

Healthcare@Home

*“Portal Technologies for Patient-centred
Integrated Care”*

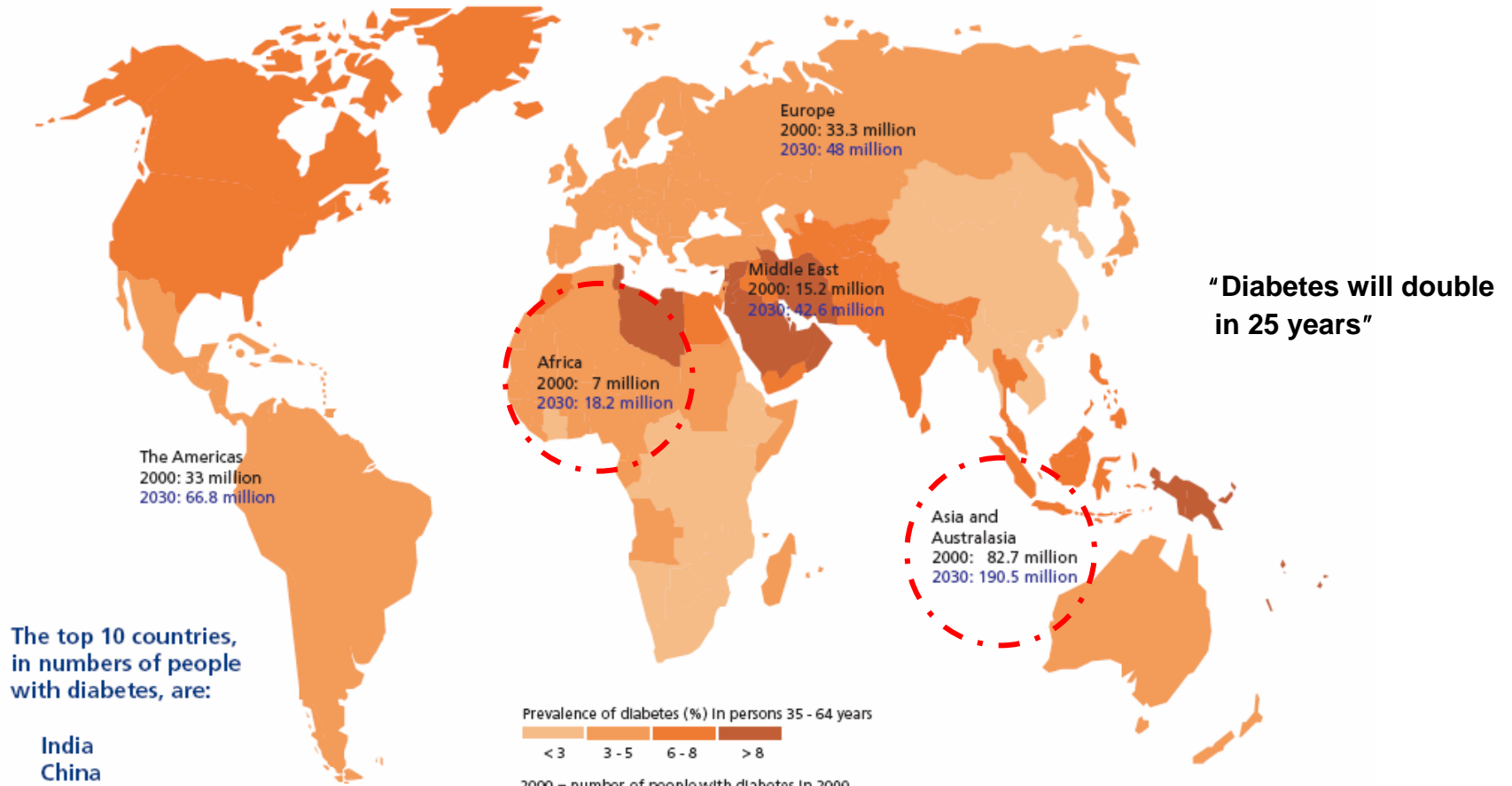


Mahesh Subramanian, Edward C. Conley, Alex Hardisty, Omer F. Rana, Ali Shaikh Ali , Steve Luzio & David R. Owens



Prevalence of diabetes

Source: WHO



“Diabetes will double in 25 years”

The top 10 countries, in numbers of people with diabetes, are:

- India
- China
- USA
- Indonesia
- Japan
- Pakistan
- Russia
- Brazil
- Italy
- Bangladesh

