



Horizon 2020
European Union Funding
for Research & Innovation

C3-Cloud

**“A Federated Collaborative Care Cure Cloud Architecture for
Addressing the Needs of Multi-morbidity
and Managing Poly-pharmacy”**

**PRIORITY Objective H2020-PHC-25-2015 - Advanced ICT systems and services for
integrated care**

D1.1 Project Presentation

Work Package: WP1 Project Management
Due Date: 31 May 2016
Actual Submission Date:
Project Dates: Project Start Date: 01 May 2016
Project End Date: 30 April 2020
Project Duration: 48 months
Deliverable Leader: WARWICK

Project funded by the European Commission within the Horizon 2020 Programme (2014-2020)		
Dissemination Level		
PU	Public	X
CO	Confidential, only for members of the consortium (including the Commission Services)	
EU-RES	Classified Information: RESTREINT UE (Commission Decision 2005/444/EC)	
EU-CON	Classified Information: CONFIDENTIEL UE (Commission Decision 2005/444/EC)	
EU-SEC	Classified Information: SECRET UE (Commission Decision 2005/444/EC)	

Document History:

Version	Date	Changes	From	Review
V0.1	26-05-2016	Initial Document	WARWICK	All Consortium
V0.2	31-05-2016	Contributions from partners	SRDC, EuroRec, ORU, KG, MEDIXINE WARWICK	All Consortium
V1.0	31-05-2016	Final version submitted to Commission	WARWICK	

Contributors (Benef.)	Sarah N. Lim Choi Keung (WARWICK), George Despotou (WARWICK), Gokce Banu Laleci Erturkmen (SRDC), Pascal Coorevits (EuroRec), Tapio Jokinen (MEDIXINE), Dolores Verdoy Barastegi (KG), Gunnar Klein (ORU), Theodoros N. Arvanitis (WARWICK)			
Responsible Author	Theodoros N. Arvanitis	Email	t.arvanitis@warwick.ac.uk	
	Beneficiary	WARWICK	Phone	+44 247 615 1601

EXECUTIVE SUMMARY

This document describes the C3-Cloud project concept, the main goals, the expected results and the partners who are working to realise those goals over the four years of the project duration. The deliverable includes a set of slides that has been prepared for presenting the project and a press release from the consortium.

TABLE OF CONTENTS

Executive Summary	3
Table of contents	4
1 Project Overview	5
1.1 Project Information	5
1.2 Project Participants	5
1.3 Background	6
1.4 Project vision	7
1.5 Overall Project Goals	8
1.6 Expected Impact	10
2 Presentation Slides	11
3 Press Release	20
4 References	22

1 PROJECT OVERVIEW

1.1 Project Information

Project Acronym: C3-Cloud
Project Name: A Federated Collaborative Care Cure Cloud Architecture for Addressing the Needs of Multi-morbidity and Managing Poly-pharmacy
Project Number: 689181
Funding Scheme: Horizon 2020 Research and Innovation Action
Topic: PHC-25-2015 - Advanced ICT systems and services for integrated care
Timeline: 01 May 2016 - 30 April 2020
Duration: 48 months
Project budget: 4,995,000 EUR



1.2 Project Participants

Beneficiary number	Beneficiary name	Beneficiary short name	Country
1 (coordinator)	University of Warwick	WARWICK	United Kingdom
2	SRDC Yazilim Arastirma ve Gelistirme ve Danismanlik Ticaret Anonim Sirketi	SRDC	Turkey
3	Institut National de la Santé et de la Recherche Medicale	INSERM	France
4	European Institute for Health Records	EuroRec	France
5	empirica Gesellschaft für Kommunikations- und Technologieforschung mbH	Empirica	Germany
6	Medixine Oy	MEDIXINE	Finland
7	South Warwickshire NHS Foundation Trust	SWFT	United Kingdom
8	Servicio Vasco de Salud - Osakidetza	OSAKI	Spain
9	Asociacion Centro De Excelencia Internacional En Investigacion Sobre Cronicidad - Kronikgune	KG	Spain
10	Örebro University	ORU	Sweden
11	Region Jämtland Härjedalen	RHJ	Sweden
12	Cambio Healthcare Systems AB	CAMBIO	Sweden

Coordinator contact details:

Prof. Theodoros N. Arvanitis
Institute of Digital Healthcare, WMG
University of Warwick
Gibbet Hill Road
Coventry CV4 7AL
United Kingdom
Email: t.arvanitis@warwick.ac.uk
Phone: +44 2476 615 1601

1.3 Background

A growing share of the population in OECD countries is age 65 and over: 15% in 2010, and expected to reach 22% by 2030 (1). Life expectancy of elderly has also increased significantly in the last 50 years. People at age 65 in OECD countries will expect to live for 21 years on average for women and 17 years for men, which is an almost 40% increase since 1960 (2). However, older age is associated with an increased accumulation of multiple chronic conditions: multi-morbidity, including a growing number of functional and cognitive impairments (3).

More than half of all older people have at least three chronic conditions, and a significant proportion has five or more (4). A recent US study indicates that more than 95% of the Medicare patients with a chronic disease like congestive heart failure, depression, or diabetes have at least another chronic condition, and the majority (80%, 71%, and 56%, respectively) have four or more chronic conditions (5). 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 (6).

“More than half of all older people have at least three chronic conditions, and a significant proportion has five or more.”

