Active and Healthy Ageing in Europe

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Main strategies in active and healthy ageing in Europe

New technological and health service approaches for better integrated care

Active and Healthy Ageing (AHA) is one of the main directions in the Horizon2020 agenda. One of the basic tasks is the challenge of turning existing research efforts into reality for healthy and chronic diseased elderly people across Europe, as well as their family environment and carers. Existing and evolving ICT and medical devices based solutions' could empower elderly users in their daily routine ,and provide essential stability and adjustment to continue being and feeling independent. Thus, within AHA we will need to develop personalised, adjustable and easy to use ICT based solutions and services. These services will address daily activities such as shopping, eating, physical activity, commuting, mental stimulation, communication, social interaction, chronic disease management, and multimorbid patients etc. We also need to take into account chronic diseases/disorders, comorbidities, cognitive impairments, activity management, and address the mental well-being of their informal and medical carers, whether living in their own home or in health care centres.

The main idea is to turn existing research efforts into reality for real people across Europe. For example, existing flexible ICT solutions could assist elderly users with cognitive problems in completing everyday tasks that have always been part of their life, and constitute essential stability factors to keep them independent. Emphasis should be given to elderly and carer interactions, communications, and even care scheduling and monitoring.

In order to meet the above objectives, integrated and mature platforms such as the IN-LIFE project in the framework of Horizon2020 will have to set up a technical infrastructure undertaking the following functionalities:

- Monitor user activities and preferences in an unobtrusive way (only those related to the user cases and services to be supported).
- Support elderly people with cognitive impairments and other problems in a variety of indoor and outdoor activities.
- Provide help and instructions to care givers.
- Enable service/application providers to easily integrate their products in the IN-LIFE framework.
- Enable easy, transparent, personalised and contextualised access to the IN-LIFE (and other possible products/platforms) services and applications through an application centre.

The conceptual architecture of the IN-LIFE project is depicted in Figure 1. The specific components of the IN-LIFE architecture constitute a whole range of functions based on medical devices, ICT and behavioural/psychological components and functionalities, which can be identified as follows:

- **Monitoring:** This module will be responsible for the monitoring of the use of the existing and IN-LIFE services through subjective and objective tools.
- **User data repository:** The user data repository will be used for secure storage of the data coming from the use of the services by each user.
- **Sensor data repository:** The sensor data repository will be used for secure storage of the data coming from the sensors connected to the services/modules i.e. door sensors in eDoorman app, GPS position for navigation module.
- **Data pre-processing and user profiling:** This module will be responsible for the first processing stage of data coming from the user data repository and the sensor data repository. At this first stage, the environment will be recognised and also the user profile will be automatically constructed.
- **User clustering/modelling:** This mechanism will be responsible for the clustering and modelling of the users. Users will be clustered according to the 4 taxonomies of the business models (namely as dependent, assisted, at risk and active), as detailed in section 1.4.2). Furthermore, individual user profiling will also be supported.

