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## eHealth in integrated care programs for people with multimorbidity in Europe: Insights from the ICARE4EU project<sup>☆</sup>



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### ABSTRACT

**Introduction:** Care for people with multimorbidity requires an integrated approach in order to adequately meet their complex needs. In this respect eHealth could be of help. This paper aims to describe the implementation, as well as benefits and barriers of eHealth applications in integrated care programs targeting people with multimorbidity in European countries, including insights on older people 65+.

**Methods:** Within the framework of the ICARE4EU project, in 2014, expert organizations in 24 European countries identified 101 integrated care programs based on selected inclusion criteria. Managers of these programs completed a related on-line questionnaire addressing various aspects including the use of eHealth. In this paper we analyze data from this questionnaire, in addition to qualitative information from six programs which were selected as 'high potential' for their innovative approach and studied in depth through site visits.

**Results:** Out of 101 programs, 85 adopted eHealth applications, of which 42 focused explicitly on older people. In most cases Electronic Health Records (EHRs), registration databases with patients' data and tools for communication between care providers were implemented. Percentages were slightly higher for programs addressing older people. eHealth improves care integration and management processes. Inadequate funding mechanisms, interoperability and technical support represent major barriers.

**Conclusion:** Findings seems to suggest that eHealth could support integrated care for (older) people with multimorbidity.

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### 1. Introduction

Chronic diseases are the main cause of morbidity and mortality in Europe, and by 2030 these are estimated to cause the death of 52 million people in the European Region [1]. Furthermore, an increasing number of people in Europe (about 50 million) are suffering from multiple chronic conditions or multimorbidity [2,3], of which 60% are people aged 65 years and older [4]. This leads to poor quality of life and high healthcare utilization, reflected in for example elevated numbers of primary care consultations and

hospital admissions [5]. The complex health and social care needs of multimorbid patients pose a great challenge to health systems and social services and requires new tailored integrated approaches that are patient-centered, proactive and well-coordinated. It also could benefit from innovative technologies to support patients' self-management and improved multidisciplinary collaboration between teams of professionals and/or informal caregivers [6–8]. However, European health systems are not yet designed to deliver the comprehensive care people with multimorbidity need, since care services are still fragmented and single-diseases oriented [9], and not fully supported by eHealth.

According to the definition given by the European Commission, eHealth is “the use of ICTs in health products, services and processes combined with organisational change in healthcare systems and new skills, in order to improve health of citizens, efficiency and productivity in healthcare delivery, and the economic and social value of health” [10]. This includes Information and Communication Technologies

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(ICTs) that could potentially improve self-management, information systems, remote monitoring and independent living solutions [11]. eHealth tools could play a key role for a better integration of healthcare and social needs. This is true not only in hospital and institutional settings, but also in community care.

European countries have implemented some general eHealth tools in their healthcare systems, but we do not know much about their level of implementation in programs or practices that provide integrated care for people with multimorbidity. eHealth development over the last decades included mainly the implementation of health informatics in hospitals, primary care and institutional settings, with use of patients' Electronic Health Records (EHRs) [12–14]; the use of telemedicine and telehealth services allowing remote monitoring of chronic conditions [15,16]; the availability of some intelligent/assistive technologies at home to increase independence and safety of the patients [17] and support for the family caregivers [18,19]. Concerning telecare for older people, estimated levels of implementation of social alarms and similar solutions varied across countries, with relatively high values in the United Kingdom and Ireland (14–16% of older people covered), medium-high in Denmark, Finland and Sweden (6–10%), and low coverage in a great part of the remaining countries (less than 3%). Moreover, the main providers of home telehealth services were mainly local initiatives [20]. A more recent WHO global survey on eHealth [21] showed that 62% of Member States have national policies addressing telehealth.

There is some evidence showing benefits of using eHealth [12,15,17,19]. For instance, eHealth applications enable improving coordination/integration and continuity of care between professionals by enhanced opportunities for digital data sharing, communication and consultation at a distance, which also reduces healthcare utilization costs [22]. Moreover, patients can overcome barriers for accessing healthcare services and also benefit from better monitoring and continuity of care, improved self-care/management and independent living at home (especially for the older people). Yet various regulatory, technical and economic barriers exist that may limit the adoption of eHealth technologies [17,20,23], in addition to lacking/limited digital skills or cultural resistance of potential users, especially older patients [24,25].

On the whole, studies use a variety of terms interchangeably (e.g. telecare/telemonitoring, telehealth/telemedicine) and generally investigate the use of eHealth for chronic care, and only indirectly target people with multimorbidity. Moreover, these studies mainly focus on the general population rather than specific groups like the elderly. To our knowledge, literature with a specific focus on eHealth implementation in integrated care programs or practices for people with multimorbidity is virtually lacking. Therefore, our research questions are:

- 1 To what extent have eHealth applications been implemented in integrated care programs targeting people with multimorbidity in European countries?
- 2 What are the (reported) outcomes/benefits of the use of eHealth applications in integrated care programs targeting people with multimorbidity?
- 3 What are the (reported) barriers for (further) implementation?

These research questions are further explored with regard to possible differences between adults and the elderly (over 65 years old).

## 2. Methods

The care programs that are analyzed in this paper originate from the Project “Innovating Care for People with Multiple Chronic Con-

ditions in Europe” (ICARE4EU). This project was initiated in 2013 to contribute to the innovation of care for European citizens with multiple chronic conditions by gaining more insight into potentially effective and efficient patient-centered, multi-disciplinary care approaches that have been developed and implemented in 31 European countries [3].