Multi-morbidity creates diverse and sometimes contradictory needs, which challenge patients and the delivery of health services. The clinical management of patients with multi-morbidity is much more complex and time-consuming than those with single diseases. WHO Europe reports that while the number of older people living alone is increasing, the availability of informal care by family members is declining due to greater distances between the members and increased rates of divorce (7). There is

“Current medical models focus primarily single conditions, often overlooking the interconnected basis of chronic diseases.”

consequently a growing demand for health care services to handle multiple chronic conditions, and for social-care services to enable such patients perform everyday activities, supported by informal carer or home / community care services.

Currently those with chronic conditions and long-term care needs experience shortcomings and gaps in care provision. This is particularly prominent at the interfaces within and between health and social care delivery organisations. Achieving good quality integrated care is an acknowledged difficulty in many health systems.

Unfortunately, current European medical models (e.g. as directed by clinical guidelines) focus primarily on short and medium term interventions on the basis of single conditions, failing to integrate care planning well across providers and often overlooking the interconnected basis of chronic diseases. The over-arching societal challenge addressed by C3-Cloud, and by this call topic is: How can we effectively care for and support elderly patients with multi-morbidity needs?

1.4 Project vision

The C3-Cloud objective is to improve the quality of care experienced by patients. The two scenarios described below, illustrate how the contributions of C3-Cloud are expected to affect the care experienced by multi-morbid patients.

1) Mrs Jane Bee's story: Diabetes and heart failure collide



Mrs Bee is a 67-year-old woman who has been living with type 2 diabetes for 10 years. She thinks getting diabetes was inevitable, because her mother had it too; her mother had horrible complications and went blind despite treatment. Mrs Bee is worried about such complications but does not know why her disease will be any different to her mother's, these injections seem to just change medical readings rather than make her feel better.

Dr Wilkins is Mrs Bee's General Practitioner (GP) and has been caring for her diabetes in the community. She has become breathless recently with some fluid at her ankles. Mrs Bee is already on many tablets but he was worried about heart failure so added a water tablet. If her breathlessness keeps worsening, he will have to refer Mrs Bee to the cardiologists at the local hospital.



Mrs Bee is not happy at having to go to the hospital to see more doctors, she has enough problems as it is, she does not have much sensation in her feet so mobility is a major problem but her husband helps at home.

Dr Burke is the cardiologist, he has not spoken directly to Dr Wilkins, but is aware of her other problems. He offers lifestyle advice and adds another medication, if her heart failure worsens, she will need a pacemaker, he writes to Dr Wilkins, her GP.



Mrs Bee's husband is concerned she is getting more tired and confused so is checking her blood sugar readings more often. He phones Dr Wilkins who is still waiting for the hospital letter; he advises if she is not better by Monday, to arrange an appointment at the GP practice.

Mrs Bee is admitted as an emergency to hospital, due to acute heart failure. They have outline information available from the GP. They can read Dr Burke's letter. She is suffering from pulmonary oedema and requires a specialist infusion on the cardiology ward.



Mrs Bee improves with the infusion and is planned to have a cardiac resynchronisation pacemaker, inserted urgently as an outpatient. However, when social services see her prior to discharge they realise how unsafe her mobility is at home; she will have to wait in hospital whilst her house is adapted, this takes 2 weeks. Mrs Bee develops a hospital-acquired pneumonia, the medical team warn her husband that she is very unwell and may not survive, however after iv antibiotics and a further 10 days in hospital she is discharged home. Mrs Bee is weak after her extended inpatient admission and rarely leaves her home now; a significant carer burden is placed on her husband who struggles to cope.

1) Mrs Brenda Jones' story: An example of multi-morbidity in harmony



Mrs Jones is a 67-year-old woman who has been living with type 2 diabetes for 10 years. She did not understand how the new diabetes medications she was prescribed worked, but usually took them on the advice of her GP. Her GP had introduced her to the **C3-Cloud Patient Empowerment Platform**, which explained in simple language how each drug works and explains the benefits; she now never misses a dose.

Dr Wallace is Mrs Jones' GP and has been caring for her diabetes in the community. He noted some fluid on her ankles and updated her **Personalised Care Plan** via **C3-Cloud Personalised Care Plan Development Platform**, which helped reconciliation of clinical guidelines for diabetes and her new diagnosis of heart failure. **Clinical Decision Support Modules** of the Platform advised switching some medications including stopping her thiazolidinedione and goal-orientated lifestyle and activity modifications. The heart failure has since remained stable.



Mrs Jones read on her **Patient Empowerment Platform** on tablet that diabetes could cause loss of sensation to the feet. She remotely got in touch with social services, who have started adapting her home to make it safer. Remote fall sensors and wireless medical sensors including a glucometer and O² saturation monitor have been installed in her home to provide her with confidence that she can access help if needed. Sensors are seamlessly integrated with the **Patient Empowerment Platform**, so that readings are immediately uploaded to her profile, which then become available to her and her husband again through the **Patient Empowerment Platform** and to her multidisciplinary care team (MDT) through the **Coordinated Care and Cure Delivery Platform**.



The **Coordinated Care and Cure Delivery Platform** identified Mrs Jones breathlessness and remotely monitored O² saturations, deviating from the goals in the **Personalised Care Plan**, and alerted the MDT. Mrs Jones was referred to the cardiologist, who through the **Interoperability Middleware** of the platform had full access to her GP and secondary care records and sensor measurements. Using the **Personalised Care Plan Development Platform** the cardiologist, Mrs Jones and her GP (remote) modified her treatment and medication dosages, according to best evidence managing diabetes and heart failure in harmony.



