WMG
THE UNIVERSITY OF WARWICK

Institute of Digital Healthcare

# Adopting Models of Technology:
## Addressing the Needs of Multimorbidity and Managing Poly-pharmacy -The C3-Cloud H2020 project


**Theodoros N. Arvanitis, RT, DPhil, CEng, MIET, AMIA, NYAS, FRSM**

Professor of e-Health Innovation & Head of Research
Institute of Digital Healthcare, WMG, University of Warwick
Affiliate Professor, Warwick Medical School
Honorary Professor, Institute of Cancer and Genomic Sciences, University of Birmingham


C3CLOUD

In partnership with

WARWICK
MEDICAL SCHOOL

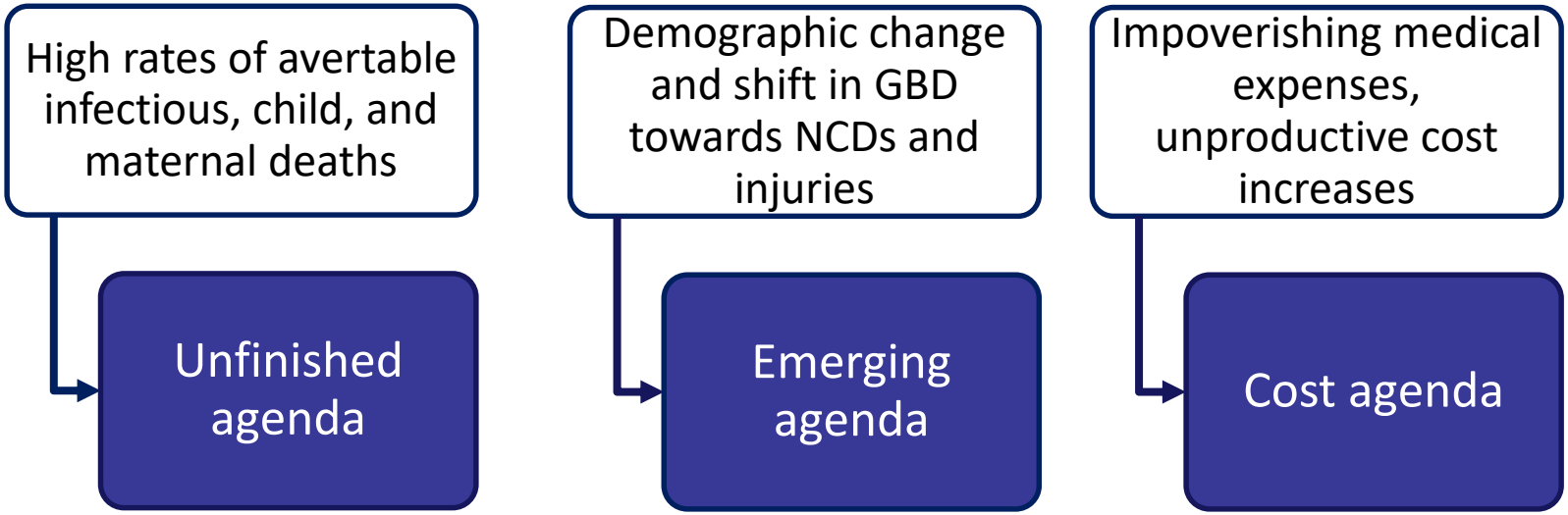
# Motivation

- Putting innovative ideas into practice can create a culture of change, support, and improvement.

- Maximising the value of technologies such as telehealth, telecare, telemedicine, tele-coaching and self-care apps creates the potential for people to be empowered to manage their own healthcare in the right way, at the right time and in the right place.

- C3-Cloud: A Federated Collaborative Care and Cure Cloud Architecture for Addressing the Needs of Multi-morbidity and Managing Poly-pharmacy
  - Adopting a new model of digitally-enhanced integrated health care

