IRIS Seminar Autumn 2010

Strategic Intelligence Monitor: Personal Health Systems (SIMPHS)
Brussels, 9 November 2010

JRC – IPTS – IS Unit
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The views expressed in this presentation are those of the authors and do not necessarily reflect the position of the European Commission. Neither the Commission nor any person acting on behalf of the Commission can be held responsible for the use which is made of this presentation.
**Digital Identity (eID):** Personal Identity
Data are key to unlocking Digital Economy potential and are increasingly being monetised. No single eID framework exists but a dozen overlapping policy areas making intervention more complex.

Our research focuses on the economics of digital identity, the trust and privacy perceptions of individuals, the legal gaps in the existing regulatory framework as well as the implementation hurdles of large-scale interoperable infrastructures.

**SIMPHS:** Ageing + shrinking Health budgets beg for ICT-led innovation in tele-monitoring / home care which has proven to save lives (QUALY), ease the burden on medical resources and may also release 2-3% of health budget (~30 billion €).

Our work investigating pilot schemes, deployment business models & EU policy options needs to establish lead-market data. Area is sensitive (sources and robustness of data). A current political priority due to health budget pressures and ageing population. Work will include some modelling.
eID Workplan 2010

Behavioural Aspects
- Survey follow up
- Euro barometer

eID Legal Framework
- Privacy by law
- Privacy by choice
- Privacy by design

Gaps in eID Legal Framework
- Article: “New Challenges and Possible Policy Options for the Regulation of Electronic Identity”

eID Economics
- Behavioural economics
- New Business models

eID market
- Report: “State of the eID market: technologies, infrastructure, services and policies”

User defined
- Government
- Industry

eID-SEA

eID-Compass: One-stop-shop for eID research and policy for EU institution colleagues

Report: “State of the eID market: technologies, infrastructure, services and policies”
Contents

ICT in Healthcare: some figures

Personal Health Systems in 2020

Remote monitoring market and innovation dynamics


Additional background
Is ICT in Health important?

• Public Health expenditure and Long Term Care (on average):
  – 5.7% and 1.1% (6, 8%) of GDP today (~800 bln Euro);
  – Grows at a pace of 4% a year (faster than EU economic growth);
  – may double (12.8%) by 2050 (~1600 bln Euro if no action taken)

• Health sector employs 9.3% of total workforce in the EU:
  – more than 15 Million people (compared to retail 13.0 M, business services 13.3 M)

• Public Budget Recession for EU
  – Public Deficits rising (7% on average) and MS Debt levels (>80% of GDP)

• Ageing of the EU Population
  – Old-Age dependency ratio from 0.25 to 0.33 (2020) to 0.5 (2050)
  – Tax payers and employment impacts (46% of older workers to 62% in US/JP)

• Shortages of Health Care Professionals and LTC workers

• ICT penetration is low compared to other sectors.

There is great potential for productivity gains in health delivery sector if technology, leadership and skills come together.
EU eHealth market

EU27 Health expenditure
~ €1000 billion*

eHealth potential to rise to 5%
(in the next 5-10 years)

ICT market value
€ 668 billion***

eHealth Market
€ 14,2 billion**

> 2% of total expenditure

Compare to:
Government 4%
Financial sector 13%

* Deloitte&Touche - HINE report 2008
** RAND/Capgemini Report 2009
*** EITO 2007
eHealth in EC taxonomy

- New markets/New jobs
- Increased output efficiency
- More people included
- Active workers’ life prolonged

RMT market: 127 M€
(Frost & Sullivan)

Secondary Usage Non-Clinical Systems: 71.6%
Clinical Information Systems: 22.5%
Health Information networks: 5.0%
Telemedicine and homecare services: 0.9%
of which:
Remote Monitoring and Treatment: 0.6%

“Accelerating the development of the eHealth market in Europe”,
EC eHealth Taskforce report 2007: In preparation for the Lead Market Initiative,
Luxembourg: Office for Official Publications of the European Communities, 2007 p. 10
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Additional background
Francis Bacon in 1627, in New Atlantis roadmap, described how ageing will be delayed, bad health will be restored and how human beings’ intellectual, physical & psychological capacities will be increased.

New nano-, bio-, info-, technologies can seriously reshape the human body (body + mind) and raise expectation of reaching the New Atlantis utopia.

