



CONNECARE

WP7 – EVALUATION & SCALE-UP

D7.4: RECOMMENDATIONS OF FINAL SERVICES AND PROPOSALS FOR SCALE-UP INTEGRATED CARE

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Abstract	<p>Background: Integrated care models are conceived to generate health and social care efficiencies. It is acknowledged that well-identified complexities of real-world deployment of integrated care services are unacceptably slowing-down large-scale adoption of digital innovations needed in the field. Practicalities of deployment of integrated care following an implementation research approach have been insufficiently tested.</p> <p>Objectives: CONNECARE has been designed to address two aims: i) Development, testing and deploying a digital platform enabling integrated care services; and, ii) Assessment of deployment of an organizational model for integrated care.</p> <p>Methods: The CONNECARE digital platform has been developed as a patient-centered integrated care model to support: (i) Smart adaptive case management; (ii) patients' empowerment; and, (iii) Collaborative work among the various stakeholders, across health and social care tiers. Evaluation was done through deployment initiatives under two umbrella scenarios: i) Community-based prevention of unplanned hospital-related events in chronic</p>
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patients (Case Study 1, CS1); and, ii) Preventive patient-centered interventions in chronic patients undergoing elective major surgical procedures (CS2 and CS3). CONNECARE has been deployed in 4 sites actively involved in scalability of digitally enabled integrated care services: Assuta-Ashdod (IL), Groningen (NL), Barcelona and Lleida (ES). An implementation research approach has been adopted, using observational study designs with an intervention group and in some sites a matched control group.

Results: Consolidated achievements in several dimensions were: i) Development, testing and deployment, in different real-life scenarios and sites, of digital tools with very high potential for scalability; ii) Deep understanding and implementation of the practicalities of the CONNECARE organizational model; iii) Successful application of a PDSA approach and pragmatic use of an innovative and comprehensive evaluation frame; and, iv) Contributions to scalability of the target services in the implementation sites.

Conclusions: CONNECARE represents a major breakthrough in our current understanding, and solving, of some fundamental challenges faced in large-scale deployment and adoption of integrated care. We report relevant recommendations fostering transferability of CONNECARE achievements.

Table of contents

1. EXECUTIVE SUMMARY	5
2. PERSONALISED CONNECTED CARE FOR COMPLEX CHRONIC PATIENTS: RESULTS FROM THE CONNECARE PROJECT	6
ABSTRACT	7
INTRODUCTION	8
METHODS.....	9
<i>The co-creation approach</i>	<i>10</i>
<i>Digital health tools to support integrated care services</i>	<i>10</i>
<i>Evaluation of digitally enabled integrated care services.....</i>	<i>11</i>
<i>The CONNECARE implementation studies.....</i>	<i>12</i>
<i>Data analysis.....</i>	<i>13</i>
RESULTS	13
<i>Digitally-supported integrated care services</i>	<i>13</i>
<i>Assessment of digital tools.....</i>	<i>15</i>
<i>Transferability and recommendations for site adoption.....</i>	<i>16</i>
DISCUSSION	17
<i>Main achievements.....</i>	<i>17</i>
<i>Strengths and limitations of the project development.....</i>	<i>18</i>
<i>Future perspectives</i>	<i>18</i>
CONCLUSIONS	19
TABLES.....	20
REFERENCES.....	24



1. Executive Summary

The current deliverable has been conceived, and is presented, as an advanced draft manuscript planned for submission for publication in its final form to Journal of Medical Internet Research (JMIR) within January 2020.

The work reported in the document concerns the main results of CONNECARE in terms of digitally supported integrated care, assessment of the CONNECARE digital tools, transferability, main achievements, strengths and limitations, as well as future directions to be taken beyond the project lifetime.



2. Personalised Connected Care for Complex Chronic Patients: Results from the CONNECARE Project

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Abstract

Background: Integrated care models are conceived to generate health and social care efficiencies. It is acknowledged that well-identified complexities of real-world deployment of integrated care services are unacceptably slowing-down large-scale adoption of digital innovations needed in the field. Practicalities of deployment of integrated care following an implementation research approach have been insufficiently tested.

Objectives: CONNECARE has been designed to address two aims: i) Development, testing and deploying a digital platform enabling integrated care services; and, ii) Assessment of deployment of an organizational model for integrated care.

Methods: The CONNECARE digital platform has been developed as a patient-centered integrated care model to support: (i) Smart adaptive case management; (ii) patients' empowerment; and, (iii) Collaborative work among the various stakeholders, across health and social care tiers. Evaluation was done through deployment initiatives under two umbrella scenarios: i) Community-based prevention of unplanned hospital-related events in chronic patients (Case Study 1, CS1); and, ii) Preventive patient-centered interventions in chronic patients undergoing elective major surgical procedures (CS2 and CS3). CONNECARE has been deployed in 4 sites actively involved in scalability of digitally enabled integrated care services: Ashdod (IL), Groningen (NL), Barcelona and Lleida (ES). An implementation research approach has been adopted, using observational study designs with an intervention group and in some sites a matched control group.

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Conclusions: CONNECARE represents a major breakthrough in our current understanding, and solving, of some fundamental challenges faced in large-scale deployment and adoption of integrated care. We report relevant recommendations fostering transferability of CONNECARE achievements.

Key words: Assessment; Chronic patients; Digital health; Elderly; Integrated care; Social support; Telemonitoring; information and communication technology.

Introduction

Health and social care systems worldwide face major economic and functional challenges prompting the need for a profound re-design in order to ensure both quality and sustainability (1,2). Ageing population and the increasing number of people with at least one chronic disease are demanding more resources and increasing the burden on health and social care systems. Integrated care models are conceived to respond to such challenges by generating health and social care efficiencies through defragmentation of care, promotion of collaboration and continuity among care settings with adoption of a patient-centered, preventive model (3,4). It is acknowledged, however, that well-identified complexities of the deployment of integrated care services (5,6) are unacceptably slowing-down large scale adoption of needed innovations in the field. Moreover, the practicalities of proposed frameworks for assessment of deployment of integrated care following an implementation research approach (7,8) have been insufficiently tested which ultimately is detracting transferability of deployment experiences managing the boundary – or interface – between care services.