# 2015-2035: Three Domains of Global Health Challenges




Source: The Commission on Investing in Health

THE LANCET GLOBAL HEALTH 2035

# The Context

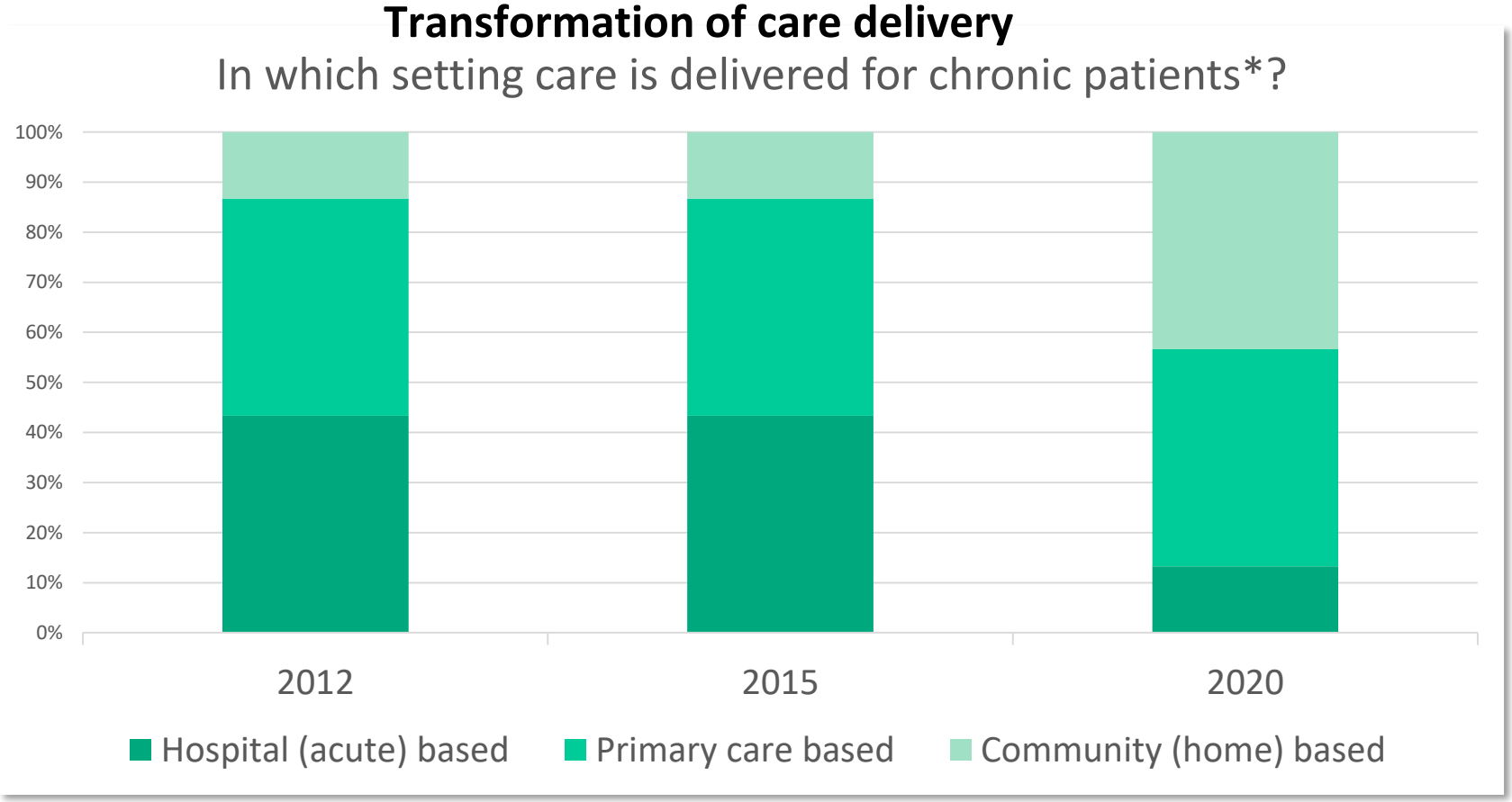
- Chronic diseases are the main reason for **poor health and restricted activity**, affecting over one third of Europe's population and accounting for 70% of healthcare expenditure in Europe.

- Ageing is associated increased accumulation of multiple chronic conditions known as ***multi-morbidity***, including a growing number of functional and cognitive impairments.
  - More than half of all older people have at least three chronic conditions, and a significant proportion has five or more

# The Challenge I

- The clinical management of patients with multi-morbid chronic conditions is much more complex and time-consuming for the **healthcare system**.
- Further burden on **social care services** to enable such patients perform everyday activities, supported by informal carer or home / community care services.
- Long-term care needs experience shortcomings, especially **within and between** health and social care delivery organisations.
- Financial burden in the delivery of complex care demands

# The Challenge II




*European Innovation Partnership on Active and Healthy Ageing, Action Plan on 'Replicating and tutoring integrated care for chronic diseases, including remote monitoring at regional levels'. http://ec.europa.eu/research/innovation-union/pdf/active-healthy-ageing/b3_action_plan.pdf*

# Digitally-Enabled Integrated Care

- At present, it is suggested that there is no **'single model'** that can be applied universally to achieve care services for people with complex needs.
- Integrated Care
  - The management and delivery of health services so that citizens receive a continuum of preventive and curative services.
    - According to their needs over time and across different levels of the health system.
  - Can potentially provide such a co-ordinated approach.
- Digitally-enabled approaches and models can provide more adaptive and radical solutions to the provision of integrated care.

# Why Digital?
# Healthcare is Transforming through Technology

In healthcare, **digital technology systems** are no longer confined to the intensive care unit or the GP's desktop computer.

- linked **electronic records** to support the delivery of care;
- **harnessing data** to support research and real-time public health **decision making**;
- **integrated decision support systems** which aim to maximize **effectiveness and patient safety**;
- tools for delivering **remote monitoring** and **self-management**
- online consultations and interventions, supporting upstream **models of health care**, away from the hospital;
- wearable and implantable devices, providing **new ways to capture** and **monitor physiological parameters**.

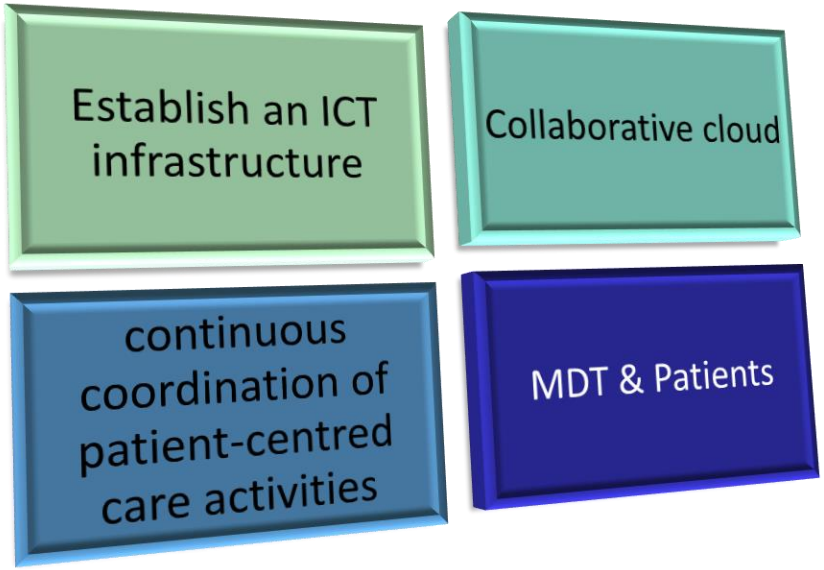
# Digitally-Enabled Integrated Care: Opportunities & Challenges