Prevalence of diabetes (%) In persons 35 - 64 years

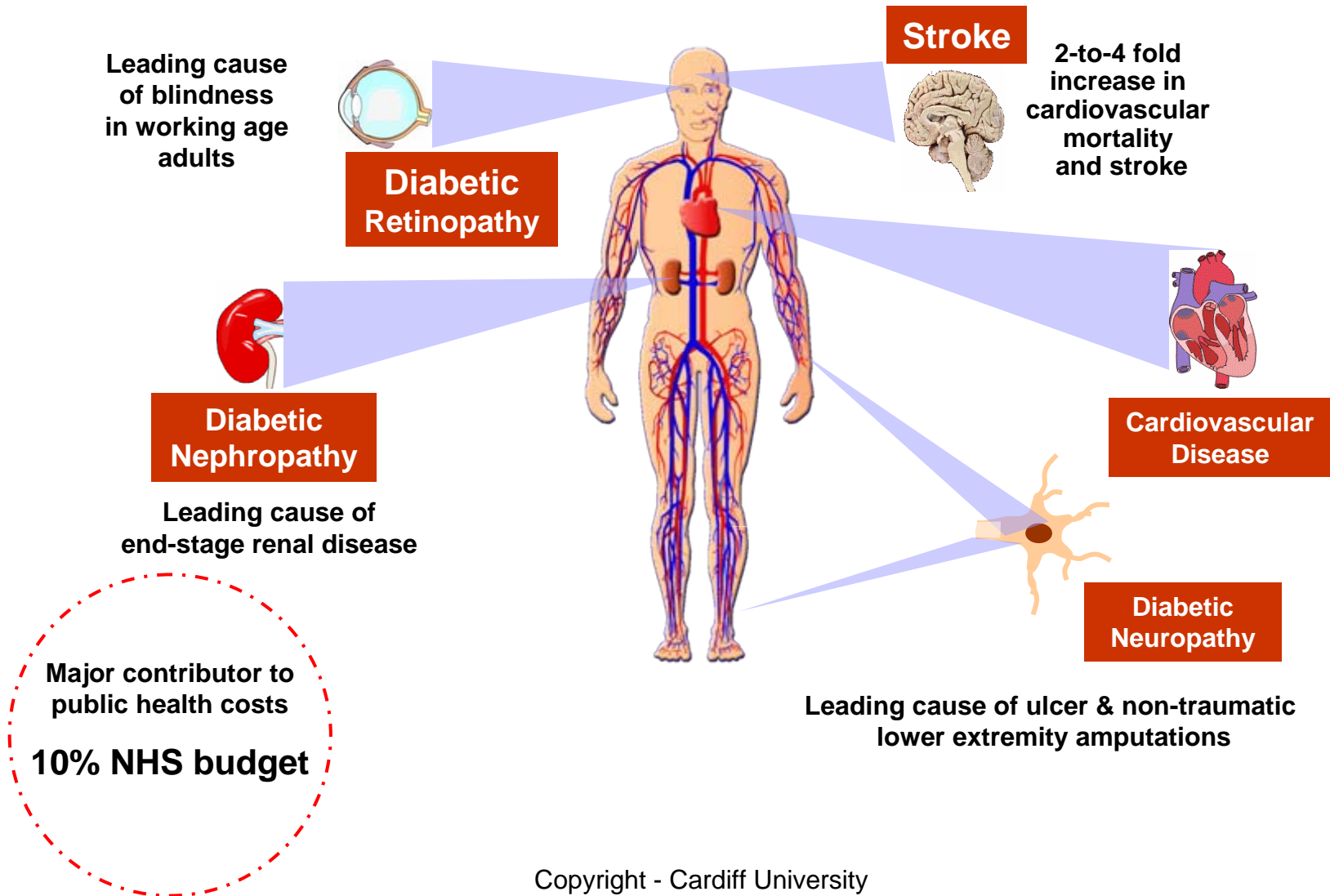


2000 = number of people with diabetes in 2000
2030 = number of people with diabetes in 2030

Source: Wild et al, 2004

Year	2000	2030
Ranking	Country	People with diabetes (millions)
1	India	31.7 79.4
2	China	20.8 42.3
3	United States of America	17.7 30.3

Human cost of diabetes



Wellness-centric Model

- Transition in clinical approach from an illness centric model to wellness-centric model
 - Relies on real time data aggregation
 - Made possible through data collection points being close to the patient
 - Allows for a flexible lifestyle for patients
 - Adoption of care pathways for healthcare delivery to patients based on their specific needs
 - Consistency in clinical care and practice
 - Familiarity for patients with the ongoing treatment process
 - Collate information from different care providers to build a holistic picture of the patients condition
 - Information flow in a decentralised care setup