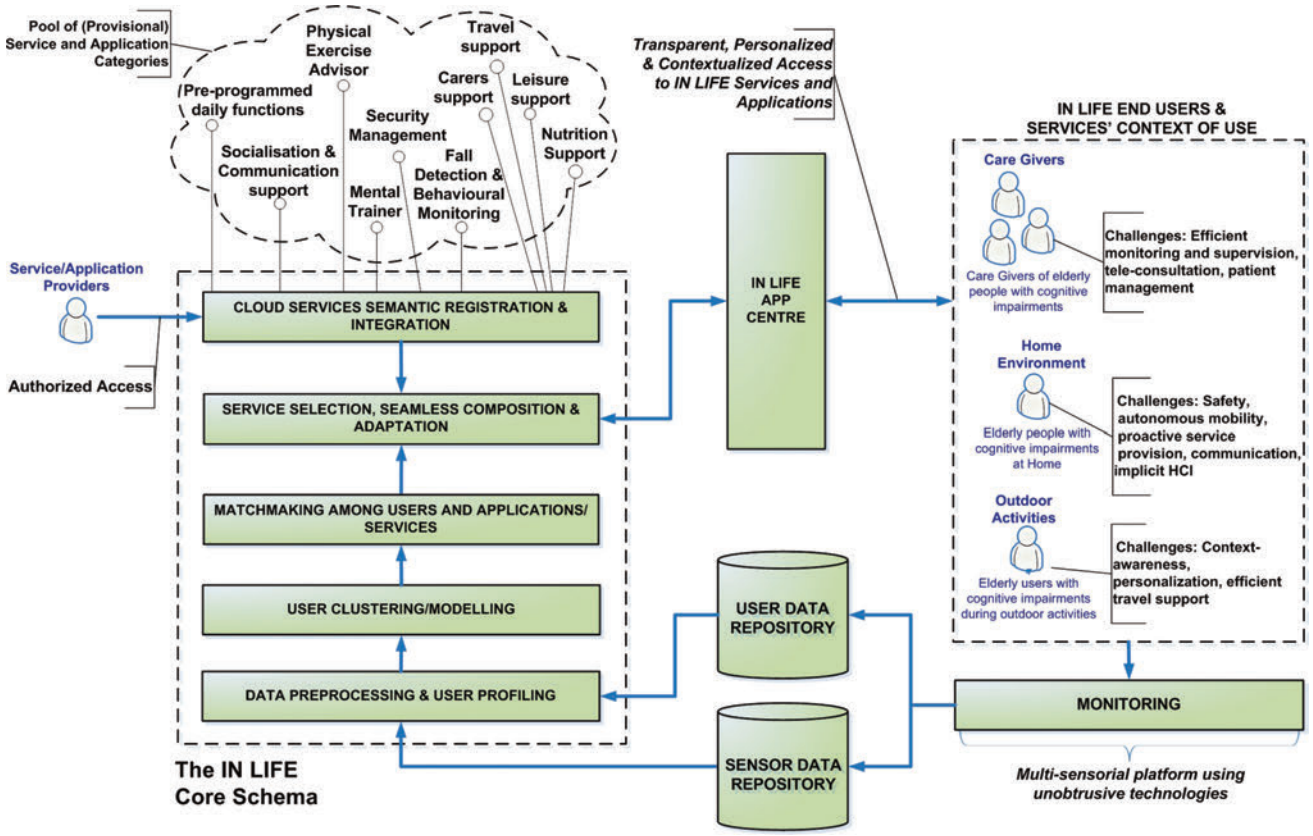


Figure 1: The IN LIFE conceptual architecture for managing cognitive impairment in AHA

- **Matchmaking among users and applications/services:** In this step, the mapping among service/application descriptions and users will be performed based on rule-based matchmaking techniques, statistical approaches and service semantics.

- **Service selection, seamless composition and adaptation:** This module will be responsible for the dynamic combination of different services that will allow the better adaptation according to user needs.

- **Cloud services semantic registration and integration:** This mechanism will allow service/application providers to easily register their products in a semantic way and to also integrate them on the cloud platform.

- **IN-LIFE application centre:** The IN-LIFE app centre will enable transparent user access to all supported services and applications supported by the IN-LIFE framework.

Current practices and state-of-the-art AHA systems

The importance of health monitoring and management, and in particular of non communicable diseases (NCD) such as cardiovascular disease, is reflected in a number of national and EU projects that focus on remote monitoring, integrated sensors (e.g. in clothing), life-style behavioural change efforts and disease prevention. A number of projects such as HEARTCYCLE has been in development for years – the third generation telemonitoring system which includes a feedback loop for continuous interaction between the various actors both from the patient as well as the medical community (Figure 2). These systems are expected to play a big role in advancing the new era for AHA in Europe and the world.

More specifically, HeartCycle aimed at researching, developing and clinically validating innovations for the next generation of telehealth systems for disease management. Therefore, HeartCycle started from an application point of view. We have investigated and analysed the needs of patients and medical professionals for specific disease management solutions. Based on the identified needs, we investigated and developed specific HeartCycle concepts. More specifically as we can see in Figure 3, issues such as haemodynamic tailoring or management of arrhythmias and coronary artery diseases or congestive heart failure would be radically affected to the benefit of the patient and the health delivery system.