Mrs Jones' husband is concerned she is getting increasingly breathless, he logged onto **Patient Empowerment Platform**, as an informal caregiver, and read that her heart failure might have worsened, he contacted Dr Wallace her GP online.



Dr Wallace through **Coordinated Care and Cure Delivery Platform** could read the cardiology input and organized a **virtual case review meeting**. The medical teams remotely communicating with each other and Mr and Mrs Jones, who agreed to come to hospital for a scan and check-up. Being within the hospital for just 4 hours before discharged home with an outpatient cardiac resynchronisation pacemaker planned. Hospital blood tests noted her renal function had deteriorated further so metformin was stopped, as suggested by **Decision Support Modules**.



Mrs Jones is able to continue enjoying life and is having regular follow up by the cardiac nurse specialists. She is independent at home supported by the social care team, who help with the housework. Through the **Patient Empowerment Platform**, she is managing her own treatment, achieving the goals set by the MDT and sharing her story with other diabetes patients.



1.5 Overall Project Goals

Achieving good quality integrated care within and across health and social care delivery organisations is a challenge in current health systems. The C3-Cloud project aims to address the overarching societal challenge of effectively coordinating, caring and supporting elderly patients with multi-morbidity needs. It aims to facilitate this by establishing an underlying information and communication technology (ICT) infrastructure to enable a

“C3-Cloud will enable a collaborative and coordination of patient-centred care activities by a multidisciplinary care team and informal caregivers.”

collaborative and continuous coordination of patient-centred care activities by a multidisciplinary care team and informal caregivers. The specific objectives of C3-Cloud are:

- Enable the **development of personalised care plans** for multi-morbid conditions through systematic and semi-automatic reconciliation of digitally represented clinical guidelines for individual chronic conditions, by a group of collaborating health and social care givers, and with the informed participation of the patients and their informal care givers.
- Provide an innovative **online platform** through which multidisciplinary care team members (MDT) can collaboratively manage (execute, monitor, update) the integrated personalised care plans for patients with multi-morbid conditions.
- Provide **Clinical Decision Support Modules** to support personalised care plan development and execution by clinical guideline reconciliation, risk stratification, poly-pharmacy management and goal setting and monitoring.
- Ensure **active participation of patients** and their informal caregivers to the management of their multi-morbid chronic conditions through a **Patient Empowerment Platform** to alleviate challenges that patients face to adhere to various treatment regimes for each chronic condition.
- Provide an **Interoperability Middleware** addressing that will seamlessly integrate all the interoperable components of the infrastructure in accordance to best-practice and state-of-the-art technologies and standards.
- **Demonstrate the applicability of C3-Cloud integrated care approach** by piloting in three European regions (South Warwickshire, Basque Country and Region Jämtland Härjedalen) with different health and social care systems and ICT landscapes.
- **Analyse** the trajectories of C3-Cloud participants and their data to **strengthen the evidence base** in caring for patients with multiple conditions and to inform future development of more streamlined and optimised multi-morbidity care pathways.
- Develop experiment and refine **new adaptive models of integrated care** and organisational change management guidelines for achieving the design and implementation of integrated care supported with ICT in diverse settings.

Figure 1 illustrates the C3-Cloud concept, offering an overview of the architecture of the main C3-Cloud components.

