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Mapping of Effective Technology-based Services for Independent Living for Older People at Home

Deliverable 1

Dr Stephanie Carretero

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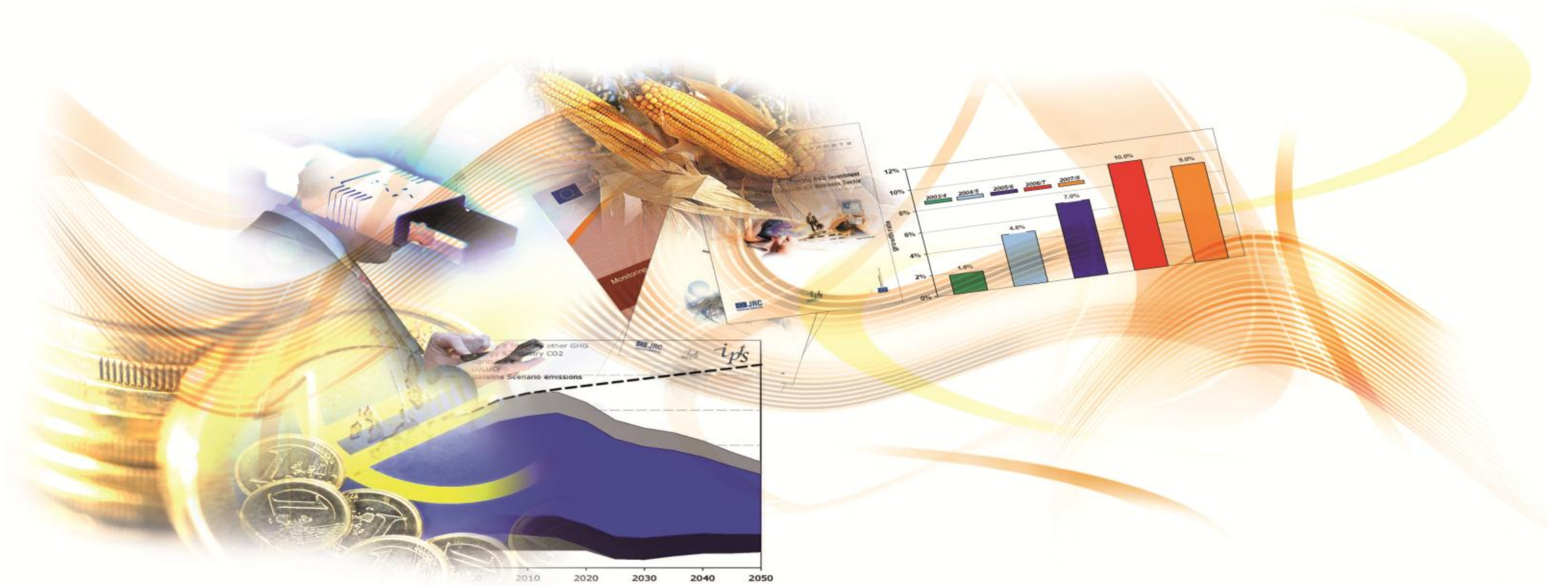

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Abstract
This report identifies and maps technology-based services which have successfully enhanced the independent living of older adults at home in and outside Europe. This is the first deliverable of the research project "Long-term care strategies for independent living of older people (ICT-AGE)". This project aims to produce policy recommendations for DG EMPL to support the Member States in their long-term care strategy, according to the EC policy priorities of the Social Investment Package, the European Semester and the European Innovation Partnership on Active and Healthy Ageing. We found 14 different, mature and mainstreamed technology-based services for the independent living of older adults at home that effectively address a set of long-term care needs. To the best of our knowledge, this is the first study that has managed to obtain a number of practices in technology-based services scientifically shown to increase the independence of older people living at home, improve the productivity of carers, enable better quality of care, and generate savings, contributing to the financial sustainability of the long-term care systems.

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The quality of this report has been revised by the following two experts in the field:

- Karina Marcus, Manager of the Ambient Assisted Living Joint Programme.
- Geja Langerveld, Responsible of the Ambient Assisted Living Joint Programme at the The Netherlands Organisation for Health Research and Development (ZonMW).

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This report may be referenced as follows:
Carretero, S. (2014). Mapping of effective technology-based services for independent living for older people at home. Seville: Joint Research Centre, Institute for Prospective Technological Studies, JRC Scientific and Technical Reports Series.

[1] A list of experts of the Stakeholders Consultation Workshop is available at the following web page: http://is.jrc.ec.europa.eu/pages/EAP/eInclusion/carers_ICTAGE.html

Preface

This report identifies and maps good practices in technology-based services which aim to enhance the independent living of older adults at home. This is the first deliverable of the research project "Long-term care strategies for independent living of older people (**ICT-AGE**)". The Directorate General of Employment, Social Affairs and Inclusion (DG EMPL) commissioned the Joint Research Centre (JRC) to do this study through an Administrative Arrangement[2] (AA). The work is being carried out by the team of ICT for Employability and Inclusion of the Information Society Unit at the Institute for Prospective Technological Studies (IPTS).[3] The project started in May 2013 and will last 19 months.

ICT-AGE aims to help DG EMPL to support the Member States (MS) in the development of long-term care strategies promoting independent living of older adults at home through technology-based services. These solutions refer to any kind of technology including Information and Communication Technologies (ICT) that empower older adults to self-manage despite frailties and with quality of life, and that also improve the organisation of care provision or increase the productivity and quality of long-term care delivery. The project is one of the actions of the Social Investment Package (SIP) of the European Commission (2013a,b), which aims to help the Member States to implement the Country-specific Recommendations of the European Semester for more effective long-term care policies.

The research will produce guidelines for the Member States on how to implement technology-based services for independent living, by:

- Identifying and mapping good practices in technology-based services for independent living at home for older adults with different needs. These good practices have been successfully implemented in Europe, United States and Japan.
- Analyzing a selected number of good practices case by case, focusing on their business case, business model, technology and organizational change, technical standards, quality, scale and scale-up, and the role the individual Member States and the EU could play as regards leadership and transfer.
- Elaborating manuals on long-term care strategies to help policy makers design policies which increase the independent living of older adults through the use of technology.
- Identifying how the European Union could help the Member States to implement these technology-based services.

This deliverable covers the first objective of the ICT-AGE project, being the research carried out between May 2013 and December 2014. We found 14 different, mature and mainstreamed technology-based services for the independent living of older adults at home that effectively address a set of long-term care needs. To the best of our knowledge, this is the first study that has managed to obtain **a number of practices in technology-based services** which have scientifically evidenced to increase the independence of older people living at home, improve the productivity of carers, enable better quality of care, and generate savings, contributing to the financial sustainability of the long-term care systems.

More information on the project can be found at:
http://is.jrc.ec.europa.eu/pages/EAP/eInclusion/carers_ICTAGE.html

2 JRC Nº 33156-2013-05 EMPL D.3.
3 IPTS is one of 7 research institutes that form the European Commission's Joint Research Centre.