HeartCycle has developed, implemented and validated

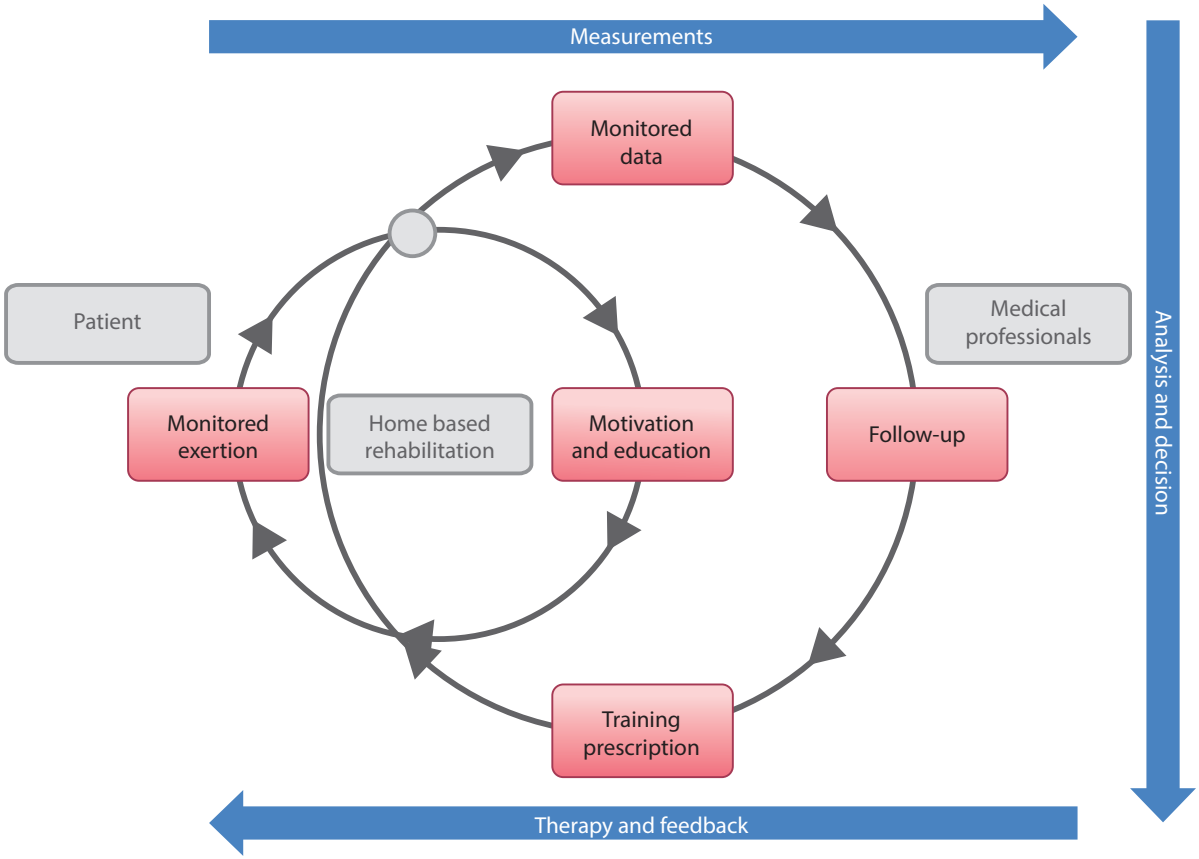
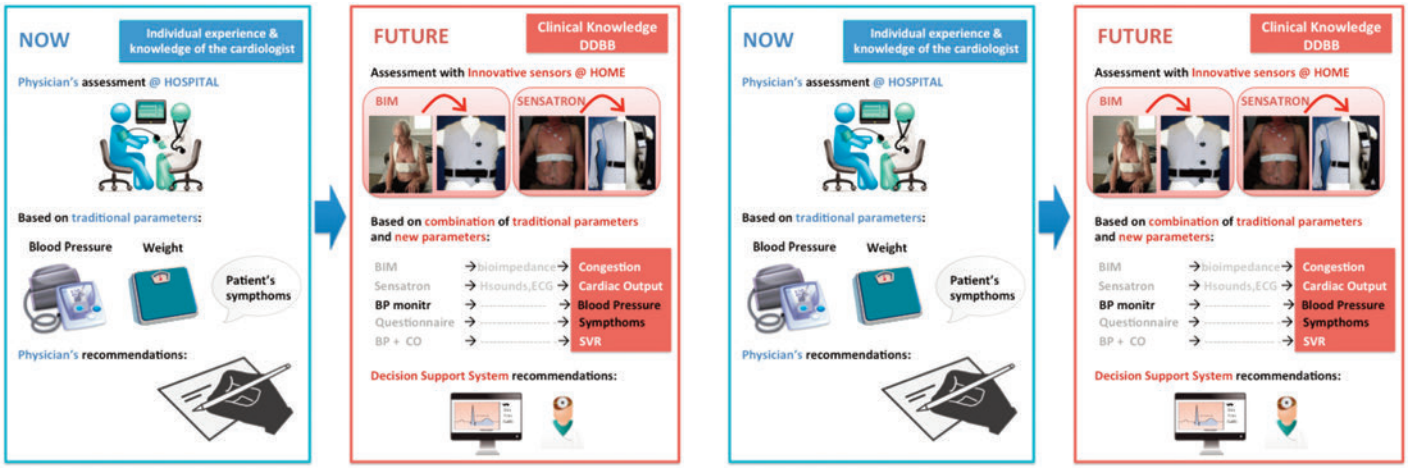