One of the most problematic interfaces (**Figure 1**), due to poor communication and coordination, is the hospital-community care interface, showing a clear need for vertical integration. It is of note that continuum of care across community-based health and social care services, horizontal integration, also shows limitations that could be solved with deployment of a proper organizational model of integrated care.

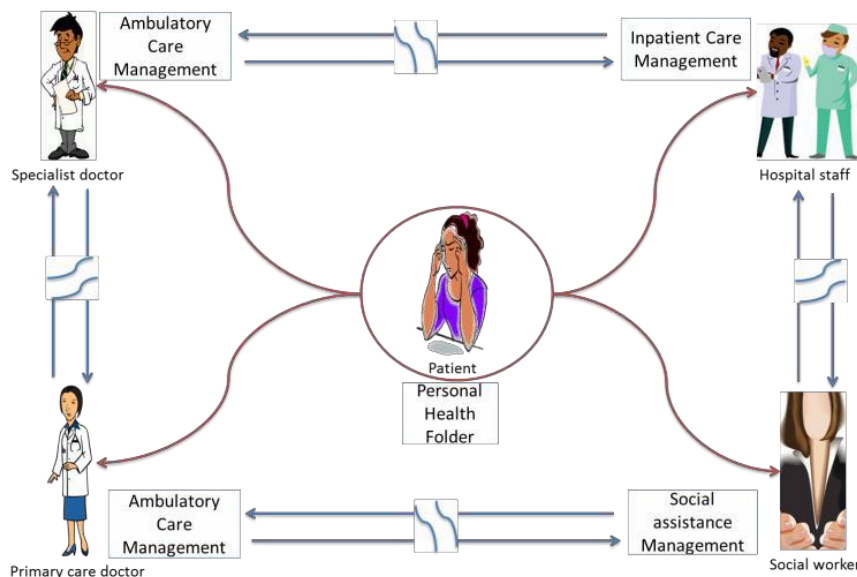


Figure 1 - Traditional scenario in which the patient interacts with all the above-mentioned professionals, whereas professionals have difficulties to communicate each other to act and share on an agreed care plan.

CONNECARE “Personalised Connected Care for Complex Chronic Patients” is an H2020 EU Research and Innovation project, running from April 2016 till December 2019. It was designed to cover two major components with well-defined aims: development and testing of a digital platform enabling integrated



care services; and, assessment of deployment of an organizational model for integrated care. The CONNECARE digital platform is intended to support a patient-centered integrated care model for: (i) Smart adaptive case management of patients with multimorbid conditions; (ii) Collaborative work among the various stakeholders, including patients and their families across health and social care tiers, involved in the services; and, (iii) Patient empowerment for self-management. The CONNECARE consortium is composed of nine partners from six European countries (Spain, Israel, The Netherlands, Italy, Germany, and United Kingdom) including clinical institutions in four deployment sites (Ashdod (IL), Groningen (NL), Barcelona and Lleida (ES)) and five technological partners each of them developing specific aspects of the technological platform. Details of the consortium composition can be found in the CONNECARE website (9).

The project evaluated different deployment initiatives under two umbrella scenarios: i) Community-based prevention of unplanned hospital-related events, admissions and/or emergency room visits, in chronic patients with high risk for hospitalization (Case Study 1, CS1); and, ii) Preventive patient-centered interventions in chronic patients undergoing elective major surgical procedures (CS2 and CS3). These deployment initiatives were assessed in the four CONNECARE deployment sites actively involved in scalability of digitally enabled integrated care services. An implementation research approach, using observational study designs with an intervention group and a matched control group, was adopted in all sites.

The current report describes relevant characteristics of the CONNECARE design, summarizes key results, shares lessons learnt throughout the project development and formulates recommendations for transferability of the current experience, taking into account the need for site specific customizations. Within the main results, we focus on: (i) The technology-enabled integrated care services implemented in the four sites; (ii) The co-creation process undertaken throughout the project lifespan; (iii) The CONNECARE assessment framework (10); (iv) Lessons learnt from the development of the digital tools; (v) Contributions to site specific strategies for scalability of integrated care; and, (vi) Recommendations for transferability and site adoption.

The ultimate aim of CONNECARE, and the current summary report, is to contribute to future directions defining how digital support can foster scale-up of integrated care services. We believe that the structured evaluation framework applied in the project may be useful to enhance trialability and comparability of future deployments of integrated care services.

Methods

The section summarises the main methodologies applied in CONNECARE. Further details on the different subheadings can be found in D2.5 (co-creation approach), D3.6 (SACM), D4.7 (SMS), D5.3 (generic CONNECARE system), D6.2 (Results from Case Study 1), D6.3 (Results from Case Study 2), D6.4 (Results from Case Study 3), and D7.3 (Evaluation of clinical studies deployment and PDSA iterative cycles).



The co-creation approach

CONNECARE adopted a co-creation approach using iterative 6-month Plan-Do-Study-Act (PDSA) cycles (11,12) to generate the design of digitally-supported interventions associated to the three case studies addressed in the project, as well as to refine the technological tools throughout the project lifetime. To this end, a multidisciplinary collaborative setting was established at site level in order to capture the feedback of all actors of the integrated care process. The outputs of each of the four sites: Ashdod, Groningen, Lleida, and Barcelona were integrated at consortium level at the end of each 6-month PDSA cycle.