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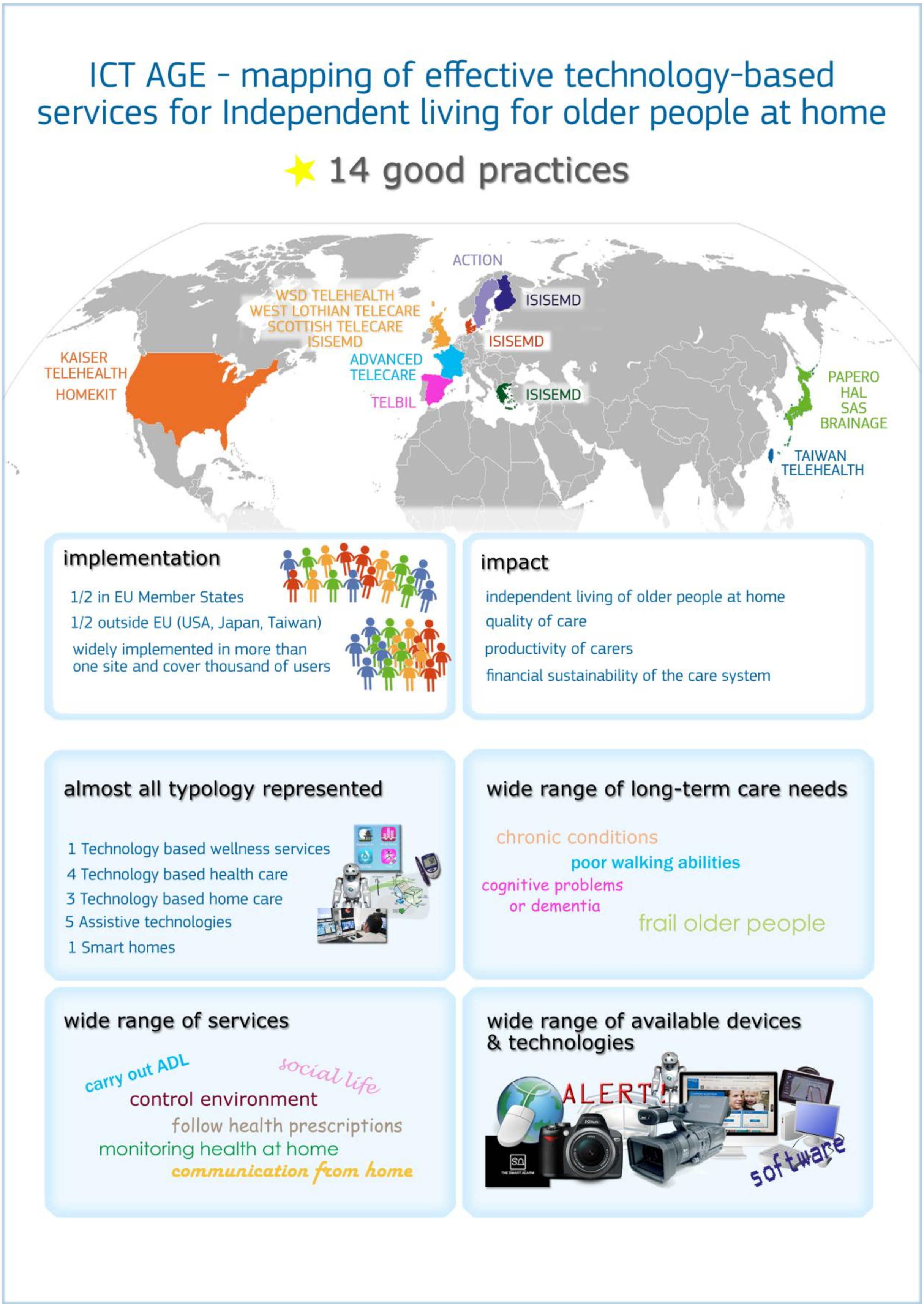
Executive Summary



In the coming years, Member States will find it challenging to ensure quality of life to the growing number of older adults with functional limitations, while being, at the same time, more efficient with the economic and human resources they allocate to their care systems. For example, according to a constant disability scenario,[4] it is expected that around 39 million older people in the EU27 will be in need of some form of long-term care in 2060, compared with 20.7 million in 2007 (Przywara et al., 2010). Public expenditure on long-term care in the EU27 could therefore almost double over the period 2010–60 - a possible increase of +1.7 percentage points of GDP (ECFIN, 2012). This situation could be worsened by factors such as the difficult working conditions experienced by formal carers or the finite availability of informal carers.

In 2013, the Commission published the **Social Investment Package** for Growth and Jobs – SIP – (European Commission, 2013a, b) in which it urged the Member States to develop policies to achieve the following four objectives:

- increase the functional capacity and independent living of older adults,
- improve the productivity of care
- improve the quality of long-term care delivery,
- maintain the financial sustainability of care delivery - as has also been recommended by the 2013 European Semester (European Commission, 2013c).

The use of technologies has been identified as the key to addressing these objectives. The JRC-IPTS was commissioned by DG EMPL to carry out the **project "Long-term care strategies for independent living of older people (ICT-AGE)"** as an action of the Social Investment Package for Growth and Jobs (SIP) of the European Commission (2013a,b). This targets the development of science-based policies to close the gap between growth in long-term care needs and stagnant and shrinking resources through the use of technologies. The findings of ICT-AGE will also help the Member States to implement the country-specific recommendations of the European Semester for more effective long–term care policies.

Concretely, the **project ICT-AGE aims** to help the Directorate General for Employment, Social Affairs and Equal Opportunities (DG EMPL) to support the Member States in elaborating strategies to deliver long-term care for the independent living of older people at home based on the use of technologies. One of the project's first tasks was to identify and map good practices in technology-based services that enhance the independent living of older adults at home. This report presents the findings of this mapping exercise.

The identification and mapping of good practices **was carried out** through a **systematic literature review, followed by an analysis of the outputs** obtained. We limited the selection of good practices according to certain criteria, i.e.:

- we specified key words related to the definition and typology of technology-based services,
- we looked for practices that have reported their effectiveness in scientific articles, and
- that have been implemented at public or private level.

The good practices selected were analysed using a template we designed to collect information on their scope, aim, services delivered, and effectiveness. This information was collected using articles from the literature review (in English) and any other documents available on internet obtained by

[4] In the "constant disability scenario" the total number of years spent with disability during a person's life time is assumed to remain the same while life expectancy increases. Thus, if between time t and t+1, total life expectancy increases by n years for a cohort of age a, "disability-free" life expectancy for that very same age cohort must also increase by n years in order for the dynamic equilibrium hypothesis to be valid. If "disability free" life expectancy increases by n years, then the disability prevalence of this cohort of age a at time t+1 will be the same as the disability prevalence of cohort of age a-n at time t (European Commission and the Economic Policy Committee, 2011).

desk research. The information was processed and analysed according to the template. We also carried out a cross-analysis in order to find trends and to understand the development and evaluation of the good practices. These research tasks were carried out between May 2013 and December 2014.

The **literature review revealed** a total of 14 good practices in technology-based services for the independent living of the older adults at home. These services have been effective regarding the European policy objectives and are being delivered **by private or public organisations** to cover the needs of older people at home and their carers. The **analysis of these 14 good practices showed us** that they represent almost all the types of technology-based services for independent living available as good practices in the literature. These services cover a wide set of **long-term care needs** of older adults, mostly chronic conditions. Half of these good practices have been **implemented in the Member States**, and the other half **outside the EU** (the USA, Japan and Taiwan). It seems that the good practices selected are being mostly delivered in the **long–term care system** where the provision of long-term care is more oriented to formal services and with the support of informal care, than totally dependent on the informal sector.

9 of the fourteen good practices are in **operation** and have been running for many years. The newest good practice has provided services to older adults for 4 years and the oldest for 35 years. **Cost** information varies for each practice, though usually the service is provided by the implementing organisation in exchange for a fee paid by the end-user. These technology-based services for independent living have been widely implemented on **more than one site** and in many cases to **thousands of users**. They generally focus either on providing services that control the environment of the users in order to avoid emergencies, or help the users to follow health prescriptions and carry out the activities of their daily lives. Others focus on monitoring the health of older people at home, avoiding as far as possible their admission to care centres or hospitals. Other services include the maintenance of their social lives, and supporting ways of communication from home. A wide range of **devices** are being used to provide these services: internet/website, cameras, video, sensors, alarms, alerts, screens, computers, GPS, robots, software, remote controls, home automation, microphones, peripheral devices for health monitoring, games and consoles.

When **we analysed the studies on effectiveness** carried out by the good practices, we saw that these have been mainly initiated by the organisations that developed or implemented the service. The **methodologies** used to study the effectiveness of these 14 good practices are diverse, although we can identify a common tendency to select quite a high number of patients (more than 1,000 individuals) and to apply experimental or observational research designs. As regards the variables evaluated, it has been much more difficult to find a common pattern, as each good practice used different indicators. Regarding the **findings of the research on effectiveness** of the 14 technology-based services for independent living, 10 of them claimed to improve the independent living of older people at home, 6 claimed to increase the productivity of the carers, 3 the quality of care, and 10 generated savings for the public care systems contributing to their financial sustainability. Only one showed benefits for all four policy objectives.

To conclude, it is relevant to say that, to the best of our knowledge, this is the first study that has managed to document **a representative number of good practices** which have been scientifically demonstrated to deliver an increase in independence for older people living at home, an improvement in the productivity of carers, better quality of care, and the generation of savings contributing to the financial sustainability of the care system. These technology-based services cover a wide range of different, mature and mainstreamed technology-based services and products that are able to address effectively a set of long-term care needs.

1. INTRODUCTION

This report identifies and maps good practices in technology-based services that enhance the independence of older adults living at home. It is the first deliverable of the research project "Long-term care strategies for independent living of older people (**ICT-AGE**)". **ICT-AGE** aims to help DG EMPL to support Member States (MS) in the development of long-term care strategies promoting independent living for older adults at home through technology-based solutions. These solutions refer to any kind of technology including Information and Communication Technologies (ICT) that empower older adults to self-manage despite their frailties and with quality of life, or that help providers better organize the provision of care and increase the productivity and quality of long-term care delivery. The project is one of the actions which aims to achieve the objectives of the Social Investment Package for Growth and Jobs (SIP) of the European Commission (2013a,b), and to help the Member States to implement the country-specific recommendations of the European Semester for more effective long–term care policies.