- **integration** and **interoperability** of data for both care and research can provide insights to the whole patient pathway
- understanding the complexities of disease through **open access quality data** and **evidence**
- awareness of health and wellbeing through **knowledge empowerment of the patient as a citizen** – involving patient in own healthcare management.
- **Digital community** settings provide **choices** for people's support or care.
- Efficient/cost **effective contact** and **patient experience** through telecare services

C3CLOUD

THE FRAMEWORK PROGRAMME FOR RESEARCH AND INNOVATION
HORIZON 2020

European Commission




To demonstrate feasibility, pilot studies will focus on diabetes, heart failure, renal failure, depression in different **comorbidity combinations**. (3 European regions)

- **Collaborative creation and execution of personalised care plans** for multi-morbid patients through systematic and semi-automatic reconciliation of clinical guidelines.
- **Decision Support** for risk prediction and stratification, recommendation reconciliation, poly-pharmacy management and goal setting.
- **Fusion of multimodal** patient and provider **data**.
- **Integrated Terminology Server** with advanced semantic functions will enable meaningful analysis of multimodal data and clinical rules.
- **Active patient involvement** and treatment adherence evaluation.

# C3-Cloud Partners

## SMEs

SRDC

MEDIXINE

empirica

Cambio Healthcare Systems
Safer and Smarter

## Academic and Research

WARWICK
THE UNIVERSITY OF WARWICK

kronikgune
research centre on chronicity

Inserm

ÖREBRO UNIVERSITY

EUROREC

## Healthcare organisations and pilot regions

REGION JÄMTLAND HÄRJEDALEN

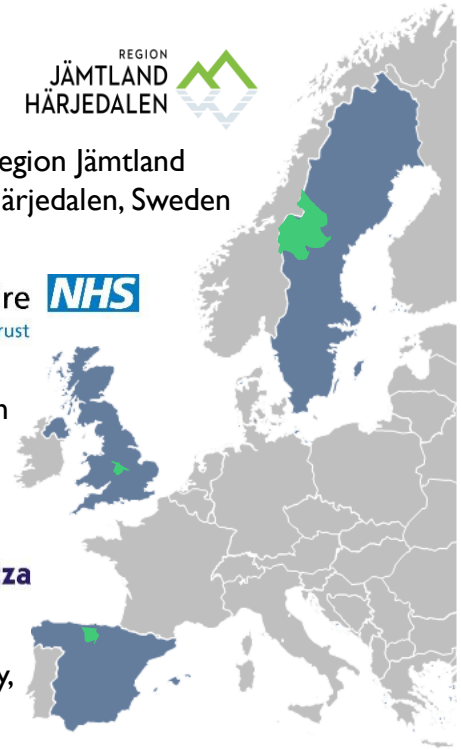
Region Jämtland Härjedalen, Sweden

South Warwickshire NHS
NHS Foundation Trust

Warwickshire, United Kingdom

Osakidetza

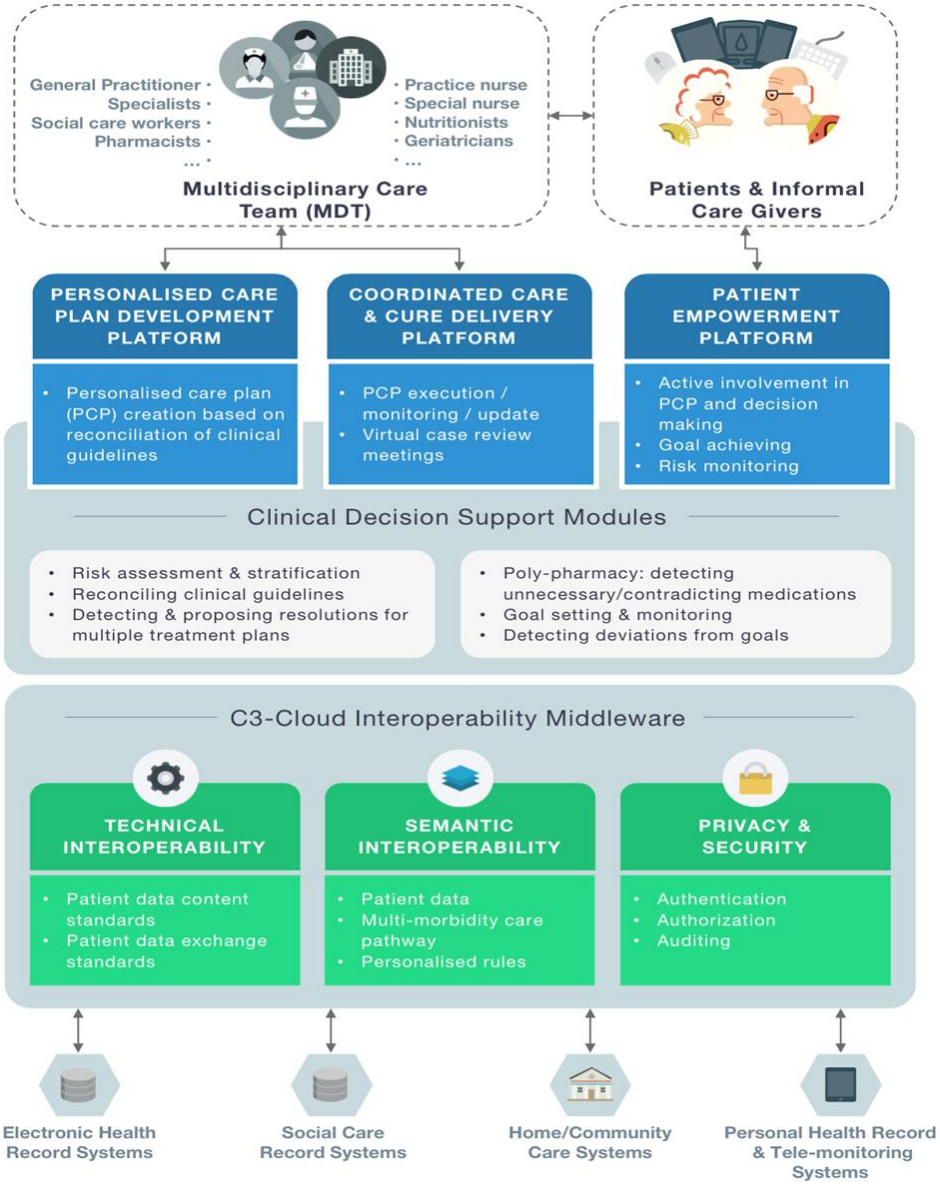
Basque Country, Spain



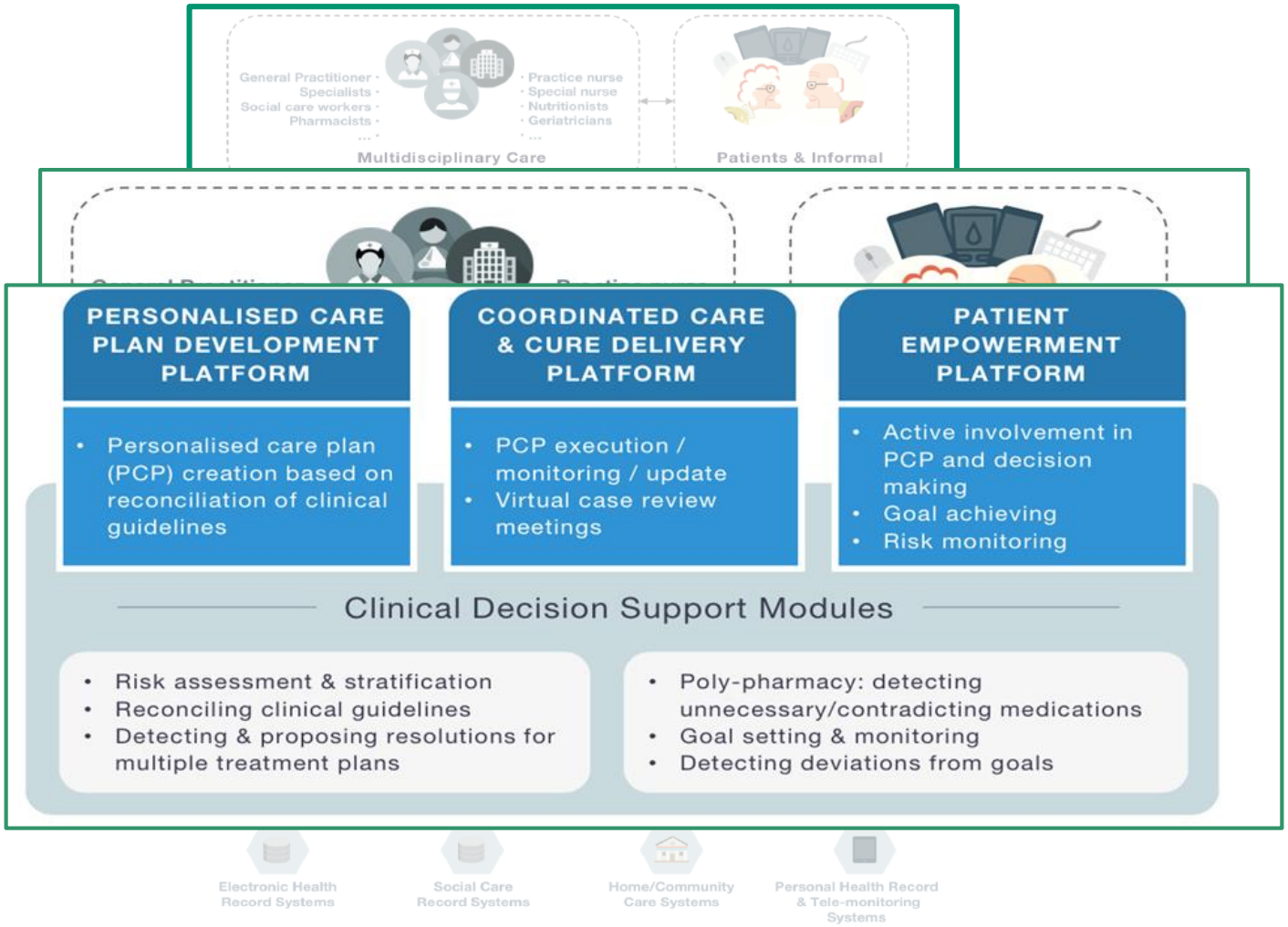
# C3-Cloud Journey

| Specific Challenges | C3-Cloud Objectives | Research Pillars | C3-Cloud Results | Expected Impact |
|---|---|---|---|---|
| Clinical guidelines are **single disease centred;** hence fall short for **multi-morbidity** | Enable **personalised care plan** development for multi-morbid patients by systematically **reconciling clinical guidelines** | Developing the **Personalised Care Plan Development Environment** | C3-Cloud integrated care approach and supporting bundle of ICT components as an **end-to-end solution** for integrated care delivery | Improved online and F2F **cooperation** among formal and informal **care givers** in an informed manner |