The two initial PDSA cycles, first year of the project, conformed the **Co-Design** phase aiming at: (i) Participating in the conceptual redefinition of existing services and the definition of the characteristics of the technological developments by defining the requirements; (ii) Adjusting the details of the service workflows to the characteristics of each site before initiation of the clinical studies; and (iii) Assessing suitability and acceptance of key indicators to be used for evaluation of the clinical studies. The remaining PDSA cycles up to the project end, defined the **Refinement and Fine-tuning** phase, aiming to support technological developments and evolutionary integration with provider-specific health information systems. The Refinement and Fine-tuning phase included the testing of an already operative system, even if some of its features were not fully developed until late stages of the project.

Digital health tools to support integrated care services

The two core modules of the CONNECARE platform are: (i) the **Self-Management System** (SMS) for patients and carers, including a recommender system to empower patients. It is conceived to support the patient, and/or carer, to manage his/her condition by monitoring daily steps prescription, receiving motivational messages, providing access to educational material, generating patient reported outcomes (PROMs) and patient reported experiences (PREMs), and enabling communication with the patient; and (ii) the **Smart Adaptive Case Management system** (SACM) in which the clinician creates a care plan, prescribes the tasks for the patient and monitors patient adherence, in an interface that allows for effective communication and coordination among the different actors of the health and social care process. It has been defined and developed to assist case managers and professionals in managing and following-up the patients with the support of an integrated Clinical Decision Support System (CDSS) that can be fed by dynamic predictive modelling. **Figure 2** shows the main components and the corresponding subsystems and services.

During the entire period, heterogeneities among sites generated a continuous and rich debate due to the emerging technological needs identified during the process. All CONNECARE implementation studies helped to develop the CONNECARE technological platform interoperable with site-specific health information systems. However, implementation studies in Barcelona also adopted or adapted three additional digital health tools, namely: (i) MyPathway®, from the CONNECARE partner ADI; (ii) the CONNECARE SMS suitably adapted for perioperative case; and, (iii) Health-Circuit, from Atos-Unify

(see detailed description of MyPathway® and Health-Circuit in D6.4, and in the supplementary material, in preparation).

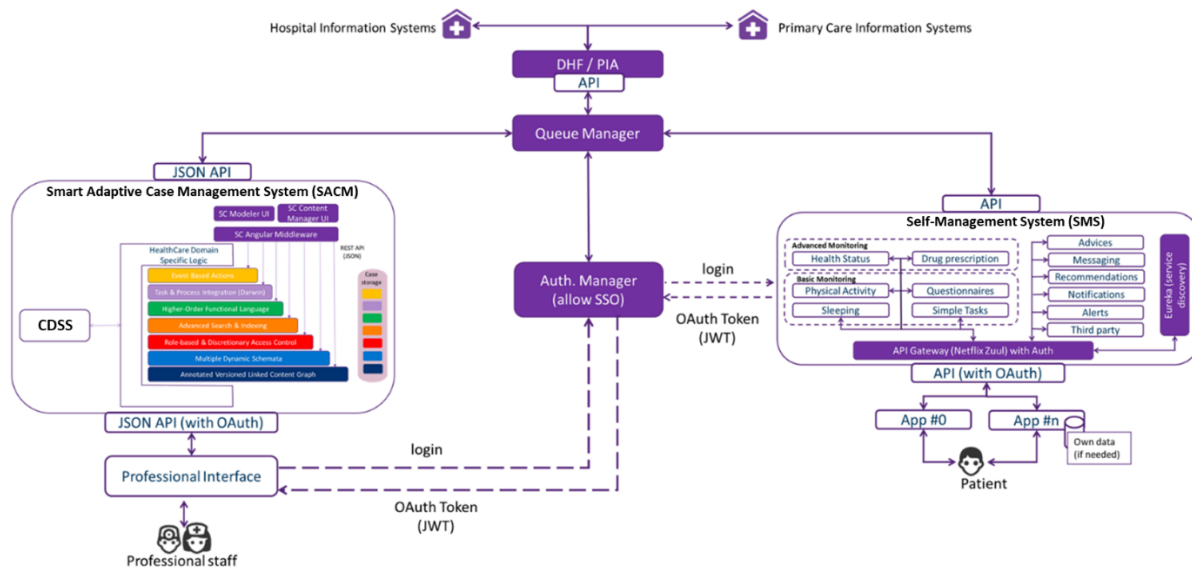


Figure 2 – CONNECARE platform: (i) A collaborative platform for the joint adaptive case management of patient itineraries (SACM), including Clinical Decision Support Systems (CDSS) aiming to prompt and assess personalised clinical pathways, which will consider historical data, patient health status, social and physical environment constraints, and the context in which the pathway has been defined; and, (ii) A Self-Management System (SMS) for patients that include the possibility to communicate with his/her care team, capture patient reported outcomes and patients reported experience with the aim to enhance patient empowerment for self-management. An extended description of the CONNECARE platform can be found in D5.3. Final Release of the generic CONNECARE system.

Evaluation of digitally enabled integrated care services

CONNECARE considered that the following key aspects should be taken into account for a proper assessment of digital tools supporting healthcare services (13) before their introduction into the clinical arena following established best practices: (i) Robustness and interoperability as mandatory conditions for use of the digital tool in a real-world setting; (ii) Potential for health value generation; and, (iii). Potential for generalization of the use and transferability of the digital tool. To this end, in the clinical implementation studies, CONNECARE measured actual patient use of the digital tools and performed structured evaluations of usability (and actual use of the digital tools), satisfaction and perception of continuity of care using standardized questionnaires administered to patients and/or professionals namely: (i) System Usability Scale (SUS) (14); ii) Overall Satisfaction and Net Promotor Score (15); (iii) Person-centred coordinated care experience questionnaire (P3CEQ) (16) and iv) Nijmegen Continuity Questionnaire (NCQ) (17). Moreover, the potential of the technology tested in the project for health value generation in integrated care services was addressed using the mini-MAST checklist. The Model for Assessment of Telemedicine (MAST) (18), is a Health Technology Assessment inspired framework extensively used for assessing the quality of telemedicine applications as supporting tools of healthcare services. In Denmark, the mini-MAST checklist is often used as a summarized version of MAST for a pragmatic and quick assessment of telemedicine applications in field studies. In all four sites, data was extracted from local health information systems to assess the impact of the digitally supported integrated



care services in healthcare service utilization. In addition, in all four CONNECARE sites, the evaluation of other aspects of the digital tools has been done through expert opinions from technologically-oriented expert professionals (i.e. staff and management of providers' health information systems). It is of note that identical assessment methodologies were used for the evaluation of other supporting digital tools, namely: MyPathway® and Health-Circuit.