Figure 2 : Closed-loop approach for the Guided Exercise (GEx) system



(a) (b)

Figure 3: The HeartCycle Process: Starting from insights into existing needs of patients and professionals in telehealth, innovations have been developed and tested in clinical studies to finally allow acceptance and endorsement of the medical community for the new telehealth services. In this Figure we can see how the haemodynamic tailoring can be achieved especially for CHF patients and how the arrhythmia management which is another global problem to resolve shall be addressed.

Finally, as we can understand from the aforementioned, HeartCycle focused on medical and technical innovations on three concepts:

Heart failure Management (HFM) including:	- Medication Management via TeleHealth - Decision Support (Patient & Professional) for TeleHealth - Education & Automated Coaching for Patient Self-Management via TeleHealth - Health Maintenance
Guided Exercise (GEx) including:	- Independence & Compliance for cardiac rehabilitation training - Safety & Confidence for patients - Improved Treatment Delivery & Closer Follow-up - New sensor and vest / whole system developed from scratch
Assessment Use Case (AUC) including:	- Novel Sensors to Enhance Patient Assessment in the Home Environment - New Information Processing for Integration & Interpretation of Sensor & Patient Data - Improved Decision Support

these concepts to a level that has allowed operation in clinical tests. Important aspects of the process have included testing the technical feasibility, the user acceptance in these groups, and making sure the concepts present new ways to deliver improved healthcare to patients and reduce workflow for professionals.

ICT solutions are existing applications and services which will be improved subsequently according to their Technology Readiness Level (TRL), a scale from 1 to 9, with 9 corresponding to a product ready for the market. This scale was originally developed by NASA and adopted by the EU also in the DGRTD HEALTH as well as in the AHA unit. Several solutions are already commercial or open source products and are available for use. Others were developed within the framework of European projects and are still at the prototype stage. It is expected that we start from a relative mature level 5 (levels: 1-9) for the majority of tools and we anticipate to reach a TRL of 7 or more for approximately 75% of tools within the next 7 years.

AHA and chronic disease patients with comorbidities – Coordinated care

Most, if not all of elderly people suffer from chronic diseases, which produce comorbidities. This is a very difficult situation, and has triggered the need to produce models for coordinated care. In this context, the WELCOME project in the EU is state-of-the-art, and provides a major leap forward in the management of Chronic Obstructive Pulmonary Disease (COPD) with co-morbidities, namely Chronic Heart Failure, Diabetes, Anxiety, and Depression. It aims to combine continuous monitoring, ICT, shared decision support systems, and personalised guidance to provide a shift from reactive to predictive, preventive, personalised, and participatory (P4) medicine. The proposed holistic integrated care approach is based on a variety of data with clinical and patient-reported markers and includes:

- Continuous accurate remote monitoring of patient with multi-parametric sensors.
- Prevention of disease deterioration in everyday living with the chronic disease.
- Early identification of disease exacerbations.
- Provision of multi-level care, ranging from personalised guidance to primary and secondary care by coordinating at various scales and in a coherent way the monitoring and treatment based on an individual patient's conditions, disease evolution and corresponding needs.