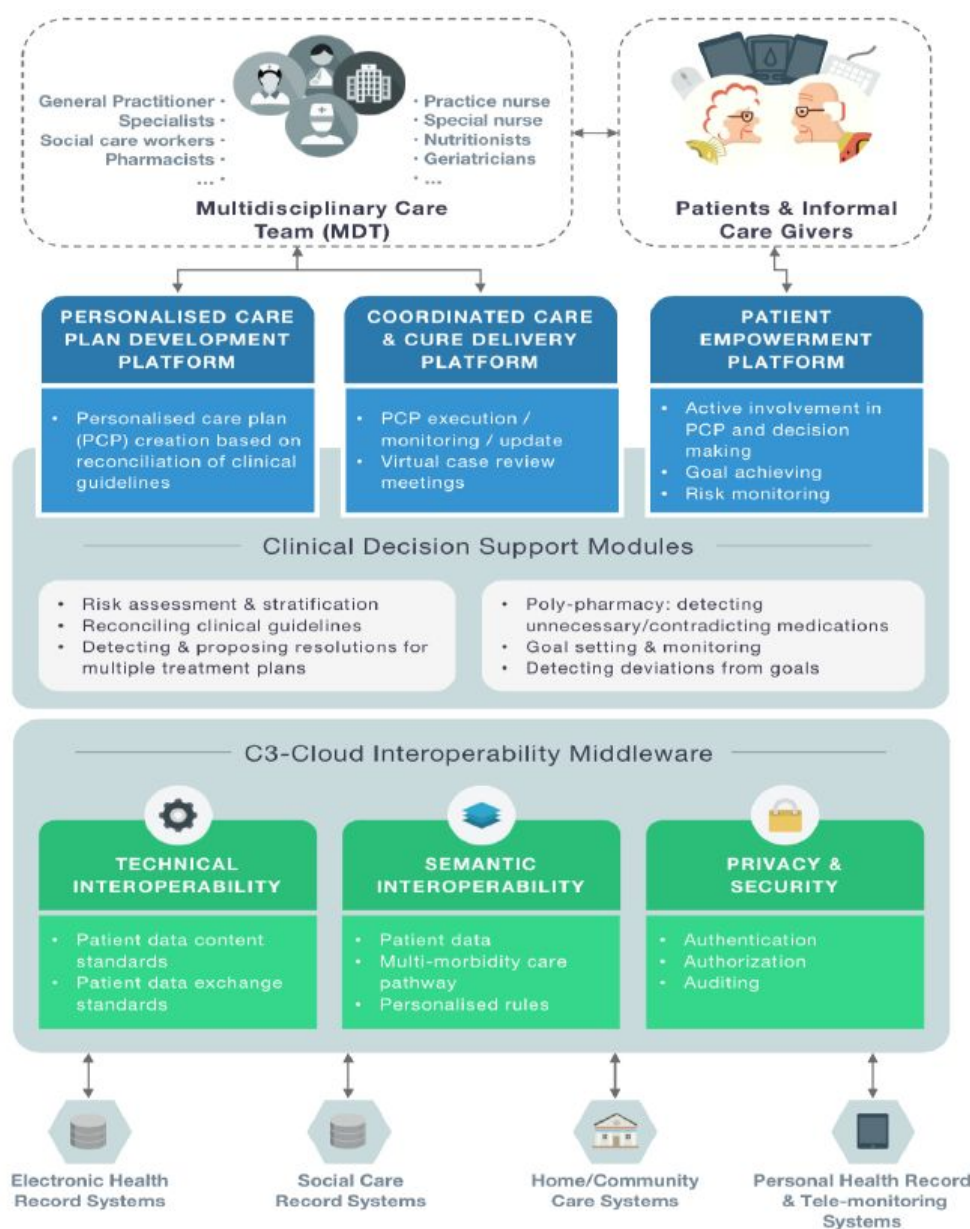


Figure 1: Overall C3-Cloud Architecture

1.6 Expected Impact


The C3-Cloud project will propose new patient pathways and organisational models for addressing multi-morbidity, complemented with innovative set of ICT tools for improved provision of patient-centred coordinated care services to elderly patients. These will:

- Reduce non-elective hospitalisation, readmission and length of hospital stay. The number of acute events and poly-pharmacy issues will also be decreased.
- Increase social impact through the increased participation of patients and informal carers to decision-making, and a reduction in isolation.
- Improve online and face-to-face cooperation amongst formal and informal caregivers.
- Increase patient and caregiver participation through user-friendly ICT interfaces and instructions.
- Increase automation and reconciliation of clinical guidelines

- Develop new adaptive models of patient-centric integrated care and organisational change management guidelines.
- Improve resource utilisation of resources for multi-morbidity patients, resulting in efficiency gains.
- Strengthen medical knowledge of multi-morbidity care.
- Strengthen European industrial position, by leading new care paradigms, and enabling integration of state-of-the-art technologies.

2 PRESENTATION SLIDES


The general presentation of the project is provided as a handout, with the full set of slides provided in the file accompanying this document.




Overview of the Collaborative Care and Cure Cloud (C3-Cloud) Project

Prof. Theodoros N. Arvanitis
C3-Cloud Coordinator
Institute of Digital Healthcare, WMG, University of Warwick, United Kingdom

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 689181




Context



- Chronic diseases are the main reason for **poor health and restricted activity**,
 - Affect 30% of Europe's population.
 - Account for 70% of healthcare expenditure in Europe.
- Ageing is associated with increased accumulation of multiple chronic conditions known as **multi-morbidity**
 - Includes a growing number of functional and cognitive impairments.
 - More than 50% of all older people have *at least 3 chronic conditions*, and a significant proportion *has 5 or more*.