### 2.1. Inclusion criteria of the programs

Programs were considered for inclusion in the survey when meeting all the following criteria, which were identified via a literature review and agreed by the partners of the ICARE4EU Consortium [26]:

- target adult people (aged 18 and older) with multimorbidity, defined as two or more medically (i.e. somatic, psychiatric) diagnosed chronic (not fully curable) or long lasting (at least six months) diseases, of which at least one has a (primarily) somatic/physical nature;
- include formalized collaboration(s) between at least two services;
- involve one or more medical service(s);
- are evaluable/evaluated in some way;
- currently running (2014), or finished less than 24 months ago, or start within the next 12 months.

### 2.2. Data collection

In a first step, information on programs was collected with the support of expert organizations/program managers in each country included in the study. A list of potential country experts – working in organizations in the field – was constructed for each of the 31 countries of the European region included in the study, and validated with input from all partners of the ICARE4EU Consortium (own extensive network and relevant expertise), according with the following selection criteria: the organization is a formal body; has expertise on multi-morbidity care; can provide/access to (by an extensive network of experts) reliable information on innovative, multi-disciplinary care approaches/programs for people with multiple chronic conditions in its country; the contact person from the expert organization is fluent in English and has the role of coordinating the various actors who will provide information for each program/initiative.

Country experts were approached via email and asked to verify whether their organization meets the above mentioned selection criteria and would be able to participate in the survey, also by providing some evidence of their expertise (e.g. publications, CV, organization and personal web pages). They were asked to search and identify existing care programs/approaches at a national or regional level (or local, if information is available), and to report detailed information on all integrated care programs focusing on multimorbidity in their country, by means of a link to a web-survey and filling in an online questionnaire for each eligible program/initiative, also with the support of their expert network and program managers/leaders. The online questionnaire was available in eleven languages (when English was not known by managers of programs supporting the country experts in filling in the questionnaire) and contained a short introduction with instructions and general questions (e.g. information on patients, quality and evaluation of the program). Key elements of multimorbidity care were addressed from the following perspectives: patient-centeredness e.g. involvement of patient/family in the development of the care plan; management practices and professional competencies, e.g. collaboration, integration, exchange of information among professionals; financing mechanisms/systems use, e.g. public/private funding, reimbursement mechanism; and

use of eHealth technologies eventually adopted within the programs themselves, to enhance the prevention, diagnosis, treatment and management of health/diseases.

According to the above mentioned inclusion criteria, the country experts identified initially 189 integrated care programs for patients with multimorbidity in 25 European countries (out of 31 countries surveyed). After a further critical review performed by the ICARE4EU partners, in order to verify their actual eligibility, 77 programs were excluded for different reasons, including a lack of multimorbidity focus, unavailability of evaluation results, or a lack of proper care practices (e.g., initiatives were only protocols or guidelines). Furthermore, data on 11 French programs were not complete due to staff problems of the related expert organization, and these programs were discarded for the purposes of this analysis. Thus the final dataset consists of 101 programs from 24 European countries.

In a second step, eight good practices were selected for an in-depth case study analysis, including site visit and further qualitative data collection (i.e. purposefully selecting information-rich cases) [27]. To this end, the project team assessed the 101 programs on the basis of quantitative and qualitative criteria. Each program was scored in five dimensions: (1) a general score (e.g. evaluation design, perceived sustainability and transferability), and an indication of its level of (2) patient-centeredness, (3) integration of care, (4) use of eHealth technologies and (5) its innovativeness in financing mechanisms. This led to identify the 'top' eight 'high potential' programs (in the ranking) to be object of case study analysis. These programs were operational in Belgium, Bulgaria, Cyprus, Denmark, Germany, Finland, the Netherlands and Spain. We used a qualitative case study methodology, that allows understanding complex phenomena within their contexts, by exploring individuals (e.g. program managers, key care professionals from various disciplines or services), organizations, relationships or programs using multiple data sources [28,29]. Site visits were organized to integrate the quantitative survey data and to gain insights in integrated care practices, by scrutinizing contexts and related ordinary activities [30]. Information were gathered by using a common methodological framework (e.g. with details on participants and organisation of interviews) for conducting semi-structured in depth interviews with program staff and eventually patients and their family carers (approximately five interviews per program). A topic guide-questionnaire was used in all site visits, in which we asked their experiences with the program and further data and reflections over its implementation. We also collected relevant program documents if available (e.g. interim or final reports, program evaluations). All interviews were conducted each by two members of the ICARE4EU project team and were recorded. A translator was arranged when necessary. Interviewees received the draft text of the case report for validation, and approved the final report. All interviewees signed a written/informed consent form and an agreement to record the interviews and publish the related case reports. The results of these visits are described in eight case reports that were published on the ICARE4EU website ([www.icare4eu.org](http://www.icare4eu.org)), and are edited following a common template with sections for each key dimension of multimorbidity care used in the project (patient-centeredness, integration of care, use of eHealth technologies, and financing mechanisms). For this paper we only analysed information from those high potential programs that include aspects of eHealth (i.e. six out of eight programs).

### 2.3. Measures

With regard to the type of eHealth, literature provides many examples which seem relevant to support integration of care in programs or practices targeting people with multimorbidity [20,31–33]. In this respect we distinguished four categories by their

main functions, and in order to structure findings by accounting for the diversity of eHealth options, we built a classification by adapting elements of the conceptual framework from the Chronic Care Model (CCM) [34] and the eHealth Enhanced Chronic Care Model (eCCM) [35]. The four types of eHealth are ICT tools for: Remote Consultation, Monitoring and Care; Self-Management; Healthcare Management; and Health Data Analytics [36].

