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Modelling and Analysis of Four Telemedicine Italian Experiences*

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***Abstract*— In the last 10 years the European population aged 65 years and over grew of 2.3%, with Italy having the highest share of elderly persons in the total population. OPLON (OPportunities for active and healthy LONgevity) is a project supported by the Italian Ministry of Education, Universities, and Research aiming to identify and prevent frailty and to improve the life quality of elderly subjects. The main goal of OPLON is to develop a "Care&Cure" model for the management of subjects with different morbidities and co-morbidities, adaptable to the subject's risk level and to the regional contexts. In this study we analyzed four Italian telemedicine experiences addressed to chronic, geriatric or partially self-sufficient subjects. Each of them was exhaustively described by means of three process modelling tools (synopsis, workflow and swimlane activity diagrams). Starting from this analysis, we defined a general model of tele-monitoring and tele-assistance of frail and pre-frail people with different needs and pathologies. The proposed model was characterized by three macro processes (enrollment, assessment and assistance) and four groups of actors (patient, general practitioner/specialist physician, multidisciplinary team, and healthcare professionals). Combining this model with a detailed analysis of regulations and legislations in force both at local and national level, it will be possible to design the complete and efficient "Care&Cure" model.**

I. Introduction

In 2015 it was estimated that the 18.9% of the European population was aged 65 years and over, with an increase of 2.3% compared with 10 years earlier. [1]. This population ageing obviously involves enormous changes both from the social and the economic point of view, for example with respect to labor markets, social security, pension systems, and government finances [2]. For these reasons, in the last years the European Union (EU) implemented several policies and initiatives in the context of population healthy ageing and well-being promotion [3].

Across the EU Member States, Italy is the European country with the highest share of elderly persons (aged 65 and over) in the total population (21.7 %) [1].

OPLON (OPportunities for active and healthy LONgevity) is a project funded by the Italian Ministry of Education, Universities, and Research (MIUR) within the "Smart Cities and Communities" program that aims to promote the active ageing of population and the well-being of frail and pre-frail people.

The aim of OPLON is two-fold: to identify and prevent frailty and to improve the life and care quality of elderly people. More specifically, this will be possible by means of:

- ✓ the development of new tools and technologies for early diagnosis of pre-frail subjects, based on multidimensional assessment and psychophysical scales;
- ✓ the design of a "Care&Cure" model for the management of subjects in the "risk zone" with different morbidities and co-morbidities, that is adaptable according to the subject's risk level and to the regional contexts.

Concerning the last aspect, it is important to consider that the healthcare environment is a multidimensional context in which actors with different expertise and roles, resources, and documentation synergically interact among them in order to assure an adequate care level to the patient, according to the actual regulations. For this reason, the definition of the "Care&Cure" model must be essentially based on two aspects: firstly, an exhaustive understanding of organizations and procedures, that already exist in the context of interest, and then a detailed analysis of regulations and legislations in force.

In this work, we present the design of a general management model for homecare assistance based on the analysis of some local telemedicine experiences conducted across the Italian territory. The model objective is to homogenize different regional situations, overtaking the existing gaps. This model includes the activities common to all experiences and highlights all stakeholders involved in the process of patient's care and cure, such as general practitioners, physicians, nurses, social workers, physiotherapists, caregivers.

II. Materials and Methods

A two-steps procedure was used to build the model. The first step consisted of the description and analysis of all the processes involved. During the second step, the comparison of the different experiences allowed the construction of a model that represents the best practice of the actual assistance services.

Four telemedicine services active in different Italian regions were analyzed. For the description of the analyzed services, three different process modelling (PM) tools were used together.

Synopsis diagrams [4] provide a graphical high-level overview of the process. This diagram highlights actors involved in the process, both internal and external to the

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organization, inputs and outputs data, triggering events and final results.

Workflow diagrams [5] depict all tasks to be executed during a specific process, showing sequential, parallel, selective and iterative flows of activities. They also may show resources (in terms of actors, devices and documents) and triggering events needed to perform a given activity.

Swimlane activity diagrams [6] show the progression of the activities through the process, with a clear definition of responsibilities. This is obtained by dividing the diagram in partitions, one for each actor, and drawing each task in the partition related to the actor in charge of it. Moreover, contrary to the classical flowchart diagrams, swimlane activity diagrams allow for modelling also parallel tasks, which are common during the clinical routine.