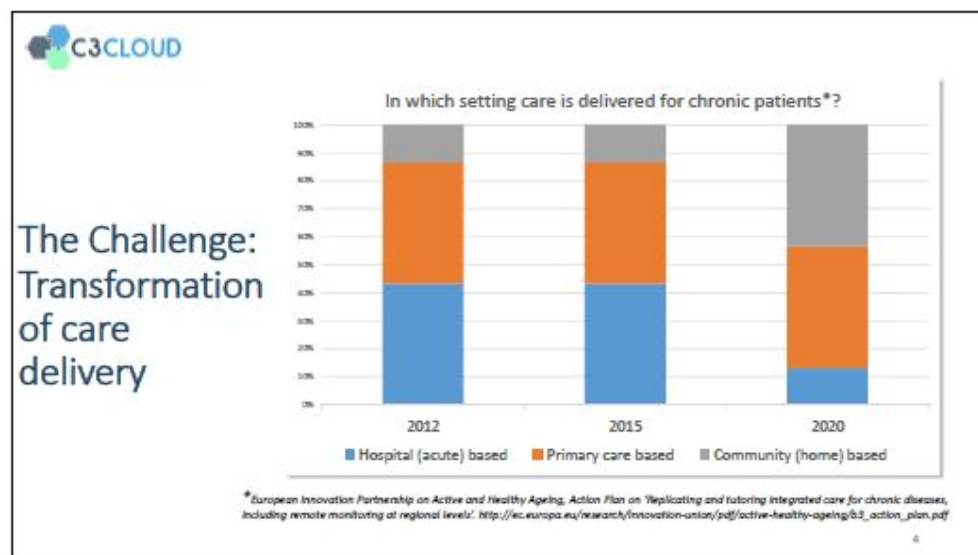
2

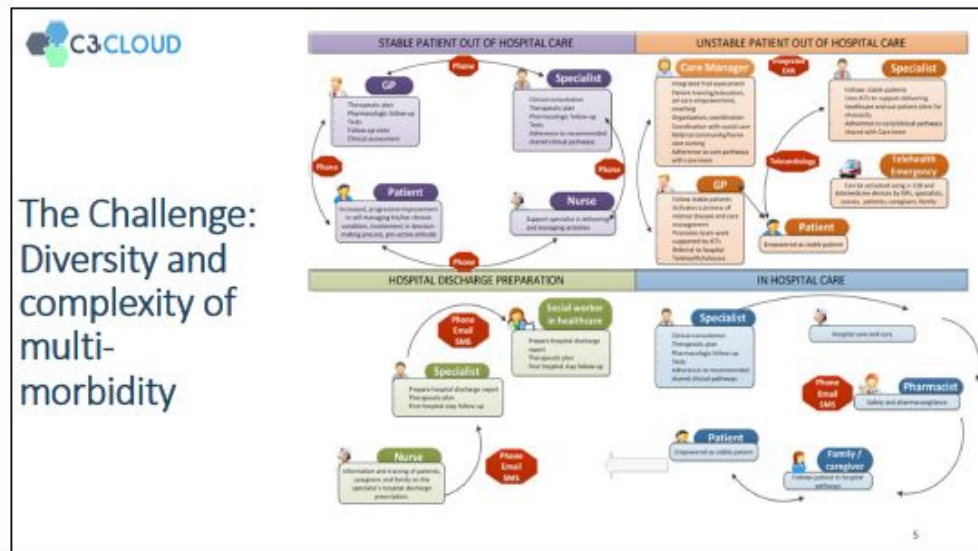
The Challenge



- 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.

3

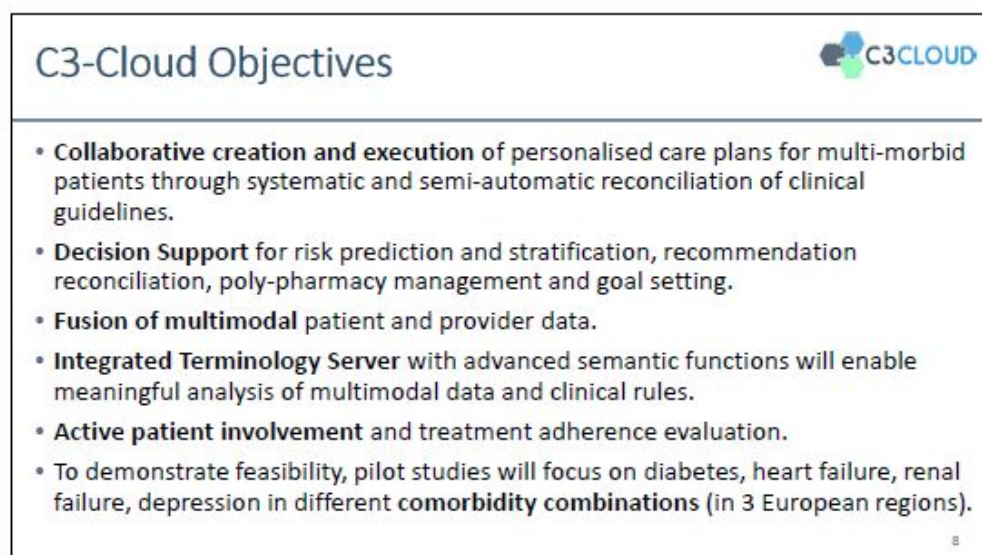
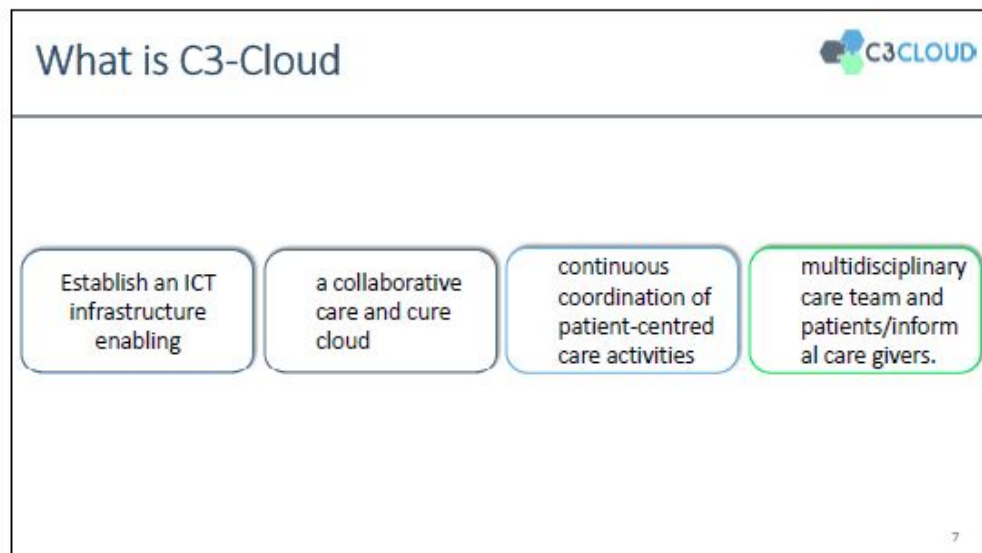