To achieve progress, research ought to focus on tools to manage, analyse and understand data collected so as to turn it into knowledge, wisdom, and action; thus attempting to treat human beings instead of dealing with disease.

Fritz Kahn, medical Doctor / artist, Berlin, 1925
Personal Health Systems (PHS) assist in the provision of continuous, quality controlled, and personalized health services to empowered individuals regardless of location. They consist of:

- **Ambient and/or body (wearable, portable or implantable) devices**, which acquire, monitor and communicate physiological parameters and other health related context of an individual (e.g., vital body signs, biochemical markers, activity, emotional and social state, environment);

- **Intelligent processing of the acquired information and coupling of it with expert biomedical knowledge** to derive important new insights about individual’s health status;

- **Active feedback based on such new insights**, either from health professionals or directly from the devices to the individuals, assisting in diagnosis, treatment and rehabilitation as well as in disease prevention and lifestyle management.


Personal Health Systems

Data acquisition

Sensors for multi-parametric monitoring

Data processing & analysis

Intelligent analysis

Support to diagnosis decision & treatment

Medical expertise

Data communication and feedback

Health / call Centre

Hospital

Treatment, Rehabilitation
Prototype PHS

Examples
- Wrist-worn devices
- Body Sensor Networks
- Biomedical clothes

AMON

MOBIHEALTH

MYHEART

WEALTHY
MEMS implant for CHF

Figure 31: Implanted MEMS sensor

Implanted Pressure Sensor

People with congestive heart failure could have a permanent implant in the aorta or left atrium.

Catheter

Aorta

Left atrium

Batteryless sensor sends out blood pressure reading when scanned.
Nanorobot delivering drugs

Figure 28: Nanorobots search for organ-inlets demanding protein injection

Source: Cavalcanti et al (2008a)
• Currently very basic first generation sensors are deployed;
• Ongoing research needed to improve wearable smart sensors and textiles, implantable sensors, and on-board data processing capacity of sensors;
• Integrated, intelligent (auto-adaptive/self-callibrating), non-invasive and personalised PHS in future research.
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• Ongoing research needed to improve wearable smart sensors and textiles, implantable sensors, and on-board data processing capacity of sensors;
• Integrated, intelligent (auto-adaptive/self-calibrating), non-invasive and personalised PHS in future research.
PHS personalised and fully accepted by healthcare professionals when they will integrate evidence and knowledge from clinical practice and biomedical research
• **PHS of the future to be truly personalised and efficient will function**

  – Capturing the very peculiar characteristics of individuals (vital and physiological signs, but also their genetic outlook, as well as their clinical history, and their socio-demographic and socio-economic conditions);

  – Ensuring awareness of very punctual contextual conditions (location, activity being performed, emotional status, physical and chemical conditions in the environment, etc);

  – Intelligently processing such information to support traditional action and automatic actuation, thus, enabling new applications and services going beyond monitoring;

  – Using devices as minimally invasive and constraining of normal life as possible, adaptable to the very personal specificities and needs of each single individuals (i.e. avoiding materials to which one may be allergic)

  – Optimising energy and bandwidth consumption and minimising waste disposal

  – Providing ‘front-end’ fruition modalities that respond to different attitudes and needs of different typology of users;
However, PHS still presents gaps

- Personal Health Systems are still mostly about remote monitoring of Cardiovascular Diseases, COPD and Diabetes

- PHS are far from being personalised and have no genetic or bio-medical content

- PHS are not integrated into the Disease Management Cycle

- Data processing needs …

- H/w and s/w (sensor technology and interfaces)

- Still what we have today is promising …
PHS Segmentation – cloud

In some form all of the above Health Care segments are related to PHS

AAL = Ambient Assisted Living; PHS = Personal Health Systems; RMT = Remote Monitoring and Treatment
**PHS Segmentation – issues**

**ACUTE**

**INDIVIDUALS WITH CHRONIC CONDITIONS**

**ELDERLY**

**WORRIED**

**WELL**

**REST OF POPULATION**

**CASE MANAGEMENT**

Highly Complex Patients

**LEVEL 3**

**SPECIALIST DISEASE MANAGEMENT**

High Risk Patients

**LEVEL 2**

**SUPPORTED SELF-CARE**

70-80% of Chronic Population

**LEVEL 1**

**Self-care**

**Professional management**
PHS Segmentation – proposal

- **Integrated Prevention & Wellness**
  - High
  - AAL (Ambient Assisted Living)
  - LoC (Lab on Chip)
  - RMA (Remote Monitoring and Actuation)
  - LS&D (applications for adherence to drugs and lifestyle prescriptions)
  - IHBT (Intensive Home-based Treatment)
  - TCARE (Telecare)
  - RMT (Remote Monitoring and Treatment)
- **Out-of-pocket M-Health for WW & FIT**
  - Low
  - Chronic (any age) 65 and older
  - Healthy below 65