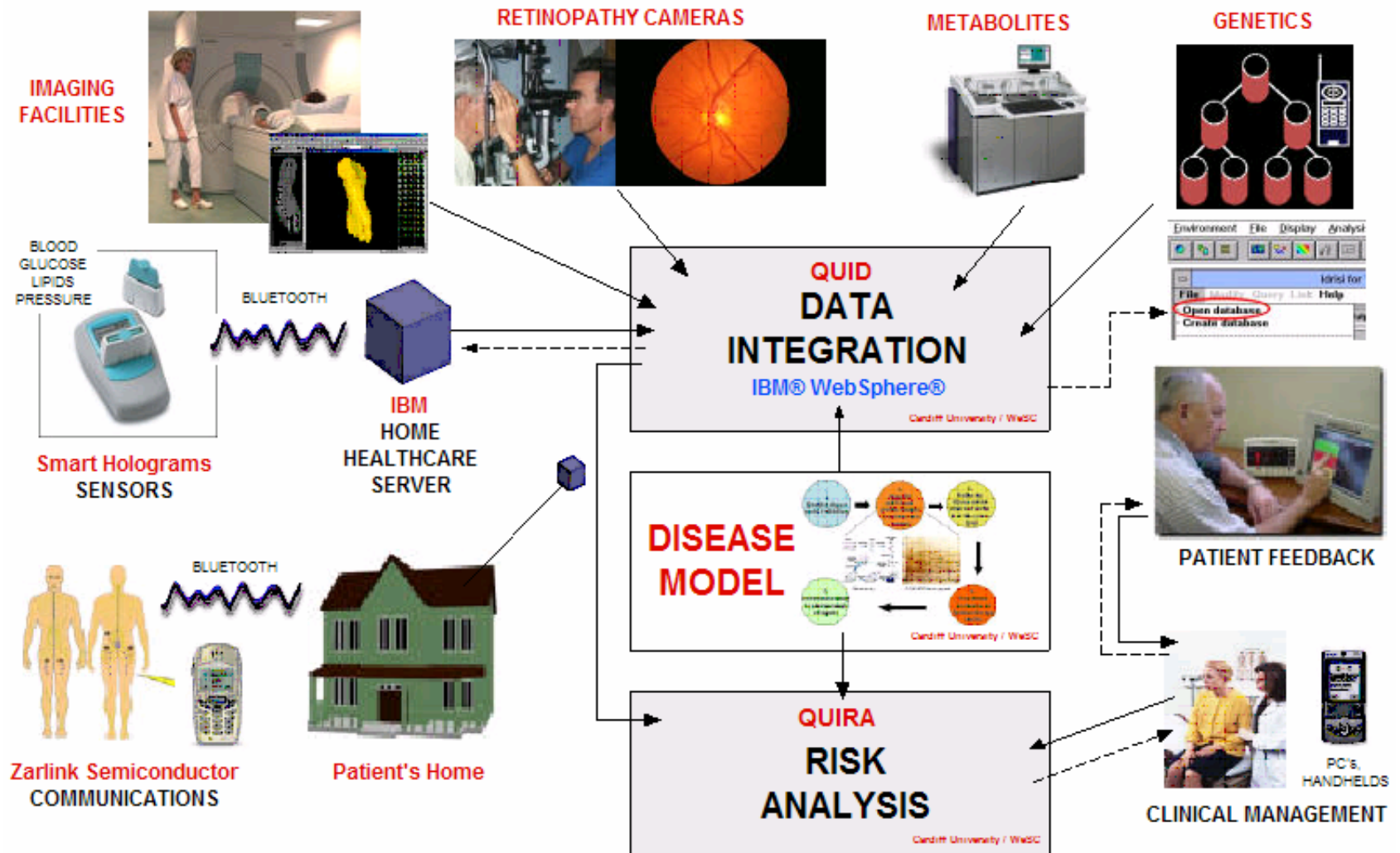
Current Clinical Approach

- Paper-based approach still widely employed
 - Results in transcription errors
 - Delay in recovering records – information retrieval slow
 - Records not easily accessible by other clinical care providers
 - Delay in obtaining records from another clinical site
- Lack of consistency in healthcare delivery across clinical sites
 - Different procedures followed in different clinics
- No standard interface for data perusal

Healthcare@Home is...

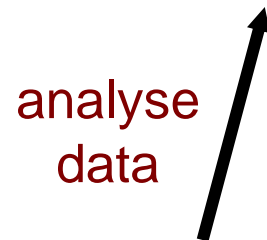
- a DTI funded project
 - collaborators include IBM, Smart Holograms, Zarlink Semiconductors and Diabetes Research Unit
- a research-phase demonstrator
 - no real patient data used (as yet)
 - clinical evaluation currently underway
- a decision support system to aid clinicians
- a system founded on the requirements of National Service Framework (NSF) standards and associated Integrated Care Pathways
- a system utilising wireless sensor devices coupled with mobile communication technologies and biometric authentication to enable remote patient monitoring
- a risk analysis engine

Healthcare@Home (H@H) approach



Roles in the system

Clinicians



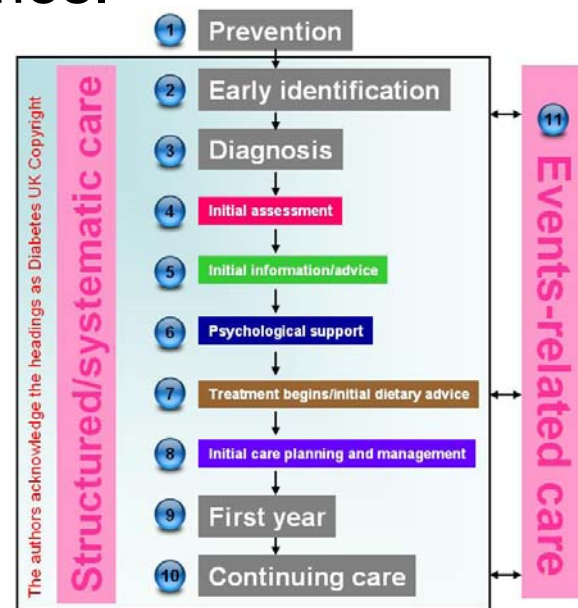
Researchers

Integrated Care Pathways (ICP)

