

# A Holistic Infrastructure to Support Elderlies' Independent Living



**Marco Nalin**

*Telbios, Italy*

**Ilaria Baroni**

*Telbios, Italy*

**Manuel Mazzara**

*Service Science and Engineering Lab, Innopolis University, Russia*

## INTRODUCTION

This chapter starts from a literature analysis of definitions, indices and scales related to fragility and pre-fragility, to identify all those aspects which can be monitored unobtrusively and remotely from a person. In this respect, an holistic profile has been defined, which includes vital signs, information related to behaviors (e.g., daily habits, elderly person's mobility level, etc.), and information related to the environment (with ambient assisted living solutions). The SITAD project, co-funded by Lombardia Region, proposed a scalable and extendable architecture, which allows the integration of heterogeneous set of devices, sensors and actuators, through a variety of wireless and wired connections and protocols.

Such platform, which will be described in this chapter, will allow the monitoring and the early identification of meaningful variations in the daily habits, and the possible decline of the functional and cognitive abilities of the elderly person. This will hopefully create alternative diagnostic tools which will be cheaper than those currently used (PET, MRI, etc.), less invasive (being invisibly installed in the house or in the worst case worn by the person), remote (the person doesn't need to go to the hospital) and continuous (it's not a one-shot analysis, but it's continuously generating data).

## BACKGROUND

In a common medical sense, the frail elderly have an advanced age, chronic pathologies, clinical instability, social isolation and a certain degree of disability. The condition of "pre-frailty" is present when only a few frailty factors are observed.

In Italy, there are one million of frail patients, and this number will double in next 20 years, with a consequent proportional increase in healthcare spending related to their management. Therefore, it is a fundamental goal for scientific research to define objective and standardized criteria of classification for these patients and for prediction of the temporal evolution of their frailty in order to implement appropriate forms of early diagnosis, monitoring of disease status and of intervention at the local and national level.

Within the framework of the EU initiative "Innovation Partnership on Active and Healthy aging" (EIP-AHA), the document "Prevention of functional decline and frailty", action plan number 3 "Prevention and early diagnosis of frailty and functional decline, both physical and cognitive, in older people" issued at the 1st Conference of Partners on November 6th, 2012 in Brussels, clearly shifts the objective from

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“frailty” to “pre-frailty”, revealing the necessity not only to define diagnostic criteria but also prediction models with the “active elderly” population as their target. Moreover, the document reveals the need to add cognitive performance indicators, currently not always included in clinical status scales and in the frailty evaluation models, defining the “multidimensional and functional decline” due to physical and cognitive causes or their combination.

The need to implement indices and clinical practices for the collections of information related to cognitive functions comes from the dramatic increase in the probability of developing Alzheimer’s disease (AD), a neurodegenerative process which extends for several years without any manifestations of cognitive decline (pre-clinical phase). Then, for some years, there is a slight objective cognitive decline, called mild cognitive impairment (MCI). In a remarkable percentage of cases (approximately 50%) amnesic MCI subjects can be considered as prodromal AD that, after a few years, progresses into a serious cognitive impairment and loss of functional autonomy. To diagnose AD in the pre-clinical or prodromal phase, distinguishing it from benign cognitive deficits related to reversible psycho-physical condition, instrumental tests have been developed, such as the examination of beta and tau amyloid proteins in the cerebrospinal fluid, the volume of the hippocampus and of the cerebral cortex through magnetic resonance imaging (MRI), the assessment of cerebral metabolism and of the accumulation of beta amyloid through positron emission tomography (PET).

The goal of creating an effective screening for cognitive frailty, which in some cases could contribute to an early AD diagnosis and to the identification of reversible conditions (based on nutrition, relate to mood disorders, co-morbidity, etc.) requires a revision of the currently validated instruments and a reconsideration of the areas of frailty data collection, which cannot be connected only to the hospital/clinical setting. EIP-AHA also recommends the implementation of validated tools, tests and protocols with low cost ICT equipment to be used on populations defined on a EU basis and for co-morbidity groups, and on data gathered not only in a healthcare environment, but also in a “holistic” ecological environment.

The SITAD project, co-funded by Lombardia Region, represents a scalable and extendable architecture allowing the integration of a heterogeneous set of devices, sensors and actuators, through a variety of wireless and wired connections and protocols. The SITAD system is an advanced home care platform for elderly people and operates through the synergic actions of domotic and biomedical tools. Data are continuously collected and analyzed in order to identify potentially critical (life threatening) situations. SITAD architecture is based on the integration of both hardware and software components of heterogeneous nature and provenance. Such heterogeneity is partly due to technical choices and partly to the presence on the market of project participants or manufacturers related with them in business terms.

In the SITAD system multiple devices work together to monitor specific event related to users’ needs and profile.

## **REFERENCE MODELS**

### **Frailty and Pre-Frailty Definitions**

The prediction and identification of possible frailty or pre-frailty condition is an important issue in the elderly social and health care. As visible in Figure 1, frailty represents a period in which the patient suffers from a functional decline (a sort of “accelerated” aging) which leads quickly to disability, with increasing patient’s management costs (Akner 2013).

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