The research will produce guidelines for the Member States on how to implement technology-based services for independent living, by:

1. Identifying and mapping good practices in technology-based services that enable older adults with different needs to live independently at home. These good practices have been successfully implemented in Europe, United States and Japan.
2. Taking a selected number of good practices case by case, and analysing their business case, business model, technology and organizational change, technical standards, quality, scale and scale-up, and national and EU role for leadership and transfer.
3. Elaborating manuals for policy makers on long-term care policies that could use technology to increase the independence of older adults living at home.
4. Identifying how the European Union could help Member States to implement these technology-based services.

In this report, we address the first objective (1), where we mapped these good practices for the independent living of older people at home. This report is structured as follows:

- In this section, we explain the background and structure of this report.
- In Section 2, we describe the research and policy framework that justifies the ICT-AGE project.
- In Section 3, we elaborate on the methodology followed to identify and map the good practices.
- Section 4 presents the results of the mapping.
- Section 5 offers conclusions, and introduces the next steps of the research (objective 2 in the list above).
- Section 6 provides the advantages and limitations of the study.
- We also provide 3 annexes at the end of the report: Annex I contains the list of articles obtained from the literature review of the good practices, Annex II includes the template used to collect the information of each practice, and Annex III describes each good practice according to the type of technology-based services for independent living of older adults at home it delivers.

2. RESEARCH AND POLICY FRAMEWORK

The European Commission (EC) has been proactive in supporting national social protection policies of the Member State (MS) to help them face the challenge posed by increasing numbers of older adults with functional limitations in Europe. The EC has been working with the Member States since 2004 through the Open Method of Coordination[5] on health and long-term care (European Commission, 2004) to ensure accessible, highly quality and sustainable long-term care services in the national systems. Across the European Union, long-term care for older people refers to a range of services and assistance for persons who over an extended period of time are dependent on help with basic activities of daily living and/or instrumental activities of daily living[6]. In Member States with extensive provision, social protection against long-term care risks also increasingly includes measures that help prevent, postpone or mitigate the onset of long-term care needs (European Commission, 2013b).

In 2013, EC policy stressed the importance of prioritizing long-term care for the coming years, mainly through the Social Investment Package for Cohesion and Growth (SIP) (European Commission, 2013a,b) and the European Semester[7] (European Commission, 2013c). The SIP points to the need to develop policies to close the gap between growth in long-term care needs and stagnant or shrinking resources. The policy focuses on enabling older people to continue to live independently with functional limitations, raising the productivity of care delivery and reducing the incidence and prevalence of frailty and disability. More concretely, particular attention is paid to **ways of increasing the capacity of people to live independently even when they are frail or have contracted multi-morbidities. These include a more age friendly environment and technologies to increase the older people's functional capacity, and also raising the productivity and quality of long-term care delivery** (European Commission, 2013a,b). The 2013 European Semester also asks the Member States to implement reforms to achieve more efficient use of limited public resources and access to high quality long-term care (European Commission, 2013c). In this task, **technologies** could play an important role by helping older people to live independently for longer at home, improving their quality of life and health, providing more qualified care and improving the cost-effectiveness of public spending in long-term care (Carretero et al., 2012b; Billings et al., 2013). Innovation for an active and healthy ageing are in fact objectives being also addressed since 2012 through the European Innovation Partnership in Active and Healthy Ageing (European Commission, 2012a).

We explain below the rationale behind European Union policy for prioritising policy solutions for long-term care at European level, the relevance of focusing on independent living, and the role played by technologies in achieving this objective.

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5 The social OMC is a voluntary process for political cooperation based on agreeing common objectives and measuring progress towards these goals using common indicators. The process also involves close co-operation with stakeholders, including Social Partners and civil society.

6 **Activities of Daily Living (ADLs)** are self-care activities that a person must perform every day such as bathing, dressing, eating, getting in and out of bed or a chair, moving around, using the toilet, and controlling bladder and bowel functions. **Instrumental activities of daily living (IADLs)** are activities related to independent living and include preparing meals, managing money, shopping for groceries or personal items, performing light or heavy housework, and using a telephone (European Commission, 2013b).

7 The European Semester represents a yearly cycle of EU economic policy guidance and country-specific surveillance. Each year the European Commission undertakes a detailed analysis of EU Member States' programmes of economic and structural reforms and provides them with recommendations for the next 12-18 months. http://ec.europa.eu/economy_finance/economic_governance/the_european_semester/index_en.htm

2.1 The increase of older adults in need of long-term care in Europe

Older people lose their **independence** when they do not have "the ability to perform the activities of daily living with little or no help from others" (WHO, 2002). In other words, older people turn **in need of long-term care** when they arrive at "a state in which, by reason of lack or loss of physical, psychological or intellectual autonomy, they require significant assistance or help in carrying out their usual day-to-day activities" (Council of Europe, 1998).

The demographic and epidemiological transitions experienced by European countries since the beginning of the 20th Century are **increasing the number of older Europeans with functional limitations**. Member States are finding it challenging to maintain sufficient quality of life for more old people, and, at the same time, be more efficient with their economic and human resources. In fact, the number of Europeans aged 65+, and particularly those aged 80+, who are affected by chronic conditions that limit their independence and affect their relatives' lives, is increasing. Forecasts tell us that older people (65+) will represent 30% of the total EU27 population in 2060, against the current 17%. Very old people (80+) will make up 12% of the population by 2060 (4% in 2008) and will represent 40% of all older people for that year (25% in 2008) (Giannakouris, 2008).

Table 1: Self-perceived limitations in daily activities (activity restriction for at least the past 6 months) by sex and age (%) [hlth_silc_07]

	SEVERELY HAMPERED					HAMPERED TO SOME EXTENT				
TOTAL										
AGE	2005	2006	2007	2008	2009	2005	2006	2007	2008	2009
From 15 to 24 years	1,4	1,4	1,4	1,5	1,6	5,5	5,0	5,1	5,2	5,6
From 25 to 34 years	2,3	2,5	2,3	2,3	2,2	7,8	7,4	7,3	7,0	7,5
From 35 to 44 years	3,9	3,8	3,8	3,8	3,9	11,4	11,0	10,8	10,8	10,9
From 45 to 54 years	6,8	7,1	6,9	6,9	6,6	16,0	16,1	15,7	16,3	16,5
From 55 to 64 years	10,4	10,1	10,0	10,9	10,6	23,1	23,0	22,8	23,5	24,1
From 65 to 74 years	14,0	14,3	14,2	14,6	14,7	31,2	30,5	29,8	31,5	32,1
From 75 to 84 years	22,7	23,5	23,8	25,0	25,0	35,8	35,6	35,0	37,1	37,1
85 years or over	36,1	38,3	37,2	39,5	37,6	32,6	31,2	31,4	34,4	35,6
Total	7,7	7,8	7,8	8,1	8,1	16,7	16,4	16,2	16,8	17,4
MEN										
AGE	2005	2006	2007	2008	2009	2005	2006	2007	2008	2009
From 15 to 24 years	1,5	1,4	1,5	1,5	1,7	5,1	4,5	4,4	4,6	5,0
From 25 to 34 years	2,4	2,4	2,4	2,5	2,4	7,4	6,7	6,5	6,7	6,9
From 35 to 44 years	3,8	3,5	3,6	4,0	4,1	10,7	9,9	10,0	9,8	9,7
From 45 to 54 years	6,7	6,8	6,8	6,9	6,4	14,7	14,6	14,1	15,1	15,1
From 55 to 64 years	10,5	10,1	10,1	11,4	11,0	21,6	20,7	21,2	22,0	22,1
From 65 to 74 years	13,0	13,4	13,0	14,0	13,9	29,6	27,9	27,3	28,7	29,9
From 75 to 84 years	20,3	21,2	21,3	22,7	23,0	34,4	33,7	33,7	36,3	34,1
85 years or over	30,9	32,6	32,1	35,2	33,2	32,6	32,7	32,4	34,9	35,8
Total	6,9	6,9	6,9	7,5	7,5	15,2	14,4	14,3	15,1	15,4
WOMEN										
AGE	2005	2006	2007	2008	2009	2005	2006	2007	2008	2009
From 15 to 24 years	1,2	1,3	1,3	1,5	1,4	5,8	5,7	5,8	5,8	6,1
From 25 to 34 years	2,3	2,6	2,3	2,2	2,0	8,3	8,0	8,1	7,3	8,0
From 35 to 44 years	3,9	4,0	4,1	3,5	3,6	12,0	12,0	11,6	11,8	12,0
From 45 to 54 years	6,9	7,5	7,0	6,9	6,8	17,2	17,6	17,3	17,4	17,9
From 55 to 64 years	10,3	10,0	9,9	10,4	10,2	24,4	25,1	24,2	24,8	26,0
From 65 to 74 years	14,9	14,9	15,3	15,1	15,3	32,6	32,5	31,9	33,7	34,0
From 75 to 84 years	24,3	25,0	25,5	26,5	26,4	36,7	36,9	35,7	37,7	39,1
85 years or over	38,6	41,1	39,8	41,6	39,8	32,7	30,5	30,9	34,2	35,4
Total	8,4	8,7	8,6	8,7	8,7	18,1	18,3	18,0	18,5	19,2

Notes. European Union (EU6-1972, EU9-1980, EU10-1985, EU12-1994, EU15-2004, EU25-2006, EU27).
Source: EU-SILC. Eurostat database, http://appsso.eurostat.ec.europa.eu/nui/show.do

Nowadays, although we have gained in life expectancy, we have also lost in health in the last years of our lives. As we get older, we are more likely to be affected by several chronic diseases that limit our capacity to carry out the activities of daily life. For example, in 2009, men and women in the EU27 lived 15.5 and 20.4 years with disability, respectively. Those who are 65 years old now will live more than 50% of their remaining years of life with a disability (Eurostat, 2010). Moreover, as we can see in Table 1, the percentage of people who perceive themselves to be severely hampered in carrying out the activities of daily life in the last 6 months due to a health problem is higher in older groups. People over 85 years old and women are the most affected.