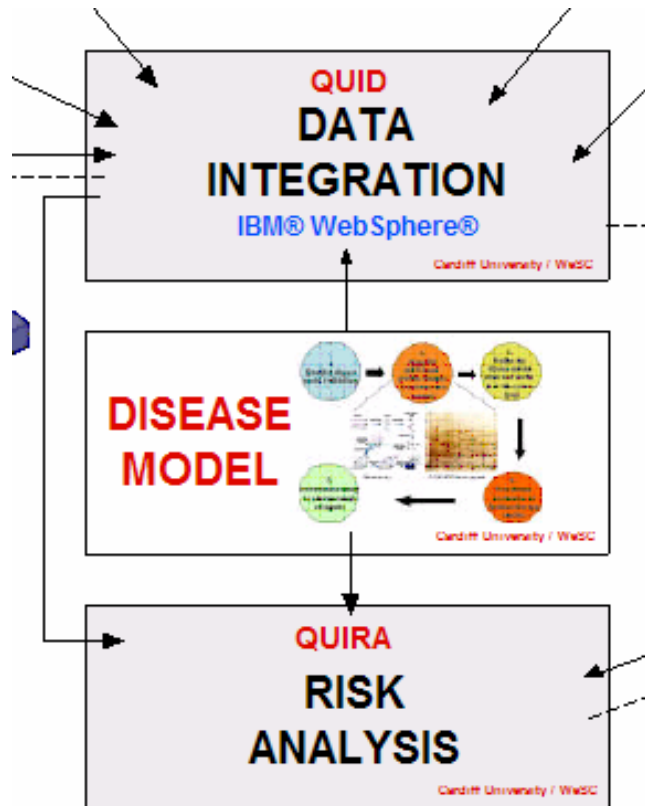
Definition:

“... a multidisciplinary outline of anticipated care, placed in an appropriate timeframe, to help a patient with a specific condition or set of symptoms move progressively through a clinical experience to positive outcomes.”

- H@H adheres to the guidelines set in the ICP framework for Type 2 diabetes formulated by Diabetes UK.
 - Not all aspects are covered and considered within scope for the research demonstrator



Healthcare@Home – QUID

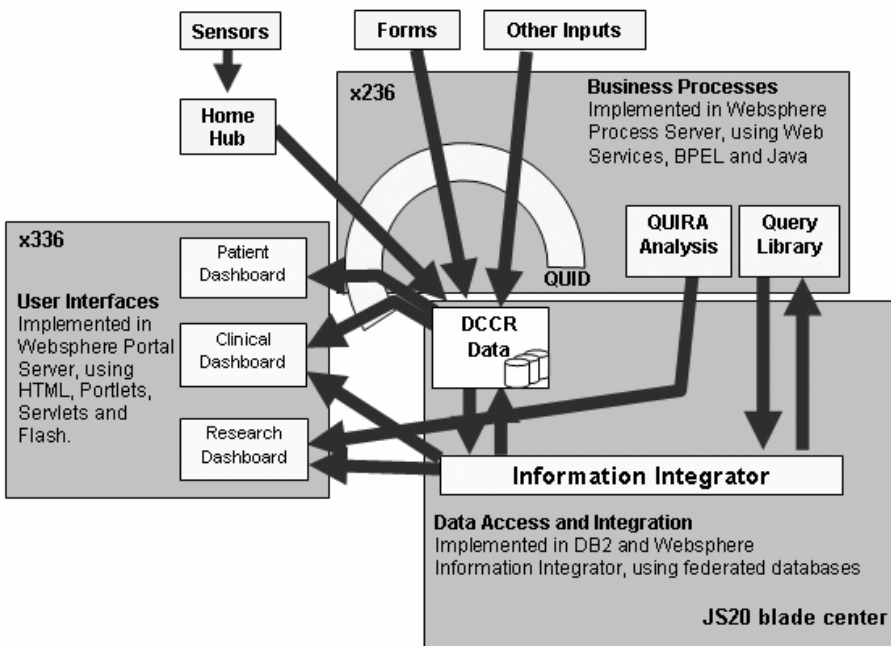


- QUID = QUantitative Individualised Data integration
- Focuses on data collection, data storage, process execution
- Supports portal infrastructures for system users (clinicians, patients etc...)
- Guided by the requirements of Integrated Care Pathways (ICPs) for diabetes
- Emulates workflows in real-world care pathways