We chose these methods because they provide a graphical representation of processes that is easily understandable also by non-expert people and highlight different aspects of the process. Each tool depicts the progression of the activities with different detail levels, focusing on particular aspects of the analyzed procedures. Moreover, they show how people, resources, and documents interact among them during the process.

The information required for an accurate PM of the four local experiences was acquired by means of on-field observation of procedures, actors' interviews and analysis of existing documentation.

III. Description of the Local Experiences

A brief description of the four experiences is reported below.

A. *Service for Geriatric Patients*

In 2013, a local health district of Piedmont area established a tele-monitoring service for geriatric patients. It is focused on elderly subjects (aged 75 and over) affected by different chronic morbidities (diabetes, cardiac arrhythmia, …). When he thinks that one of his patients may take advantage of the assistance, the general practitioner describes to him the service and asks for his/her approval to be inserted in it. If the patient is interested, he sends a request to the service team. After an initial check of the patient's inclusion requirements, the clinical staff in charge of the service (made of a geriatrician and some nurses) performs a multidimensional assessment of the patient to understand his/her needs. This allows for defining a personalized tele-monitoring program in terms of acquired vital parameters/signals and the acquisition scheduling. The process of home care and monitoring, involving patient, caregiver, nurses and physicians, is routinely performed according to the defined program. At the end of each home visit, the clinical staff writes a medical report to describe the patient status. When necessary, the tele-monitoring program is modified.

B. *Service for Patients with Chronic Cardiologic Diseases*

In another local health district of Piedmont area, a telemedicine service addressed to subjects suffering from heart failure is available. The inclusion in the service of a new patient is recommended either by the general practitioner or by the cardiology ward of the reference hospital. A specific hospital team verify the patient's compliance to the inclusion requirements, according to the information provided in the recommendation phase (patient's medical chart and clinical status description). In this case, a set of fixed parameters is acquired with a frequency that is defined every time according to the actual patient's status. At the end of each home session, a cardiologist is in charge of reporting the acquired signals and scheduling the following monitoring session.

C. *Service for Patients with Chronic Kidney Diseases*

A telemedicine service is active at the Polyclinic Hospital of Bari for the home monitoring of subjects treated with dialysis. In this case the inclusion in the program is recommended directly by the patient's nephrologist, that also