**Products/Services sophistication**

**Health conditions**
- Healthy
- Risks/impairments
- Chronics

**Definitions**
- **AAL**: Ambient Assisted Living
- **LoC**: Lab on Chip
- **RMA**: Remote Monitoring and Actuation
- **LS&D**: Applications for adherence to drugs and lifestyle prescriptions
- **IHBT**: Intensive Home-based Treatment
- **TCARE**: Telecare
- **RMT**: Remote Monitoring and Treatment
- **WW**: Worried Well
- **FIT**: Fitness

**Notes**
- **Chronic (any age) 65 and older**
- **Healthy below 65**
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Additional background
Main Research Activities …

- Inventory of health care system of various EU countries

- RMT country analysis ES, IT, DK, NL + outsourced FR, DE, SE, UK

- Collection and aggregation of relevant literature on PHS/RMT-markets

- Inventory of 200+ firms on PHS market in broad terms and analysis of 50 more RMT focused

- Review and analysis of projects/trials, in Europe (EU/national/regional & industry-led)

- Analysis of specific business cases/networks: Barcelona (Hospital Clinic); Vitaphone (Germany); HTN (Lombardy, IT); ECCH (N. Ireland)

- Systematic review of Randomised Control Trials literature and of other evaluation focused literature (both clinical and from economics of ICT)
RMT Ecosystem

Healthcare Authorities/Government HTA Agencies

Call Centres

Clinical Service Providers

Payers Insurances

Device Manufacturers

IT Solutions Providers

Telecom network Providers/ Mobile operators

Systems Integrators

Business Process Management

Patient

Emergency intervention

Patient feedback

Call Centre

GP

Hospital

Patient devices

Comm. devices

EHR

Systems

Integrators
<table>
<thead>
<tr>
<th>Common issues</th>
<th><strong>SPAIN</strong></th>
<th><strong>UK</strong></th>
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<tbody>
<tr>
<td>1. Universal health care free at the point of service – National Health Insurance</td>
<td>Purchase of health insurance at the point of service – National Health Insurance</td>
<td>Provider - purchaser split</td>
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<tr>
<td>2. GP as a gatekeeper</td>
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<td>Physicians salary (incl GP) based on quality and DRG implemented</td>
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<td>3. Ageing populations and emphasis in chronic disease management</td>
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<td>Healthcare is the competence of the 4 home countries with some variations on degrees of ICT and health care expenditures. High interoperability each of the four home counties.</td>
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<td>4. Decentralisation of the system</td>
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<td>England follows a top-down approach being currently reformulated. In addition they piloted three Whole System Demonstrators – in Kent, Cornwall and Newham - exploring possibilities opened up by truly integrated health and social care working supported by telehealth and telecare.</td>
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<td>5. Trend towards convergence between health and social care</td>
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<td>Emphasis on HTA agencies (i.e.: NICE)</td>
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<table>
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<th>Different issues</th>
<th><strong>SPAIN</strong></th>
<th><strong>UK</strong></th>
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<tbody>
<tr>
<td>1. Provider - purchaser split in very few regions (Catalonia)</td>
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<tr>
<td>2. Physicians (incl GP) salary civil servant style and DRG only for monitoring</td>
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<td>Physicians salary (incl GP) based on quality and DRG implemented</td>
</tr>
<tr>
<td>3. Healthcare is the competence of the 17 regions (CCAA) with massive variations on health care expenditures, degrees and approaches to ICT and lack of interoperability- i.e: Andalucia top-down approach; Catalonia: middle-out approach</td>
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**Note:**