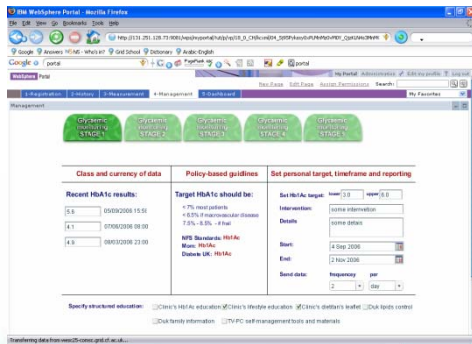
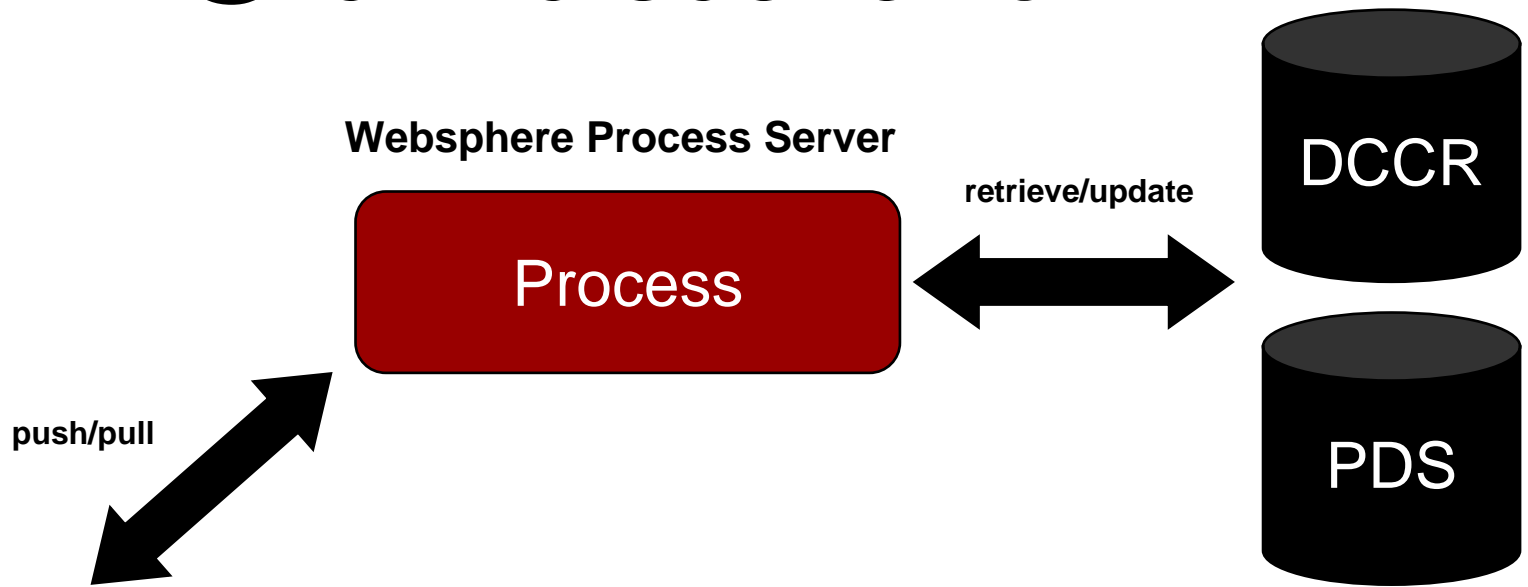
Server-side architecture

■ 3-tier architecture

- Portal server to support front end framework mirroring ICP approach
- Process server to translate ICP workflows and process business logic
- DB2 database replicating DCCR and PDS