| **Poly-pharmacy** in elderly incrementally leads to **more co-morbidities and medications** | Enable **MDT members** to **collaboratively** manage integrated care plans, and **support them** to provide best possible care | Developing the **Coordinated Care and Cure Delivery Platform** to be used by the MDT members | Open source interoperability solutions, Decision Support Modules to **facilitate integrated care solutions** in Europe | Increased **informed participation** of patients and informal care givers in care management through **user-friendly** interfaces |
| Managing multi-morbidity w/o **informed involvement** of all stakeholders results in **specialty silos** and **fragmented care** | Prevent the fall of the patient into the **cracks between the silos of care** | Developing **Clinical Decision Support Modules** for risk stratification, rec-ommendation reconciliat-ion, poly-pharmacy man., goal setting/monitoring | C3-Cloud approach and pilot application **validated** across **3 European regions with diverse health systems and underlying infrastructures** | Improved **health outcomes** and **quality of life** of multi-morbid elderly |
| **Patients** and their **informal care givers** often do not have a **voice** in their own care | Ensure active **participation of patients/informal carers** | Developing the **Patient Empowerment Platform** to increase involvement and adherence of patients | | **Care efficiency gains** through effective resource utilisation |
| **Evidence base is biased** towards patients with single diseases | **Seamlessly integrate** with the existing health care, social care, homecare **information systems** | Developing **technical, semantic, privacy/security interoperability** solutions to seamlessly integrate with existing inf. systems | **Evidence** published as optimised multi-morbidity **care pathways** and organisational **models** based on **qualitative and quantitative assessment** of the pilot applications | **Strengthened evidence base** of multi-morbidity care pathways |
| Existing **organisational models and care pathways** are **inadequate** for integrated care delivery to multi-morbid elderly | **Identify best practices** in caring for multi-morbid patients across several sites | Exploration of **new patient pathways and organisational change models** for improved coordination of care services | An innovative **large-scale impact modelling tool** for industrial exploitation and large scale roll out | **Strengthened European industrial position** via marketing C3-Cloud solutions by i) leading C3-Cloud **industrial partners**, ii) **C3-Cloud Vendor Forum** to be established, and iii) **public community** |
| | Develop new organisational **models** and **care pathways** for integrated care delivery | | | |