- *HC systems in Spain/UK: highlights*
- *SPAIN*
- *UK*
- *Common issues*
- *Different issues*
<table>
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<tr>
<th>Common issues</th>
<th>France</th>
<th>Germany</th>
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<tbody>
<tr>
<td>1. Universal coverage through Statutory Health Insurance (SHI) and Provider - purchaser split</td>
<td>2. Ageing populations and emphasis in chronic disease management</td>
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<tr>
<td>3. Higher cost-sharing than UK or Spain</td>
<td>4. Trend towards convergence between health and social care</td>
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<td>5. Introducing health cards aiming at EMR, but so far mainly for reimbursement purposes</td>
<td>6. Weak gatekeeping role for GPs</td>
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<td>1. Decentralized: sickness funds often occupational and influenced by Lander and provider negotiations. Reimbursement varies per sickness fund</td>
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<td>2. Physician payment mainly fee-for-service</td>
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<td>3. Social services run by general councils at local/regional level</td>
<td>2. Physician payment mainly capitation</td>
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<td>3. Social services depend on the Lander</td>
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• Key Research questions:
  – Is there a need and how can RMT help? Yes, doing better and more at contained costs and creating new markets
  – How much RMT market deployment so far? and how this compares with the potential? less than expected - A tiny fraction
  – Is there evidence that RMT work? Is it sufficient to convince stakeholders? Yes to some extent- not sufficient or sufficiently known
  – What is blocking us from realising the potential? A vicious circle
  – What must be done to overcome barriers? and what we stand to loose if we do not act? A lot - A lot
Mapping of selected pilots & programmes

**USA - Veterans Administration**

Veterans Administration with 40,000 veterans, and 202 home care agencies offering telehealth (NAHCH study)
Companies and value chain

- Rough mapping placing companies on the value chain according to the segment they are most active in

- Most companies active in several segments, except for cardiac implant manufacturers

- Difficult to draw typical PHS provider profile, but mapping helps visualise type of activity

Company positions in the value chain

- Implantable devices (mainly heart)
  - Medtronic
  - Biotronik
  - St. Jude
  - Boston Scientific
- Measuring and Monitoring (Vital signs)
  - HeartLink
  - Ameyo
  - GEMED
  - IEM
  - Konka
  - Vitalsigns
  - Alpinum
  - Aetertel
  - MetaDa
  - Omron
  - SHL
  - Philips
  - GE
  - Health
  - Schiller
  - Roche
- Communication device
  - CardGuard
  - eMII
  - Viamatic
  - 3Pics
  - Vitaphone
  - DGN
  - Service
  - Saule
  - Nova
  - Honeywell
  - Vodafone
  - Tunstill
  - Cisco
  - Nokia
  - Telefonica
  - Sorin
- Medical platform
  - Ericsson
  - Tesan
  - GoodIT
  - Vita
  - Vital
  - Electronics
  - BodyTel
  - IAT
  - Ectaboo
  - e-HTN
  - Health
  - Hero
  - Orange
  - Vitallion
  - Agfa
  - Bayer
  - Intel
  - ICW
  - Bosch

'In-patient' BAN

'Patient Home' PAN

GP – CC – Hospital WAN
MARKET SIZE:
- RMT market estimated worth €127.9 million in 2007, to increase to €292.3 million in 2014
- 40% market share to RMT vendors (€ 52m) / 60% to service providers (€ 76m)
- Service quantification does not include medical activities
- UK is EU leader, followed by Germany, Italy & France

BUT,
Market data not representative:
- Boundaries for RMT are very fuzzy
- There is no consensus on what activities should be in/out
- There is a myriad of small scale activities going unnoticed

Medical activities not in market
- Business model exemplification
- Data do not allow granular quantification to include medical part when it is indeed a market transaction
- We may want to talk about “RMT total expenditure” to reflect medical activities

Data from F&S 2008 European RMT Report
… but not yet reaching expected scale…

Total value of RMT market
- Government 4%
- Financial sector 13%

Total health costs for cardiovascular diseases
- 109 Bn € (S. Allender, European Cardiovascular Diseases Statistics, 2008 edition)

Total value of ICT market
- 127 M€ (Frost & Sullivan)
- 660 Bn € (EITO)

Total Healthcare expenditure
- 1177 Bn € (OECD Health Data 2009, EU19)

eHealth + General Purpose ICT
- € 20 billion = 1.7% of total healthcare expenditure
Slow comparative take up of RMT

- Drivers and evidence would justify expectation of RMT having took off

- Diffusion remain limited

- RMT comparatively a laggard

- Turf wars, training needs, technology fragmentation as some of the reasons

### eHealth adoption in Hospitals

N= 907 hospitals in EU27 (questionnaire to CIO)
Source: Benchmarking of eHealth Deployment Survey (C4, Deloitte & Ipsos)

- **TLM & DM**
- **Telemonitoring**
- **ePrescriptions**
- **Adverse events**
- **PACS**
- **eBooking**
- **Billing**
- **EPR**

Confidential
NOT 2B diffused

EPR= Electronic Patient Record
PACS= Picture Archiving and Communication Systems
DM = Disease Management
TLM = Telemonitoring
RMT outcomes

• RMT proven outcomes
  • Clinical outcomes: robust evidence
  • Cost-effectiveness: inconclusive?
  • CHF:
    - Re-hospitalisation due to CHF reduced
    - All cause re-hospitalisation not?

