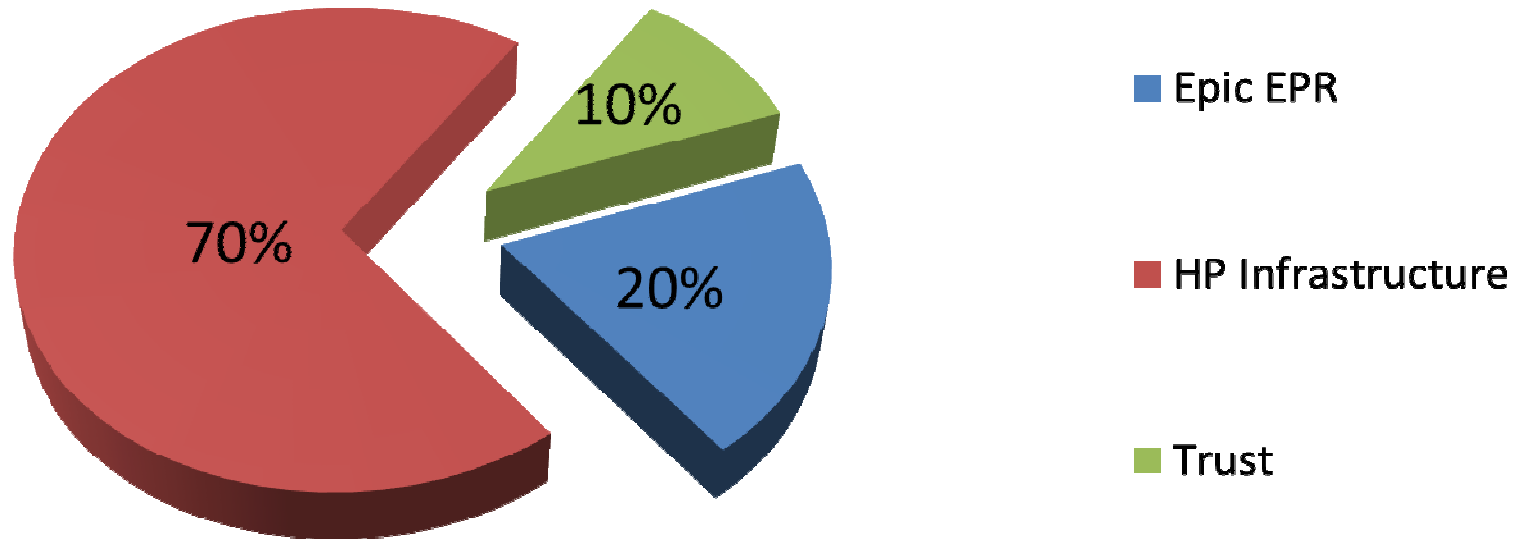
Dress-rehearsals

Go Live: 26 October 2014

- **150 Work Stations supported 24 hours per day for 6 weeks**

- **22,000 support calls**

£200m over 10 years*

- Epic EPR
- HP Infrastructure
- Trust

* Do nothing = £110m

	Budget	Out-turn	Variance
Capital	£28,990,000	£29,296,000	-£306,000
Revenue	£36,273,000	£32,897,000	£3,376,000
TOTAL	**£65,263,000**	**£62,193,000**	**£3,070,000**

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CUH Healthcare Information & Management Systems Society (HIMSS) Status

EMR Adoption Model SM	
Stage	**Cumulative Capabilities**
Stage 7	Complete EMR integrates all clinical areas (e.g. ICU, ED, Outpatient) displacing all (medical) paper records in the hospital; Continuity of Care standards to exchange data; Data Warehouse used as basis for clinical and business analytics
Stage 6	Clinical Documentation interacts with advanced Decision Support (based on discrete data elements) AND Closed Loop Medication Administration
Stage 5	Integrated Image Management Solution (e.g. PACS) displaces all film-based images throughout the hospital
Stage 4	Electronic Ordering provides Clinical Decision Support (based on rules engines) in at least one clinical service area and for medication
Stage 3	Clinical Documentation as well as Electronic Ordering of Physician and/or Nursing Care services; includes tracking of Medication Administration (eMAR)
Stage 2	Clinical Data Repository / Electronic Patient Record allows collection and normalization of data from disparate clinical sources throughout the hospital
Stage 1	Information Systems for major ancillary departments (Laboratory, Radiology, Pharmacy) are installed or data output from external service providers are processed electronically
Stage 0	Information Systems for major ancillary departments (Laboratory, Radiology, Pharmacy) are not installed or data output from external service providers cannot be processed electronically

15 Oct 2015 → Stage 6

25 Oct 2014 → Stage 1

HiMSS UK

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Daily eHospital Activity

- 3,200 concurrent users at peak times

- 6,750 new PCs to date
- 395 Workstations on Wheels

- 420 'Rovers' - iPod Touch with Honeywell barcode sled
- 1000 staff - Haiku / Canto mobile Epic apps

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Standardised Documentation

Clinical data

-Clear, legible, **ALL** notes in one place

-Instantaneously available to all – more prompt review

-Standardised coding

- Diagnoses/ Symptoms/ Problems – SNOMED CT/ ICD-10

- Medications –dm+d

- Procedures OPCS 4.7

Care plans

- 221 underlying care plans, using NIC/NOC & NANDA

-18 care plans personalised for CUH with decision support

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Increased Standardisation in Orders

- Medications, lab, radiology, procedures, nursing, referrals, resuscitation status…

- January 2016
    - > 462,000 inpatient orders
    - CPOE rate: 96.41%
        - (95.7% medication, 97.1% procedures)

    - > 23,000 inpatient ordersets used
    - From 9% to 16% of all orders in just over a year

Nursing Documentation – Device Integration

- Time saved = 88 WTE extra face to face nursing / year
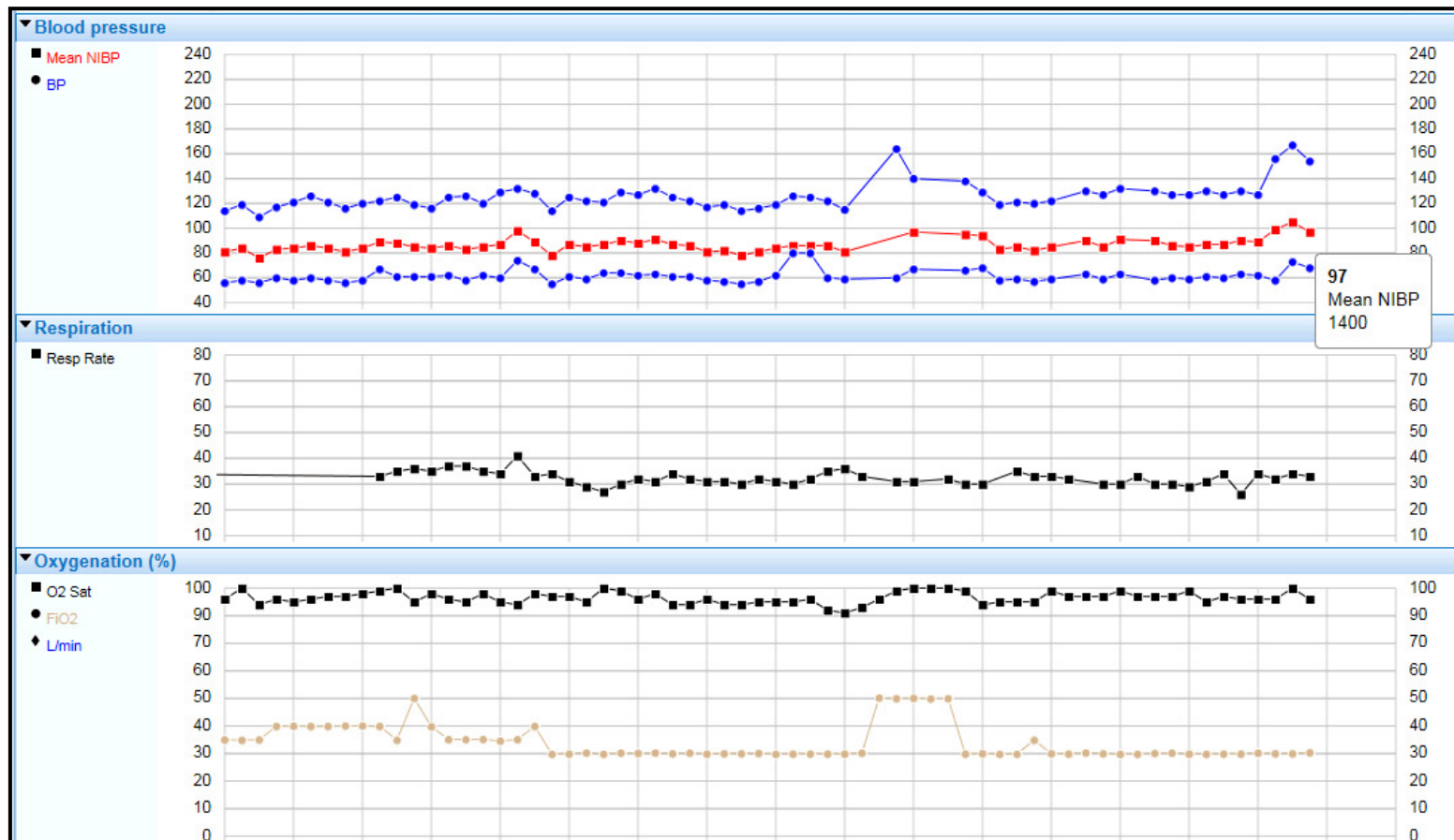
Nursing Documentation – Medication Admin.

