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

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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.
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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 |
|--------------------|------------------|------------------------|---------|
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| 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 |
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).

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 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 O\(^2\) 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 O\(^2\) 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.
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.

Figure 1: Overall C3-Cloud Architecture
• 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

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.
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.

The Challenge: Transformation of care delivery

- In which setting care is delivered for chronic patients?
- European Innovation Partnership on Active and Healthy Ageing, Action Plan on Implementing and Tailoring Integrated care for chronic diseases, including remote monitoring at regional level: http://ec.europa.eu/research/innovation-union/pdf/active-healthy-ageing/aih_plan_en.pdf
The Challenge: Diversity and complexity of multimorbidity

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.
What is C3-Cloud

- Establish an ICT infrastructure enabling
- a collaborative care and cure cloud
- continuous coordination of patient-centred care activities
- multidisciplinary care team and patients/informal care givers.

C3-Cloud Objectives

- **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.
- To demonstrate feasibility, pilot studies will focus on diabetes, heart failure, renal failure, depression in different comorbidity combinations (in 3 European regions).
C3-Cloud Overall Architecture

Clinical Decision Support Modules
- Risk assessment & stratification
- Personalizing clinical guidelines
- Detecting & proposing deviations for multiple treatment plans
- Polypharmacy: detecting unnecessary, non-interacting medications
- Goal setting & monitoring
- Detecting deviations from goals

C3-Cloud Interoperability Middleware
- Technical Interoperability
  - Patient data, content standards
  - Patient data exchange standards
- Semantic Interoperability
  - Patient data
  - Multidisciplinary care pathways
  - Personalized care
- Privacy & Security
  - Authorization
  - Authentication
  - Auditing

Electronic Health Record Systems
Social Care Record Systems
Home/Community Care Systems
Personal Health Record & Tele-monitoring Systems
Digitally-Enhanced Tools in C3-Cloud

Thank you

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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 recherché 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).
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