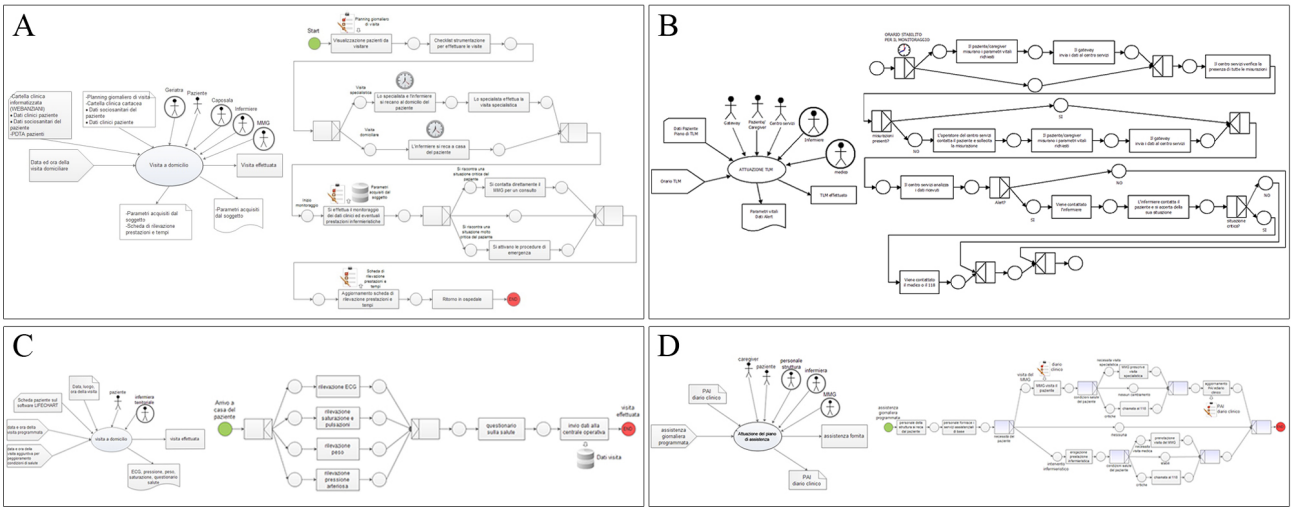

Figure 1. Synopsis and workflow diagrams (on the left and right side of each panel respectivelly) describing the assistance process carried out by the four analyzed services: the service for geriatric patients (panel A), the service for patients with chronic kidney diseases (panel B), the service for patients with chronic cardiologic diseases (panel C) and the service for partially self-sufficient patients (panel D).

defines the tele-monitoring program and requires the appropriate monitoring kit. Once the kit is provided to the patient, he/she or a caregiver is in charge of performing the parameters measurements according to the defined scheduling. The acquired data are automatically sent to a service center, that analyzes the data and activates the alert procedure, if necessary. Moreover, once a month the service center transmits a report of the patient's status to the nephrologist.

D. Service for Assistance of Partially Self-Sufficient Patients

Since 2011, in a local health district of Lombardy it is actuated an assistance service for partially self-sufficient patients hosted in community residences. Here, people are supported for their daily living activities such as dressing, self-feeding, taking medications and so on. In this case, the general practitioner or directly the patient sends the request to the team responsible for the multidimensional assessment (made of general practitioners, nurses and social workers). If the subject can be admitted to the community residences, the assistance and tele-assistance program is defined according to the patient's frailty level. The living activities are supported by social workers and families/caregivers, whereas the general practitioner and the nurses are in charge of the patient's monitoring from the clinical point of view. Finally, every three months, the multidimensional assessment of the patient is repeated in order to update the assistance and tele-assistance program.

IV. Analysis of the Local Experiences and Definition of a General Model

The four analyzed experiences were modelled with synopsis, workflow and swim lane activity diagrams. Fig. 1 shows the synopsis and workflow diagrams of each service. Looking at the figure it is evident that the actors and the number and flow of activities are quite different.

The main differences are patients' characteristics (age, pathology, living situation) and type of support provided to them (monitoring of vital signs, assistance for the daily living activities). Nevertheless, from a more detailed analysis it was possible to identify three macro-processes in common to all services: enrollment, assessment and assistance.

The enrollment process is usually started by the general practitioner. For patients with chronic pathologies, the enrollment could be the result of a hospital admission. In the latter case, the specialist physician starts the enrollment process. At the end of this process, if the patient is interested in the assistance his/her name is provided to a team that assesses his\her needs and compliance to the enrollment criteria.

The assessment process consists of two steps. First, the team performs a multidimensional evaluation of the different clinical and behavioral problems of that specific patient. According to the results of the first step, a personalized assistance program is defined. The program is based on tele-assistance/tele-monitoring activities.

The assistance process consists in the routinely accomplishment of the care and cure activities included in the program, according to the patient's needs and the scheduled plan.

Four groups of actors were recognized analyzing all stakeholders and people involved in each service. The first group of actors contains the patient and the caregivers that are the persons whose the care service is provided. The second group is formed by the general practitioner and the specialist physician that have the responsibility to identify patients. A multidisciplinary frailty team made of geriatricians, specialist physiscians and social workers, was respondible for the patient's assessment. Finally, the team of health professionals delivers the home care service (physicians, nurses, social workers, physiotherapists and so on).