• US VHA study:
  • Diabetes: 20.4% utilisation decrease;
  • CHF: 25.9% utilisation decrease
  • COPD: 20.7% utilisation decrease

• Other Studies:
  • RCT for HBT in Italy (↓ hospitalisation readmission, ↓ mortality)
  • Similar outcomes with diabetes/ COPD in other studies

Reducing diabetic death
11,000 deaths caused by complication ensuing from diabetes could be reduced in the six Member States through the combined applications of EMR and disease management

Source: EU Swedish Presidency, (2009) eHealth for a Healthier Europe!, p. 34

Reduce hospitalisation
Application of telemedicine and home health monitoring could avoid 5.6 million admissions to hospitals for chronically ill patients in the six Member States

Source: EU Swedish Presidency, (2009) eHealth for a Healthier Europe!, p. 36
Industry players views

• Lack of reimbursement
  – No unified approach at EU level
  – Unclear business models, revenues
  – Not viable as out of pocket market
• Buyers’ fragmentation
  – Locally based strategies
  – Institutional and market fragmentation feed each other to raise uncertainty
• Entry “barriers”
  – End-to-end provision by suppliers not easily accepted; need for IOP & standards
  – Not fully operational PHR/EHR linked to PHS
  – Lack of consolidated evaluation methods

HC experts and insiders views

• Unfavourable incentives for HC pros.
  – Neither “fee for service” nor “capitation” incentives work for RMT; “outcomes-based” reimbursement might!
• Primary, secondary & social care
  – Improved education for Patients/Carers.
  – NO integration between Health- & Social- Care.
  – Silos, turf wars
• Missing policy box
  – RMT is part of ‘territorial’ medicine; it competes for attention and funds with other applications.
  – In need of clear policy & political support.
• Evidence/awareness vicious circle
  – Need for large scale clinical evidence.

Unclear business model, shaky revenues, fragmentation
Lack of strategic vision on organisationally embedded and integrate health and social care
Need to break the stalemate

- Low take up
- Limited evidence (or awareness about it)
- Lag time for RCT
- Delayed investment resistances reinforced
- Local champions and hubs lose support
- Market scale limited
- Little increased affordability of devices & services
- Mimetic process by mainstream players delayed
What needs to be done

• Break stalemate by raising awareness on impacts and by creating consensus on evidence and measurement methods

• Place PHS/RMT into a clear policy box

• Provide incentives to organisations/professionals to use PHS/RMT

• Continue and increase efforts on inter-operability and standards

• Optimise funding by better linking pre-competitive R&D, deployment pilots as to create the condition of sustainability
What we stand to lose? (1/4)

- Social innovation and more inclusive quality care
- Contribution to health and social care sustainability
- New jobs and growth in a strategic industry
- Contribute to pensions system sustainability: helping older workers (55-64) remain active
What we stand to lose? (2/4)

- 20% of CHF patients treated:
  - RMT market in 2007 for all disease: 127 M€
  - RMT potential market for CHF only: 2600 M€
Cost and benefits for the CHF deployment scenario

Scenario 1 RMT cost 4€ per patient per day; Scenario 2 RMT cost 2€ per patient per day
Cost and benefits for the Diabetes II deployment scenario

Scenario 1 RMT cost 4€ per patient per day; Scenario 2 RMT cost 2€ per patient per day
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Additional background
• **Market perspective not adequate:**
  – Not a stand alone ICT solution: start from needs
  – Look at systemic integration in view of health and social care needs
  – Market driven quantifications unreliable

• **Plenty of successful cases worth studying more in depth to:**
  – Understand the socio-economics of innovation dynamics
  – Identify the drivers / choices explaining success
  – Assess the transferability and extract insights for optimal policies and remodelling of health and social care delivery