The increase in the number of older people also affects the number of older people with functional limitations. Data in Table 2 confirms that while in 2005, dependent older people represented 52% to 62% of people in need of long-term care, in 2050, this figure will be 70% to 78% (Grammenos, 2005).

Table 2: Number of people in need of long-term care, EU - 25

Table 2: Number of care dependent people, EU 25.

	Narrow definition (ADL)					Wide definition (ADL and/or IADL)				
	2005	**2030**	**2050**	Change 2005-30	Change 2030-50	**2005**	**2030**	**2050**	Change 2005-30	Change 2030-50
	Absolute number			%		Absolute number			%	
25-64	3.467.706	3.187.553	2.398.707	-8,1	-24,7	14.872.111	13.839.951	10.853.629	-6,9	-21,6
65+	5.762.455	7.836.499	8.607.444	36,0	9,8	16.412.520	22.914.690	25.647.023	39,6	11,9
Total	**9.230.161**	**11.024.051**	**11.006.151**	**19,4**	**-0,2**	**31.284.631**	**36.754.641**	**36.500.651**	**17,5**	**-0,7**

Note. Narrow indicators of care dependency refer to the need of assistance for the activities of daily living (ADL). Wider definitions cover ADL and instrumental activities (IADL).
Source: Grammenos, 2005.

Arthritis and especially osteoarthritis, dementia, strokes and coronary heart disease, sensory problems, diabetes mellitus, and Chronic Obstructive Pulmonary Disease (COPD) are the main causes of loss of independence in old age (Spiers et al., 2005; WHO, 2008; Jagger et al. 2011). These chronic diseases limit the capacity of older people to carry out alone the activities of daily life. Walking ability and speed, climbing, pulling/pushing, lifting/carrying and reaching/extending, and grip strength are the activities that are most affected (Seidel et al., 2011) – see Box 1 for more details on specific problems to dependency by chronic disease.

Box 1: Limitations to daily activities by main chronic diseases linked to dependency

Cognitive impairments and dementia are certainly the most challenging risk factors, because there is no cure today for dementia. The most common cause of dementia in the European Union is Alzheimer's disease (around 50-70%), followed by successive strokes that lead to multi-infarct dementia (around 30%). They affect memory especially and severely disrupt social functioning and the activities of daily life (American Psychological Association, 1987). The relationship between cognitive impairment and dependence is explained by the fact that cognitive resources allow individuals to respond and adapt to demands and environmental needs and to engage in higher levels of functioning (Femia et al., 2001).

In the case of **arthritis** (Figure 1), osteoarthritis is the most common problem affecting human joints. It causes pain, stiffness, weakness, joint instability, and reduced range of motion. Rheumatoid arthritis affects between 1 and 3% of the population in most countries. Although the exact cause is unknown, evidence suggests that an immune reaction causes inflammation of the joints and other tissues, and may result in tiredness, fatigue, weight loss, fever, pain, and disability and deformity of the joints. Other musculo-skeletal conditions like osteoporosis are caused by low bone mass and deterioration in the bone structure, and can lead to fracture after mild or moderate trauma. The most common fractures occur in the arms, vertebrae, and hips. Fracture risk increases with age and has an important impact on quality of life, mortality, and healthcare costs in most countries (DCP2, 2007).

Figure 1. Estimated burden of Musculoskeletal conditions, by gender and region, 2001

Estimated Burden of Musculoskeletal Conditions, by Gender and Region, 2001					
	Total	Males	Females	Developing Countries	Industrialized Countries
Numbers of DALYs (thousands)					
Osteoarthritis	16,372	6,621	9,750	11,049	5,323
Rheumatoid arthritis	4,757	1,353	3,404	3,238	1,520
Other musculoskeletal conditions	8,699	5,033	3,638	6,789	1,880
All musculoskeletal conditions	29,798	13,007	16,792	21,076	8,723

Source: Calculated from WHO (2004).

Source: DCP2, 2007.

Strokes constitute a leading neurological cause of long-term disability. Over half of those still alive after six months depend on others for everyday activities (Wolfe, 2000) and at least one-quarter remains moderately or severely disabled three years after a stroke (Patel et al., 2006). Strokes have also been associated with depression (Hackett et al. 2005) and have been shown to increase the risk of dementia (Liebetrau et al., 2003) and of falls and fractures (Poole et al., 2002), further adding to the overall disease and disability burden (Pomerleau et al., 2008).

Diabetes mellitus has a major impact on the global burden of disease through its detrimental effects, if not controlled, on the heart, blood vessels, eyes, kidneys and nerves, so accelerating death and disability from other conditions. In 2002, approximately 1.5% of the total disease burden was attributed to diabetes in Europe (men, 1.2%; women, 1.8%) (WHO, 2004). The number of disability-adjusted life year (DALYs)[8] lost through diabetes tends to increase with age up to 80 years. Rates tend to be higher among men under the age of 60 but higher for women at older ages (Pomerleau et al., 2008).

In the case of chronic airways conditions, **COPD** places a considerable burden on affected individuals, including poor physical functioning and distressing symptoms that require frequent hospital admission. The burden of COPD is estimated to be 393 DALYs per 100,000 population, with particularly high rates in individuals aged 70 years and over (WHO, 2004). At the age of 60–79 years, rates are almost twice as high in men as in women, reflecting the leading role of smoking as a causative factor (Pomerleau et al., 2008).

Psychological states like depression, bad self-perceived health and social isolation have been related to the onset and changes in disability, while social support and emotional vitality can have a positive influence on recuperation of the capacity to deal with daily life activities (The Finnish Centre for Interdisciplinary Gerontology, 2004; Carretero et al., 2006).

Thus, demographic ageing is increasing the number of older people who are losing the capacity to carry out the activities of daily life by themselves, and therefore need long-term care. Although there is very little doubt about the fact that the European Union is facing massive population ageing (Scherbov and Mamolo, 2006), there is substantial debate about the changes in the prevalence of disability: compression or expansion of disability in old age. But in general many authors agree on the increase in the number of very old people will also mean an increase in the number of severely disabled older people[9] (Jagger et al., 2006; Lafortune and Balestat, 2007; Robine et al., 2009).

[8] DALY (disability-adjusted life year) is a composite measure that combines the number of years lived with a disability and the number of years lost to premature death. As pointed by the Word Health Organization, one DALY can be thought of as one lost year of "healthy" life (http://www.who.int/healthinfo/global_burden_disease/metrics_daly/en/).

[9] The debate around the prevalence of the disability at old age is due to that the longevity has improved and people are also adopting better behaviours and the medicine is testing new treatments So it could be reduce the chronic diseases and their impact in the future among older population. In fact, these authors affirm that although several current trends like older people better educated or fewer smokers could mitigate this growth, but no generating a compression of the disability. This is mainly because that there is an increasing prevalence of other chronic conditions such as arthritis and diabetes and risk actors like hypertension and obesity that can increase the number of disabled people unless greater efforts are made to either prevent or treat these conditions.

This trend will lead to increased demand for formal and informal long-term care. For example, in 2004, 12.6 million of 65+ people had some degree of dependency for the activities of daily life in the EU25, see Table 3. Of these, 14.6% were in formal care institutions, 26.6% received formal care at home and 55.7% were only cared for by their families or did not receive any care (Tsolova and Mortesen, 2006).