Rover

- Time saved = 36 WTE extra face to face nursing / year
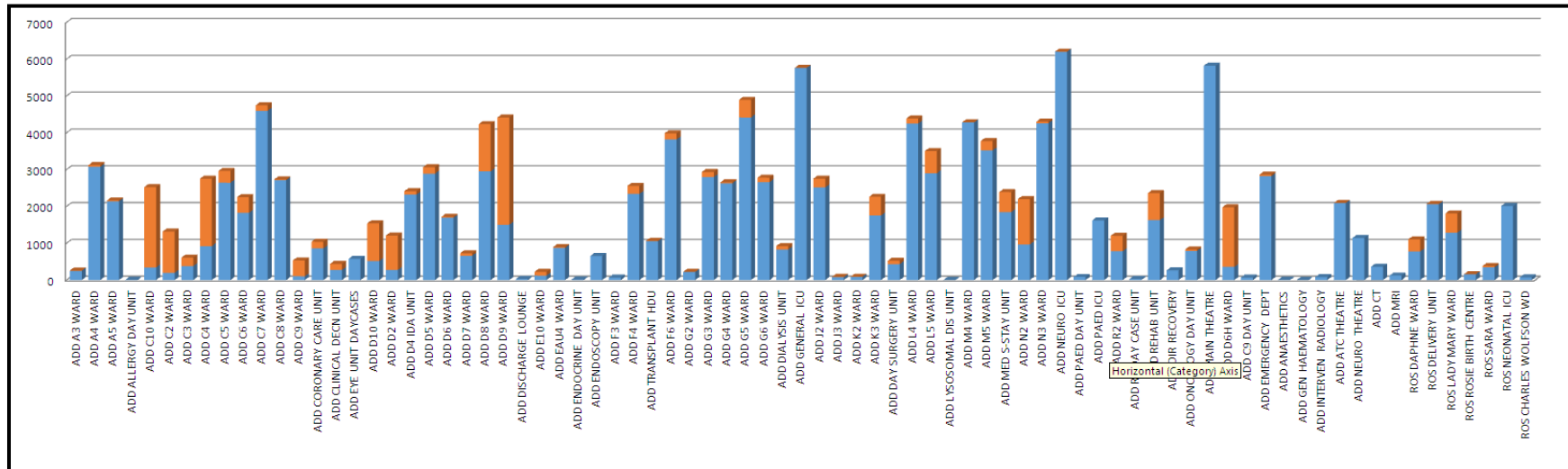
Patient Safety Summary

eHospital Incidents by Week
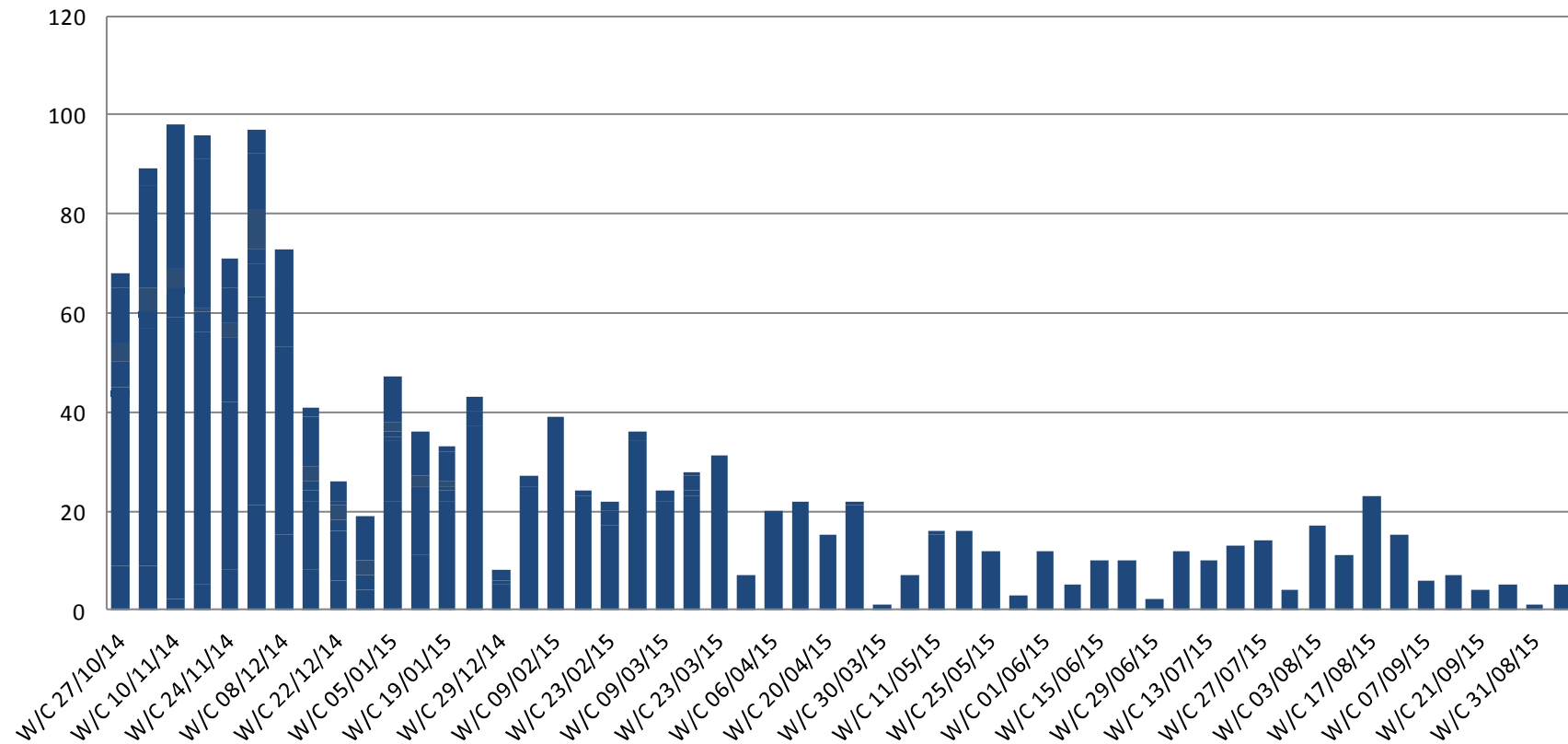
Patient Experience Data

Complaints & PALS data	Complaints	Epic related	PALS concerns	Epic related
October 2014	51	0	378	8
November	58	4	393	28
December	47	6	361	27
January 2015	53	1	322	26
February	44	0	347	2
March	45	0	354	4
April	51	0	308	4
May	34	0	240	2
June	40	1	306	1
July	44	0	277	0
August	31	1	263	3
September	51	0	278	5
October	47	0	278	1
November	42	0	261	1
December	39	0	203	2
January 2016	52	0	158	1

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Staff Experience

Item	April 2015	March 2016
Staff are able to find relevant patient info easily in Epic	81.4%	86%
Staff are able to access the reports or metrics in the Epic system that are relevant to their role	79.7%	85.8%
Staff are satisfied with the support available/provided for Epic issues/Epic changes that arise	**60%**	**68.2%**
Staff who are able to find information about eHospital	84.9%	89.6%
Staff who are confident, at the present time, that the Epic system supports them in caring for their patients	**77.2%**	**88.4%**
Staff who are confident that, in 6 months time, the Epic system will support them in caring for their patients	**85.3%**	**89.6%**

% of staff reporting neutral, agree or strongly agree

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Healthcare Workers (HCWs) Interaction with eHospital

- Qualitative interviews with 76 Healthcare workers
  - Consultant & Junior Doctors
  - Nurses, Midwives, Allied health professional
  - Pharmacists
  - ~ 1 hour

- Areas of Exploration
  - Adoption – barriers & facilitators
  - Patient safety – perceptions/ beliefs
  - Perceptions about the system – responsibilities, control

Interviewees

CUH Wards and Clinics

Legend: A2, A3, A4, A5, C2, C3, C4, C5, C6, C7, C8, C9, C10, D2, D4, D5, D6, D7, D8, D9, D10, E10, F2, F3, F4, F5, F6, G2, G3, G4, G5, G6, J2, J3, K2, K3, L4, L5, M4, M5, N2, N3, R2, R3, S3, Eye Unit, CIW, CRF, CCU, IDA, PICU, PDU, Rosie Delivery, Lady Mary, Rosie Neonatal, Sara, Charles Wolfson, Outpatient Clinic 1, Outpatient Clinic 2, Outpatient Clinic 2A

Bar chart categories (top to bottom):
- Healthcare Assistant: 2
- Occupational Therapist: 1
- Physical Therapist: 1
- Pharmacist: ~3.5
- Physician's Assistant: 2
- Other Doctor: 0
- Surgeon: 1
- Medical Doctor: 12
- Nursing Assistant: 0
- Nurse Manager: 0
- Nurse Specialist: 5
- Nurse Prescriber: 0
- Nurse Practitioner: 2
- Nurse: 13
- Midwife: 5
- Other: 6