@ clinic scenario

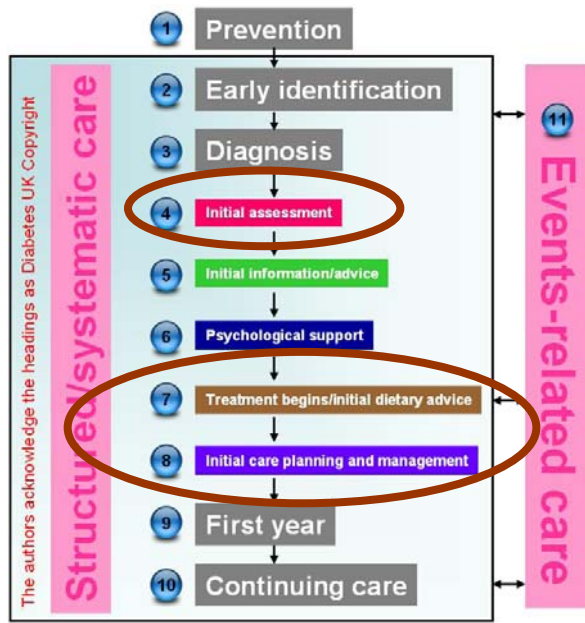


WebSphere Portal Server
Flash forms
XML

Portal



Healthcare@Home – Clinician Portal



Initial Visit - Measurement

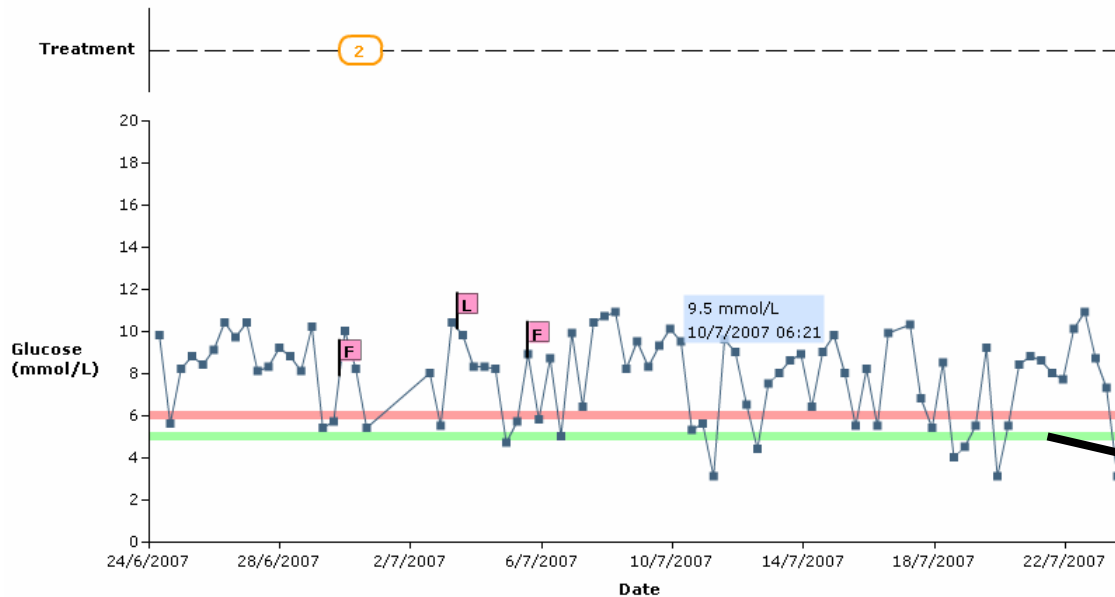
Height	<input type="button" value="Record"/>	<input type="text" value="1.68"/>	metres
Weight	<input type="button" value="Record"/>	<input type="text" value="70"/>	kg
Calculated BMI	<input type="button" value="Compute"/>	<input type="text" value="24.8"/>	kg/m ² <input type="button" value="Clear"/>
Waist Circumference		<input type="text" value="42"/>	cms
Blood Pressure	<input type="button" value="Record"/>	<input type="text" value="150"/> / <input type="text" value="90"/>	mm Hg
HbA1c		<input type="text" value="7.0"/>	%
Lipids: LDL Cholesterol	<input type="button" value="Record"/>	<input type="text" value="4.0"/>	mmol/L
Lipids: HDL Cholesterol	<input type="button" value="Record"/>	<input type="text" value="7.0"/>	mmol/L
Lipids: triglycerides	<input type="button" value="Record"/>	<input type="text" value="1.3"/>	mmol/L
Urine microalbumin	<input type="button" value="Record"/>	<input type="text" value="6.0"/>	mmol/L
Peripheral pulses	L <input type="button" value="Select"/>	R <input type="button" value="Select"/>	
Sensation	L <input type="button" value="Select"/>	R <input type="button" value="Select"/>	
Visual acuity	L <input type="text"/>	R <input type="text"/>	
Retinal photo grade	L <input type="text"/>	Date <input type="text"/>	
	R <input type="text"/>	Date <input type="text"/>	

Additional diagnostic tests

Patient Demographics at Glance		at Glance
First Name:	Joe	
Last Name:	Best	
Postcode:	CF56 2DR	DR
Date of Birth:	14/01/1957	11-14

Healthcare@Home - Dashboard

View mode: Day Week Month Year Custom
View period: 24/06/2007 to 24/07/2007
 <<< Previous Next >>>



Patient Data
 Joe Best
 NHS : 407149086
 DOB: 14/01/1957

- Glucose
- Targets
- Lifestyle
- Treatment

Food
 Date and Time : 5/7/2007 14:00
 Description : 2 burgers and a pint of beer

Set personal target, timeframe and reporting

Set HbA1c target lower upper %
Set Glucose target lower upper mmol/L
Intervention
Details
End:
Send data:

Business Integration - Assembly Diagram: HHModule - IBM Rational Software Development Platform

File Edit Navigate Search Project Run Window Help

Business Integration

InitialAssessment 1.1 (Binary)
 >PatientVisit 1.1 (Binary)
 >ReceiveSensorData 1.2 (Binary)
 >RegisterPatient 1.1 (Binary)
 >SetPatientMonitoring 1.1 (Binary)
 >SetPatientTargets 1.1 (Binary)
 >SetPatientTreatment 1.1 (Binary)

State Machines
 Rule Groups
 Rules
 Human Tasks
 Selectors
 Java
 DCCRManagerImpl 1.2 (Binary)
 PDSManagerImpl 1.1 (Binary)
 XMLUtilitiesImpl 1.1 (Binary)