- 1 *Remote Consultation, Monitoring and Care*: ICT tools providing remote interaction between patients and health professionals at distance (e.g. consultations and visits by telehealth and telemedicine services, continuous monitoring of specific conditions). Specific tools for the communication are on-line scheduling of clinical appointments, ePrescriptions and direct communication with healthcare staff.
- 2 *Self-Management*: ICT tools (e.g. computers, tablets, mHealth, wearable devices, other assistive technologies) providing health advice and reminders, and promoting ability to self-care, used by patients to live more independently. Also tools used by informal carers to co-manage care activities or for supporting their own psychological and social needs.
- 3 *Healthcare Management*: ICT tools for improving the integration, quality and efficiency of care processes within and between care providers (e.g. EHRs and health information systems on individuals for their sharing between professionals; personal health records – PHRs – managed by patients). Moreover, ICT tools can be used to manage the collaboration and communication between care professionals (e.g. eReferral systems).
- 4 *Health Data Analytics*: ICT tools which analyse data in patient databases and/or clinical evidence for prevention, monitoring and treatment purposes, for instance: decision support systems (DSSs) used by health professionals for clinical decision-making; risk stratification systems for monitoring the health data of a regional or national population, and identifying people with specific health risks.

Further aspects that were analyzed in the study are the training on use of eHealth for care providers and patients; data security/privacy when using health information technologies; innovation in eHealth tools specifically developed for the program.

To explore potential benefits [e.g. 19] and barriers [e.g. 20] hampering the adoption of eHealth within the mapped integrated care programs, we asked for agreement/disagreement of managers with regard to:

- five potential improvements concerning the quality, integration and management of care, the quality of life of patients enrolled, and cost-efficiency of the program;
- twelve potential barriers concerning inadequate national eHealth legislative framework, funding, ICT infrastructures, technical-ICT support; lack of skills in using eHealth among care providers and patients; general cultural resistance and resistance by care providers and patients; uncertainty about cost efficiency; compatibility/interoperability between different eHealth tools; privacy issues.

### 2.4. Data analysis

For this paper we have first analyzed the questionnaire data on the 101 integrated care programs targeting people with multimorbidity with regard to some general characteristics, and then more in depth on their use of eHealth solutions (e.g. frequencies and bivariate relations). We then analysed the identified eHealth solutions on their (reported) outcomes and the (reported) barriers for (further) implementation. The bivariate relation between eHealth aspects and age of patients involved in the programs was also ana-

lyzed. Insights on programs for people aged 65 years and more, compared to the programs targeting adult people (aged 18+ years) in general (i.e. programs not specifically targeting older people, but without excluding them), were reported when relevant. The statistical software SPSS 15.1 was used to carry out the quantitative analyses.

Moreover, qualitative information from six site visits of high potential programs provided additional insights with regard to benefits and barriers and how programs have used eHealth tools in their care delivery to people with multimorbidity. The qualitative data analysis was performed by exploring the case study reports from the eHealth perspective, using as keywords the terms presented in the paragraph 2.3 and Table 2 of this paper. A manual coding process was performed [37] and led to conventional content analysis [38] with the purpose of identifying interrelations and causal relations between key program elements concerning primarily implementation and outcomes.

### 3. Results

#### 3.1. Integrated care practices in European countries

Among the 101 integrated care programs mapped by the ICARE4EU study, 50 specifically targeted older people. Countries with the highest number of programs identified are Spain ( $n = 15$ ), Greece ( $n = 9$ ), and Germany ( $n = 8$ ), whereas from Austria, Portugal, Slovenia, Switzerland and the United Kingdom (UK) only one program met the inclusion criteria. Furthermore, 82% of programs were still running at the time of the questionnaire. The profile of the organizations included in the analysis and their characteristics are the following (Table 1):

- the main objective is increasing the level of multidisciplinary collaboration (80% of the programs), in addition to improving patient involvement and care coordination (both 71%). Reducing hospital admissions (69%) was also mentioned as key objective;
- regarding the types of organizations and care providers involved, primary care practices (70%) and general practitioners (81%) were respectively most often mentioned;
- regarding levels of integration with healthcare systems, implementation and geographical coverage, 42% of programs were fully integrated, 77% overall were operating mainly at a local/regional level, and 78% covered both rural and urban areas.

#### 3.2. Integrated care practices using eHealth applications

Out of 101 programs identified in 24 countries by the ICARE4EU project, 85 included eHealth tools, of which 42 focused explicitly on older people. The scale of the initiatives remained mostly local and/or regional (78%), although 62% of the programs operate at both policy/management and patient care levels, 45% were integrated into the regular healthcare system, and 82% covered rural/urban areas.