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HCWs & eHospital - Adoption

"We took everything they knew, and changed it overnight." – Afzal Chaudhry, CMIO

Barriers
-Negative attitudes of peers
-Personal attitudes: fear, lack of acceptance
-More information than anticipated
-Interactions with IT/ Equipment/ Software
-Little Epic knowledge in the working team
-Perceived feelings of value to the Trust

Facilitators
-Negative attitudes of peers
-Personal attitudes: giving oneself time to adjust
-Mutual support/ working together
-Willingness to try
-Feeling supported
-Expert experience

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HCWs & eHospital – Patient Safety

Safety Concerns

-Notifications

-Alert fatigue

-Being able to care for patients from the desk

Safety Improvements

-Prescribing – dose, interaction, allergies automatically checked

-Having all data available at once

-Being able to read notes/ knowing who initiated/ recorded something

-Compliance with regulations

-Better documentation

Medication Related Benefits

Pharmacy integration

- Preparing discharge medication reduced from 90 to 45 mins

Antibiotic prescribing

- **100%** recording of indication for prescribing

Paediatrics

- **Zero** PICU sedation related drug errors since go-live
- Barcode meds admin in general paediatrics

Allergies

- approx. 51,000 alerts, approx. 8,500 led to a change in prescription

Facture Clinic Benefits & Cost Savings

Virtual fracture clinic

- 4,500 appointments freed up
- **£200k / year saving**

Hip fracture pathway

- Achievement of best practice care **rising from 66% to 82%**

Notes retrieval

- 99% reduction for in-patients
- 99% reduction for out-patients
- **£115k savings / qtr**

Document handling

- 153k / year - discharge summaries sent electronically
- **£157k savings / qtr**

- total 900k+ documents / year

August 2016 eHospital Data Summary

Item	Total
Demographics	2.97 million
Diagnoses	1,437,000
Lab results	355 million
Pathology reports	265,000
Radiology reports	792,000
Procedure reports	143,000
Medication records	5,459,000
Medication admin	12,868,000
Trial subjects	36,500

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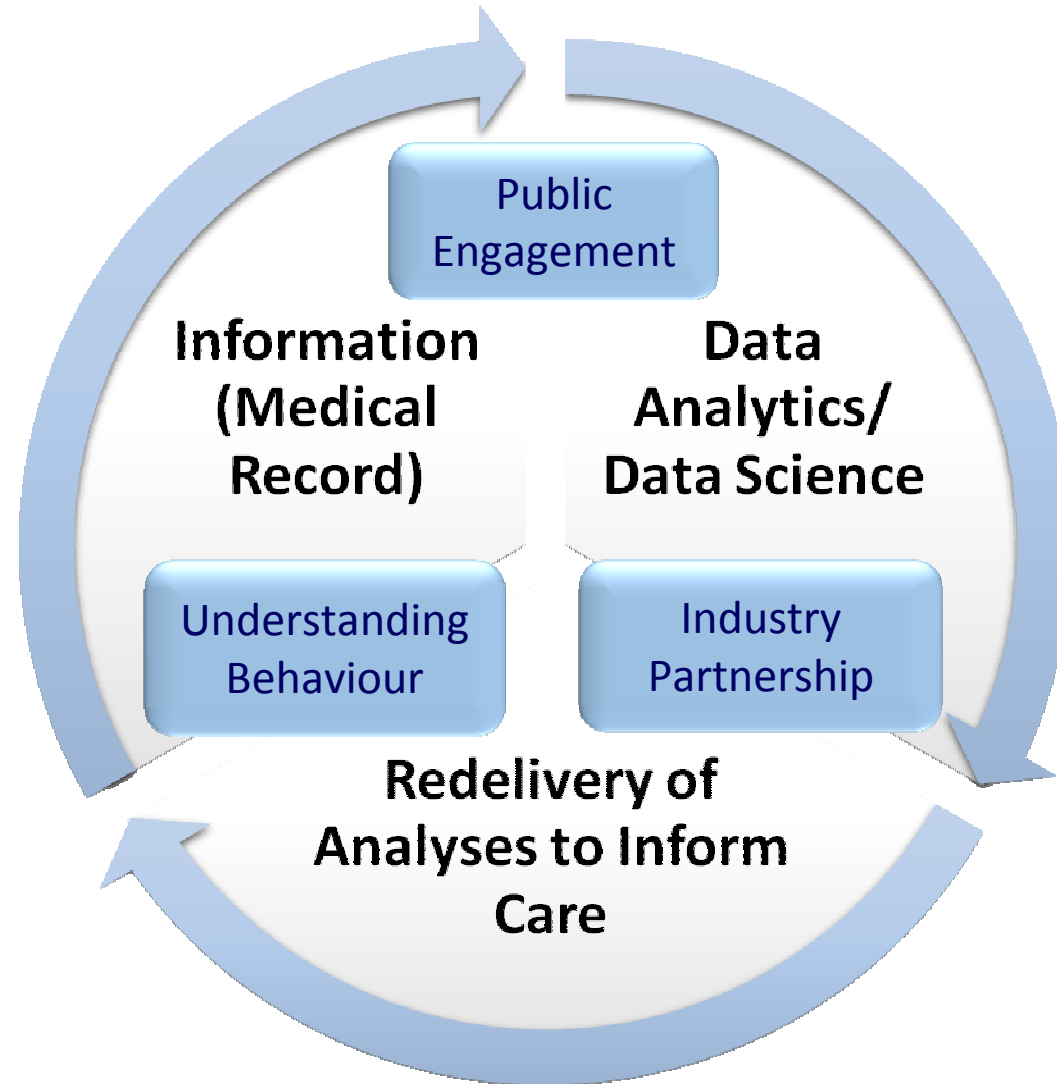
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Cambridge Clinical Informatics (CCI) Infrastructure: eHospital
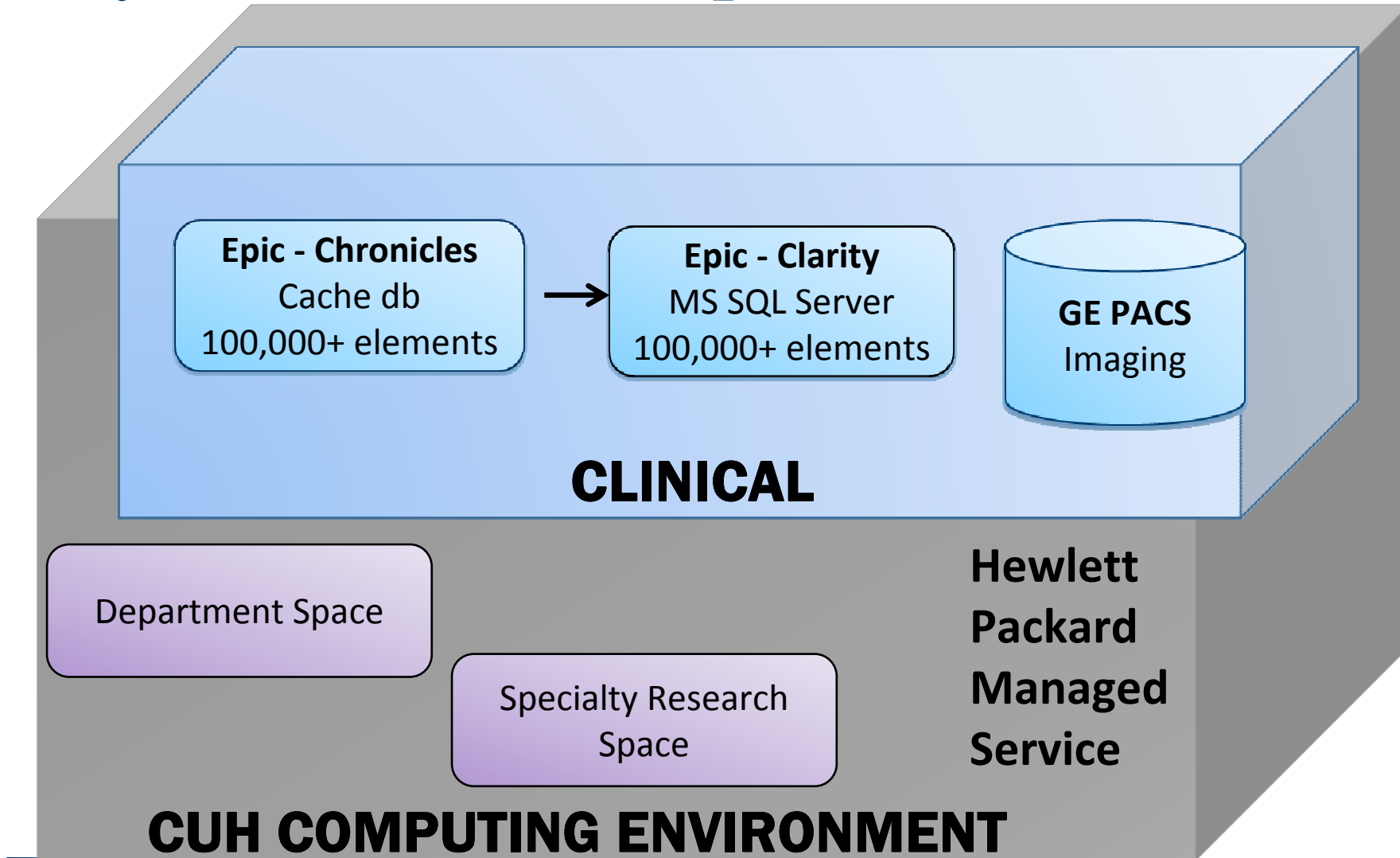
CCI Infrastructure: Built in Data Extraction for Research
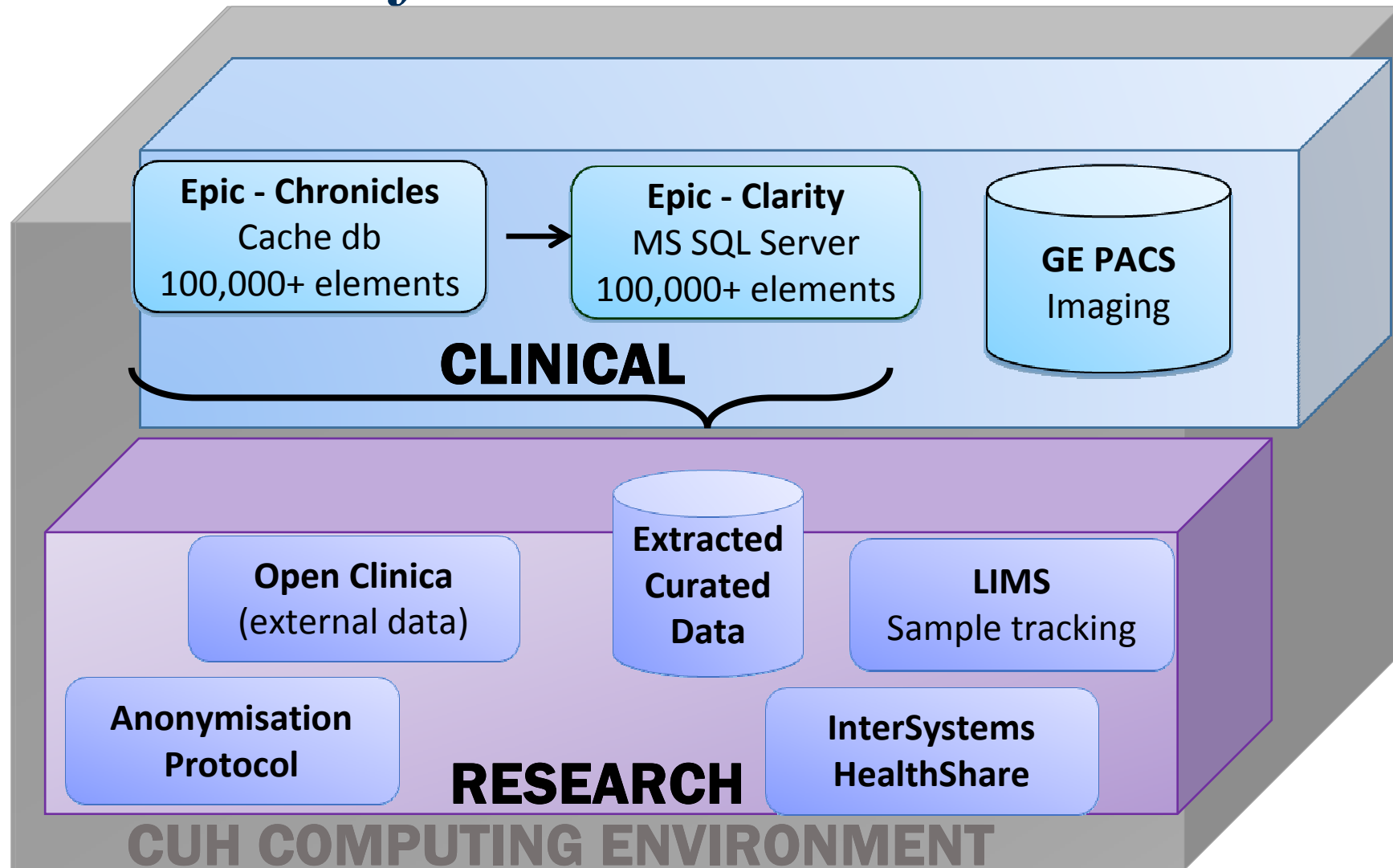
Research in Medical Informatics