Moreover, the project generated a structured evaluation framework (10) to assess deployment of integrated care services in the health district of Barcelona-Esquerri (AISBE, 520 k inhabitants). The evaluation framework includes three core modules: (i) Assessment of the intervention outcome following a Quadruple aim (19,20) approach, (ii) Evaluation of the implementation strategies using the consolidated framework for implementation research (CFIR) (21,22) , and (iii) Assessment of the ecosystem maturity using the SCIROCCO approach (23). An additional component is the identification of Key Performance Indicators (KPI) useful for long-term follow-up of health services after adoption encompassing three dimensions: health outcomes, processes and structure (24). It is of note that the proposed evaluation frame has not been applied in a homogeneous manner in the project.

The CONNECARE implementation studies

The aim of the implementation studies in each of the four sites has been to assess the potential cost-effectiveness of a digitally enabled case management model that facilitates communication among different health and social care actors and patients, professional monitoring of patient activities and outcomes and patient empowerment. Moreover, implementation studies also aimed at assessing the perceived usability and acceptability of the CONNECARE digital tools both by the patients and healthcare professionals, as well as to assess their potential for scalability beyond the project lifetime.

The specific aims, interventions, study groups and protocol designs of the implementation studies in the four sites are summarized in **Tables 1 and 2**. All of them are grouped in two main case studies. CS1 addresses “*Community-based prevention of unplanned hospital-related events in frail complex patients with high risk for hospitalisation*”, including different site customized interventions aiming at enhancing vertical and horizontal integration that should result in reduction of unplanned hospital and/or emergency room admissions (**Table 1**). Likewise, CS2 and CS3 address “*Preventive patient-centred intervention in chronic patients undergoing elective major surgical procedures*”, including different interventions aiming at preventing perioperative complications, as well as enhancing post-operative recovery (**Table 2**).

Heterogeneities among sites are mostly explained by the two following reasons. Site customization of the interventions in order to mimic real-life settings was a relevant factor in Lleida, Israel and Groningen. On the other hand, Barcelona combined testing of the CONNECARE organizational model in large-scale deployment scenarios with assessment of several digital tools. It is of note that, in Barcelona, in addition to the CONNECARE platform, other technological tools complying with the CONNECARE concept, like adaptations of MyPathway® and Health-Circuit, were also tested. Moreover, despite a huge amount of project effort devoted to formalization of the service workflow for all implementation studies, clinical heterogeneity among the four CONNECARE sites was high. As widely acknowledged in the literature



(25), there is a general lack of standardization of clinical practice. Consequently, the meta-analysis of the interventions, at consortium level, carried out in the Results section necessarily constitutes a high-level approach.

Data analysis

The implementation studies (**Tables 1 and 2**) were assessed (10) using a mixed-method approach: (i) a meta-analysis combining site level results; and, (ii) qualitative methodologies for specific dimensions (e.g. maturity of the ecosystem, implementation challenges, transferability, etc.). The sources of information for the analyses at project level were: (i) outcome variables collected in the implementation studies with a quadruple aim approach; (ii) information obtained from an implementation log and the ecosystem in each site (e.g. maturity of digital transformation, implementation strategies, data on service sustainability analyses, etc.); and, (iii) variables collected at healthcare provider and at regional levels.

Results

Digitally-supported integrated care services

As indicated, CONNECARE evaluated representative services of vertical and horizontal integration for enhanced management of chronic patients in the community, CS1, (**Table 1**) and a spectrum of interventions under the umbrella of perioperative care, CS2 and CS3, (**Table 2**). The current section analyses jointly the results from the four deployment sites (*see detailed descriptions at site level in D6.2, D6.3, D6.4 and D7.3*).

Management of complex chronic patients (CS1, Table 1) - Across clinical sites, the CS1 interventions, although tested in relative small groups in Israel and Lleida, suggests significant improvement in patient health outcomes and in the use of healthcare resources. The domain of physical activity improved across patient groups, following the intervention, in Israel (physical dimension of SF-12 mean change: +2.65; p-value<0.001) and in Lleida (physical dimension of SF-12 mean (SD) change: +3.7 (12.8); p-value=0.004). In Groningen, a non-significant improvement in disease severity was observed in both groups, with the intervention group improving in mental status. Likewise the EuroQol-5D (26,27) average score in Israel (mean change 12.32; p-value<0.001) and in Barcelona (mean change 5; p-value<0.001) significantly decreased in pain discomfort and increased in feeling of health and well-being. Likewise, patients in the home hospitalisation group in Barcelona (Protocol IA) displayed better patient reported outcomes in terms of quality of care transitions (mean CTM-15 change 29.83; p-value<0.001) and patient experience (mean IEXPAC change 1.32; p-value<0.001). Moreover, in Protocol IA a significant reduction of both unplanned early readmissions (5% and 11%, home hospitalization versus usual care, p=0.031) and emergency room consultations (4% and 13.3%, respectively, p<0.001) was achieved. Similar results were seen with Health-Circuit with preliminary results in a small group of patients (Protocol IIIC) wherein reduction of primary care visits, emergency room consultations and hospitalizations was realized along with significantly enhanced patient reported outcomes (p<0.001) and patient reported experience (p<0.001). Lleida also showed a significant



reduction in use of healthcare resources in terms of hospitalization rate (mean (SD) change: -1.27 (1.8); p-value=0.006).