A wide variety among the tools in these 85 programs was found and subsequently classified in four categories (Table 2). The three most used eHealth applications were EHRs (71%), registration databases with patients' health data that can support decision-making (64%) and digital communication between care providers (47%), which come under Healthcare Management, with a slightly higher uptake of these tools among programs focusing on the elderly (respectively, 76%, 67%, and 52%). Other eHealth applications that could be especially beneficial to meet the very complex health needs of multimorbid patients, such as those supporting self-management of patients (e.g. electronic reminders, computerized tools), computerized decision support systems for

**Table 1**  
General characteristics of the programs (%).<sup>a</sup>

	All programs N = 101
Main objectives	
Increasing multidisciplinary collaboration	80
Improving care coordination	71
Improving patient involvement	71
Reducing hospital admissions	69
Organizations involved	
Primary care	70
General hospital	57
University hospital	41
Care providers involved	
General Practitioner	81
Medical specialists	66
Integration level	
Fully integrated in the regular healthcare system	42
Well-established and comprehensive program	33
Small scale (pilot) program	26
Implementation level	
Regional	30
Local	29
Local/regional, as part of a national program	18
National	14
National, as part of international programs	7
International	3
Geographical coverage	
Both rural and urban areas	78
Only urban	16
Only rural	6

<sup>a</sup> The programs were identified in the following 24 European countries: Spain, Greece, Iceland, Germany, Italy, Finland, The Netherlands, Denmark, Sweden, Luxembourg, Bulgaria, Cyprus, Belgium, Croatia, Malta, Lithuania, Norway, Ireland, England, Austria, Portugal, Slovenia, Latvia, and Switzerland. No eligible program was identified in Romania, Czech Republic, Hungary, Poland, Slovakia, and Estonia. Information on French programs was incomplete and thus excluded from the analysis.

professionals, and monitoring/interaction at distance, are less used by the programs and not yet widely implemented. In particular, self-management online decision supports (4%) were the least frequently implemented tools. Although 47% of programs use digital healthcare communications for sharing information between different care providers (see above) only 29% of programs (31% of programs focusing on the elderly) use such systems to also communicate with patients. Furthermore, the most frequently adopted form of electronic/remote health consultation by providers was monitoring of patient health status parameters (33% of programs, 45% of programs focusing on the elderly).

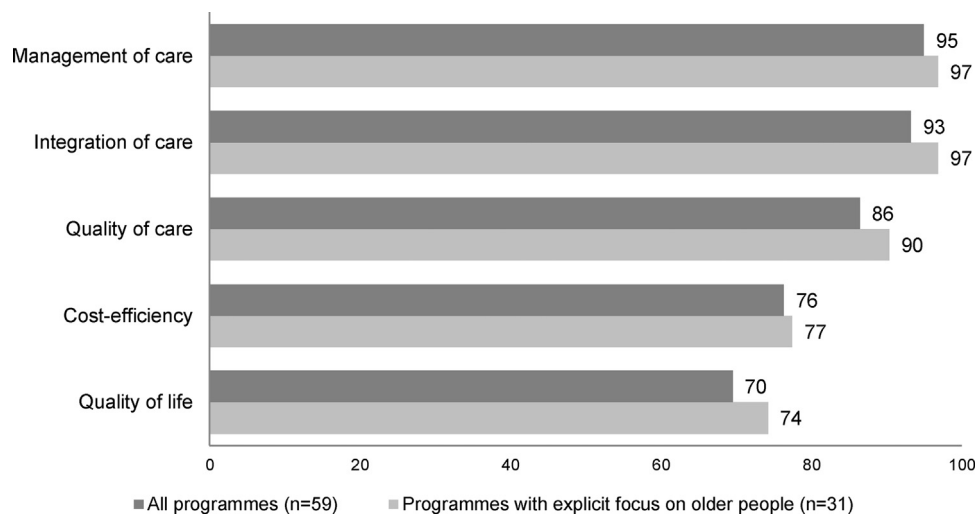
Further information gathered by the survey showed that access to EHRs was mainly allowed to medical care providers involved in care delivery (58%) rather than patients (10%), and over half of the programs provided training on the use of eHealth tools to the care providers (52%), but only 24% provided it to the patients (or their representatives, e.g. carers). These percentages are slightly higher for programs addressing older people (55% and 26%). About 70% of the surveyed programs assured privacy/confidentiality of medical information, 59% addressed data security/risk management, and 57% disclosed all necessary information needed by a patient for making an informed decision. These aspects were even found less in programs targeting the elderly, with 36% of them not addressing any of these issues. Concerning innovation, in 30 programs (of which 18 focusing on the elderly) out of 85 programs adopting eHealth solutions, tools were specifically developed for the program.

**Table 2**  
eHealth tools implemented in the programs, by categories (% of programs).<sup>a</sup>

	All programs N = 85	of which focused explicitly on older people N = 42
<b>Remote Consultation, Monitoring and Care</b>		
Monitoring of health status parameters by providers	33	45
Communication between care provider/patient (incl. ePrescription)	29	31
Monitoring/interaction at distance (e.g. by video, phone)	27	36
On-line appointment scheduling	26	21
Registration of health status parameters by patients	25	29
<b>Self-management</b>		
Electronic reminders	26	24
Computerized self-management tools	25	29
On-line decision supports	4	5
<b>Healthcare management</b>		
Databases with patients' health data	64	67
ICT-based communication between care providers	47	52
Systems providing warning messages/recommendations/information	35	36
eReferral systems	33	31
Electronic reminders	27	31
PHRs <sup>b</sup> used	18	21
PHRs <sup>b</sup> planned	7	5
EHRs <sup>b</sup> used	71	76
EHRs <sup>b</sup> planned	13	10
<b>Who can access EHRs</b>		
Relevant medical care providers	58	58
All relevant care providers	47	50
Patients	10	11
<b>Health Data Analytics</b>		
Computerized decision supports	35	29
On-line decision supports	15	17

<sup>a</sup> This table is partly adapted from a publication of the authors: [36] Barbabella et al.