Potential for Transforming Medicine

Research
- Extended phase IV trials
- Repurposing of medications -metformin
- Understanding a condition better – norovirus infection
- Assessing care pathways and procedures – prostate cancer care
- Understanding biology & genetics – differential response to drugs

Informing policy/ care delivery
- Efficiency, effectiveness – repeat laboratory orders
- Aberration detection for critical incidences – preventing capacity incidences
- Economic modelling
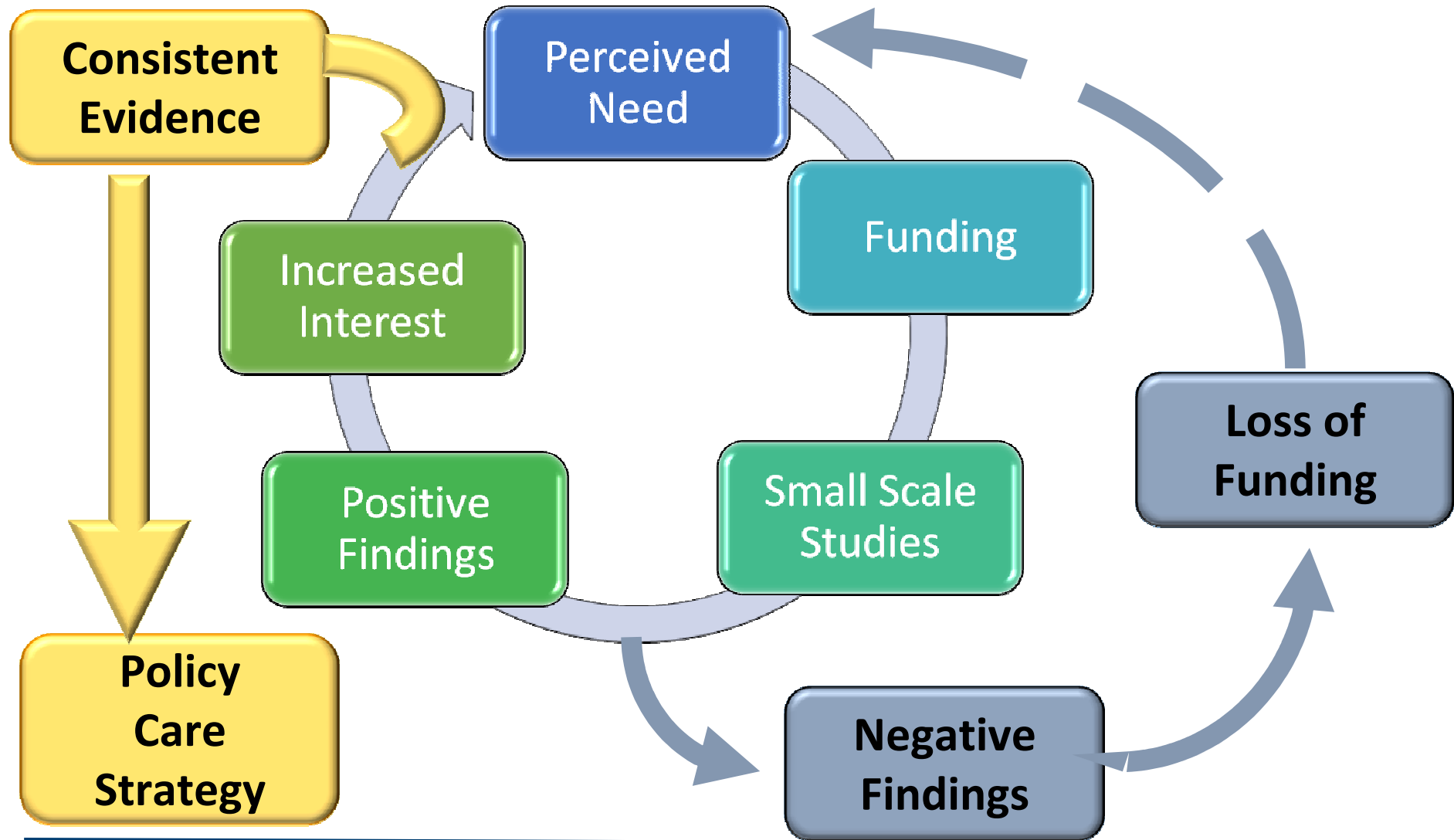- Changes in population service needs
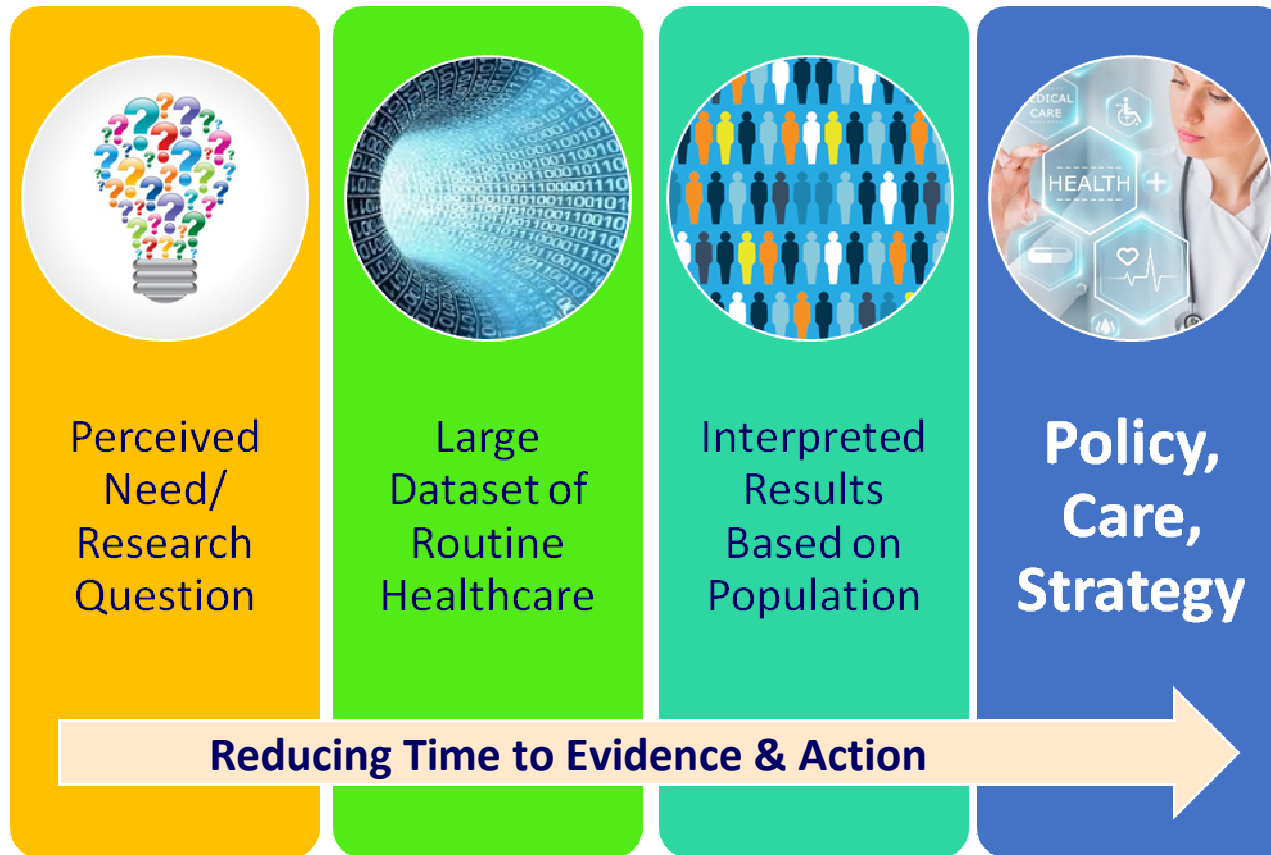
Informing research
- Supporting clinical trials activities