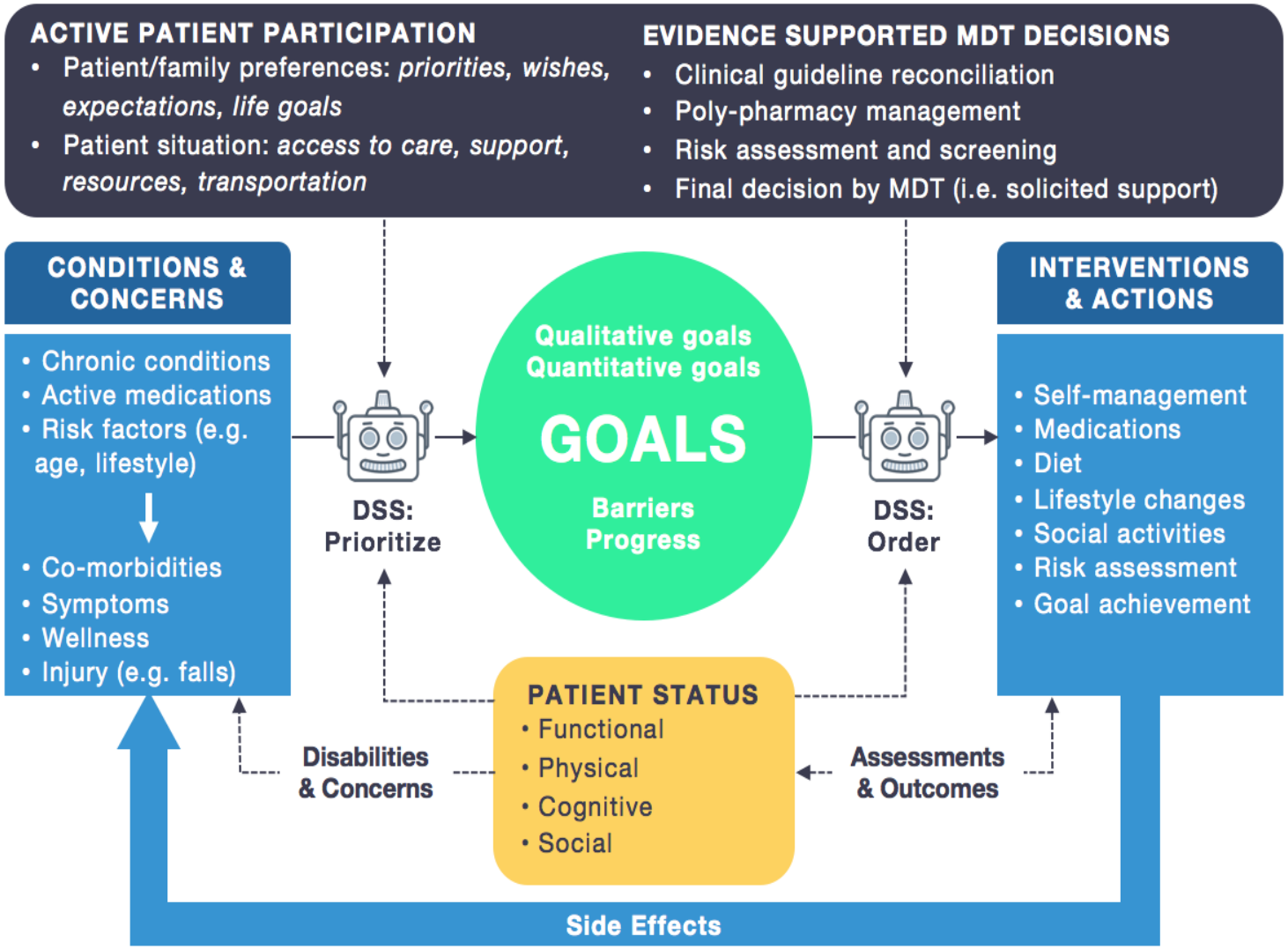
# The C3 Cloud Architecture I



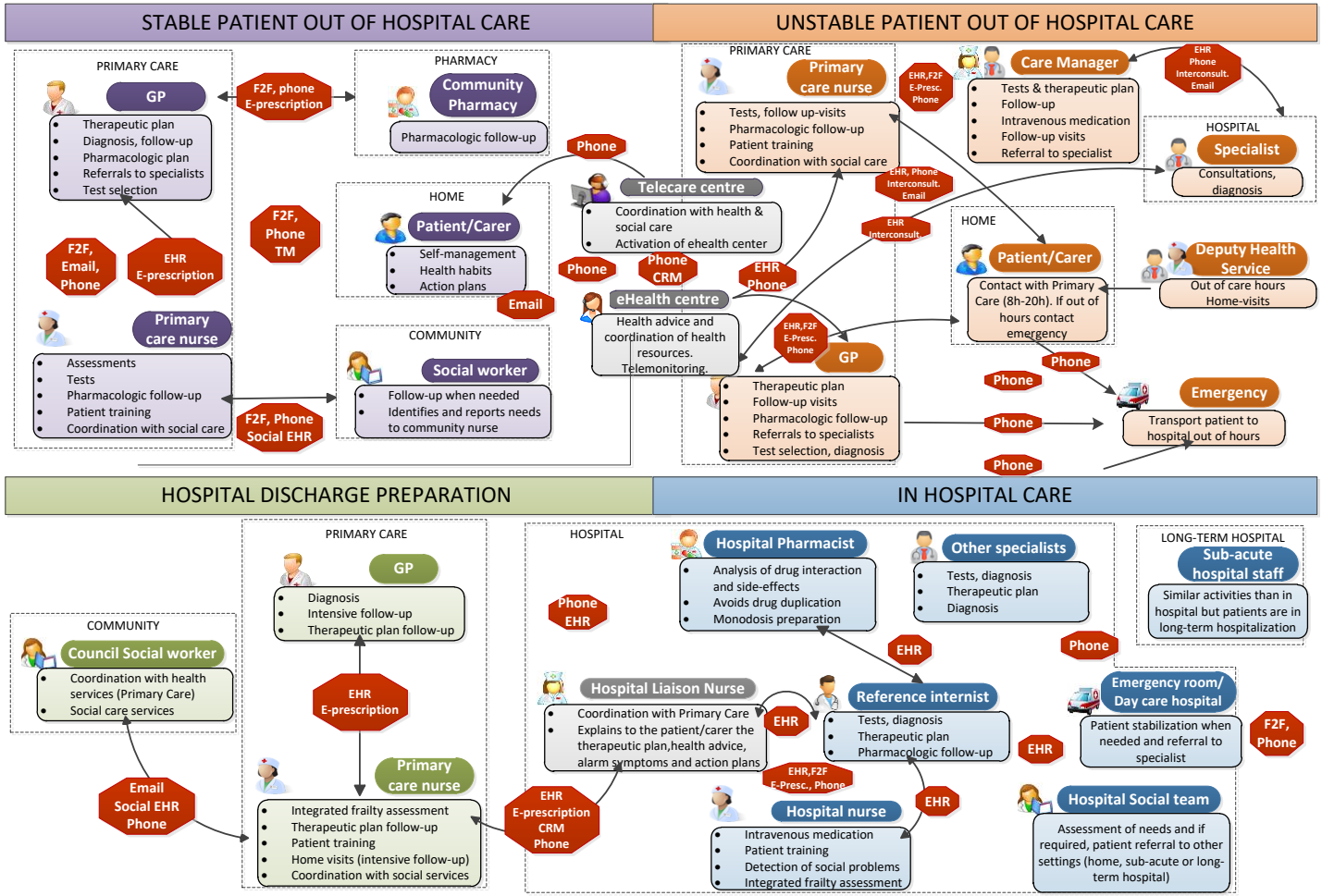
# C3-Cloud Architecture II



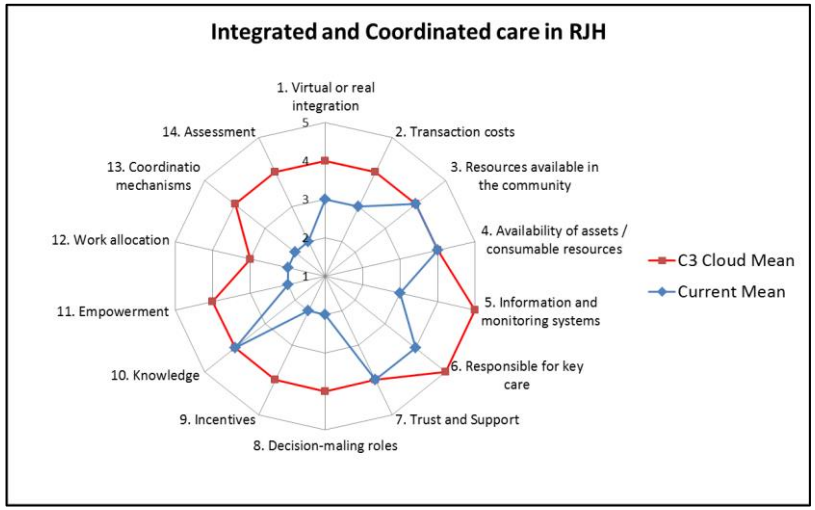
# C3-Cloud Personalised Care Plan

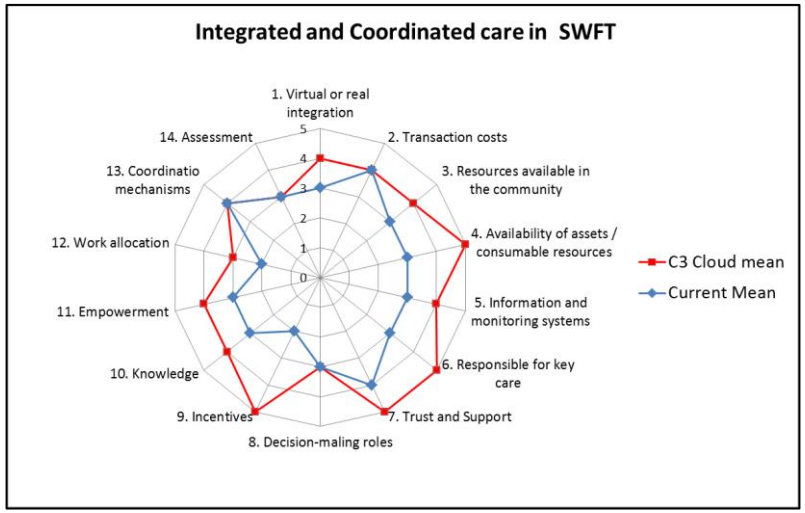


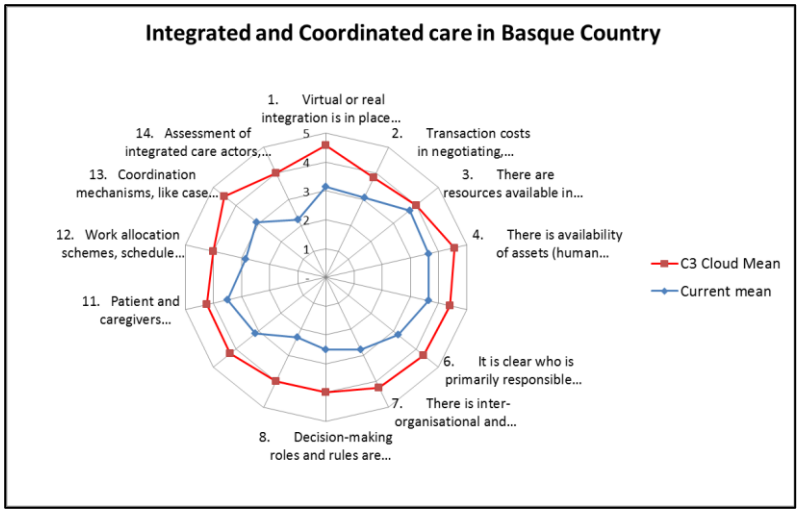
# Care Pathways – Multi morbid patient



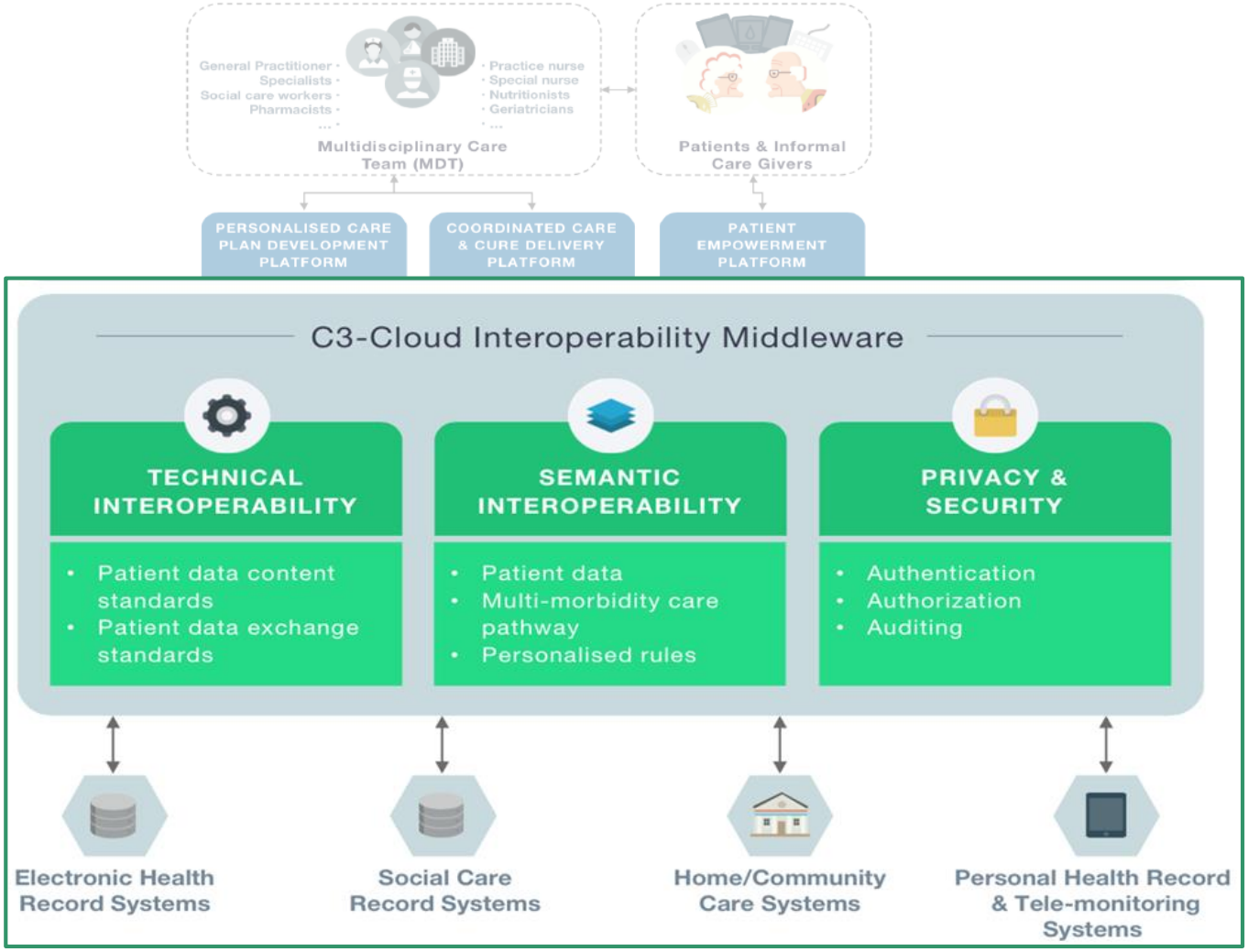
# Need for Changing Models of Care



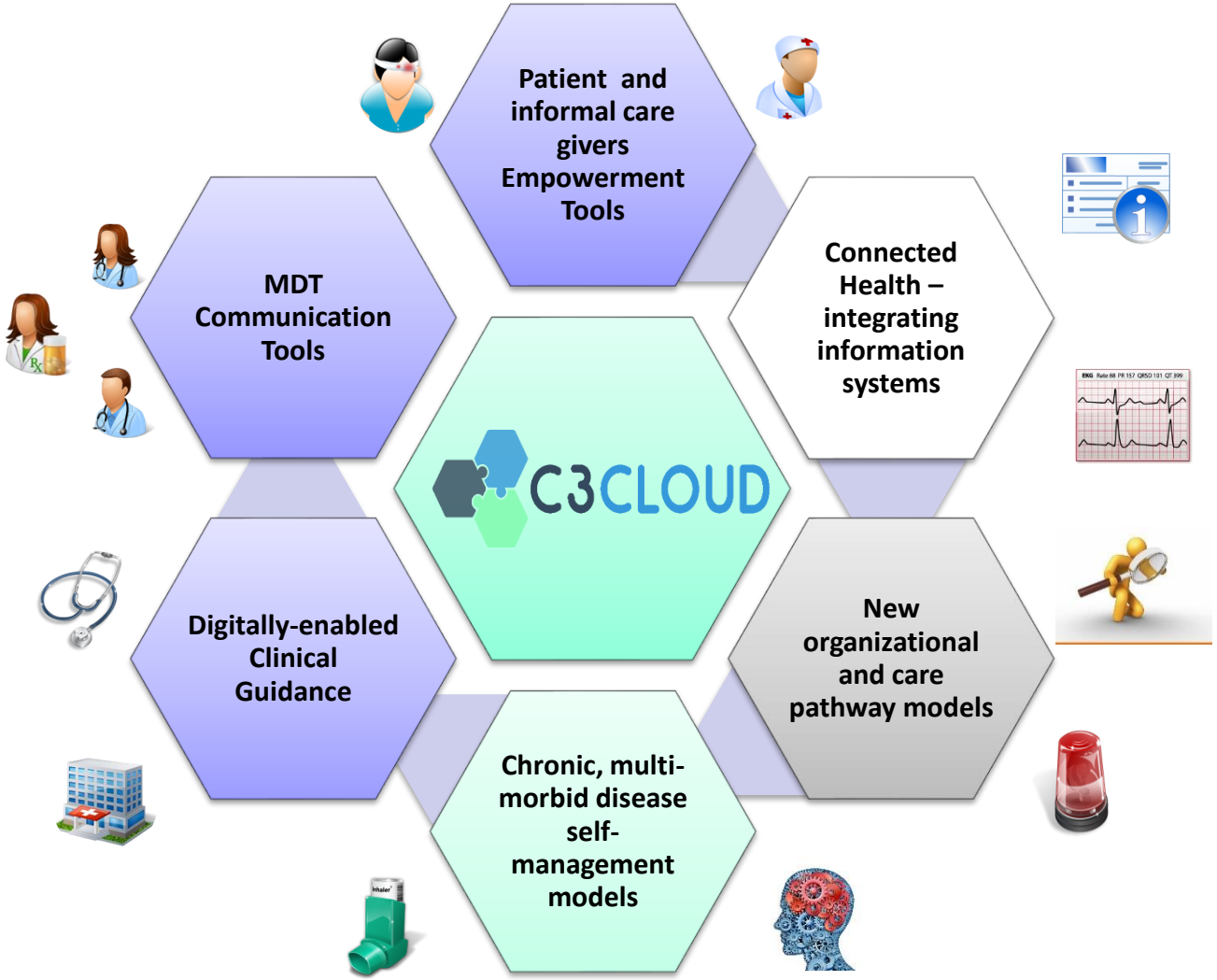



# C3-Cloud Architecture III



# Digitally-Enhanced Tools in C3-Cloud



# Digitally-Enhanced Tools in C3-Cloud: example of self-empowerment platform

C3CLOUD