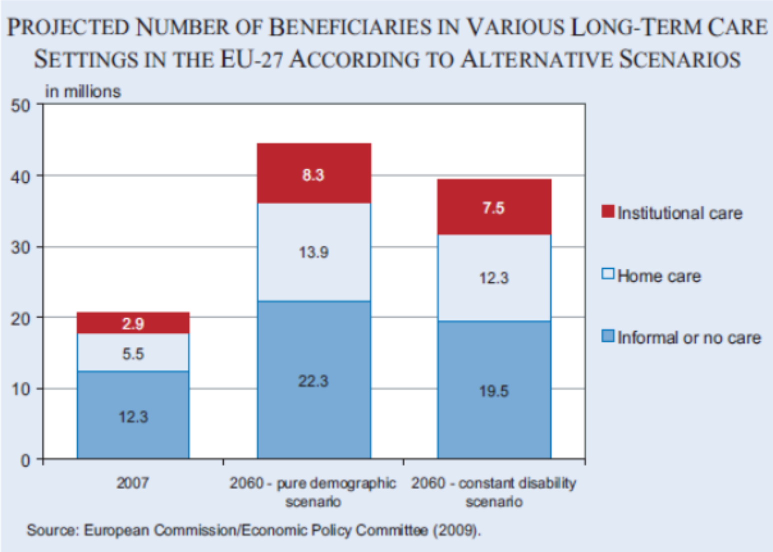
Table 3: Population with functional limitations in EU Member States in 2004: absolute and percentage of total population 65+

Countries Number of persons (000´s) % of population aged 65+			% of people with functional limitations		
			Formal care in institutions	Formal care at home	Informal or no care
BE	416	23.1	35.3	27.4	37.0
DK	139	17.4	9.4	126.6	0.0
DE	2790	18.7	19.2	34.9	45.9
ES	1449	20.4	10.9	19.7	69.3
IE	91	22.8	22.0	31.9	46.2
IT	2214	19.9	8.7	42.1	49.1
LU	13	13.0	23.1	30.8	46.2
NL	362	15.7	21.8	n/a	n/a
AT	197	15.2	n/a	n/a	n/a
FI	183	22.9	31.1	28.4	40.4
SE	322	21.5	31.7	44.1	24.5
UK	2899	30.5	9.6	15.2	75.2
CZ	299	21.4	25.8	18.7	55.5
LT	103	20.6	23.3	4.9	71.8
LV	65	16.3	7.7	6.2	87.7
MT	19	19.0	68.4	26.3	5.3
PL	885	17.7	11.9	5.0	83.3
SK	127	21.2	24.4	29.1	46.5
SI	58	19.3	20.7	17.2	62.1
EU25	12631	16.8	14.6	26.2	55.7
EU15	11075	17.0	14.3	28.5	53.4
EU10	1556	15.4	17.0	10.3	72.6

Note: n/a: not available. Data not available for Greece, France, Portugal, Cyprus, Estonia and Hungary.
Source: Economic Policy Committee and the European Commission (DG ECFIN), 2006, table retrieved from Tsolova and Mortesen, 2006

In 2007, the number of older people with functional limitations rose to 20.7 million. This figure has a similar breakdown to those needing care in 2004: 14.01% were in formal care institutions, 26.57% received formal care at home and 59.42% were only cared for by their families or did not receive any care. Following different scenarios, the number of people in need of formal care is expected to almost double from now to 2060. Most will need home or institutional care. Following a constant disability scenario, for example, around 20 million of people with functional limitations in the EU27 will be using some kind of formal care in 2060 (Przywara et al., 2010), see Figure 2.

Figure 2: Projected number of beneficiaries in various long-term care settings in the EU-27 according to alternative scenarios



Source: ECFIN (2009) extracted from Przywara et al., 2010

This increase in demand for long-term care by older people is a challenge for the Member States. On the one hand, the formal care system will not have enough economic and human resources to deal with this increase. We know that public expenditure on long-term care in the EU27 could almost double over the period 2010–60: +1.7 percentage point of GDP increase (ECFIN, 2012). Moreover, the intensive work, the non-standard working hours and low wages, and other unsatisfactory working conditions (e.g., lack of promotion, social and labour recognition) of the sector that cares for the older adults make it difficult to attract and retain large numbers of qualified workers (Maucher, 2008; Fujisawa and Colombo, 2009; Simonazzi, 2009). On the other hand, informal care will be also a limited resource for care in the future. Current demographic change projects a decrease in the availability of informal carers and a gap between demand and supply in informal care (Robine et al., 2007; Karlsson et al., 2004; Pickard, 2008; Pickard et al., 2009). Caring also represents an unsustainable opportunity cost for women, because it leaves them out of economic and working life and leads them to mental and physical health problems, related to burden this kind of work represents (Carretero et al., 2007, 2009).

Independent living services have the potential to help older adults remain independent in their homes as long as possible and, at the same time, mitigate the workforce shortages and financial burdens that are inherent to long-term care (SCAN Foundation, 2010). They can maintain the quality of care provided to older people and help European care systems remain sustainable. We elaborate below the importance of these services in supporting long-term care policies.

2.2 Independent living services

Independent living services are any kind of services that help older adults to overcome barriers to independence. These services have been defined as "any product, application or service that enables people, whose independence in daily life is challenged, to lead a more independent and participatory life" (Cabrera and Özcivelek, 2009). They include those services that help individuals who have impairments (physical, mental, cognitive, or sensory impairment) or face other economic or social barriers to independence, to function independently in the community. These services assist these people in their efforts to maintain or obtain independence and control over the decisions and directions of their own lives. The goals of these independent living services are to maximize empowerment, independence and productivity of individuals and their integration and inclusion in the mainstream of society (Malanowski et al., 2008).

Technologies are playing a role to develop effective independent living services for the older people at home. Previous work at the Institute for Prospective Technological Studies (JRC-IPTS) has identified **technologies for independent living services** as those technologies which aim to prolong the time old people can live decently in their own homes by increasing their autonomy and self-confidence, and to allow them to live and participate actively in society (Dries et al., 2006; Cabrera and Özcivelek, 2009).

The role that technologies have in assisting older people to maintain independence in their homes is increasing in many European countries. Nowadays, technology-based services for independent living cover different devices and applications. Descriptions of the different types can be found in the literature (Dries et al., 2006; Malanowski et al., 2008; Gassner and Conrad, 2010; Lewin et al., 2010; SCAN Foundation, 2010). We have classified them as follows:

- **Generic information and communication technology (ICT) products, services and applications.** They are generic because they are ICT products, services and applications available in the market and developed for everybody, and in addition they play a relevant role as a technology service for the independence of older adults at home. These services include mostly communication devices such as mobile phones and applications on internet, that can be remotely access from homes to engage older people in a range of activities: e.g. social, working, learning or entertainment activities. They can open up many opportunities for participation for people who have restricted mobility, for social contact with distant family or kin and in friendship networks. Older people can obtain consultancy, information and educational content and participation in cultural and political life, and improved technical preconditions which help them retain work. They can also access daily life services such as banking or shopping. For example:
    - *Teleworking services* help people to work remotely from home for an employer, a voluntary organisation or themselves. These services need remote computing to work successfully.
    - *Information and training platforms* train and supply documentation for education.
    - *Social Networking technologies* enable the creation of social networks and focus on building communities of interest that help older adults communicate, organize, and share with other older adults and with their care providers. They can include platforms to organise meetings on the Internet or in real life which helps older people with their leisure activities and social lives: examples are chat, talent exchange, flea market, search for former friends, partner search forums, internet communities, and computer assistance (Empirica, 2005).
    - Online services such as those offering tele-shopping or tele-banking.

- **Assistive technologies** refer to devices and equipment that compensate for sensory, physical/mobility, and cognitive impairments. They include voice recognition software, text telephones, accessible keyboards, speech recognition software (Pew and Van Hemel, 2004), intelligent electric magnifiers and reading lenses, and other assistive devices to drive a car or to do sports (Gassner and Conrad, 2010).

  These technologies also include *assistive robots,* defined as those that help older people with physical disabilities to carry out daily life activities or to recover or maintain some capacity. There are prosthetics robots that replace lost or damaged parts of the body; or mobility aids i.e. non-prosthetic technology which replace or extend the functionality of a leg or an arm; robots for training and rehabilitation to be used for individual training, exercises and rehabilitation; and finally robots that carry out logistic and cleaning tasks, which can be used for personal care (Hansen, 2011).

- **Smart homes** refer to different ICTs integrated in older people's houses to help them to perform everyday life activities independently. They include remote-controlled home automation systems, which have various sensors for doors and gates, microwaves or normal stoves, security devices, lighting, and an on/off switch for various appliances and home entertainment (Allen et al., 1995). The lighting systems may for example be controlled. They can also include generic ICT applications such as online services offering tele-shopping or tele-banking (Gassner and Conrad, 2010). Smart homes are composed of sensors, actuators, controllers, a central unit, networks and an interface (Laberg et al., 2005). The ICT components are programmed to react and communicate with each other through a local network, and with the surroundings via the Internet, ordinary fixed telephones or mobile phones. The technology can be used to monitor, warn and carry out functions according to selected criteria.