Data Types
 Interfaces
 Action 1.1 (ASCII -kiv)
 CarePathwayStatus 1.1 (ASCII -kiv)
 ChosenAction 1.1 (ASCII -kiv)
 InitialAssessment 1.1 (ASCII -kiv)
 PatientDemogr 1.1 (ASCII -kiv)
 PatientMonitor 1.1 (ASCII -kiv)
 PatientTargets 1.1 (ASCII -kiv)
 PatientTreatment 1.1 (ASCII -kiv)
 PatientVisit 1.1 (ASCII -kiv)
 SensorDataDB 1.1 (ASCII -kiv)
 XMLUtilities 1.1 (ASCII -kiv)

Mapping
 Data Maps
 Interface Maps
 Relationships
 Roles
 Web Service Ports
 HHAction_Act

References
 Module
 ChooseFlow
 References
 Interfaces
 DCCRManager
 Interfaces
 Interfaces
 CarePathway
 InitialAssessment
 PatientDemogr
 PatientMonitor
 PatientTargets
 PatientTreatment
 PatientVisit
 SensorData
 InitialAssessment
 PatientVisit
 PDSManager
 ReceiveSensorData
 RegisterPatient
 SetPatientMonitoring
 SetPatientTargets
 SetPatientTreatment
 XMLUtilities
 HHAction

IBM WebSphere Portal - Mozilla Firefox

http://131.251.128.73:9081/wps/myportal/tut/p/vp/18_0_CH/kcxml/04_Sj9SPykssyC

Management

Glycaemic monitoring STAGE 1
 Glycaemic monitoring STAGE 2
 Glycaemic monitoring STAGE 3
 Glycaemic monitoring STAGE 4
 Glycaemic monitoring STAGE 5

Class and currency of data	Policy-based guidelines	Set personal target, timeframe and reporting
Recent HbA1c results: 10.6 08/09/2006 11:42 3.3 10/06/2006 08:00 9.7 11/03/2006 23:00	Target HbA1c should be: < 7% most patients < 6.5% if macrovascular disease 7.5% - 8.5% - if frail NFS Standards: Hb1Ac Mom: Hb1Ac Diabets UK: Hb1Ac	Set Hb1Ac target: lower 4.0 upper 6.5 Intervention: Oral Monotherapy Details: Metformin Insulin secretagogue Start: 8 Sep 2006 End: 8 Dec 2006 Send data: frequency 6 per day
Specify structured education: <input type="checkbox"/> Clinic's Hb1Ac education <input type="checkbox"/> Clinic's lifestyle education <input checked="" type="checkbox"/> Clinic's dietitian's leaflet <input type="checkbox"/> Duk lipids control <input type="checkbox"/> Duk family information <input checked="" type="checkbox"/> TV-PC self-management tools and materials		
Specify structured assessment: <input type="checkbox"/> Dietary changed SA <input checked="" type="checkbox"/> Physical activity SA <input type="checkbox"/> Smoking cessation SA <input type="checkbox"/> Alcohol intake SA		

< Back Save
 Data has been successfully updated

Transferring data from wesc25-comsc.grid.cf.ac.uk...

Healthcare@Home – Patient Portal

- Enables patients to follow a prescribed treatment
- Maintain a log of activities – supplements information collected by the clinicians
 - aspects of Personal Health Record (PHR) system introduced here
- Pro-actively monitor their health condition

Patient Portal (contd...)

- Targeting ease of use to enable utilisation by a wider demographic community (elderly, disabled, etc...)
 - presenting the portal through a variety of mediums (TV, PC's, handheld devices)
- Enable patients gain a better insight of their condition
- Work in progress



Healthcare@Home – Research Portal

Research Portlet - Service Data Aggregator Data feed from anonymised diabetes registers

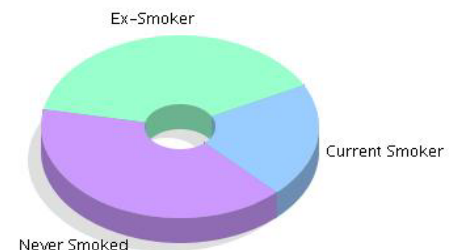
Select registers to aggregate: Diabetes Clinic, Cardiff II OGSA-DAI

Research Query		Select
Display diagnostic category of patients with <input type="text" value="Type 1"/> diabetes trait	<input type="radio"/>	<input type="button" value="Submit"/>
Display profile of patients with ALL diabetes trait listed	<input type="radio"/>	
Display gender profile of <input type="text" value="Male"/> patients with <input type="text" value="Type 1"/> diabetes trait	<input type="radio"/>	
Display numbers and percentage of patients for age <input type="text" value="<= 20"/>	<input type="radio"/>	
Display age profile of all the patients	<input type="radio"/>	
Display smoking profile for all patients	<input checked="" type="radio"/>	
Aggregate <input type="text" value="DIABETES_TYPE = 'Type 1' AND SEX = 'M'"/> (help)	<input type="radio"/>	

Results for patients classified based on their smoking habits

Registered diagnosis	Result
Type 1	84.15 (%)
Type 2	6.93 (%)
IFG	2.97 (%)
IGT	3.96 (%)
GDM	0.0 (%)
MODY	1.98 (%)

Patient Smoking Habits Profile



Current Smoker 20% Ex-Smoker 39% Never Smoked 40%

Research Portal (contd...)