<sup>b</sup> EHRs were used in 60 programs (32 focusing older people) and were planned in 11 programs (4 focusing older people); PHRs were used in 15 programs (9 focusing older people) and were planned in 6 programs (2 focusing older people).



**Fig. 1.** Benefits of using eHealth tools included in the programs (% agreeing).

### 3.3. Potential benefits

ICARE4EU findings seem to suggest some potential benefits of eHealth, as reported by program managers. Among the programs using eHealth, 95% reported that management processes improved, 93% agreed that care integration was enhanced, and 86% confirmed that quality of care provided had increased (Fig. 1). Benefits were also reported in terms of cost-efficiency of the program (76%) and in the quality of life of patients enrolled (70%). These benefits were also reported (with slightly higher percentages) for programs targeting the elderly.

General benefits emerging in the project survey were also supported by site visits of the six high potential programs. Improve-

ments of management processes, as enhanced care coordination and integration, seem visible in the *Gesundes Kinzigtal* program in Germany [39], where the physicians share EHRs and can use digital benchmark information to compare their prescriptions. Another example is the sharing of EHRs, not only among physicians but also among patients in the program, as occurs in the *Clinic for Multimorbidity and Polypharmacy* in Denmark [40], where a *Regional Electronic Patient Journal* is used to access information on a patient's medical history. The *INCA* program in the Netherlands also plans to implement care profiles for patients that are accessible by professionals and patient in a dedicated on-line application [41].

The potential benefits of advanced decision support systems (DSSs) and data management are visible in the Strategy for Chronic Care in the Valencia Region in Spain [42]. This program operates a computerized DSS for professionals by connecting available clinical evidence on adequate treatments and best practices with the complex profile of multimorbid patients. Another example is the Finnish POTKU project [43], which employs a computerized decision support e-tool for GPs. This system connects evidence based medical information with the patient records and provides individually customized care guidance, reminders and warnings. In the Spanish Strategy for Chronic Care [42] the quality of care provided to the most complex patients reportedly improved because a population stratification system enables identification of at-risk patients followed by a targeted preventive and proactive intervention.

eHealth tools could also improve the quality of life of patients with multimorbidity living at home. For example, the POTKU project in Finland stimulates self-management using instruments that empower patients to check coping behaviors and adherence to treatment, which are a particular challenge for multimorbid persons [43].

Finally, remote monitoring and therapies at a distance can improve access to healthcare services and the quality of life multimorbid patients especially in rural/deprived areas. For example, the TeleRehabilitation program managed by the Nicosia General Hospital in Cyprus provides a cardio-respiratory rehabilitation service at a distance [44]. This service applies advanced telemedicine services to patients after discharge from hospital. It has managed to reduce readmissions and thus proved to be cost-effective, while at the same time maintaining good satisfaction among users and health professionals.

#### 3.4. Potential barriers

As shown in Fig. 2, various barriers hampered the use of eHealth tools in integrated care programs. As reported by the program managers, these include: inadequate funding (60%); compatibility/interoperability problems between different tools and inadequate technical/ICT support (55% both); lacking IT infrastructure (53%); the lack of skills in using eHealth among patients and providers (respectively, 52 and 45%); and the lack of a dedicated legislative framework (50%). Other barriers that were mentioned ranged from 22 to 40% were uncertainty on cost efficiency of the program, privacy issues, and cultural resistance to adopt eHealth tools by providers (33%) and patients (22%). There are no large differences between programs targeting adults or elderly. However, greater than 10 percentage point differences were found in “lack of technological skills among care providers” (occurred more often among programs focusing on the elderly) and inadequate funding (mainly reported in programs for the general population).

Further insights concerning barriers for the adoption of eHealth were also gathered from the six above-mentioned promising practices. Questions/issues related to funding are reported in two programs. First, the Strategy for Chronic Care in the Valencia Region in Spain [42] uses ICTs solutions as a fundamental pillar but it has to be financed from usual care funding of the regional health system. Second, the TeleRehabilitation program in Cyprus [44] does not have any financial incentives for staff or for patients to participate in the program.

Compatibility/interoperability problems emerge in several programs. First, the POTKU project in Finland [43] is challenged by incompatible information systems between health and social care. Second, the Danish program Clinic for Multimorbidity and Polypharmacy [40] suffers from different IT-recording systems in hospitals, which makes it more difficult to utilize/exchange patient records among clinicians.

Several examples of barriers are seen in the *Gesundes Kinzigtal* program in Germany [39]. It has a limited IT infrastructure in the remote areas of Kinzigtal and the majority of the target population (relatively high average age) is reluctant to adopt eHealth, also due to lack of trust regarding data safety. Lastly, the limited electronic skills of some patients also prevent a high level of self-management in the INCA program in Netherlands [41].

#### 4. Discussion

The ICARE4EU study reports the pioneers or good practices in integrated care programs which are currently implemented in Europe. The overall findings presented in this paper, in the light of the adapted conceptual framework we derived from the CCM [34] and the eCCM [35], seem in particular to suggest that eHealth has some potential to support integrated care for multimorbidity. However, the fact that the survey was based on the personal expertise and perception of country-experts and program managers, without exploring further actors (such as patients and their caregivers) due to project constraints, poses problems regarding reliability and objectivity of their answers, and this context should thus lead to some caution in the interpretation of results, in particular those concerning the positive potential of eHealth.