- **Technology-based healthcare.** The following healthcare technologies can help to prevent, detect early, cure, and manage chronic conditions ;
  - *Telemedicine* is defined by the WHO as "the delivery of healthcare services, where distance is a critical factor, by all healthcare professionals using information and communication technologies for the exchange of valid information for diagnosis, treatment and prevention of disease and injuries, research and evaluation, and for the continuing education of healthcare providers, all in the interests of advancing the health of individuals and their communities" (WHO, 1998). Telemedicine involves secure transmission of medical data and information, such as biological/physiological measurements, alerts, images, audio, video, or any other type of data needed for prevention, diagnosis, treatment and follow-up monitoring of patients (European Commission, 2009).
  - *Telehealth* or disease management applications deliver services from a healthcare provider to a citizen, from one health professional to another, or between citizens and family members (Stroetman et al., 2011). Telemedicine and telehealth are similar and in many documents appear as the same concept, but the former refers to service delivery by physicians only, and the latter to services provided by health professionals in general, including nurses, pharmacists, and others (WHO, 2009). In this framework of long-term care needs, home telehealth refers to a range of support, typically including not just clinical (medical) monitoring and intervention, but also a broader range of homecare support that more traditionally falls within the scope of social/homecare services (Empirica, WRC and European Commission, 2010).
  - *Telemonitoring or remote patient monitoring* is the remote exchange of physiological data between a patient at home and healthcare professionals at a hospital to assist in diagnosis and monitoring. Several technologies remotely manage and monitor a range of health conditions, and collect/send vital signs to a monitoring station for interpretation. A home unit measures and monitors temperature, blood pressure and other vital signs for clinical review at a remote location (for example, a hospital) using phone lines or wireless technology (COCIR, 2011). Point-of-care (e.g., home) monitoring devices, such as scales, glucometers, and blood pressure monitors, may be used individually to collect and report health data, or they may be part of a fully integrated health data collection, analysis, and reporting system that communicates to multiple nodes of the health system and provides alerts when health conditions decline (SCAN Foundation, 2010).

- **Technology-based home care** refers to the use of ICTs to monitor well-being and to provide a secure home environment. They include:
  - *Telecare:* this refers to the provision of social care from a distance using telecommunications (Empirica and WRC, 2010). Three generations of telecare have been identified (Empirica and WRC, 2010):

    - First-generation telecare consists of social/emergency alarms which use a telephone unit and a pendant with a button that can be pressed when help is required by the users. After the users press the button, monitoring centre systems receive the call and identify the callers and

their address. An initial diagnosis of the nature and urgency of the need can be explored by voice link. Nominated response personnel (informal or formal carers) are alerted as required by the situation, following an established protocol.

- Second-generation telecare adds a 'passive' or automatic alarm dimension (no need for the older person to actively trigger the alarm) enabled by the installation of sensors such as smoke, fire and flood detectors, among others, in the older person's home; when activated, these trigger an alert to the call centre and initiate the necessary response.

- Third-generation telecare collects everyday activity data automatically through various sensors such as front door open/closed detectors, fridge open/closed detectors, pressure mats, bed/chair occupancy and electrical usage sensors. This data is presented to care personnel or family carers to monitor wellbeing and assess the need for help and support.

  - *Medication Optimization* refers to a wide variety of technologies designed to help manage medication information, dispensing, adherence, and tracking. Technologies range from fully-integrated devices that use ICTs to inform and remind stakeholders at multiple decision and action points throughout the patient care process to the simpler, standalone devices with more limited functionality.

- **Technology-based wellness services** deliver services for healthier lifestyles to older people at home. They include mainly cognitive and physical fitness and assessment technologies, such as thinking and cognitively challenging games to maintain or improve cognitive health. Many cognitive fitness technologies are computer- or Internet-based, and they include an assessment and tracking component. They can also include social robots whose tasks is to maintain some form of interaction (Fong et al., 2003), and to engage older adults in natural social exchanges (Breazeal, 2000). They give a sense of social presence in an interaction and the capacity for touch and physical interaction (Kidd and Breazeal, 2005).

Below in Figure 3, we schematized this classification of technology-based services for independent living.

Figure 3: Classification of technology-based services for independent living

Advocates argue that the use of technologies for long-term care permits a more person-centred approach. Technologies can support older people with both physical and mental long-term conditions, and assist carers thus reducing their burden. Evidence is accumulating about the value of technologies such as telecare, telemedicine and telehealth and how their use is becoming more widespread. For example, reviews and studies are emerging that reveal that these technology-based services are able to reduce hospital admissions, the length of stay for patients (Benatar el al., 2003; Cleland et al., 2005; Dar et al., 2009; Polisena et al., 2010), the non-attendance rates of patients to consultations or the number of trips to the care centre (Hasvold and Wootton, 2011; Wootton et al., 2011). These effects are beneficial to the broader sustainability of social and health systems and use of resources. In fact, some technology-based services for independent living have provided reliable evidence that they improve the delivery and efficiency of health and social care systems and can be taken as examples of good practice for long-term care policies among Member States (Carretero et al., 2012a).

Despite these advances across Europe, the implementation of technology-based services for independent living is still slow in the Member States mainly due to the following challenges (Carretero et al., 2012a, b; Billings et al., 2013):

- Technology-related issues: Older people can lack the 'digital' competences required. According to Eurostat (2011), in 2010, 49% of men and 61% of women aged 55 to 74 in Europe have either never used the Internet or have not used it for more than a year. Moreover, equipment, interfaces and services designed to promote healthy and active ageing are not tailored to the functional limitations of older people. In addition, because care systems are slow to adopt new ways of working, the necessary 'simultaneous innovation', where the system changes to keep pace with technology, does not occur (Goodwin, 2012). Moreover, health and social care professionals show reluctance to accept new technologies, mainly because the technology implies to learn new competences and a change in their traditional way of working, and because they are also afraid about being substituted by the technology. There are also barriers associated with interoperability and standardisation of the technology.
- There is little evidence of effectiveness and efficiency. There is still a lack of information and robust studies on the effectiveness and efficiency of these technologies, and this creates a barrier to public and private investment to implement solutions on a wider scale. For example, there is scepticism regarding the ability of technology-based solutions to produce tangible benefits, some impacts only can be measured in a long-term basis, and there are some indicators that have failed to demonstrate the effectiveness of these solutions, despite their innovative potential to increase the health and well-being of older people and their carers..
- There is little understanding of the role of technologies in long-term care systems and services, on how and where technology-based solutions can benefit long-term care structures and interfaces, particularly with respect to health and social care delivery and integration, and the links between formal and informal care.
- Up until now, development has been small–scale. There is an emerging yet growing industry, though most activities are still in the pilot phase or stop after the pilot. There is little knowledge of the steps that must be taken to scale up technology-based services for independent living for older people.
- Transferability of good practice may depend on a number of variables, such as the national or local characteristics, cultures or habits, and the surrounding health and welfare system or the existing support services.
- There is a lack of efficient business models that could show governments how many the services would cost and convince them that there would not be any 'add on' costs.

Policy could boost the introduction of effective solutions for independent living, and provide solutions for the above challenges. Besides providing funding to create, develop and innovate technology-based services for older adults and carers through R&D and innovation programmes (e.g. Framework Programmes and Ambient Assisted Living Joint Programming), one of the main strategies European policy could follow is to promote the exchange of good practices, the collection of evidence and the transferability of optimal solutions to other localities, regions and countries, to encourage the use of existing effective solutions in the EU (Carretero et al., 2012a). In fact, these strategies are already being promoted by the EC policy for long–term care, for example the SIP and the European Innovation Partnership on Healthy and Active Ageing (EIP AHA). EC policies to promote technology-based services for independent living are presented in the next section.

2.3 European Commission policies for technologies for independent living

The European Commission has being proactive in supporting the Member States' national social protection policies which face up to the challenge of the increase of older adults in need of long-term care in Europe. The European Commission has been working with the Member States since 2004 through the Open Method of Coordination on health and long-term care (European Commission, 2004) to ensure accessible, high quality and sustainable long-term care services in the national systems. The last annual report of the Social Protection Committee (European Commission, 2013d) pointed out that the search for effective long-term care policies is one of the most pressing challenges facing modern European society. The Member States perceive long-term care not only as a cost factor but also as an investment. They acknowledge that they need to develop and implement efforts to rationalize costs and to design and implement long-term care services. The exchange of information on specific measures among Member States is becoming a useful and required practice that needs to be strengthened to help them to reform their legislation and integrate long-term care services.