• **ICT solution in view of emerging health and social care integration**

• **mHealth: “buzzword” or important trend?**

• **Importance of awareness and collaboration on evidence**

• **Lack of aggregate metrics for macro extrapolation: need of building micro and meso foundations bottom up**
A New Demand driven and wider focus

- From RMT to IPHS: Personal Integrated Health and Care Services (RMT, telecare, AAL, mHealth, etc)

- From a supply driven focus to a demand driven one: start from understanding the need of
  - Regional / Local authorities
  - Producing units
  - Professionals
  - Users / patients

- Extrapolation of macro level impacts in support of IA for EIP 2011

- Collaboration with stakeholders to aggregate evidence and raise awareness about it
Integrated Personal Health and Care Services (IPHS) address the health and/or social care needs of individuals outside of care institutions and support the work of care providers in an integrated fashion: a) they can integrate assistance, remote monitoring of chronic diseases, wellness and fitness; b) they are produced as a result of integration of different institutional and information systems. They consist of:

a) Ambient and/or body (wearable, portable or implantable) devices, which acquire, monitor and communicate physiological parameters and other health and social well being related context of an individual (e.g., vital body signs, biochemical markers, activity, emotional and social state, environment);

b) Intelligent processing of the acquired information and coupling of it with expert biomedical knowledge to derive important new insights about individual’s health status and/or with social care assistance and intervention

c) Active feedback based on such new insights, either from health professionals and carers or directly from the devices to the individuals, assisting in diagnosis, treatment and rehabilitation, disease prevention, lifestyle management, as well as in social care and assistance
Research Design

STEP 1: METHODOLOGICAL SET UP

STREAM 2: DATA GATHERING
- Users
  - Institutional aspects
  - Socio-demographic
  - Clinical & social metrics
  - IPTIS metrics
  - Market activities
  - Users attitudes, behaviours, interests, needs
- Regional / Local Authorities
- Producing Units
- Market players

STEP 3: STRATEGIC INTELLIGENCE

STEP 4: INTERACTION AND COMMUNICATION WITH STAKEHOLDERS

EXPECTED OUTPUT AND OUTCOMES
Activities and Expected outputs (1/2)

• **Methodological set up:**
  – Comprehensive Analytical and Modelling IGI Framework
  – Clusterisation of EU27 (opportunistically select a few to then extrapolate)

• **IPHS for disease management and social care in selected European Regions (2 regions per 8 countries)**
  – Countries and regions statistics and relevant metrics
  – In depth case studies of regions and producing units
  – Key success factors and main barriers
  – Transferability analysis, policy recommendations, insights for modelling

• **Analysis of results of online survey of citizens**
  – General analysis of eHealth demand (needs, interests)
  – Specific analysis of actual and potential demand of IPHS
Activities and Expected outputs (2/2)

• **EU27 wide overview on IPHS (RMT, Telecare, AAL, mHealth)**
  – Demand and supply sizing and segmentation
  – Value chain analysis
  – Drivers and barriers

• **Support to Impact Assessment for 2011 EIP on ICT for Active and Healthy Ageing**
  – State of the art
  – Justification
  – Options assessment

• **Collaborate with all stakeholders to aggregate and disseminate evidence on clinical, economic, social, and cost-effectiveness outcomes**

• **Online structured repository of data gathered**
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Additional background
ECOSYSTEMS AND BUSINESS MODELS
(1) Not a market transaction, it cannot enter the estimation of market size;

(2) This is the only market transaction that should be reflected into the estimation of market size;

(3) and (4) pertain the funding side and in principle should cover (2) and the opportunity cost value of (4)
Customers

Suppliers (broadly defined ICT industry)

HC players (local health units, hospitals, etc)

3rd party payers (NHS, social or private insurances)

(1a) + (1b) = market transaction whose value should enter the estimation of market size