Interventions
- Alerts – allergies, overcrowding of emergency department
- Decision support – antimicrobial prescribing experience
- Precision medicine
- Personalised medicine

Shifting the Biomedical Action Paradigm

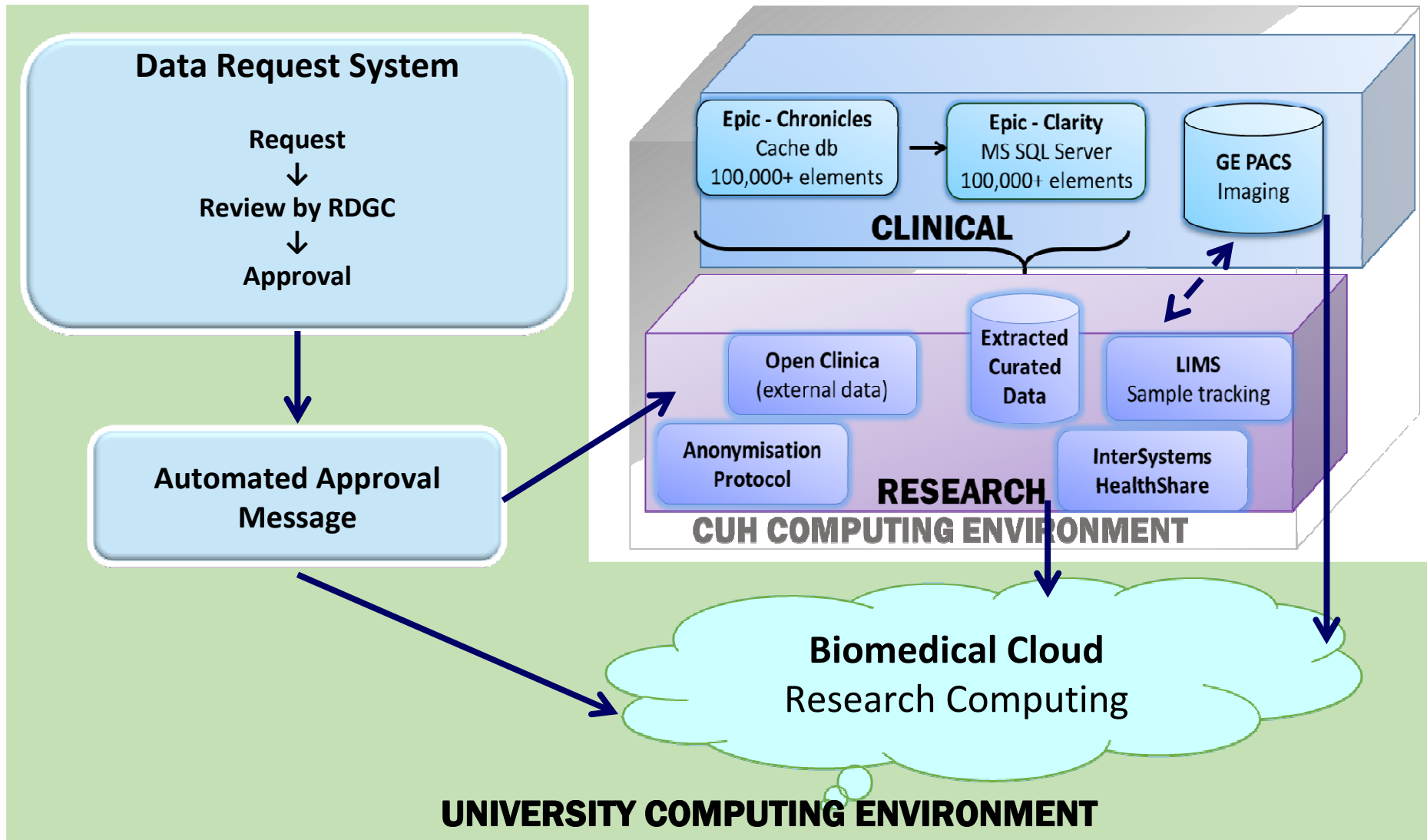- Consistent Evidence
- Perceived Need
- Increased Interest
- Funding
- Positive Findings
- Small Scale Studies
- Loss of Funding
- Policy Care Strategy
- Negative Findings

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A Potentially New Biomedical Action Paradigm