In 2013, EU policy stressed the importance of prioritizing long-term care for the coming years, mainly in the **Social Investment Package for Cohesion and Growth –SIP-** (European Commission, 2013a, b) and the **European Semester** (European Commission, 2013b).

The SIP**,** published in early 2013, develops policies to contain growth in long-term care needs, based on a medium to long-term strategy of social investments which aims to raise the productivity of care delivery, reduce the incidence of frailty and disability and enable older people to continue to live independently despite functional limitations. In the Commission Staff Working Document on long-term care accompanying the Communication of the SIP (European Commission, 2013), The Commission will help the Member States to develop these policies through a work programme of the Working Group on Ageing of the Social Protection Committee for 2013-2014, which will be tasked with generating innovative approaches to social protection against long-term care risks. These innovation policies will be established through the organisation of knowledge generation and best practice exchange on a range of policies for early prevention through to practical delivery of long-term care, including the role of informal carer. Particular attention is dedicated to policies that can increase capacity for independent living even when people become frail or contract multimorbidities. Policy solutions include a more age-friendly environment and **technologies** which increase the client's capacity to manage, thus raising the productivity and quality of long-term care delivery. These policies will respond to the challenges of limiting the growth of long-term care needs, ensure access to long-term care, secure the quality of care, and maintain care delivery's financial sustainability. Indeed, the purpose of this project (ICT-AGE) is to help the Commission and the Member States to elaborate innovation policies for delivery of long-term care for the independent living of older people at home, based on use of technologies.

The **European Semesters from 2013** will involve careful examination of social budgets and policies in all social protection areas. Following the Health Review and Long-term Care Review conducted in autumn 2012, country-specific recommendations will have to be made for each Member States, to help them reform their respective health and long-term care systems. Since 2013, health and long-term care have been set very high on the agenda and are considered to be priority areas. Specifically, the 2013 European Semester country-specific recommendations recognized the scope to improve the cost-effectiveness of public spending in long-term care. The Commission has asked the Member States for reforms to achieve more efficient use of limited public resources and improve access to high quality long-term care (European Commission, 2013c). The last assessment of policy reforms reported in the Annual Growth Survey 2014 reports that, whilst long-term care services are often affected by budget constraints, countries are also taking steps to secure better organization of these social services (European Commission, 2013e).

Other European policies also contribute to the efforts towards more independent living, productivity, quality of care and efficiency of long-term care. Promoting independent living is one of the guiding principles for **active ageing adopted by the Council of the European Union** (2012), where social innovation and more effective use of new technologies play a major role. The **Voluntary Quality Framework on Social Services of General Interest** (The Social Protection Committee, 2008) and the European **Innovation Partnership on Healthy and Active Ageing (EIP AHA)** stress the need to empower long-term care patients. The EIP AHA also highlights the exchange of good practices to resolve the challenges of long-term care. The aim of this partnership is to increase by 2 the average number of healthy life years (HLYs) in the European Union by 2020, by securing a triple win for Europe: 1) Improving the health status and quality of life of European citizens, with a particular focus on older people; 2) Supporting the long-term sustainability and efficiency of health and social care systems, and 3) Enhancing the competitiveness of EU industry through an improved business environment providing the foundations for growth (European Commission, 2012a).

The EIP AHA has identified an urgent need to shift the focus from acute, reactive, and hospital-based care to long-term, proactive and home-based care, integrating both health and social settings. This should be underpinned by health promotion, disease prevention, independent living and integrated health, social, community and self-care. Living and working environments also need to be adapted to empower older people to remain functional and active for longer. To achieve this, the Partnership must overcome or reduce barriers in the area of active and healthy ageing, by identifying cross-cutting solutions, bridging sectors, competences and instruments and sharing best practice, in a wide, results-oriented, collaborative effort, and by maximising the use of existing knowledge and best practice.

The **Employment Package for a job-rich recovery** also advocates in its **Staff Working Document on personal and household services** to create employment in the care sector and to improve the quality of care provided at home (European Commission, 2012b). In fact the number of people in the age group 80+ that could develop long-term care needs could triple over the next two decades. At the same time the pool of potential carers will shrink substantially over the next few decades as working age cohorts becomes smaller and the female employment increases. Jobs could therefore be created in formal personal and household services. In this staff working document, ICT is recognized as a way of improving the competitiveness of proximity services, reducing management costs, and improving professionalization and the attractiveness of the activity.

Ensuring and improving the **quality of long-term care services** has become an important policy priority across EU and OECD countries (OECD and European Commission, 2013). The challenge lies in measuring and developing indicators to improve quality in the care delivery. The European project **WeDo** has developed a European Quality Framework for long–term care services that is the first instrument to work at EU level (European Partnership for the Wellbeing and Dignity of Older people, 2012).

Another relevant policy topic is the **coordination of long-term care benefits** among the Member States (Regulation (EC) No. 883/04), in terms of homogeneity in national systems.

To address these objectives and achieve an exchange of good practices, the Member States and the Commission need sound scientific evidence-based solutions which can be transferred and which help the Member States to successfully adopt technology-based services for independent living. Moreover, where services have already been successful, it is necessary to know how they have been implemented. Certainly, their implementation has specific and common features that can create guidelines to support the policy and generalize its use.

In this report, we provide sound scientific evidence of the impact of technology-based services for independent living. This has been done by identifying and mapping good practices in technology-based services for independent living at home for older adults. Examples of good practice were taken from Europe and outside (e.g. the US and Japan). Besides increasing independent living at home, these technologies have also raised the productivity and the quality of long-term care delivery.

3. METHODOLOGY

In this section, we describe the methodology followed to identify, map and analyse the good practices in technology-based services for independent living of older people at home. In the following sections, we detail the criteria used to select and map these good practices, the information analysed and the instrument or template designed to collect the information. At the end of this chapter, we explain the procedure used to obtain and analyse the information collected.

3.1 Criteria and steps to select and map the good practices

To identify and map good practices in technology-based services for independent living at home for older adults, we carried out a systematic literature review followed by an analysis of the outputs obtained. We followed the steps below:

- **In Step 1, we defined and selected the key words that guided the literature review according to the objectives of this study**. For this purpose, we proposed:

  (A) A definition on what we understand by technology-based services for independent living for older people at home in this study. We took the following previously-developed definition, based on the definition of independence of the WHO (2005), where:

> ***Information and Communication Technologies for independent living services*** *are those ICTs aimed to prolong the time old people can live decently in their own homes by increasing their autonomy and self-confidence, and to allow them to live and participate actively in society (Dries et al., 2006; Cabrera and Özcivelek, 2009).*

  (B) Refining the types of technology-based services for independent living for older people at home, following the typology elaborated in Section 2.3 of the research and policy framework (see Figure 3). For the specific case of disease-specific healthcare technologies, we did not include telemedicine because it is a technology-based service focused on healthcare and the management of vital signs (Figure 4).

Figure 4: Classification of typology of technology-based services for independent living used for the research

(C) To identify only studies that have evaluated the effectiveness of these technology-based services for the independent living of older people at home. That is to include studies that contain words such as evaluation, impact and effectiveness.

- **In Step 2, we carried out an exhaustive literature review in English using a combination of key words resulting from criteria (A), (B), and (C) of Step 1.** For the literature review, we decided to search for **good practices** of technology-based services for independent living of older people at home. Good practice is a widely-used term in policy, though it has no standard definition (Compassion Capital Fund Resource Center, 2010).

Serrat defined a good practice as "*anything that **has been tried and shown to work in some way** – whether fully or in part but with at least **some evidence of effectiveness** – and that may have **implications for practice at any level elsewhere***" (Serrat, 2010).

The U.S. Department of Health and Human Services says that *Good practice is one with at least preliminary **evidence of effectiveness in small-scale interventions** or for which there is potential for generating data that will be useful for making decisions about **taking the intervention to scale and generalizing the results** to diverse populations and settings* (U.S. Department of Health and Human Services, 2003).

According to these two definitions, there are two important concepts of good practice. The first is that there must be evidence of effectiveness, and the second is that it must be possible to replicate the practice effectively in another context.

Consequently, in line with the first definition of good practice (U.S. Department of Health and Human Services, 2003; Serrat, 2010), we decided to search only in scientific databases, where the study methodology and the evidence of effectiveness have been peer-reviewed by other researchers before publication in a scientific journal. The database searches included:

- Web of Science
- PubMed/MEDLINE
- Science Direct
- Social Science Citation Index
- SCOPUS
- Health Evidence

We also **limited the searches** to:

- Publications in English of the last 5 years, that is from 2008 to 2013.
- Articles. We wanted to ensure that the study had been peer-reviewed. Therefore, we excluded from our search proceeding abstracts or any other documents like conference proceedings, poster abstracts, etc.
- Studies in which the participants were 65+ years old.