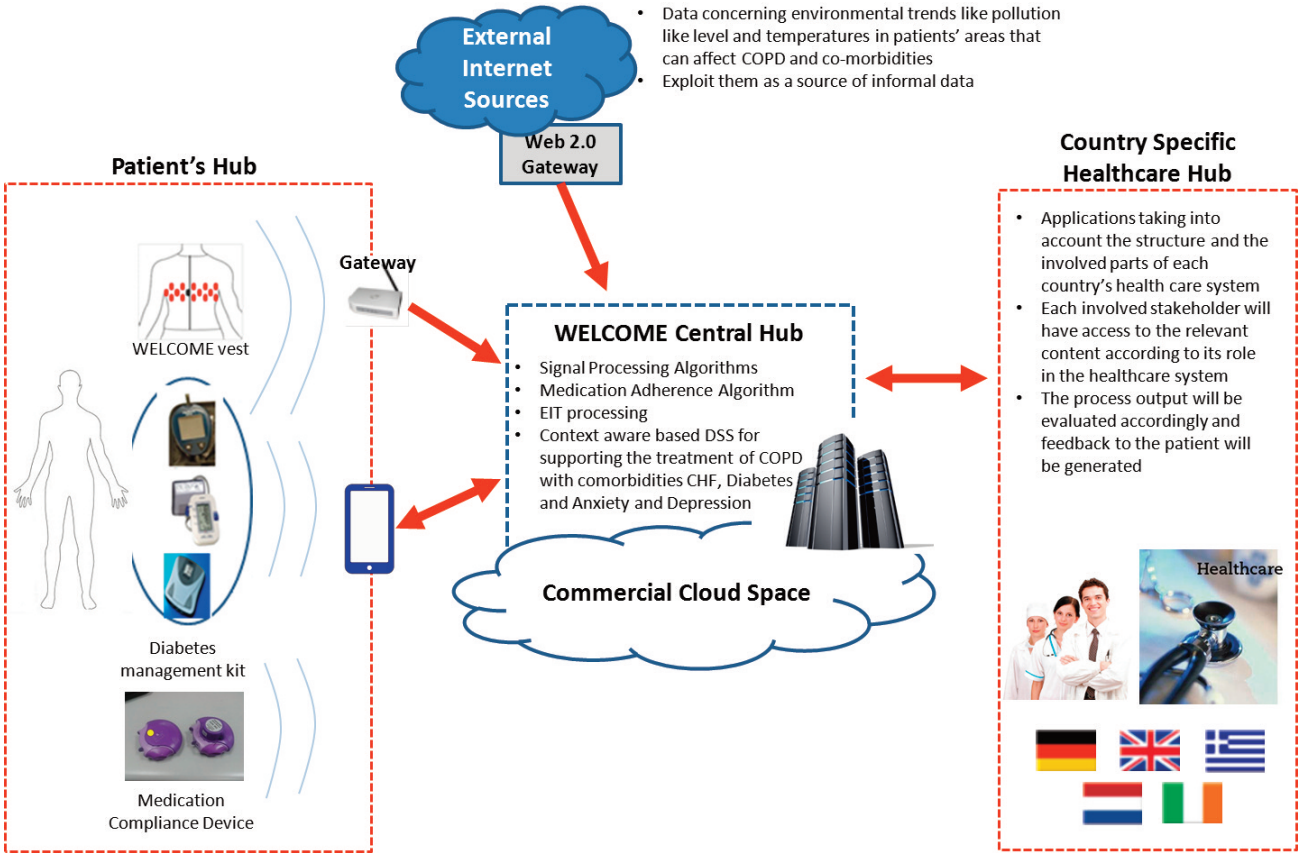


Figure 4: Schematic view of WELCOME for coordinated care

The WELCOME project aims to deliver a cost-effective approach to COPD management and treatment. It aims to better manage chronic disease and prevent exacerbations or identify the problems early.

It is clear that the needs and requirements for the addressed user groups are very important at the early stage of developing non-communicable diseases (NCD), or changing states in their organism functions, and are a cornerstone within an extended and flexible evaluation framework. This framework largely includes home based observational input and studies, and are related with behavioral and psychological functions that are related to cognitive impairment, depression and NCDs (neurodegenerative, cardio-respiratory etc).