Perceived Need/ Research Question

Large Dataset of Routine Healthcare

Interpreted Results Based on Population

Policy, Care, Strategy

Reducing Time to Evidence & Action

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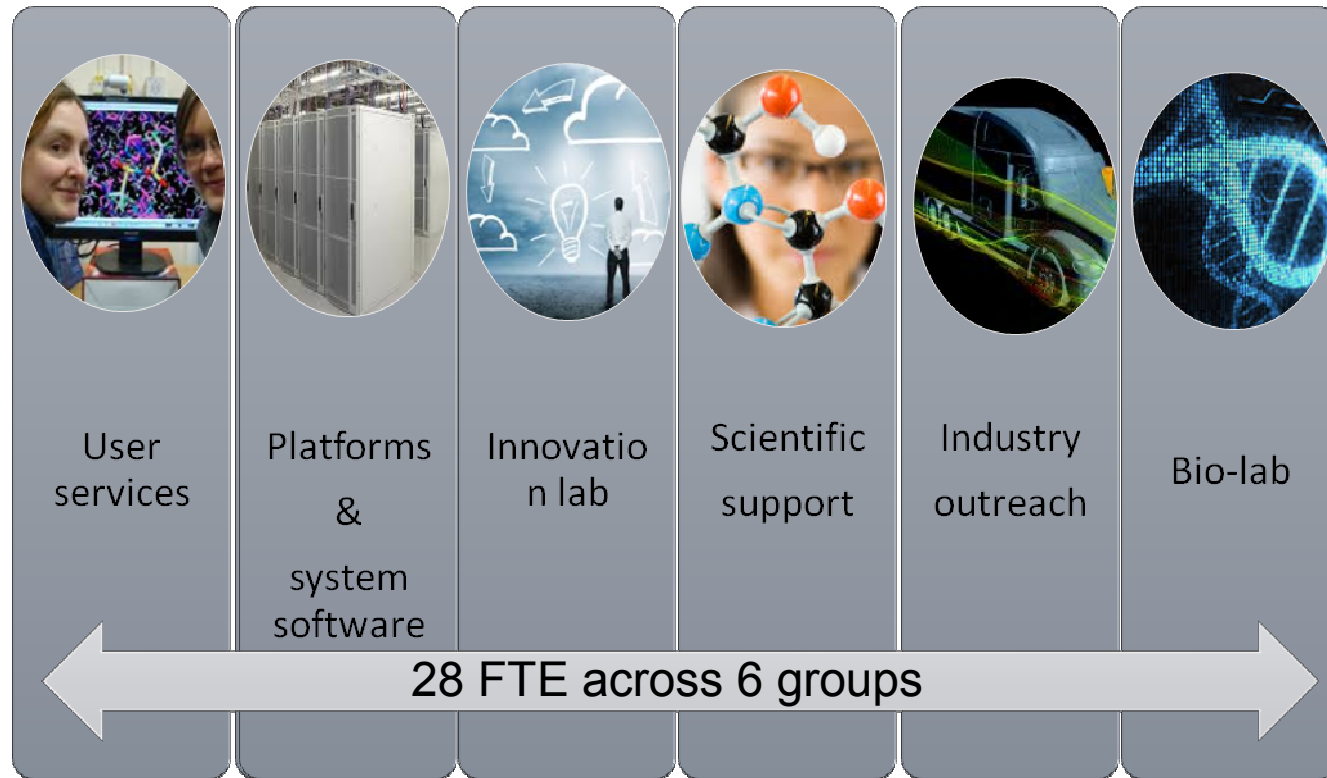NHS Foundation Trust

CCI Infrastructure: Research Computing
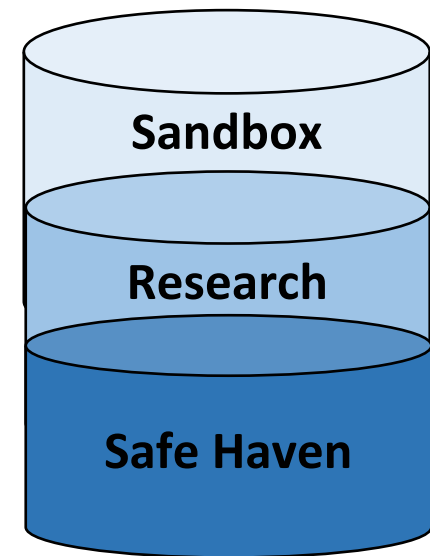
Research Computing Biomedical Cloud

- £9 million EPSRC/ University funded Research Computing

- Largest research computing centre in the UK

- Health informatics theme – data security, predictive analytics, health imaging, genomics
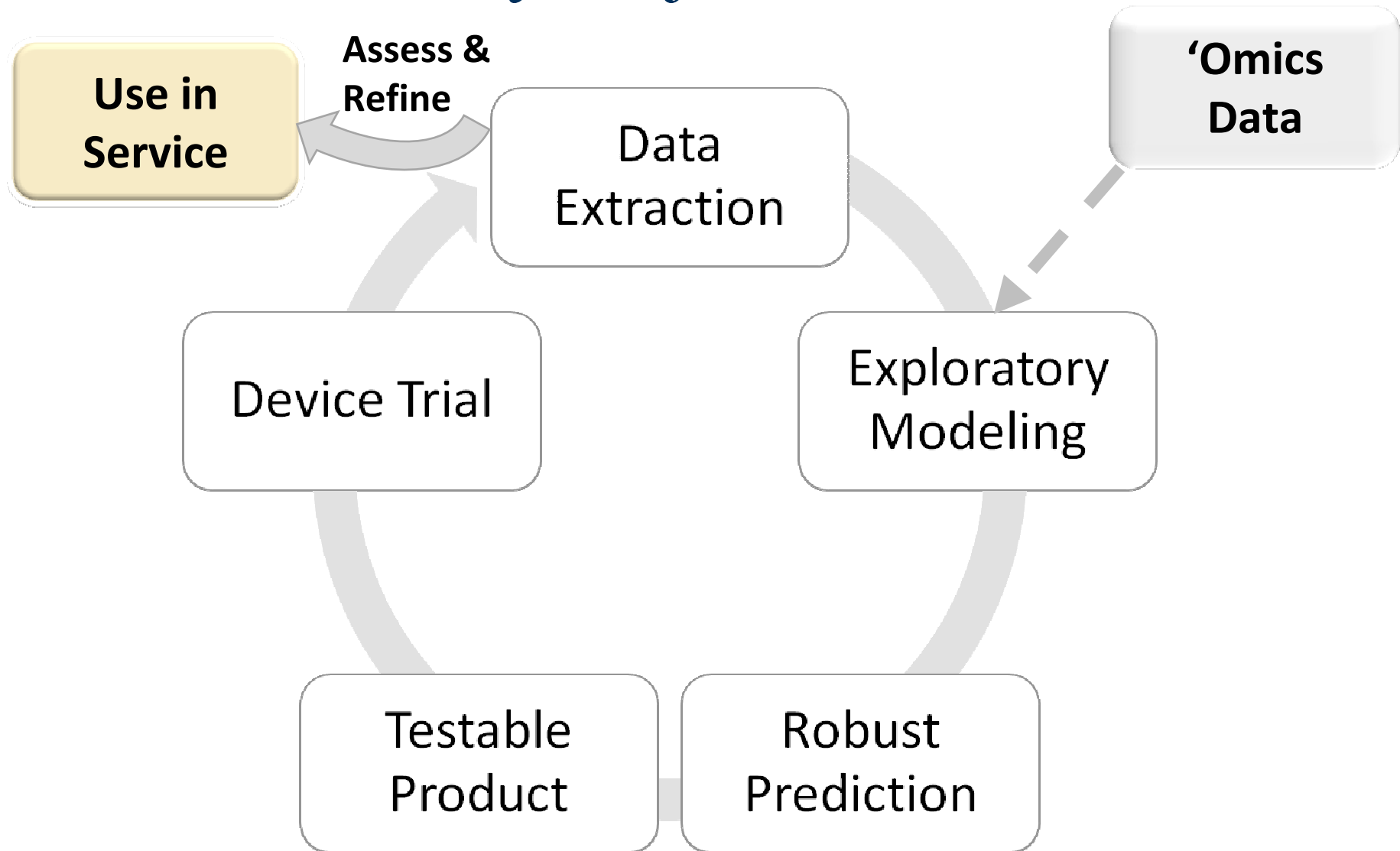
Research support | Industrial outreach | HPC & data solution development
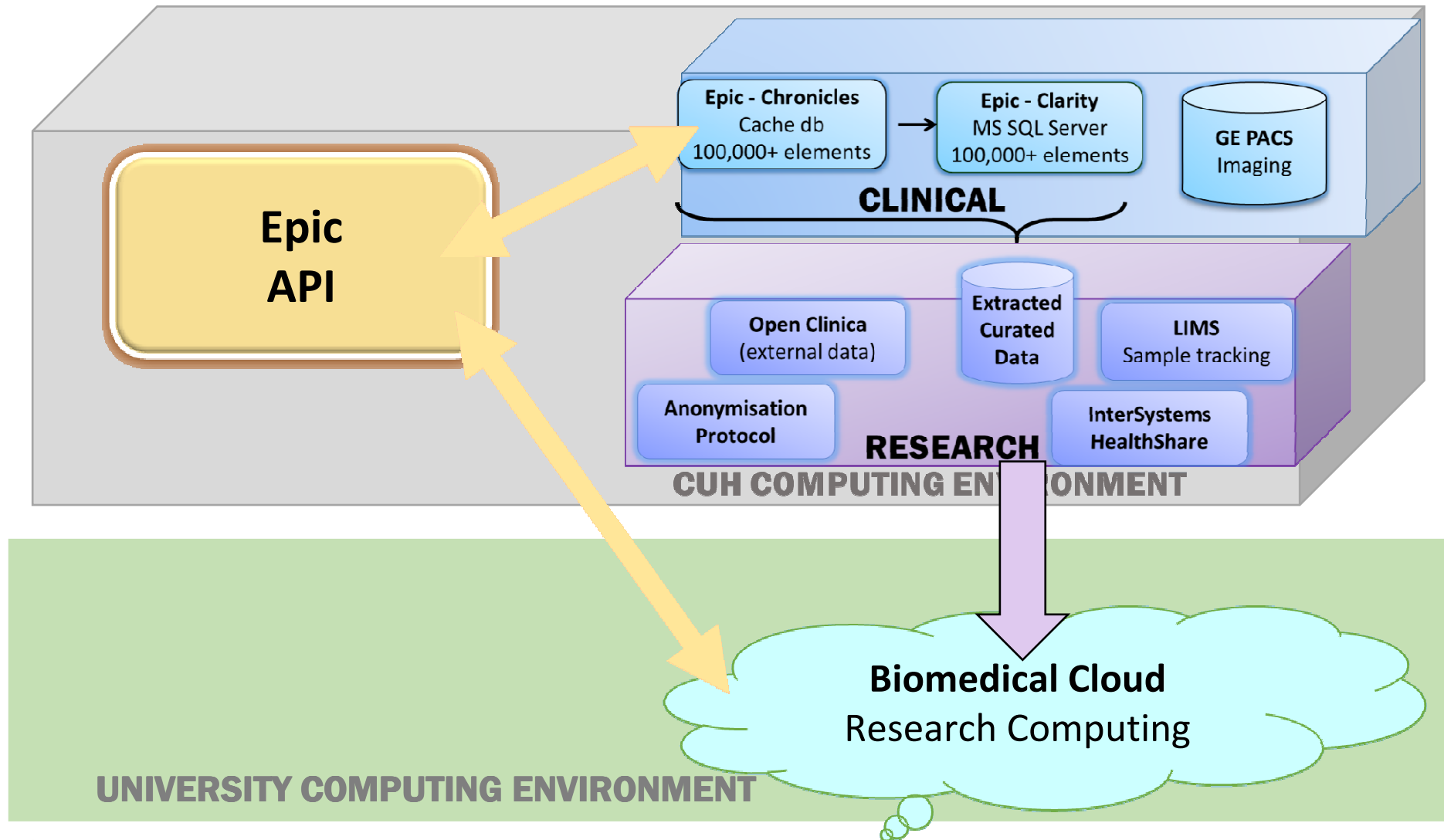
Driving discovery, impact & innovation