(2) and (3) same as previous model
PHS 2020 ROADMAP
### PHS2020: The Gaps

<table>
<thead>
<tr>
<th>Domain</th>
<th>Identified Gaps</th>
</tr>
</thead>
</table>
| Infusion of biomedical knowledge| • PHS not integrated with clinical evidence, biomedical and genetic information  
• Data from uncontrolled conditions in need of validation  
• PHS not integrated with clinical guidelines and pathways |
| Data processing                 | • Inefficient integration and processing of multimodal data  
• Need to treat and correct data from uncontrolled conditions  
• Lack of self-adaptive algorithms for automatic and personalised data processing  
• Lack of personalised aid decision tools for users |
| Sensors                         | • Lack of context awareness capacities (emotion, location, activity, environment)  
• Need to go beyond the “one sensor- one signal” and “one sensor- one disease”  
• Need to simplify and reduce the amount of data transfers (on board processing)  
• Need to increase flexibility and better adapt the sensors to individual characteristics  
• Lack of knowledge on the long term effect of sensors on human body;  
• Need of more actuation capabilities ( for diagnosis and treatment ) |
| Interfacing and interaction     | • Lack of multi-channel delivery and inter-action creating risk of exclusion due to lack of access to, or confidence in, PHS typical interaction channels  
• Need of more understandable and easy to interpret input and guidance to users;  
• Need to better inform and educate PHS users |
DRIVER FOR RMT
### Diseases

<table>
<thead>
<tr>
<th>Diseases</th>
<th>Prevalence</th>
<th>Aggregate Direct Costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diabetes</td>
<td>• 6.6% of total population</td>
<td>• about € 90 bln per year</td>
</tr>
<tr>
<td>(IDF Diabetes Atlas, plus several sources)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>COPD</td>
<td>• Range from 4% to 11%</td>
<td>• About 50 bln per year</td>
</tr>
<tr>
<td>(Several sources)</td>
<td>• 2 million DALY lost yearly</td>
<td></td>
</tr>
<tr>
<td>CVD in general</td>
<td>• 12 million DALYs lost yearly</td>
<td>• € 109 bln per year</td>
</tr>
<tr>
<td>(S. Allender, ed. 2008)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CHF</td>
<td>• Between 1% and 3% of general population</td>
<td>• 23 bln per year</td>
</tr>
<tr>
<td>(several sources, OECD 2009 Health Data)</td>
<td>• 10% among the very elderly</td>
<td></td>
</tr>
</tbody>
</table>

**Set to almost double by 2020**
Health and Care Challenges

Pressures

- More demand

Resource constraints

- Ageing
- Consumerism & access
- Income / education
- Shrinking tax base
- Scarcity of carers
- Little funds for innovation

System inefficiency

- Untapped information
- Fragmented care process
- Overshooting

Vicious circle

- Little optimisation or service delivery models
- Difficulty to meet increasing and changing demands

Financial resources barely meet ordinary delivery

Resource constraints on reform and innovation

Difficulty to meet increasing and changing demands

Vicious circle

Financial resources barely meet ordinary delivery

Resource constraints on reform and innovation

Little optimisation or service delivery models

Difficulty to meet increasing and changing demands
What can we ask of IPHS?

- Increase quantity and quality of care, while ensuring financial sustainability and coping with decreasing pool of carers
- IPHS help produce more and better output with almost the same
- IPHS can also boost the economy creating new market opportunity

**Virtuous circle**

- Optimisation of delivery models through increasing patient centricity
- Increased capacity to meet more and new demands
- ICT driven Innovation to leverage information
- Cost partially contained and more resources freed for innovation
ECOSYSTEMS AND BUSINESS MODELS
Scientific gap with policy implications (ICT in health & social care)

- No consolidated micro and/or macro evidence on impacts:
  - Neither at observational level
  - Nor at modelling level
- No truly scientific tool to help policy makers decide *ex ante* among alternative policies
  - Lack of strong arguments to win resistance to innovation
  - Inability to capture macro level overspills to go beyond RCT cost-effectiveness
  - At EU level: *ex ante* Impact Assessment must rely only on reasoned but static projections

- Design a micro-macro modelling simulation of IPHS potential impacts
  - Pilot it for one disease (diabetes) in one country (Spain)
  - Define a roadmap for mainstreaming it as an applied *ex ante* IA tool
For Instance …

Baseline data at $T_0$
- Diabetes metrics (prevalence, obesity, lifestyles, burden) in the population of reference
- Direct medical costs

Dynamic Microsimulation
- Input
  - Rules: Diabetes models (*)
  - IPHS treatment scenario

Simulated data at $T_n$
- Health status in the population of reference
- Direct medical costs
- Costs of intervention
  - C/B, C/E ratios

Efficiency and ICT industry effects could be inputted directly into CGE

Macro CGE
Computable General Equilibrium used to simulate the macro level impacts

Intermediate micro link

Households labour supply model
Improved health status inputted to simulated increase in total number of hours worked