For example in the case of cognitive impairment, the main user groups are:

1. **Mild Cognitive Impairment (MCI).** Sufferers are usually elderly who have lost cognitive functioning on at least one aspect, with no sign of dementia and still undertake daily activities. People with MCI are estimated to account for 20% of elderly over the age of 65. ICT solutions as an intervention might have more potential for people with mild cognitive impairment as users are at the early stages of the condition, and are active, eager, and still have the ability to learn new functionalities.

2. **Early stages of Dementia**. Patients have been diagnosed with dementia but are still maintaining some aspects of their daily functions (early signs of dementia are apparent) and users have been diagnosed by specialists (i.e. neurologist, neuropsychologist) and might be under medication. The improvement in daily functioning is usually rather limited compared to the deteriorating effects of the disease. Early and moderate dementia patients can still carry out certain activities with assistance.

3. **Cognitive impairment as a co-morbid condition**. Users with other conditions and diseases with cognitive

impairment as a co-condition is a common problem in the elderly. High rates of medical co-morbidity are evident in elderly living in large urban areas due to low socio-economic status (SES) and poorer access to health services.

4. **Caregivers.** Either formal (i.e. healthcare, social, etc.), or informal (i.e. family members and friends) need to be empowered with knowledge and tools to support the elderly in their everyday lives. Informal caregivers often struggle juggling work and caring for their relatives, which puts a strain on their own health and coping mechanisms.

In addition, there are many stakeholders with an interest in, but not a direct involvement in day-to-day care provision. Some main stakeholders, are described briefly below:

Regulatory authorities on a local, national or international level, regulating a wide range of aspects from device safety and essential performance, via legal, ethical and privacy related issues. This group includes an Ethics Control Board with external expertise and representatives from all the pilot sites ensuring that applicable regulations are respected.

User interest organisations work to serve the interest of their members. This group involves care centres and organisations for elderly people, and dementia centres with experience working with and for users with cognitive decline.

Standardisation bodies are organisations that define how AAL care systems should work in a consistent manner (i.e. members of Continua Alliance). Furthermore, another important standardisation body is INFOTERM, aiming to promote and support standardisation actions in the AHA area.

Public bodies, insurance companies and care organisations are important as they define the care standards offered and the reimbursement levels provided. We need to interface these stakeholders primarily via on-site care centers, outpatient clinics, hospitals, organisations, dementia research centers and their networks.