Structures Supporting Health Informatics

User services | Platforms & system software | Innovation lab | Scientific support | Industry outreach | Bio-lab

28 FTE across 6 groups

- Mixed HPC & Openstack
- Hadoop & spark
- 200 nodes, some large memory
- 10 PB storage

Sandbox

Research

Safe Haven

Predictive Analytics for Precision Medicine

Use in Service

Assess & Refine

Data Extraction

'Omics Data

Exploratory Modeling

Device Trial

Testable Product

Robust Prediction

Predictive Analytics for Precision Medicine

Epic API

Epic - Chronicles Cache db 100,000+ elements

Epic - Clarity MS SQL Server 100,000+ elements

GE PACS Imaging

CLINICAL

Open Clinica (external data)

Extracted Curated Data

LIMS Sample tracking

Anonymisation Protocol

InterSystems HealthShare

RESEARCH

CUH COMPUTING ENVIRONMENT

Biomedical Cloud Research Computing

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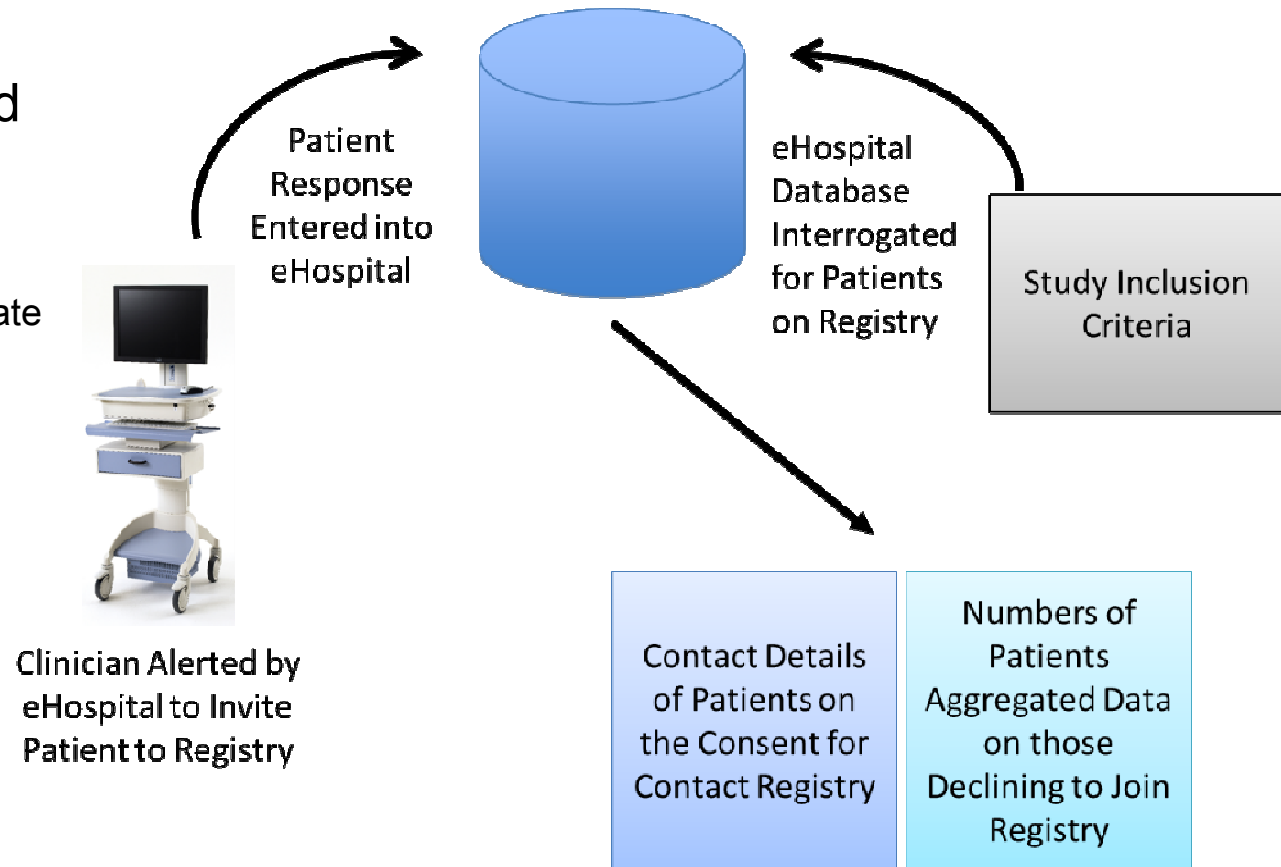Cambridge University Hospitals NHS NHS Foundation Trust