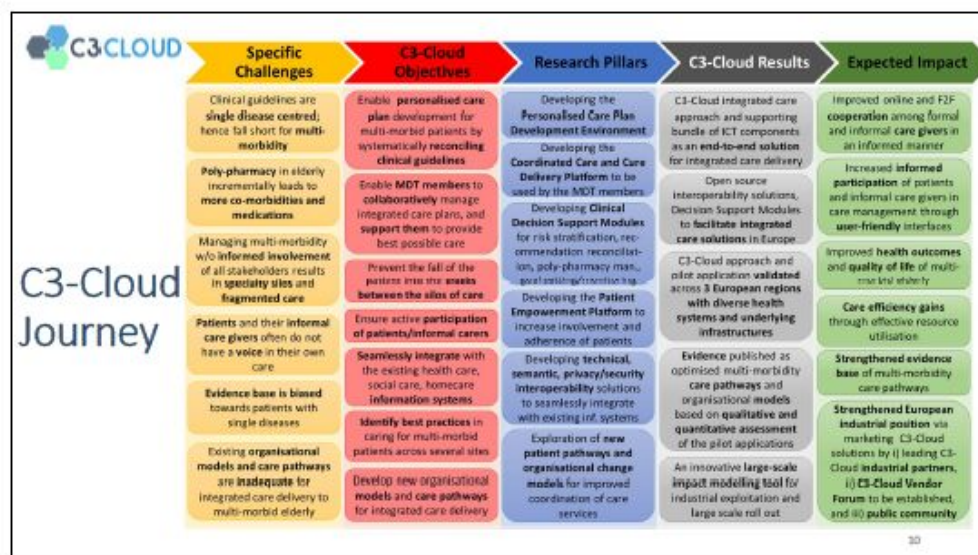


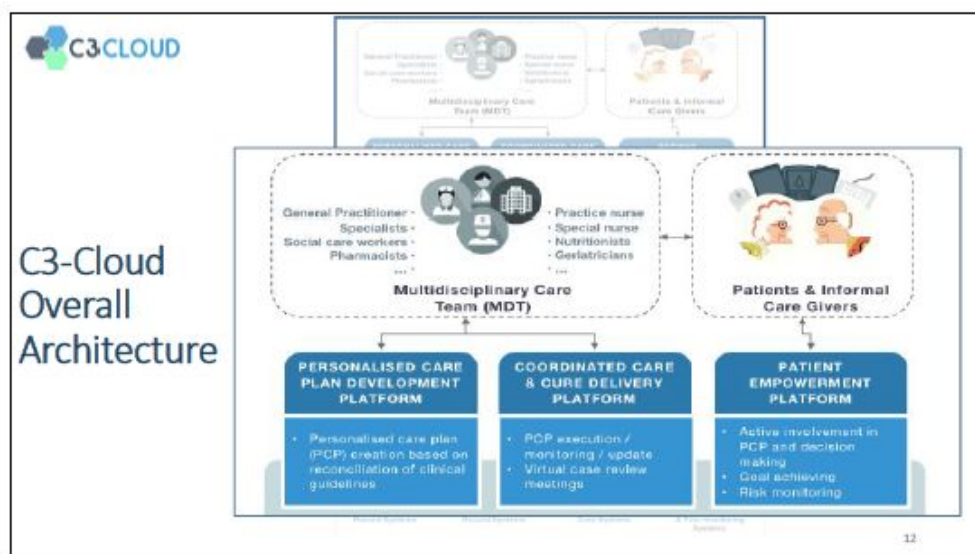
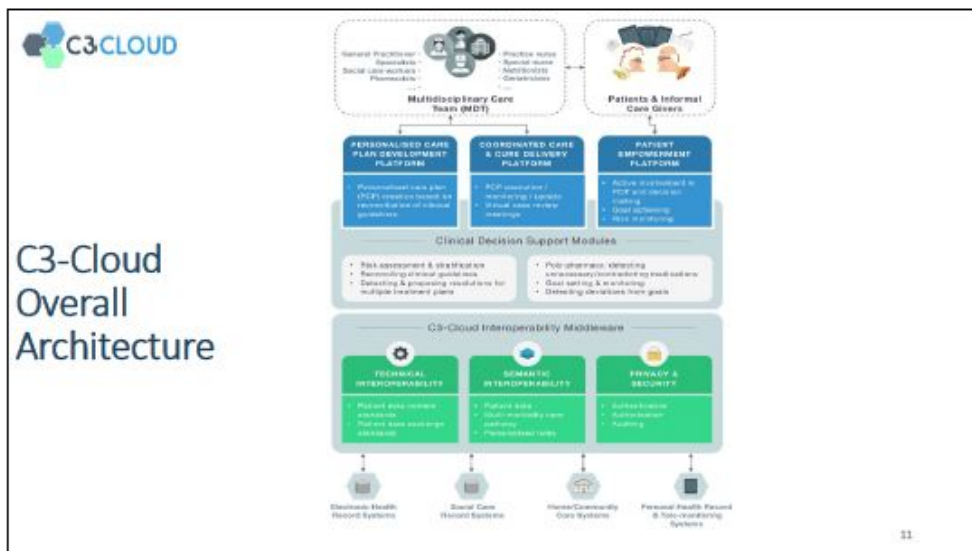
Digitally Enhanced Integrated Care