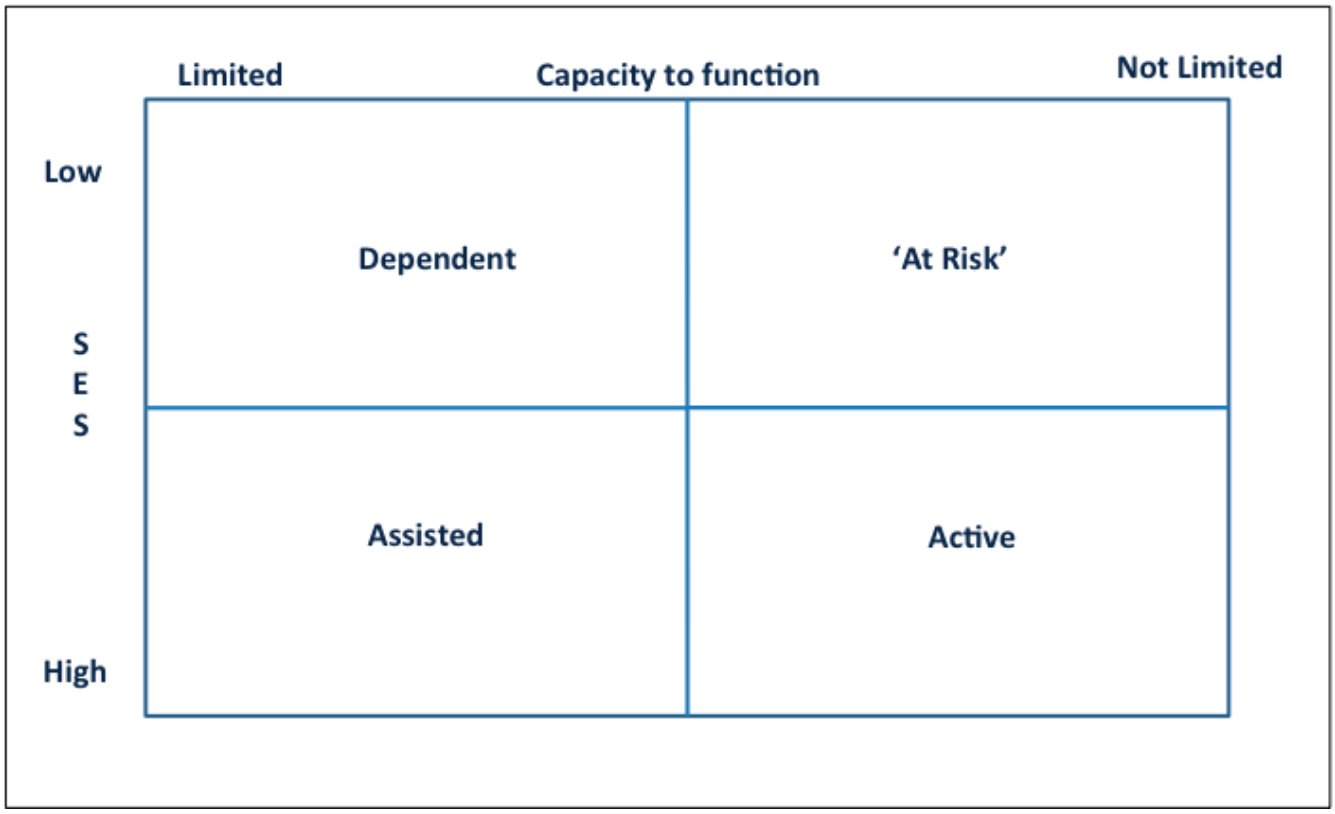


Figure 5: A resilience based taxonomy of the 'elderly'

"Within AHA we will need to develop personalised, adjustable and easy to use ICT based solutions and services. These services will address daily activities such as shopping, eating, physical activity, commuting, mental stimulation, communication, social interaction, chronic disease management, and multimorbid patients etc."

It is in the domain of consumers' study that the move away from the 'medicalisation' has been more radical with the introduction of the concept of resilience in opposition to that of frailty. The concept of resilience can be defined and measured along two dimensions: a) capacity to function in terms activities of daily life or of disability-free status; and b) Socio-Economic Status (SES), where we include not only more tangible dimensions (income, education attainment) but also social support and networks.

Using these two dimensions we determine the resilience based taxonomy identifying four archetypes (in a qualitative and ideographic fashion) that have different needs, should be the target of different interventions, and possibly of more granular monitoring indicators. For the sake of simplicity we describe the four segments of this taxonomy considering somehow the extreme (low/high) and neglecting the nuanced and intermediate situations.

Dependent. These are individuals with low SES and with poor health severely hampering the capacity to function. They may also suffer from isolation and lack of social support, which means no or little access even to informal care. They need public support for immediate care.

Assisted. These are individuals with good SES yet suffering from health related limitations. Since they can afford it, they are likely to seek quality of life improvements and can afford to buy care and other support or at least rely on social support and networks. They can potentially demand and pay for assisted living and other aids to independent life. They may be the target of some of the services that can be brought to market as they can afford them.

At risk. These are individuals with low SES but holding onto normal life due to their good health status enabling resilience at least in one dimension. They are at risk in the sense that lack of SES resources may bring them easily in the catagory of the dependent elderly when and if a health problem emerges and limits their functioning capacities. They may be the target of pre-empting public policies such as health awareness and prevention services or skills building measures

Active elderly. These are individuals with high resilience who are ageing well, and are active. We could also call them the 'discerning old'. They are likely to seek quality of experience and demand for luxury goods and leisure such as smart homes.

Based on the above baseline for COGNITIVE IMPAIRMENT AND PATIENT EMPOWERING SYSTEMS, closed loop telemonitoring systems, which address coordinated care in chronic diseased elderly patients and user profiling. The main innovation that is needed, is to visualise the real life depiction of a large-scale effort, to estimate the potentially positive effect of ICT and medical devices solutions on AHA. We need a statistically adequate number of users which reflect the diversity of real users with actual cognitive impairments for a long period of time. Ensuring the inclusion of significant Key Performance Indicators (KPIs) for successful assessment and investigation of the Quality of Life indicators establish the extrapolation of findings and the viable transfer of knowledge to business modelling and a new model of health service provision which is based on integrated and personalised health.

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