Overall, compared to care-as-usual, the interventions assessed in CS1 seem to generate value for money across most of the sites. In the case of Lleida, the implementation study demonstrated a negative incremental cost associated with 1 additional point gain in SF-12, ranging from -112.10€ to -97.84€. In the case of Israel, the overall cost per capita was significantly lower for the intervention group (1,992€) than the control group (3,068€), with a p-value of <0.04, mostly attributable to significantly lower hospital-related costs in the intervention group. Finally, Barcelona clearly indicates cost savings for the home hospitalisation group, which shows approximately half-cost, compared to the usual care group. In Groningen, a non-significant decrease in the number of general practitioner visits was observed in the intervention group, whereas an increase was observed in the control group. The cumulative number of hospital days also reduced in the intervention group, whereas in the control group this remained stable.

Preventive interventions on perioperative care (CS2 & CS3, Table 2) - In Barcelona, implementation studies aimed to assess effectiveness of prehabilitation in a real life setting, based on the already demonstrated efficacy and potential for healthcare value generation of the prehabilitation intervention in a randomized controlled trial (RCT) (28). Preliminary data of still ongoing analysis of the Prehabilitation Unit at HCB during 18-months (June 2017-December 2018, n=372) seem to confirm effectiveness of the intervention. Moreover, Barcelona showed a positive impact of prehabilitation on functional recovery (aerobic capacity, $p<0.001$; and, YPAS score (29), $p<0.001$) and decreased the use of healthcare resources during and after hospital discharge. Interestingly, pre-habilitation showed as a protective factor for 30-day hospital readmission as compared with usual care (18 versus 3%, respectively, $p=0.009$). In Israel, there was a statistically significant decrease in pain discomfort and an increase in feeling of health as measured by EuroQol-5D (26,27) (mean change: +7.05; $p=0.03$) and significantly reduced levels of anxiety as measured by HADS (mean change: -0.88; $p<0.001$). In Lleida, although the huge improvement in quality of life experienced after a hip or knee replacement surgery overwhelms any specific improvement directly attributable to the CONNECARE intervention, a significant reduction of unplanned visits (mean change: -0.79; $p=0.003$) were observed. In Groningen, there was a slight but significant increase in activities of daily living, and a decrease in depressive symptoms over time. Overall, compared to care-as-usual, the CONNECARE interventions seem to be cost-effective. In the case of Lleida, the implementation study demonstrated a negative incremental cost associated with 1 additional point gain in SF-12, ranging from -1590€ to -703€. In Israel, however, no conclusive results were obtained because the reimbursement method for elective surgery (DRG) masks the effects of significant variables such as length of stay. Interestingly, the estimated costs of care for the intervention group were higher during the intervention, but much lower during the post intervention period. In Barcelona, the aforementioned RCT (28) showed healthcare value generation that needs to be confirmed in the ongoing analysis of the Prehabilitation Unit at HCB. In Groningen, due to the lack of a suitable control group available for analyses, an analysis of cost-effectiveness could not be performed.



Site adoption of digitally enabled integrated care services - This section addresses the role of CONNECARE within the ongoing large-scale deployment strategies in the four sites.

In Israel, Assuta-Ashdod Hospital, which opened in 2017, had as vision and mission the actualization of integrated care for its region together with Maccabi Healthcare Services. The implementation studies conducted in the project were an inherent part of the process to realize their vision of digitally enabled integrated care in the area. While the results seem to indicate potential for health value generation, the studies also highlighted obstacles that still need to be overcome (as detailed in D6.2, D6.3 and D6.4) in order to move to large-scale deployment. In order to generate an action plan to address these obstacles, the SCIROCCO Maturity Model (23) was implemented among a group of senior medical and administrative managers from Assuta Ashdod Hospital and Maccabi's Southern Region in July 2019. Top-level management is committed to supporting the process to remedy problems identified and to put new processes in place to facilitate adoption of integrated care services.

In Groningen, and the whole of Northern Netherlands, providing patient-centred integrated care supported by technology is a cornerstone in keeping regional care systems accessible and ensuring health quality of care to its citizens. The implementation studies have enabled generation of broader knowledge and expertise in this respect. CONNECARE demonstrated that supporting self-management of patients by introducing a technology-enabled case management system is feasible for both patients and care professionals, with significant potential for broader implementation and scaling up. Still considerable barriers remain, hindering large-scale adoption of CONNECARE-like innovations.

In Catalonia (Lleida and Barcelona), key goals in terms of deployment of the integrated care model were established during the 2011-2015 Plan (30,31) and consolidation of the program is undertaken during the 2016-2020 period. CONNECARE implementation studies partly contributed to the selection of Catalonia as one of the EU Good Practices (32) in the process of preparation of JADECARE (*Joint Action on the implementation of digitally-enabled integrated person-centred care, to be initiated in April 2020*), which aims to foster a collaborative network at European level in terms of generation, deployment and evaluation of digitally-supported innovative health services. Moreover, the analysis of the implementation process for CS1 (home hospitalization) and for CS2 and CS3 (perioperative care) in Barcelona, following the CFIR approach (21,22), has provided highly valuable information on factors modulating the success of adoption that will be useful to generate recommendations for transferability. Likewise, the identification of KPIs (24) provides good grounds for long-term follow-up of these services after the initial deployment (*see detailed descriptions in D6.2*).

Assessment of digital tools

The self-management system (SMS), personal health system for patients and/or carers, and, the smart adaptive case management (SACM) tool for professionals to facilitate patients' management are the two key elements of the CONNECARE platform that were assessed as such, and separately during the project lifetime. Data on SMS usability and acceptability from patients/carers is summarized in tables 1 and 2. It is of note that both variables evolved from moderate to good scorings throughout the project, in parallel with enhanced maturity of the SMS during the PDSA cycles. Patients ownership or access to



a mobile phone or tablet with compatible operation system and Internet connection in order to use the SMS was identified as a limitation in approximately 30-40% of candidates. In all implementation sites, the SACM was used predominantly as a stand-alone system with very modest integration with providers health information systems (HIS from hospital and primary care) which generated resistances from health professionals. In addition, integration with existing health information exchange platforms across providers was lacking. Overall, the platform and its two main components reached a TRL (Technological Readiness Level) of 6 at the end of the project. It is of note, however, that while the SMS shows high potential for scalability for use in routine clinical practice, the current design of the SACM, besides a clear need for integration with providers' HIS, will require a higher TRL to increase its potential for scalability.