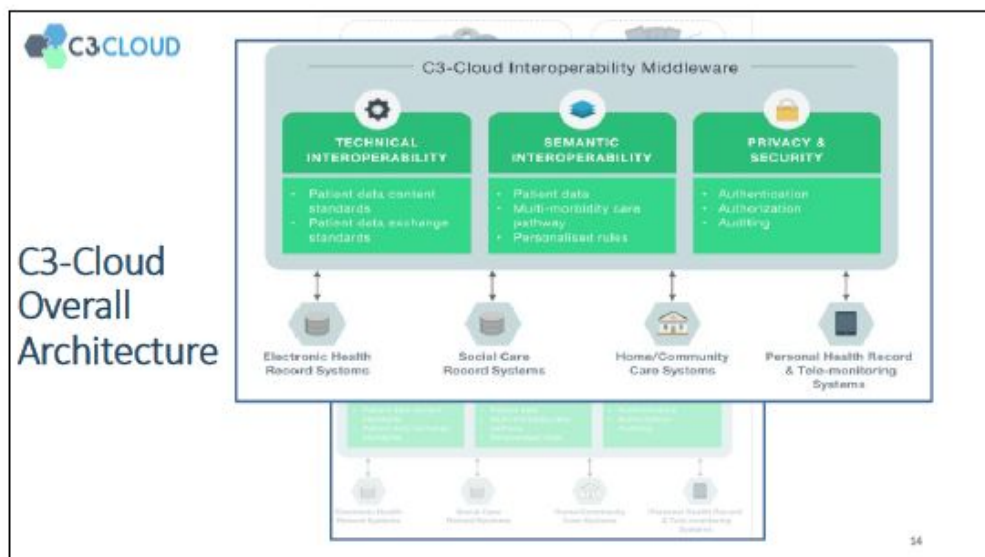
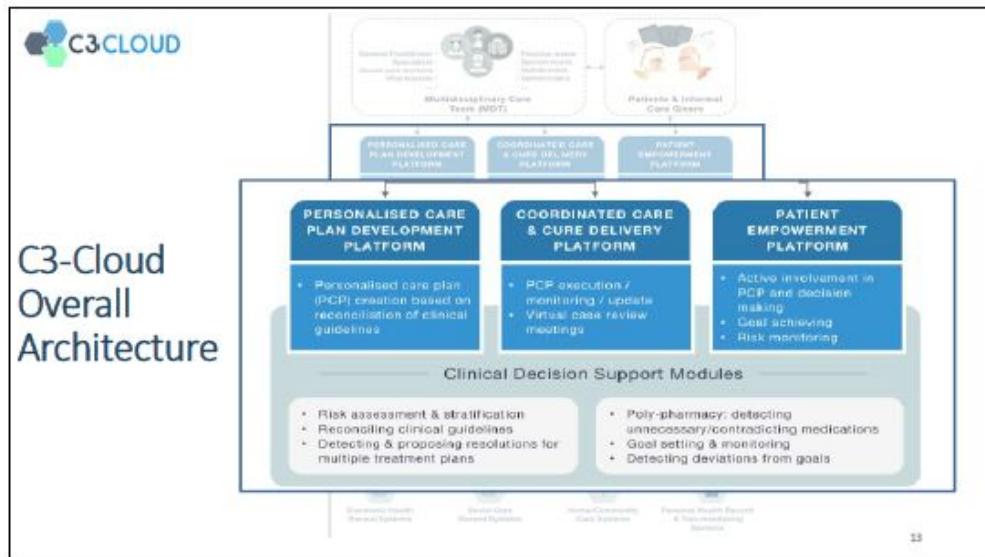


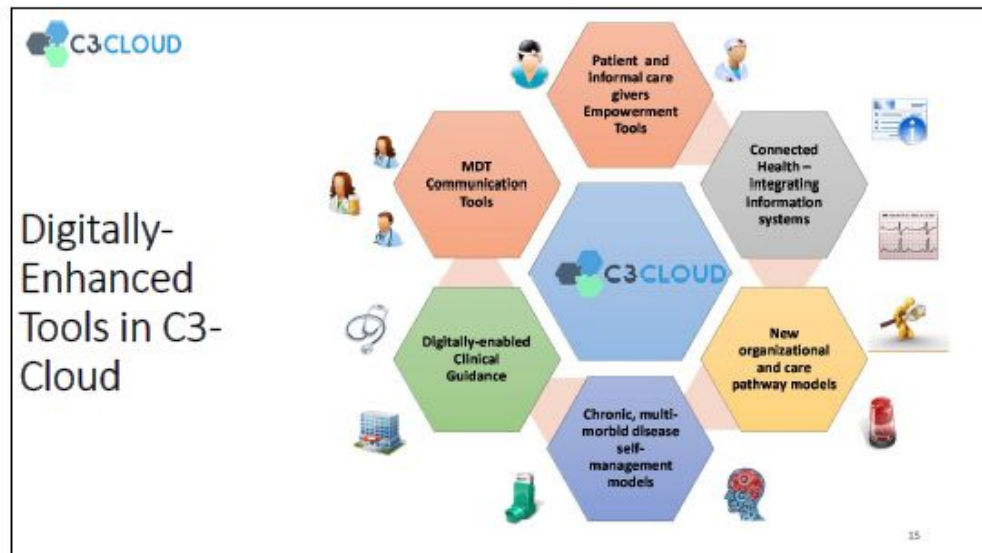
- At present, it is suggested that there is no 'single model' that can be applied universally to achieve care services for people with complex needs.
- Integrated Care
 - The management and delivery of health services so that citizens receive a continuum of preventive and curative services.
 - ❖ According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











Thank you

Prof. Theodoros N. Arvanitis
t.arvanitis@warwick.ac.uk



WARWICK
THE UNIVERSITY OF WARWICK

16

3 PRESS RELEASE



Press Release

May 2016

New EUR 5 million project that will transform care for multimorbid patients launched

Care for patients with multi-morbid chronic conditions could be transformed by a new ICT infrastructure to be developed in this EUR 5 million EU Horizon 2020 project. 12 partners in seven countries have joined forces, and are combining their expertise to improve care provided to elderly patients with multimorbidity.