- Provision of anonymised data to statisticians, policy makers for service based trends analysis
- Federated approach employed
 - allows querying of distributed databases
 - achieved through the use of OGSA-DAI and Information Integrator
 - to be implemented in the clinical portal as well (as patients may / will visit multiple clinics during their lifetime; provide clinicians with all the data required to treat the patients)
- Supports
 - pre-defined queries to allow aggregate analysis
 - customised queries
 - visualising results in graphical format

Remote Patient monitoring



- Monitoring device collects patient data
- Data is sent to mobile hub via Bluetooth
- Data is automatically sent to server but can also be inspected on hub
- Data is processed on server and inspected by physician
- Custom Features can be built such as entering data into a patient diary on the hub
- Regime is determined by physician based on medical data analysis

Remote patient monitoring (contd...)

- Allows for patients to be monitored outside conventional clinical sites
 - Convenient to patients
- Places less reliance on frequent clinical visits
 - subject to quality control/calibration safeguards
 - allows the patients to have a more robust lifestyle
- Incentivise patients to '*look after themselves*'
- Monitor progress and implement better warning signals
- Provides for the development of consistent risk prediction
 - early detection results in better management of the condition
- Possible to enable feedback delivery / event notification
 - Send reminders for medication, clinical visits...

Technology enabling remote health monitoring in H@H



Remote monitoring - Issues

- Multiple patients in the same household
 - avoid cross-contamination of data
 - bio-metrics used to tag data from sensor device to a particular patient
- In offline mode, hub capable of storing data
 - Batch transmission possible
- Hub can be used for sending notifications
 - reminders to take medication, risk warning etc...
- No standards as yet for device communications
 - work underway at Continua Healthcare Alliance with participation from a variety of vendors

Healthcare@Home – QUIRA

- QUIRA – Quantitative Individualised Risk Analysis
- Risk analysis engine
 - Ongoing research effort
 - Includes pattern matching in longitudinal streaming data
 - Developing equations to compute the probability of a complication occurring given current medical condition
 - Flagging of patients potentially at risk in the near future

QUIRA (contd...)

- Equations computing risk deployed as web services
- Ranking of patients possible, thereby enabling prioritisation of medical care
- Pattern matching feature currently being explored (DAME approach coupled with SAX being considered)

●●● Patients Risk

FirstName	LastName	BirthDate	NHSNumber	Risk
Joe	Best	14/01/1957	407149086	0.49
Joe23	Bloggs23	02/04/1958	143509559	0.47
Mahesh	Subramanian	02/08/1981	213243234	0.46
Joe9	Bloggs9	05/03/1970	262791889	0.32
Joe30	Bloggs30	01/07/1970	589961495	0.30
Joe33	Bloggs33	13/02/1971	772428707	0.30
Joe12	Bloggs12	20/07/1962	851074790	0.30
Joe28	Bloggs28	04/02/1969	303679326	0.30
Joe90	Bloggs90	27/07/1975	918122676	0.30

You have selected the following patient

First Name: Joe	NHS Number: 407149086
Last Name: Best	Risk: 0.49

Initial Visit Management Dashboard

Healthcare@Home salient features

- Portal framework for data presentation
 - Integration of data from disparate sources and provide a holistic view of the patient condition
- Adoption of ICP
 - Decision support system to aid clinicians
- Adoption of Diabetes Continuing Care Reference dataset (DCCR)
 - Enables multi-site integration
 - Consistency in data formats
 - Enable easy federation of distributed sites
- Extending data collection points close to patient
 - Enables remote patient monitoring
- Risk engine development
 - Identify patients at risk
 - Provision for better targeting of healthcare delivery

Portal evaluation

- Evaluation currently underway to determine
 - Suitability of the research demonstrator in a clinical setup
 - Ease of transition from paper-based ICP to electronic approach
 - Adherence to ICP and familiarity for end-users (clinicians)
 - Depth and adequacy of information collection through the portal
 - Completeness in presentation of patient condition

Challenges

■ Technical Challenges

- Use of standard technologies (e.g. Web Services, HL7, etc) – will Health Trust follow these?
 - HL7 – EHR data representation, XML format
- Shift from paper-based ICP approach to electronic format
- Agreement on standards for device inter-communication
 - Outputs from Continua Alliance forum will be adopted
- Adoption of XDS (Cross-Enterprise Document Sharing) architecture
 - Integrate data from disparate medical institutions
- Adoption of outputs emerging from Microsoft – NHS initiative
 - CUI (Common User Interface)

■ Administrative/Operational Challenges

- Dealing with patient data (privacy, ethics, etc)
- Suitability or ease of use for patients (elderly / disabled)



Thank you.

<http://www.healthcareathome.info>