The results from the ICARE4EU study show on the whole huge variation in the adoption of eHealth applications in integrated care programs for multimorbidity in Europe. Most widespread are EHRs, followed by registration databases with patients' health data that can support decision-making and digital healthcare communication (used mostly to communicate among providers). Moreover initiatives focusing on the elderly showed a somewhat elevated uptake of these tools compared to all programs combined. Other eHealth applications with particular relevance for providing person centered integrated care to people with multimorbidity, such as advanced electronic decision support systems for physicians, self-management support of patients, and electronic systems for telemonitoring care processes are not yet widely implemented and reveal great potential for improvement. The latter two in particular hinder the possibility of *ageing-in-place* for older patients with long-term conditions [45], that is in their home or in other living settings/facilities, within the continuum of care [46].

This high use of EHRs, and the limited adoption of more advanced eHealth solutions are also confirmed by available literature, although more in general than as specific applications for people with multimorbidity. In other words, there is a lack of studies in the literature providing evidence (in terms of both clinical and economic indicators) to support the introduction of ICTs in integrated care programs, and available data show a quite limited progress of eHealth implementation specific to multimorbidity care in Europe [21,32]. European countries have indeed adopted general and limited eHealth services, and from such a context come in turn negative consequences (as lacking dedicated eHealth support) for people with multimorbidity. In particular, policy interventions in Europe have focused mainly on EHRs and information systems in acute and secondary care settings [13], whereas the implementation and use of eHealth by GPs and primary care is far less advanced [14]. Furthermore, literature on tools for Healthcare Management and information systems for risk stratification, that is analysis of big data sets at the population level and related Health Data Analytics, are not yet developed and mapped for multimorbidity in Europe, although some promising results for other target groups are referred [21,36]. It is to highlight also that a few studies have addressed people with multiple chronic conditions because clinical research and healthcare organization are still influenced by a disease-oriented approach [9].

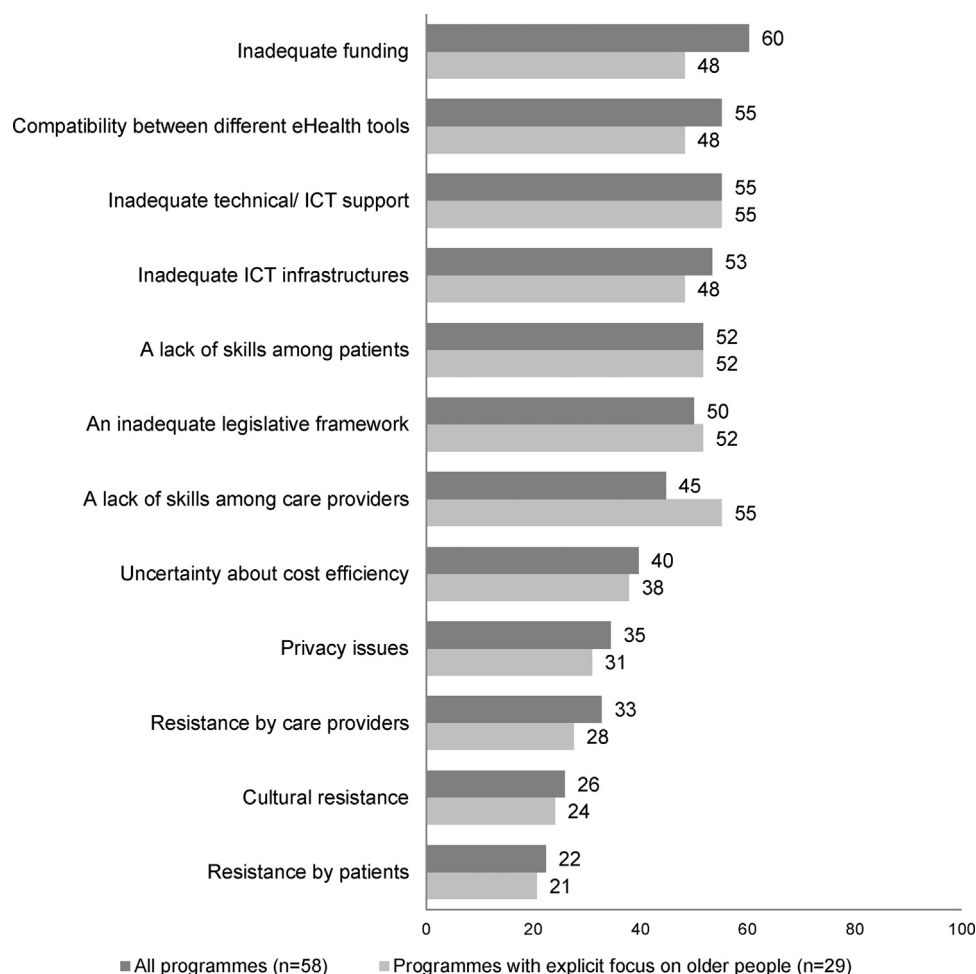


Fig. 2. Barriers hampering the use of eHealth tools included in the programs (% agreeing).

Our study also provides insights in the role of patients (or their family caregivers). They are less involved (than providers) in the use of eHealth tools, have less access to EHRs and only have few opportunities for specific training and education services. With regard to sharing of electronic health information with patients, we only found few examples that enable this [40,41]. Moreover, ensuring privacy and security of personal medical information, as well as providing all necessary information related to the use of health technology by professionals to patients, are important aspects that are not yet fully implemented by all the mapped programs. These constitute important barriers for a wider deployment of eHealth. In particular, lacking privacy of patients and security/protection of medical data can negatively impact social acceptance of telecare [25]. More encouragingly findings from a recent WHO survey [21] showed that 80% of Member States have national legislation to protect the privacy of health data in electronic format, which clearly indicates a strong national level commitment to eHealth.