The adaptations of MyPathway® tested in two protocols carried out in Barcelona: i) home-based non-invasive ventilation (CS1); and, perioperative care (CS2), is the equivalent of the SMS, with proven robustness (TRL=8-9), but with clear limitations in terms of available functionalities, as compared to CONNECARE SMS.

Finally, Health-Circuit (**Table 1**, Protocol IIIC), a digital tool to support collaborative work among stakeholders, seems to show high potential for scalability provided that the current system is enriched with a process engine supporting adaptive case management and intelligent bots guiding the patient's care path. It is of note, however, that the ongoing pilot in Barcelona is in its early phase.

Transferability and recommendations for site adoption

The project has demonstrated trialability (ability to test the interventions on a small scale in a given organization) and adaptability (capacity of tailoring the interventions to meet local needs) of the services across the implementation sites which reflects high potential for transferability and generalization of the interventions evaluated within CS1 and CS2&CS3 (**Tables 1 and 2**).

CONNECARE tackled several intertwined dimensions (e.g. organizational, technological, academic and financial) with known impact on the processes of large-scale adoption of integrated care services in real-life settings. Consequently, lessons learnt during the lifespan of the project could contribute to fostering future deployment experiences. To this end, we briefly report the following recommendations for site adoption that should be aligned with widely-accepted guidelines for implementing a multimorbidity care model (33):

1. Flexible adoption of the PDSA methodology throughout the project lifetime fostered maturity of the CONNECARE concept and technological tools. The methodology was useful to identify factors that generate bottlenecks facilitating design and adoption of timely action plans.
2. Pragmatic application of the evaluation frame proposed in CONNECARE (10) is highly recommended to facilitate comparability among deployment experiences and to identify KPIs for long-term follow-up of the service beyond the initial deployment.



3. From the technological standpoint, further evolution of the SMS and its linkage with other GDPR-compliant digital tools supporting collaborative work among stakeholders across healthcare tiers and providers constitutes a highest priority to foster digital transformation of healthcare.
4. Interoperability with health information systems from different providers and/or health information exchange platforms across providers is a must.
5. Smart Adaptive (or dynamic) case management (ACM) requires a workflow engine that can be managed by knowledge workers (e.g. clinicians) without requiring the assistance of specially trained technical people, enabling easy and dynamic collaboration and transfer of information among professionals and organizations.
6. It is of note that adoption of the ACM concept in the routine clinical practice also requires a profound evolution of the mindset of health professionals. Consequently, implementation of the concept is expected to progress in parallel with cultural changes of professionals and with maturity of the digital tools.
7. Efforts must be devoted toward the development of easy to use and technologically mature mHealth applications to support patient empowerment for self-management.
8. The need for training in the use of new digital tools for both staff and patients and ongoing technical support cannot be underestimated. This is a critical success factor in the implementation of any digitally enabled healthcare service.
9. Individual habits and organizational routines are very difficult to change. The implementation of digitally enabled care is disruptive and requires transformational change at all levels of an organization. This requires careful and solid strategic planning, taking into account all of the obstacles that may be encountered as well developing incentives, and ongoing change management with a dedicated change management team.
10. Regarding financial aspects of the digital transition, bundle payment approaches based on service performance are advised. Operational costs of innovative, digitally-supported, integrated care services are expected to decrease. Transitional costs should be covered by savings generated through decrease of operational costs. In summary, digital transformation of healthcare must be based on cost-containment.

Discussion

Main achievements

CONNECARE was an ambitious, technologically-oriented, project aiming at designing, developing, testing and deploying digital tools to support integrated care services for chronic patients, addressing vertical (specialized versus community-based) and horizontal (across community-based resources) integration of health and social support with a preventive approach. The project consolidated relevant achievements in several dimensions, namely:

- Deep understanding of the practicalities of the CONNECARE organizational concept, as well as their implementation to foster adoption of digitally enabled integrated care services.



- Development, testing and deployment of digital tools with high potential for scalability, prioritizing articulation with simple and flexible digital tools enabling collaborative work.
- Successful application of a PDSA approach and pragmatic use of an innovative and comprehensive evaluation framework (10) with potentially high positive impact on future deployments
- Contributions to scalability of the target services (CS1 and CS2/C3) in the implementation sites- all of them actively involved in regional implementation of integrated care
- Generation of relevant recommendations fostering transferability of CONNECARE achievements

Strengths and limitations of the project development

The principal strength of CONNECARE was its comprehensive, but structured and realistic, approach to address the challenge of vertical and horizontal integration of health and social care for enhanced management of multimorbidity. The project consolidated actions on several dimensions: i) explored and solved practicalities of the organizational model; ii) designed and developed novel digital tools enabling integrated care; iii) brought technological research to innovation through well-designed and executed implementation studies; iv) explored and generated relevant achievements in the field of dynamic health risk assessment; v) generated and applied novelty in evaluation of integrated care, and, vi) formulated recommendations on deployment of services that constitute relevant contributions to transferability of the project achievements.