Final micro-macro link

Beyond static projections not capturing overspills

(*) For instance see:
E. Huang et al. Projecting the Future Diabetes Population Size and Related Costs for the U.S. Diabetes Care, 32 (2009), 2225-2229
A disease burden is from population flows

- People with normal glycemic levels
- People with Pre-Diabetes
- People with undiagnosed diabetes
- People with diagnosed diabetes

Prevention, Detection, Management, Suffering, Burden, Prevalence, Deaths, Recovery
• Results of modelling exercise done in US by Sustainability Institute for the Federal Centre for Disease Control and Prevention on Diabetes
  
  – System dynamic modelling with 300 differential equations and 20 parameters
  
  – Micro simulation of what happen to diabetes prevalence and to suffering (unhealthy days from having diabetes) under several treatment scenarios:
    ▪ Improved management
    ▪ Improved management and detection
    ▪ All of the above plus prevention (proxied by reduction of obesity)
Diabetes detection and management

Sustainability Institute for US Federal Center for Disease Control and Prevention (CDC)
System Dynamic Modelling Simulation:
Scenario increased management effort (Diab mgmt)

More people living with diabetes but keeping disease burden at bay for 9 years
Sustainability Institute for US Federal Center for Disease Control and Prevention (CDC)
System Dynamic Modelling Simulation:
Scenario management and detection (PreD mgmt + Prevention efforts reducing obesity (Ob))

People with Diabetes per Thousand Adults

Monthly Unhealthy Days from Diabetes per Thousand Adults

The more obesity is reduced the sooner growth is stopped and reversed (same for burden) ... it does not happen immediately
Speaking truth to power

• The better you do in detection and management, the more you miss your goal (if the goal is just saving money)
  Effective detection and disease management increase prevalence
  Costs cannot decrease
  Only strong benefit is the reduction of suffering

• Successful prevention
  In the short term (1 decade) will only lead to slower growth of prevalence and burden
  In the mid term it will effectively close the faucet

• What helps in short term doesn’t help much in long. What helps in long term doesn’t help much in short.

• But looking only at the short term is dangerous
1 in 3 children born in 2003 will have diabetes
One pager argument

1 Problem statement
1980-2010 Tsunami of poor health has hit us:
• Chronic diseases moving into early life by decades
• Diabesity epidemics among children
• mostly lifestyle mediated (obesity key contributor)
no population experience a new shipment of genes in 2-3 decades!

2 Root causes: oversimplification
Evolutionary legacy and modernisation clash:
• Thrifty genotypes and phenotypes
• Bad diets: cheap coke and expensive blueberries
• Less energy output
Lots of glucose cause Insulin Resistance: metabolic portal to multiple adverse health outcomes

3 Systemic failures
Tsunami not predicted nor prevented:
• Acute care model for the accidentally well (gone!)
• Knowledge engines: work for illness and death only
• IT only for better care and not for better health
The better you manage the more you miss your goal (€ €), only prevention yield lasting gains

4 Complex/contested interventions
A new 4 decades war on tobacco?
• Agricultural policy?
• Tax on junk food?
• Education, built environment?
Strong resistance on the typical individualistic grounds!

5 Light touch solution
Nudging better light weight choices
• Participatory sensing
• Living epidemiology
• Persuasive technology
Future prosperity depends on crowds intelligence!
Under performing data elements

Legacy Health knowledge systems and the cost of Intelligence

- Good
- Poor
- Assumptions

Legacy Research costs increases...

High utility Health Intelligence

Time = 1980’s
Prevalence of obesity (BMI ≥ 30) in adult population (20-79) of selected countries (latest available year)

Source: OECD Health Data, 2009
Prevalence of obesity (BMI ≥ 30) in adult population (20-79) of selected countries: baseline and latest available year.

Source: OECD Health Data, 2009
Rising prevalence of overweight children

Prevalence of overweight (BMI ≥ 25) children (5-11) in selected countries: 1960-2004

Source: International Obesity Task Force (IOFT) based on 28 repeated surveys
The Diabetes Epidemics

Worldwide population with diabetes (million)

1985-2010 = + 847%
1985-2030 = + 1363%

Diabetes prevalence

Prevalence of diabetes in adult population (20-79) of selected countries: 1995-2010

Cases of Diabetes I in children (0-15) per 100,000 population per year in selected countries: 2010 (projections)

Source: IDF Diabetes Atlas (http://www.diabetesatlas.org/)