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An adaptive case management system to support integrated care services: Lessons learned from the NEXES project

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ABSTRACT

Background: Extensive deployment and sustainability of integrated care services (ICS) constitute an unmet need to reduce the burden of chronic conditions. The European Union project NEXES (2008–2013) assessed the deployment of four ICS encompassing the spectrum of severity of chronic patients.
Objective: The current study aims to (i) describe the open source Adaptive Case Management (ACM) system (Linkcare®) developed to support the deployment of ICS at the level of healthcare district; (ii) to evaluate its performance; and, (iii) to identify key challenges for regional deployment of ICS.
Methods: We first defined a conceptual model for ICS management and execution composed of five main stages. We then specified an associated logical model considering the dynamic runtime of ACM. Finally, we implemented the four ICS as a physical model with an ICS editor to allow professionals (case managers) to play active roles in adapting the system to their needs. Instances of ICS were then run in Linkcare®. Four ICS provided a framework for evaluating the system: Wellness and Rehabilitation (*W&R*) (number of patients enrolled in the study (n) = 173); Enhanced Care (*EC*) in frail chronic patients to prevent hospital admissions, (n = 848); Home Hospitalization and Early Discharge (*HH/ED*) (n = 2314); and, Support to remote diagnosis (*Support*) (n = 7793). The method for assessment of telemedicine applications (MAST) was used for iterative evaluation.
Results: Linkcare® supports ACM with shared-care plans across healthcare tiers and offers integration with provider-specific electronic health records. Linkcare® successfully contributed to the deployment of the four ICS: *W&R* facilitated long-term sustainability of training effects ($p < 0.01$) and active life style ($p < 0.03$); *EC* showed significant positive outcomes ($p < 0.05$); *HH/ED* reduced on average 5 in-hospital days per patient with a 30-d re-admission rate of 10%; and, *Support*, enhanced community-based quality forced spirometry testing ($p < 0.01$). Key challenges for regional deployment of personalized care were identified.
Conclusions: Linkcare® provided the required functionalities to support integrated care adopting an ACM model, and it showed adaptive potential for its implementation in different health scenarios. The research generated strategies that contributed to face the challenges of the transition toward personalized medicine for chronic patients.

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1. Introduction

Health systems worldwide are facing a profound evolution driven by three major forces that are converging in terms of their impact on health information systems. Firstly, the epidemics of non-communicable diseases [1–3] is prompting both conceptual and organizational changes in the way we approach the delivery of care for chronic patients. A second vector of change is the need to ensure financial sustainability of healthcare systems by generating efficiencies that ideally should lead to containment of overall healthcare costs without precluding the necessary innovations [1]. Last, but not least, Systems Medicine [4] is proposing an innovative approach to our understanding of disease mechanisms that is contributing to build-up personalized medicine [5] with important implications on future strategies for personalized chronic patient management.

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Abbrevations

ACM	adaptive case management
ACMS	adaptive case management system
BPMN	business process modelling notation
CDSS	clinical decision support systems
CMMN	case management model and notation
EAI	enterprise application integration
EHR	electronic health record
EU	European Union
HIE	Health Information Exchange
HIS	health information system
ICS	integrated care service
ICP	integrated care protocol
ICT	information and communication technologies
SOAP	simple object access protocol

A commonality of these three driving forces is the need for efficient and intensive use of Information and Communication Technologies (ICT) to support novel Integrated Care Services (ICS) for chronic patients [6]. However, conventional Health Information Systems (HIS) only very rarely incorporate the required process logic to support ICS management [7]. Conventional care relies on the management of clinical episodes with a disease-oriented approach, whereas in ICS continuity of care with a patient-centered approach are the key principles. Most importantly, integrated care requires cooperation among healthcare providers, across healthcare tiers, and with social support.

We acknowledge that examples of successfully addressing the technological requirements associated with the deployment of ICS within a given health information network do exist [8,9].

However, this issue remains a major challenge in those healthcare sectors with heterogeneous providers each one using proprietary HIS. Moreover, there is a need for new paradigms bridging traditional Electronic Heath Records (EHR) and informal care through patient's personal health records.

The current study describes an open source ICT platform (Linkcare®) developed to support the process logics of integrated care. To this end, a family of four ICS evaluated in the European project NEXES [10] and deployed in Barcelona provided a framework for evaluating the system. NEXES aimed at assessing the deployment of the four different but articulated ICS covering most of the spectrum of severity of chronic patients. The project was conducted in three European sites: Barcelona (Catalonia); Trondheim (Norway) and Athens (Greece) following similar clinical protocols, but different organizational approaches and diverse ICT support. The hypothesis behind the study was that the transfer of service complexities from hospital-based specialized care to community care could enhance health outcomes while containing overall costs at health system level.

Therefore, the central challenge was for the Linkcare® ICT platform to support the process logic of ICS that allow case management with an integrated care approach. The current manuscript describes the steps followed to develop the logics of the clinical processes (i.e. case identification, case evaluation, work plan definition, follow-up and event handling, and discharge) and the associated ICT support. It also reports on the four ICS in which Linkcare® was tested and on the healthcare outcomes generated by the project in Barcelona. Finally, we present the lessons learned in NEXES that should be useful for regional deployment of integrated care, as well as to foster future personalized care for chronic patients.

2. Materials and methods

The initial logic models for case management with an integrated care approach were build-up based on the Business Process Model and Notation (BPMN) [11] formalism, but two main limitations were identified; that is, lack of contextualization and poor dynamic adaptation to changes. Ad-hoc modifications to BPMN implemented in the process of development of the ICT platform fit with the Adaptive Case Management (ACM) model [12], reported at the end of the decade, that was later formalized as the Case Management Model and Notation (CMMN v1.0) specification [13]. Consequently, further developments in the Linkcare® platform have followed an ACM approach, as described in the manuscript.

2.1. Adaptive case management

In NEXES, Integrated Care Services (ICS) are defined as a set of well-standardized tasks to be carried out to a patient on the basis of his/her health condition and social circumstances to achieve target objectives, aligned with the comprehensive treatment plan. Two differential characteristics of the approach, as compared to usual care, are: (i) its patient centeredness; and, (ii) the longitudinal nature of the interventions which duration depends on the type of Integrated Care Service. One patient can be assigned to one or more integrated care services within a given time frame depending upon his/her individual needs.

Having the above definition of ICS into account, the ACM model was considered to build-up the process logic of each ICS because ACM provides the infrastructure for knowledge-based work (e.g. case management) that conventional systems cannot support

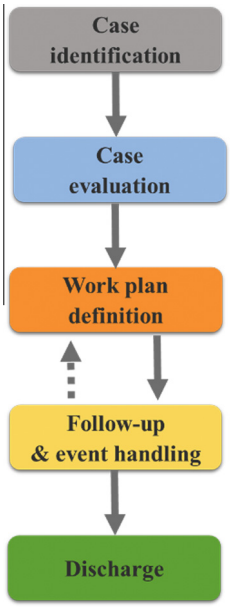

Fig. 1. Conceptual stages of Integrated Care Services (ICS) considered in this study.

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