We acknowledge, however, the limited acceptability of the SACM, likely explained by convergence of at least the major factors, such as: i) evolving maturity of the technological solutions during the project lifetime; ii) lack of standardization of medical practice; and, iii) need of further evolution of the ACM concept in the mindset of health professionals. A non-actionable limiting factor causing non-eligibility of candidates for the implementation studies was accessibility to smartphones. Fortunately, current trends in terms of accessibility to equipment and digital literacy of patients are favoring digital transformation. The evolution of usability and acceptability scoring over time in the different implementation studies clearly indicates that the rate of technological maturity during the project lagged behind the potential of patient recruitment, which partly contributed to some dropouts, but it does not detract from the high potential for scalability observed for the SMS. Finally, it is of note that highly relevant ongoing analysis may provide additional value to CONNECARE achievements, hopefully on a short-term basis

Future perspectives

Finally, a very interesting, and relevant, challenge of CONNECARE was the rather weak level of integration into providers HIS achieved during the project. There is little doubt that this was one of the factors generating resistance to the SACM among health professionals. However, the problem does not seem merely anecdotal because it prompts a relevant unanswered question: is integration of complex digital platforms an efficient strategy for fostering digital transformation? Alternatively, should we aim for integration of simpler cloud-based digital tools supporting collaborative care? The question would to indicate: that it may be worthwhile to explore articulation of the SMS with simple digital tools enabling a cloud-based collaborative care approach.



Conclusions

CONNECARE successfully applied a flexible co-creation approach for the trialability and adaptability of digital tools to support integrated care services. The application of the proposed evaluation framework for digitally enabled integrated care services allowed assessment of the digital tools by patients and healthcare professionals, improvement on healthcare outcomes and potential cost-effectiveness across the implementation sites, which reflects high potential for transferability and generalization of the interventions. We believe that CONNECARE represents a major breakthrough in our current understanding, and resolution of some fundamental challenges faced in large-scale deployment and adoption of integrated care.


Tables
Table 1. Summary of Case Study 1 in all CONNECARE sites.

	Intervention	Aims	Protocol <i>(design, number of cases, digital tool)</i>	Outcomes
Israel	Community-based prevention of unplanned hospital-related events (CS1) in home dwelling chronic patients 60+ with an unanticipated admission to the hospital through the emergency room	<ul style="list-style-type: none"> - Assess the potential cost-effectiveness and cost-benefit - Assess the perceived usability and acceptability of the CONNECARE platform and its potential for scalability 	<ul style="list-style-type: none"> - Observational matched control group study with Intervention (CS1) and control (usual care) groups compared using propensity score matching - 40 patients in each group - CONNECARE SACM + SMS + FitBit 	<ul style="list-style-type: none"> - SMS NPS -20%; mean general impression (6/10), user friendliness (7/10) and ability to use without assistance (7/10) - Patients' mean usability score: 59/100 - SACM NPS -33%; mean general impression (6/10), user friendliness (5/10) and ability to use without assistance (5/10) - Staff's mean usability score: 20/100 - Very good perceived patient-centeredness and continuity of care - Improved physical activity; decrease in pain discomfort and increase in feeling of health and well-being - Cost-effectiveness of the intervention
Lleida	Community-based prevention of unplanned hospital-related events in home dwelling chronic patients 55+ with past history of visits to the emergency room leading to hospitalizations	<ul style="list-style-type: none"> - Assess the potential cost-effectiveness - Assess the perceived usability and acceptability of the CONNECARE platform and its potential for scalability 	<ul style="list-style-type: none"> - Pragmatic, prospective, implementation study with parallel intervention (CS1) and control (usual care) groups - 48 patients in CONNECARE group and 28 controls completed the follow-up - CONNECARE SACM + SMS + FitBit 	<ul style="list-style-type: none"> - SMS NPS 67%; mean general impression (10/10), user friendliness (9/10) and ability to use without assistance (9/10) - Patients' mean usability score: 79/100 - SACM NPS 25%; mean general impression (6/10), user friendliness (6.5/10) and ability to use without assistance (6.5/10) - Staff's mean usability score: 63/100 - Very good perceived continuity of care - Improved physical activity - Reduced total number of unplanned visits - Cost-effectiveness of the intervention
Barcelona	IA - Home hospitalization (HH) + transitional care, during one year (2017-18)	<ul style="list-style-type: none"> - Assess cost-effectiveness of hospital avoidance - Evaluation of deployment strategy (CFIR) - Identification of KPIs 	<ul style="list-style-type: none"> - Intervention (HH) and control (usual care) groups compared using propensity score matching - 620 patients in each group - eHealth tools from HCB 	<ul style="list-style-type: none"> - Reduced use of healthcare resources (re-admissions and ER consultations) - Better PROMS & PREMS - High improvement of cost-effectiveness



	IB – Health risk assessment in candidates to HH and early discharge	- Generate & validate predictive modelling for eligibility and risk for early readmissions & mortality	- Machine learning approach using clinical, biological and population-based scoring (GMA) in 1832 cases from the period 2010-15. - Ongoing re-evaluation with 967 patients from the period 2017-2018 and design of CDSS	- Readmission risk at HH admission, AUC 0.70 - Readmission risk at HH discharge, AUC 0.71 - Mortality risk at HH admission, AUC 0.86 - Mortality risk at HH discharge, AUC 0.90
	II - Home-based non-invasive ventilation	- Evaluate potential to enhance patients' self-efficacy	- RCT with all patients under NIV at HCB (n=169) with 90 days follow-up period. - n= 33 intervention and n=34 controls - MyPathway®	- No impact on self-efficacy - Patients' NPS -3%; mean general impression (7.5/10), user friendliness (8.2/10) and ability to use without assistance (8.5/10) - Patients' mean usability score: 78/100 - scalability: poor
	IIIA – Community-based care of frail chronic patients	- Enhance allocation of patients in the community after hospital discharge	- Mixed-methods approach: study of 400 patients after discharge using network analysis and cluster analysis + design thinking sessions	- Ongoing data analysis
	IIIB – Testing of the CONNECARE platform	- Asses usability & acceptability & scalability potential	- Observational study of 20 complex chronic patients recruited in the community and followed-up during one month	- SMS NPS -21%; mean general impression (6/10) - SMS mean usability score: 56/100 - Scalability: good if SMS decoupled from SACM
	IIIC – Testing of Health-Circuit	-Assess usability & acceptability& scalability potential for vertical& horizontal integration	- Cluster RCT with three units (2:1 ratio – n= 75) during 3-months follow-up - n= 16 patients (Health-Circuit) & n= 16 usual care - Health-Circuit	- Reduced use of healthcare resources (re-admissions & ER & primary care visits) - Better PROMS & PREMS - Patients' NPS 31%; mean general impression (7.5/10) - Patients' mean usability score: 64/100 - Ongoing study until March 2020
Groningen	Community-based prevention of unplanned hospital-related events in asthma and/or COPD community dwelling adult patients 18+ and referred by primary care services.	- Assess the potential cost-effectiveness - Assess the perceived usability and acceptability of the CONNECARE platform and its potential for scalability	- Pragmatic longitudinal trial - Intervention group (n=41), control group (n=46) - CONNECARE SACM + SMS + FitBit	- SMS mean general impression (8.5/10), user friendliness (7.8/10) and ability to use without assistance (8.6/10) - Patients' mean usability score: 82/100 - Reduced number of GP visits - Reduced total number of hospital days