Patients with multimorbidity have two or more chronic conditions such as diabetes, heart failure, renal failure and depression that make treatment more complicated. Multimorbidity has become more prevalent among the elderly as the population has aged.

The system called C3-Cloud will transform current care models that are fragmented and address chronic conditions in isolation. This considerably limits the quality of care resulting in safety risks and increases cost. This happens mainly due to avoidable readmissions to hospitals, as well as repeated visits to various experts. C3-Cloud is a patient-centric approach, considering the unique circumstances of each patient, taking into account all their conditions and needs.

The four-year project includes public health care providers, industry, and research organisations and is led by the University of Warwick (UK). Other partners are Cambio Healthcare Systems (Sweden), Empirica (Germany), European Institute for Health Records - EuroRec (France), Institut national de la santé et de la recherche médicale - Inserm (France), Kronikgune (Spain), Medixine (Finland), Osakidetza - Servicio Vasco de Salud (Spain), Region Jämtland Härjedalen (Sweden), Software Research, Development and Consultancy Corp. - SRDC (Turkey), South Warwickshire NHS Foundation Trust (UK), and Örebro University (Sweden).

The C3-Cloud system will allow for the creation of a personalised treatment plan for each patient by letting hospitals, general practitioners and social care organisations across the health and care system exchange information, and coordinate care more effectively. The project will contribute to the knowledge in health care as well as health informatics, such as the introduction of new models of patient-centric, integrated care, and the development of automated, IT supported, clinical decision making, which will prevent incompatible treatment plans.

The project will demonstrate its contributions by 15 month long pilots, which will be conducted in the Warwickshire region of UK, the Basque Country in Spain and the Jämtland Härjedalen region of Sweden. The three European areas have been chosen because of their varied health, social care and technology systems in place. The comparisons will enhance the study's evidence base on health outcomes and efficiency gains. Eventually it is hoped that the system will be rolled out across Europe allowing patients with chronic multimorbidity to benefit from improved health and care.

Professor Theodoros Arvanitis of the Institute of Digital Healthcare, WMG, University of Warwick and project coordinator said: "The personalised care plans will be developed through systematic and semi-automatic reconciliation of clinical guidelines. The system will incorporate risk prediction and stratification, recommendation reconciliation and poly-pharmacy management. Patients and their next-of-kin are involved through a Patient Empowerment Platform ensuring that their needs are respected in the decision making taking into account preferences and psychosocial aspects."

ENDS

Notes to Editors

The project, A Federated Collaborative Care & Cure Cloud Architecture for Addressing the Needs of Multi-morbidity and Managing Poly-pharmacy (C3-Cloud)" is funded by Horizon 2020 (PHC-25-2015), the biggest EU Research and Innovation programme ever with nearly €80 billion of funding available over seven years (2014 to 2020).

4 REFERENCES

1. OECD. OECD Factbook 2009: Economic, Environmental and Social Statistics [Internet]. OECD Publishing; 2009 [cited 2016 May 31]. (OECD Factbook). Available from: http://www.oecd-ilibrary.org/economics/oecd-factbook-2009_factbook-2009-en
2. OECD. Health at a Glance 2011: OECD Indicators [Internet]. OECD Publishing; 2011 [cited 2016 May 31]. (Health at a Glance). Available from: http://www.oecd-ilibrary.org/social-issues-migration-health/health-at-a-glance-2011_health_glance-2011-en
3. The King's Fund. Providing integrated care for older people with complex needs [Internet]. 2014 [cited 2016 May 31]. Available from: <http://www.kingsfund.org.uk/publications/providing-integrated-care-older-people-complex-needs>
4. Luppi F, Franco F, Beghé B, Fabbri LM. Treatment of Chronic Obstructive Pulmonary Disease and Its Comorbidities. *Proc Am Thorac Soc.* 2008;5(8):848–56. Cited in the EIP-AHA Operational Plan, p. 26. https://ec.europa.eu/research/innovation-union/pdf/active-healthy-ageing/steering-group/operational_plan.pdf
5. University of Washington / Group Health Cooperative. TEAMcare Intervention Manual, Managing Depression, Diabetes and Coronary Heart Disease in Primary Care [Internet]. 2010 [cited 2016 May 31]. Available from: <http://mhinnovation.net/sites/default/files/downloads/innovation/tools/TEAMcare-Intervention-Manual-2011-09-06.pdf>
6. European Commission. Communication from the Commission to the European Parliament and the Council: Taking forward the Strategic Implementation Plan of the European Innovation Partnership on Active and Healthy Ageing [Internet]. 2012 [cited 2016 May 31]. Available from: <http://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX%3A52012DC0083>
7. Coyte PC, Goodwin N, Laporte A. How can the settings used to provide care to older people be balanced? [Internet]. World Health Organization 2008 and World Health Organization, on behalf of the European Observatory on Health Systems and Policies 2008; 2008 [cited 2016 May 31]. Available from: http://www.euro.who.int/__data/assets/pdf_file/0006/73284/E93418.pdf