Virtual Bio-banking

- Hundreds of thousands of samples processed/ month
  - Basic biochemistry/microbiology
  - Blood, stool, cerebral-spinal fluid, bronchial-alveolar lavage, urine, etc.
  - Residual sample disposed
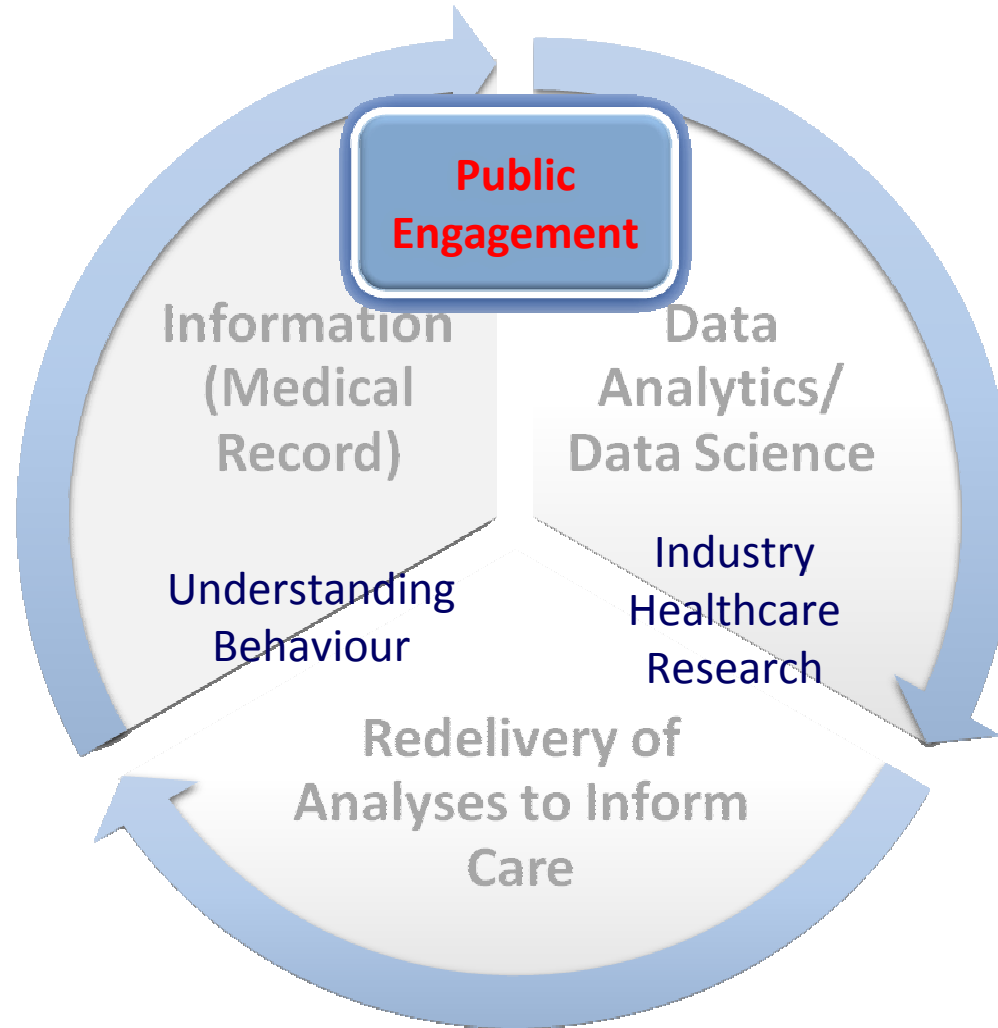- Ethical to anonymised & reuse for research
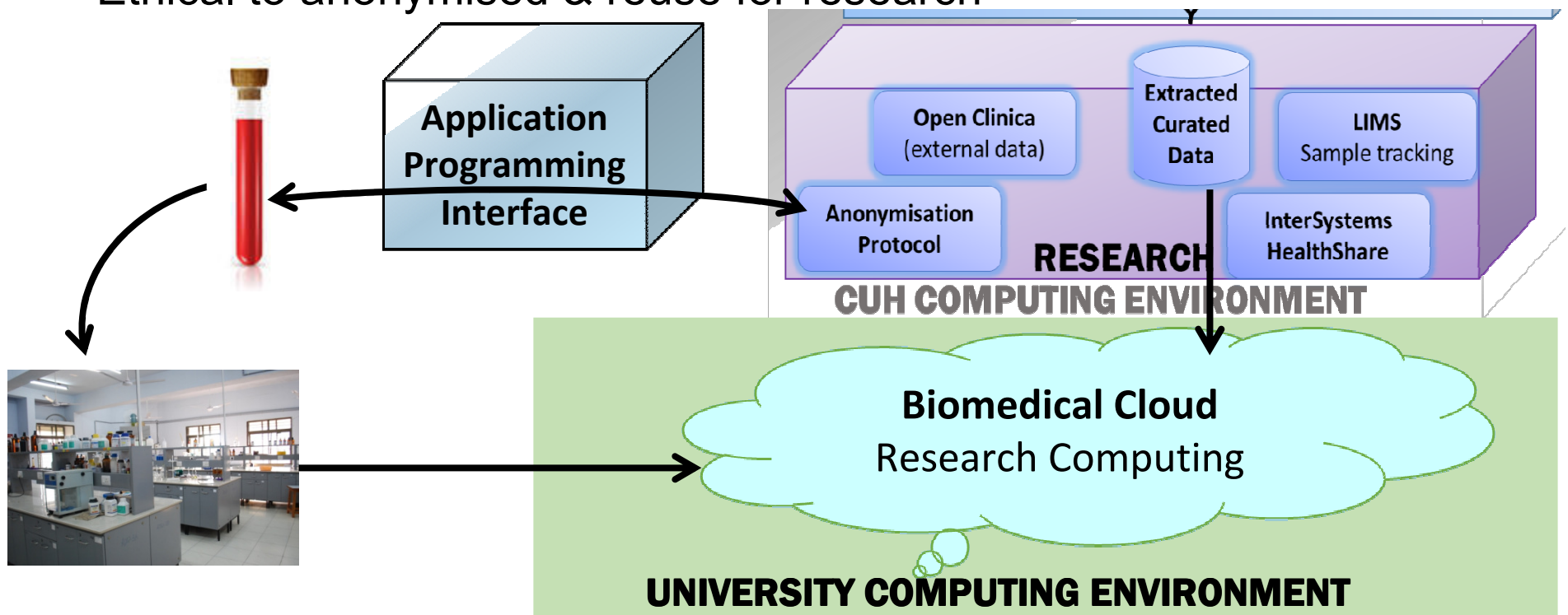
Bringing Patients & Researchers Closer: Consent for Contact Registry

- Registry of patients from CUH interested in being contacted about research studies.
  - <u>Not</u> agreeing to participate in research, agreeing to hear about research.

- Methods of how, by whom, when, and how frequently patients are approached are currently being designed by the community (PPI).

Patient Response Entered into eHospital

eHospital Database Interrogated for Patients on Registry

Study Inclusion Criteria

Clinician Alerted by eHospital to Invite Patient to Registry

Contact Details of Patients on the Consent for Contact Registry

Numbers of Patients Aggregated Data on those Declining to Join Registry

Patient & Public Engagement

Working with the Community in Our Research

- Engagement + Involvement

- Different Methods
  - Community Workshops
  - Very Elderly Focus Groups
  - Sixth Form Junior Researchers
  - Healthcare workers
  - Science Festivals
  - Community Talks
  - Website – interactive component
  - Oversight Committee

- Areas
  - Information sheet design
  - Study design
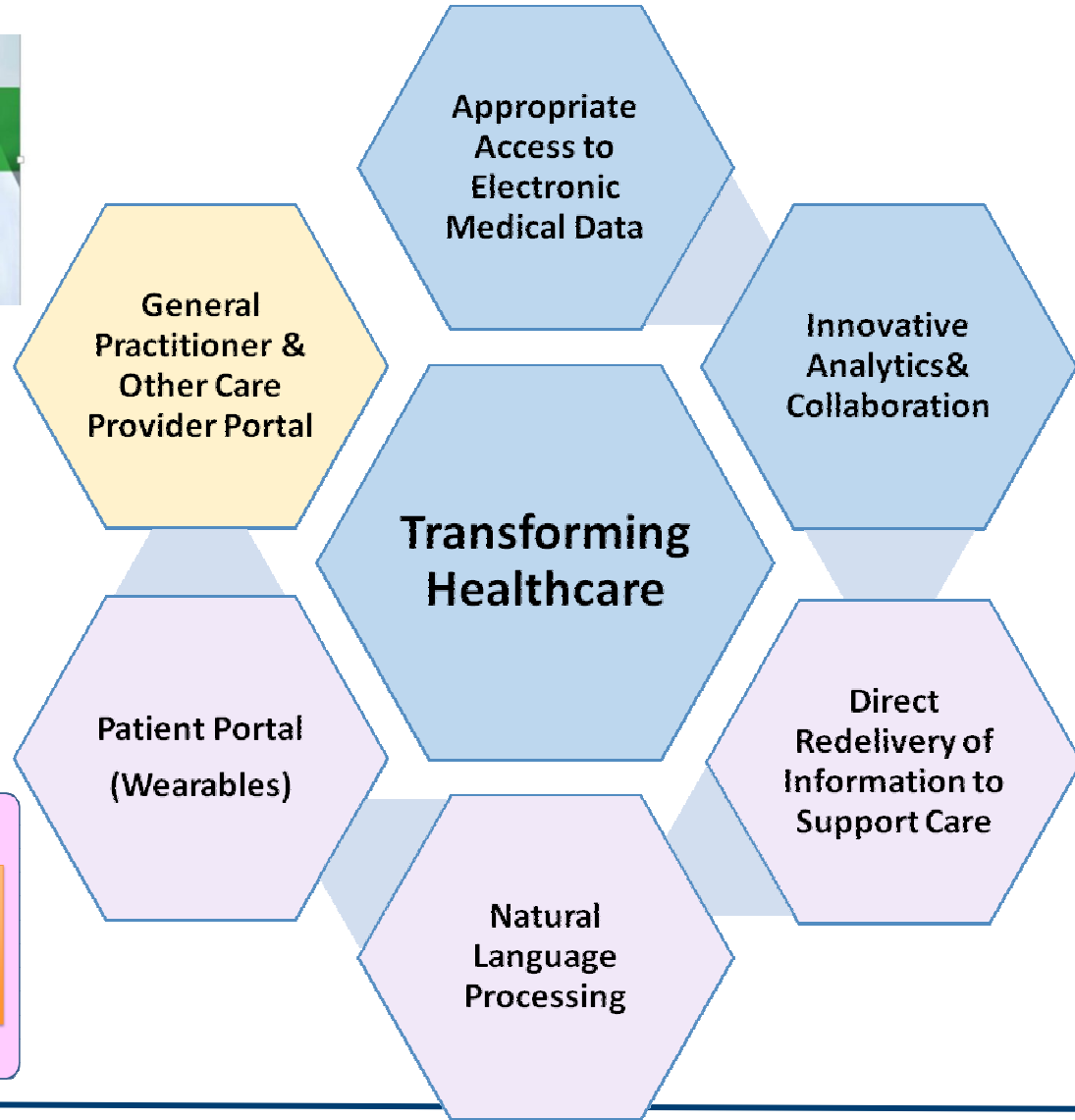 - Research question
  - Activity oversight
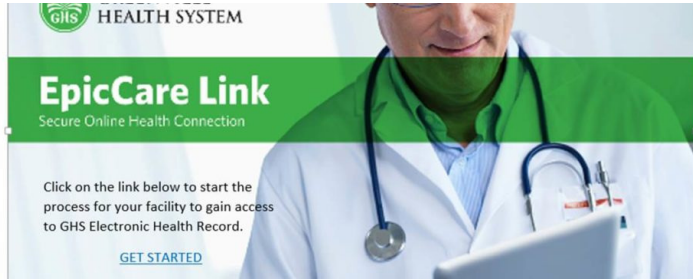 - Guiding Policy –interactions with industry

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What next….?

External communication

- MyChart patient portal – Q2 2016

- EpicCare Link for GPs, referring hospitals & others – Q1 2017

- Care Everywhere connection to:

  - West Suffolk Hospital (Cerner) – in testing

  - CDA based discharge summaries to 1° care systems

  - Research integration for decision support/ precision medicine