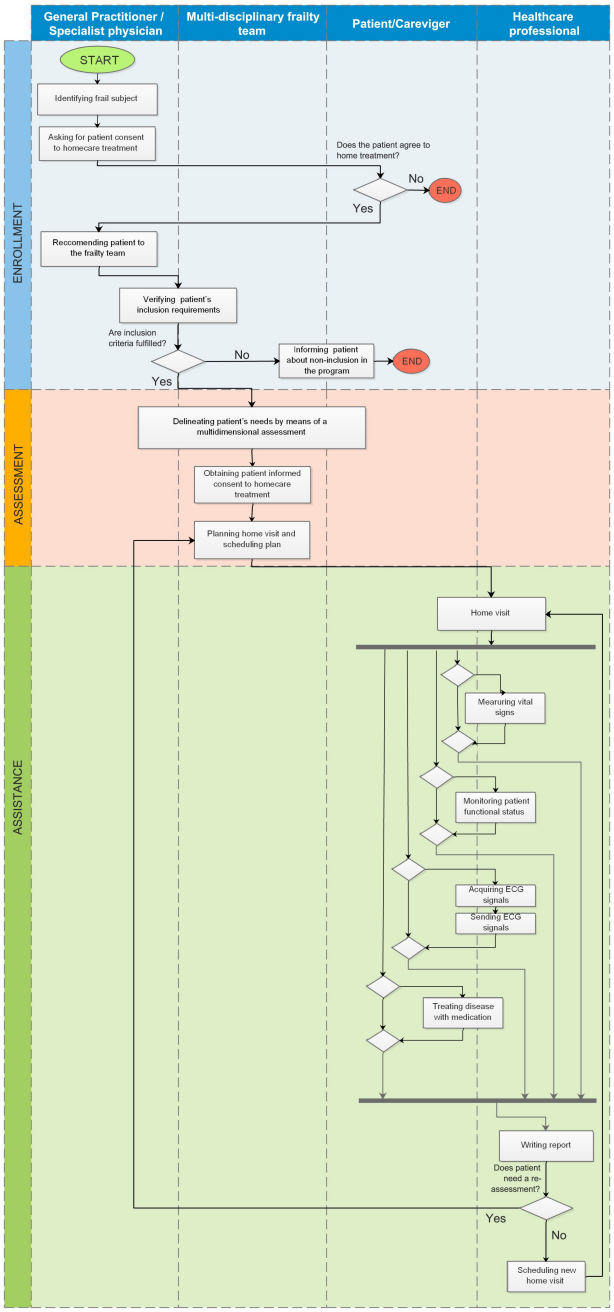

Figure 2. Swimlane activity diagram describing the general model for providing a home care service

Starting from the results of the analysis and comparisons of the four services, we defined a general model for providing a home care service that is described by means of the swimlane activity diagram showed in Fig. 2. In this diagram it is possible to identify four vertical partitions corresponding to the four groups of actors involved in the processes. Furthermore, three horizontal partitions highlight the macro processes previously described, each detailed in terms of activities to be performed.

Unlike the majority of the telemedicine projects proposed in literature that focus only on a specific pathology [7–9], this model is general, very flexible and suitable for patients with different pathologies and needs that are accurately identified by the multidimensional evaluation. This is due to the preliminary analysis of different services addressed to chronic, geriatric or partially self-sufficient patients. Moreover, for the same reason the model is applicable to different regional contexts that are characterized by a heterogeneous organization of health services.

Finally, most of the studies dealing with telemedicine focus the attention on the technological aspects, describing the project implementation in terms of ICTs (Information and Communication Technologies) [10, 11] and their architecture [12, 13]. In this general model we decided to take into account only the health care aspects and procedures to provide home assistance, disregarding devices and technologies employed to accomplish this aim. This is because, from the technological point of view, it was found that the main aspect influencing the activities organization is the presence or the absence of a 24-hours assistance [14]. In all our analyzed situations and consequently in the proposed home care general model only the case without 24-hour monitoring is considered.

V. Conclusion

This work lies in the context of the OPLON project that aims to develop tools to promote the active ageing of population and the well-being of frail and pre-frail people. In particular, in this study we started analyzing four different local telemedicine experiences conducted across the Italian territory. Based on the information acquired in this phase, we developed a general model for providing a home care service. This model is adaptable to patients with different needs and diseases. Moreover, the proposed model tends to homogenize different regional situations, overtaking the existing gaps.

The three PM tools used for the services description and analysis allowed for obtaining an accurate knowledge about the considered organizations and processes, highlighting similarities and differences among them. The description of the general model by means of the swimlane activity diagram permitted to obtain an overview of the entire process, focusing on the responsibilities entrusted to each actor.

Combining this model with a detailed analysis of regulations and legislations in force both at local and national level, it will be possible to design a "Care&Cure" model for the management of frail subjects with different morbidities and co-morbidities, adaptable to the subject's risk level and to the regional contexts.

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