Furthermore, different infrastructural, policy and practical barriers hinder the further development and implementation of eHealth tools in multimorbidity care. We mainly found: (1) inadequate funding/incentives mechanisms, (2) compatibility/interoperability issues between different tools/systems, (3) inadequate technical/ICT support and infrastructure, (4) lacking skills in using eHealth among patients (which is also linked to lacking training opportunities for patients mentioned above), and providers and (5) lacking dedicated legislative frameworks. Obviously, many of these are interrelated and they are not exclusive to programs targeting people with multimorbidity.

Limited funding can negatively impact investment in adequate ICT support and in training services for both users and providers [23,26]. In addition, inadequate funding could hamper innovation. Our results showed that only in 30 out of 85 programs, eHealth tools were specifically developed for that program. In most cases, existing applications or tools were used with only few adaptations. Inadequate ICT infrastructures, which also limit interoperability between different tools, hinder the integration within existing healthcare systems [25,47] and the integration between different providers [48].

Other important issues highlighted in previous studies are the lack of electronic skills among patients and providers, which perhaps also nurtures (cultural) resistance in using eHealth tools [49,50]. This seems unfortunate as a positive attitude and perception among physicians could play an important role in making home telehealth services more acceptable for the elderly population [51].

Literature also found that different legal frameworks and EHR systems among countries [52] as well as widely diverging views among European policymakers, make it hard to find common ground and thus limit the use of eHealth [53]. In particular, clear legislative frameworks (e.g. eHealth policy and strategy) and explicit attribution of responsibilities at European and national level seem lacking [54].

Despite these barriers, some benefits of eHealth have emerged, although only from the view of country-experts and program managers, and in some cases with slightly higher relevance for programs targeting the elderly. These benefits seem first of all related to



the support of care integration and coordination among professionals by means of shared EHRs and digital communication, but also to decision making of professionals by means of DSSs for selecting appropriate treatments and best practice. eHealth further seems to enable the following: remote consultations thus allowing access to healthcare services in particular for people with complex needs; self-management for people with multimorbidity living at home; risk analysis and proactive intervention. Moreover, risk stratification system can constitute a good tool for supporting the monitoring of people at health risk or with complex profiles, leading to better policy and practices for prevention, early detection and treatment of multiple health problems [36]. Literature in particular suggests that eHealth adoption in the healthcare sector can be effective in reducing care fragmentation and improving continuity of care, which is especially important for elderly and multimorbid patients, due to the involvement of multiple professionals dealing with multiple diseases [55,56]. Lastly, remote services in particular seems to empower patients by giving them tools to self-manage and live more autonomous in their home and enable them to keep living in deprived and rural communities, thus increasing their quality of life and possibility to access adequate care [15,25,57]. In particular telehealth seems to be a “safe option” for delivery of self-management support [58].

Apart from the above mentioned potential benefits, it seems that eHealth primarily supports the integration of care rather than, for instance, the cost-effectiveness of the delivered care. This represents a satisfactory outcome, since one of the major goals and functions of eHealth is indeed to enable better care integration between different providers, actors, institutions or services. Furthermore, the eHealth tools mapped represent usually a component within complex integrated care programs, where the different components need to be evaluated together in a comprehensive way – rather than on their own – because of existing synergy effects, also in consideration of the impact on patients’ quality of life and cost-effectiveness.

Our findings seem thus in line with previous evidence and the Chronic Care Model, showing that the key challenge for multimorbidity care is to organize and provide an integrated system of chronic care [59], also by profiling the different needs of patients for population-based interventions [60], and by enhancing an effective “collaborative care management” by both patients and professionals/health care providers, thus supporting self-care [61]. Literature shows in particular that when the well-established CCM is expanded as eCCM with the addition of eHealth technologies [35], it can further improve health outcomes for people with chronic conditions, support patient-provider interactions [62,63], and enhance self-management [64,65]. Moreover, given that in specific eHealth education is a crucial issue for self-care, an important expansion of the CCM regards the addition of “eHealth Education”, in order to provide consumers/patients with the necessary digital health literacy skills [66]. According with our findings indeed, the lack of digital skills among patients (and providers) was an important barrier to implementing eHealth.

The overall findings presented in this paper seem thus to have identified on the whole some of the key factors (e.g. barriers and benefits) for the implementation of ICT support in integrated care and also the related required changing/challenges in the management. The positive reports of the country expert organizations and managers interviewed in the ICARE4EU study are indeed consistent with basic aspects of change management which are reported in the literature [67]. The adoption of eHealth for multimorbidity implies indeed to create a “vision” for directing the “change” effort, to develop strategies for addressing the “vision” itself, to support the “change” process with new approaches by encouraging both the risk taking (against the status quo keeping) and the team work. However, the reports from country-experts and pro-

gram managers involved in our study might have underestimated critical problems and issues occurring during the implementation of eHealth services in the healthcare sector. The roles of participants/respondents in our survey could indeed have influenced their almost positive views on these issues. As literature suggests [68,69], complex eHealth programs could raise problems in their implementation, thus requiring to be adapted and refined in due course, in order to meet appropriately the needs of the users and required quality of services.