Table 2. Summary of Case Study 2 and 3 in all CONNECARE sites.

	Intervention	Aims	Protocol <i>(design, number of cases, digital tool)</i>	Outcomes
Israel	Preventive patient-centred intervention (CS2) in home dwelling patients 55+ with chronic conditions scheduled for an elective major surgery	<ul style="list-style-type: none"> - Assess the potential cost-effectiveness and cost-benefit - Assess the perceived usability and acceptability of the CONNECARE platform and its potential for scalability 	<ul style="list-style-type: none"> - Observational matched control group study with intervention (CS2) and control (usual care) groups - 24 patients in each group - CONNECARE SACM + SMS + FitBit 	<ul style="list-style-type: none"> - SMS NPS -8%; mean general impression (6/10), user friendliness (7/10) and ability to use without assistance (7/10) - Patients' mean usability score: 63/100 - SACM NPS -76%; mean general impression (5/10), user friendliness (4.5/10) and ability to use without assistance (4/10) - Staff's mean usability score: 24/100 - Good perceived patient-centeredness and very good perceived continuity of care - Decrease in pain discomfort and increase in feeling of health; reduced levels of anxiety
Lleida	Preventive patient-centred intervention in home dwelling patients 55+ with chronic conditions undergoing a major elective hip or knee arthroplasty surgery	<ul style="list-style-type: none"> - Assess the potential cost-effectiveness and cost-benefit - Assess the perceived usability and acceptability of the CONNECARE platform and its potential for scalability 	<ul style="list-style-type: none"> - Pragmatic, prospective, implementation study with parallel intervention (CS2) and control (usual care) groups - Intervention group (n=29), control group (n=31) - CONNECARE SACM + SMS + FitBit 	<ul style="list-style-type: none"> - SMS NPS 45%; mean general impression (10/10), user friendliness (8/10) and ability to use without assistance (8/10) - Patients' mean usability score: 68/100 - SACM NPS -35%; mean general impression (6.5/10), user friendliness (6/10) and ability to use without assistance (6/10) - Staff's mean usability score: 24/100 - Good perceived continuity of care - Reduced total number of unplanned visits - Cost-effectiveness of the intervention
Barcelona	CS2 – Impact of prehabilitation on postoperative recovery	- Assess the midterm clinical impact and costs from a hospital perspective of prehabilitation	<ul style="list-style-type: none"> - Cost-consequence analysis using secondary data from a randomised, blinded clinical trial. - 125 patients were included in the intention-to-treat analysis 	<ul style="list-style-type: none"> - Health value generation - Protective intervention for 30-day hospital readmissions - Sustainability at midterm of the effects on aerobic capacity and physical activity
	CS2 – Determinants of program completion and postoperative complications	- To identify factors associated with program completion, and postoperative morbidity	<ul style="list-style-type: none"> - Cohort study - n=200 	<ul style="list-style-type: none"> - Undergoing oncologic surgery, suffering from endocrine and metabolic diseases and willingness to participate in mindfulness sessions were associated with program completion - Being older was related to lower probability of completion - Higher baseline fitness and higher risk of malnutrition were related to reduced postoperative morbidity.



	CS2 – Assessment of a customization of CONNECARE SMS	- Asses usability & acceptability & scalability potential	- Observational study of 16 candidates to pre-habilitation followed-up during one month	- Patients’ NPS 31%; mean general impression (8/10), user friendliness (8/10) and ability to use without assistance (7.5/10) - Patients’ mean usability score: 67/100 - Staff’s NPS -67%; mean general impression (5/10) - Staff’s mean usability score: 52/100
	CS 3 – Analysis of the results of the Prehabilitation Unit at HCB	- Assessment of prehabilitation health outcomes with a Quadruple Aim approach - Evaluation of the service implementation strategy - Assessment of the ecosystem maturity - Identification of key performance indicators	- Intervention (Prehabilitation) and control (usual care) groups compared using propensity score matching - 372 patients from the period June 2017 to December 2018	- Ongoing data analysis of the intervention group - In the process of building a contemporaneous control group (1:1 ratio)
	CS 3 – Risk assessment of post-operative complications in patients undergoing major abdominal surgery at HCB	- Generate & validate predictive modelling for post-operative complications	- Machine learning approach using clinical, biological and population-based scoring (GMA) in 372 cases from the period June 2017 to December 2018	- Ongoing data collection
Groningen	Preventive patient-centred intervention in elderly oncological patients during recovery in the postoperative period.	- Assess the potential cost-effectiveness - Assess the perceived usability and acceptability of the CONNECARE platform and its potential for scalability	- Observational study - n=37 - CONNECARE SACM + SMS + FitBit	- SMS NPS 17%; mean general impression (7.4/10), user friendliness (7.6/10) and ability to use without assistance (7.1/10) - Patients’ mean usability score: 71/100 - Increase in activities of daily living - Decrease in depressive symptoms - 40% of the patients showed a complete recovery of physical functioning 3 months after surgery\

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