SK Sven Karlsson(a1)

Home Careplan Tracking Questionnaires Guidance

**Activities** 7
Your activities

Scheduled activities

| Activity | When | Actions |
|---|---|---|
| Enalapril once a day | Every day 1 time at breakfast | Add note |
| Daily meal photo | Every day 3 times at a meal from 2017-12-02 to 2017-12-09 | Add note |
| Fill in lifestyle questionnaire | Once between 2017-11-22 to 2017-12-09 | Add note |
| Follow the diet | Every day 5 times at 08:00, 10:30, 13:00, 16:00, 19:00 from 1999-08-13 to 2016-09-06 | Add note |
| Measure blood pressure weekly | every week 1 time during the morning from 2009-07-21 | Add note |
| Metformin twice a day | Every day 2 times (at breakfast and at dinner) | Add note |
| Atorvastatin 20mg | Every day 1 time (at breakfast) | Add note |

**Guidance** 3
Guidance material assigned to you.

Type 2 diabetes Diet for Healthy Eating
https://patient.info/health/type-2-diabetes

Type 2 diabetes
https://patient.info/health/type-2-diabetes

High blood pressure(hypertension)
https://patient.info/health/high-blood-pressure-hypertension

# Summary

- The impact of digital technology and information can be transformative for healthcare.
- Digitally-enabled integrated care the way forward: The benefits to individuals and society are multiple. People's health journeys are better understood and appropriate lifestyle choices can be better tailored and promoted to the individual.
- In the case of chronic conditions, disease management can be more effectively supported and avoidable deaths can be prevented.
- C3-Cloud provides generic digital tools and models for more advanced integrated care options in Europe

WMG
THE UNIVERSITY OF WARWICK

# Thank You

Institute of Digital Healthcare

**T.Arvanitis@warwick.ac.uk**

info@c3-cloud.eu @c3_cloud c3-cloud.eu

In partnership with
WARWICK
MEDICAL SCHOOL