There are some health policy implications that could be considered to exploit the potential of eHealth for complex needs of people with multimorbidity [36]. In this respect, the following general indications could be highlighted for supporting the adoption and implementation of eHealth solutions for multimorbidity care in Europe: defining common public health objectives and priorities for people with multimorbidity; developing adequate legal and funding frameworks for large scale implementation; carrying out comprehensive educational campaigns that address training of patients, family carers and health professionals on digital health literacy; supporting a better interoperability of EHRs in European health care systems, introducing personalized medicine services; promoting new regulations regarding mobile health solutions for self-management; adopting regional/national population stratification systems, to enable continuous monitoring and proactive interventions; promoting DSSs to improve the health professionals decision making process. These last two measures could for instance help GPs and specialists in switching the focus of multimorbidity care from a disease-oriented to a proactive approach for health promotion and prevention. Relevant, for a successful delivery of integrated care in general, and for ICT deployment in particular, seems to be also an integrated governance structure with the involvement/cooperation of all stakeholders and industry, in order to develop solutions meeting both users and service needs [70].

To date the added value and benefits of eHealth solutions remain partly under-investigated. It is essential that in the coming years eHealth investments are considered as a factor of production and integrated into the strategic resource mix/decisions [71]. Future/further empirical research is thus needed, in particular large-scale research studies and trials evaluating the impact of eHealth tools for instance on patients and caregivers, on (cost) effectiveness, and health outcomes, thus overcoming the current fragmentation of funding over many small-scale studies, which often produce inconclusive or partial results. In particular, studies aimed at verifying effectiveness, efficiency and impact of eHealth solutions for people with multimorbidity are crucial to have cost-effective eHealth solutions for the sustainability and quality improvement of long-term care (LTC) systems [72]. Investing in research on eHealth approaches could further reinforce the integration between health and social care. People with multimorbidity have indeed complex needs which should be met by comprehensive services [73]. Investing in such research could finally implement the sharing of knowledge and good eHealth practices among different countries and care providers. Moreover, although considerable evidence indicates that the CCM is a valid integrated framework for improving care and quality of life of people with chronic and multimorbid conditions [74], and that eHealth tools can strengthen and enhance the successful CCM [35], further research seems important to test and verify the eCCM as enhanced version.

## 5. Limitations

The ICARE4EU study presents some limitations, as partly anticipated in the *Discussion* section of this paper. First, our overview of relevant programs in European countries reports the perceived

impact of eHealth technologies that was based only on the views of service managers, without including the impact of eHealth on quality of life and quality of care as perceived by patients and their caregivers, or the impact on integration of care as perceived by care providers. Second, we were dependent on the personal expertise of country-experts and program managers participating in the surveys. In some cases they may not have had complete knowledge of all care approaches operating in their countries, or have been biased in their reporting, given that managers might be inclined to positively state the achievements of their programs. Third, the impact was assessed by a binary response (agree/disagree), which is insensitive to obtain partial/small improvements. Fourth, only eight selected programs could be visited in the scope of this project, which means that we had to rely only on data from the web-survey for the majority of programs. This may have led to limited available insights from daily practice into how eHealth is adopted and used. Fifth, we mapped eHealth aspects that were considered relevant for multimorbidity care, but comprehensiveness cannot be guaranteed. Despite these limitations, hampering the generalizability of findings in particular with regard to the potential benefits of eHealth, and despite the additional fact that the scale of the initiatives remained mostly local and/or regional, we believe that what is new in our study, with regard to similar findings on the status of eHealth adoption and use, is the number of eHealth initiatives which were mapped in the context of multimorbidity care. The 85 programs studied in this paper contributed to raise knowledge in the field.

## 6. Conclusion

Many health systems are looking at ways to improve efficiency, effectiveness and quality of care. In this respect, eHealth seems to have potential in dealing with the increasing numbers of people with multimorbidity, which will increasingly test the resilience of health systems.

The ICARE4EU findings, although in the light of some methodological limitations, indicate various and different eHealth initiatives in Europe, and also that eHealth applications could support the care practices, by creating new integrated services for people with multimorbidity, among them many older people living in the community. However, such services rarely exploit the full potential of eHealth. European health systems promoting *ageing-in-place* for patients with long-term conditions also need to promote infrastructure and guidelines in the eHealth sector. We mainly found adoption of EHRs, followed by registration databases with patients' health data and digital healthcare communication, which are important tools for enhancing care integration and coordination, but they are not the most advanced applications. Advanced electronic decision support systems for physicians, self-management support of patients, and electronic systems for telemonitoring care processes are not yet widely implemented but hold potential to improve person centered integrated care for (older) people with multiple chronic conditions. Unfortunately, inadequate funding, incompatible and inadequate ICT systems, lacking skills among patients and providers as well as unclear legislative frameworks too often form insurmountable barriers for wider employment and implementation of eHealth services in the healthcare sector. The good news is that these barriers could become drivers when adequately managed [75]. This would among others require politically prioritizing the development of adequate legal frameworks and funding mechanisms for eHealth, as well as fostering an ICT infrastructure and providing adequate training and support systems. Furthermore, against the background of an ageing population, the big challenge could be to move from "healthcare technologies" to "well-being technologies". This would help older

people to have a better lifestyle and a better quality of life, which would help delay or prevent them from becoming affected by multimorbidity [76].

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## Conflict of interest statement

The authors have no conflicts of interest to report.

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