We covered all the countries, mainly Europe, USA and Japan. For Europe, we focused on representing the different long-term care systems. We used for this purpose the classification of long-term care systems proposed by Kraus and colleagues (2010), see Table 4.

Table 4: Classification of long-term care systems

Nature of the System	Countries	Characteristics
Cluster 1. Oriented towards informal care, low private financing	Belgium, Czech Republic, Germany, Slovakia	Low spending, low private funding, high informal care use, high informal care support, cash benefit modest
Cluster 2. Generous, accessible and formalized	Denmark, the Netherlands, Sweden	High spending, low private funding, low informal care use, high informal care support, cash benefits modest.
Cluster 3. Oriented towards informal care, high private financing	Austria, England, Finland, France, Spain	Medium spending, high private funding, high informal use, high informal care support, cash benefits high
Cluster 4. High private financing, informal care seems a necessity	Hungary, Italy	Low spending, high private funding, high informal care use, low informal care support, cash benefits medium

Source: Kraus, 2010

A first scan of the literature revealed 326 articles, which we then evaluated against several criteria in the third step for final selection. The list of these articles is available for the reader at Annex I.

- **In Step 3, the 326 articles previously selected were reviewed against the following criteria:**

  (A) The evidenced effectiveness of the selected good practices had to be related to at least one of the following policy objectives defined in the project and the SIP:

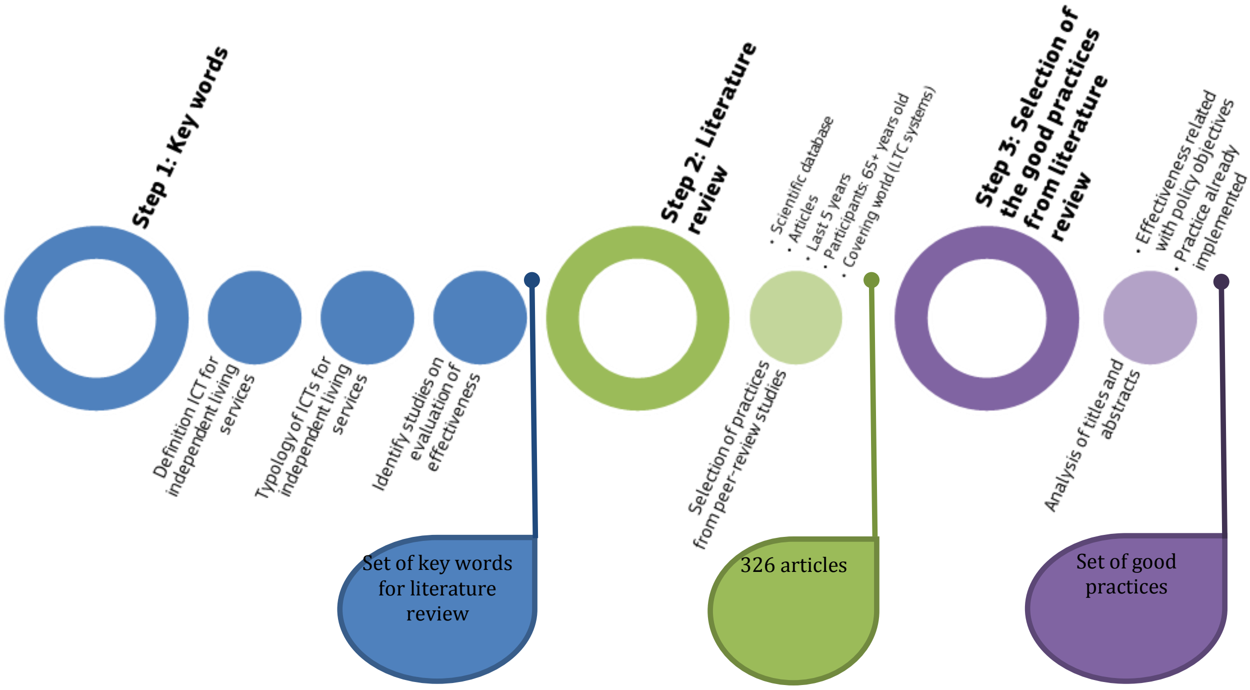
  - to maintain or improve the independent living at home for older adults.
  - to raise the productivity of the carers.
  - to improve the quality of long-term care delivery.
  - to maintain the financial sustainability of care delivery..

  (B) The technology-based service must be replicable, following the second definition of good practices (U.S. Department of Health and Human Services, 2003; Serrat, 2010). In other words, it must have been implemented already at a public or private level (by a region, the product is available in the market, etc.) and it must have generated data which can be applied in another context.

  These criteria were firstly analysed in the title and abstract of each article, and later a specific analysis of the text was required. This analysis gave us the set of good practices of technology-based services included in this study.

Figure 5 illustrates the steps for selecting and mapping the good practices in this study, explained above.

Figure 5: Steps to select and map the good practices of technology-based services for independent living for older people at home



3.2 Information analysed and instrument to collect it

For each of the practices found, we collected qualitative information through a template we designed (Available in Annex I). Concretely, we obtained the following groups of information:

<u>1.- Information that identifies the good practice:</u>

- Number: a number was assigned to each good practice to help to follow an order.
- Type of technology according to the typology defined in this report for this study (see figure 4 above).
- Complete name of the good practice and the acronym in brackets if there is one.
- Level of needs covered: i.e. the specific conditions of the older people that the good practice has been developed for.
- Country where the good practice was developed and implemented.
- Type of long-term care system in which the good practice is found. This tells us about the way countries approach the use and financing of care. We used for this study the clustering of long-term care systems from Kraus et al. (2010), as stated in Table 4.
- Website: i.e. the URL address of the good practice.

<u>2.- An overview of the scope, aim and components of the good practice:</u>

- Total years in operation, specifying the starting year and, if applicable, the ending year,.
- Type of organization implementing the practice, i.e. public, private or non-profit organization.
- Cost information: approximate costs of the practice including year and units if available.
- Scale of implementation: i.e. how many individuals were served at how many locations? (last data available)
- Aim and characteristics of the practice.
- Devices and technological components used by the practice.

3.- Evidence of the effectiveness of the good practice:

- Why was this good practice evaluated?
- What methodology was used for evaluation of effectiveness? What was the sample, the research design, and the procedure for data collection? What variables were collected, and what evaluation instruments were used?
- How effective was the practice in terms of the following objectives defined in the project and in the SIP :
    - Independent living.
    - Productivity of carers.
    - Quality of care.
    - Financial sustainability.
- Evaluation references: we have also specifically added the bibliography of the references where evidence of effectiveness was published and retrieved.

4.- Other sources used to collect the bibliography to complete the template.

3.3 Procedure for data collection

The information for groups 1 and 2 in the previous section (on identification and general overview of the practice) was obtained through desk research on the internet, collecting all the available documents on each practice. These documents consist mainly of articles, conference proceedings, reports, presentations at conferences, leaflets, news, and also information retrieved from the practice website. For group 3 (on the evidence of effectiveness), information was obtained through the articles selected in the literature review.

3.4 Data analysis

The information obtained was processed and analysed according to the template. We also carried out a cross-analysis per groups of information in order to find trends and understand the development and evaluation of the good practices, concretely, we cross-analysed the good practices selected in terms of:

- Main data of identification to give a general overview of the good practices for technology-based services for independent living for older people at home (Groups 1 and 2 of information of Section 3.2). It includes the scope, aim and components of these good practices, to know which situations they support, for what they are useful, with which services they are providing the assistance, and which technological components they are using.
- The research on effectiveness carried out by the practices, to understand the reasons why an evaluation on effectiveness was developed, the methodology followed and in which policy objectives they have shown an evidenced impact (Group 3 of information of section 3.2).

4. RESULTS

The literature review revealed a total of 14 good practices of technology-based services for the independent living of the older adults at home. These services have shown their effectiveness and are being delivered by private or public organisations to cover the needs of older people at home and their carers. In Annex II of this report, the reader can find the result of the analysis of each good practice, following the template designed by us for this research.

We present below the results of the analysis of these 14 good practices that give the reader an overview about which type of technology-based services are supporting independent living of older adults at home: what their characteristics are, what services they offer, how their effectiveness was evaluated, and for what purpose and for which specific policy objective they have evidenced an impact. More concretely:

- In Section 4.1, we give a general overview of these 14 good practices in technology-based services for independent living for older people at home. This overview presents information that identifies the good practices and their scope, aim and components: i.e. when are they useful and what for, what services they are delivering in order to provide assistance, and what technological components do they use.
- Section 4.2 presents the results of the studies on effectiveness carried out by the good practices: i.e., the reasons why an evaluation on effectiveness was developed, the methodology followed and for which policy objectives were they found to be effective.

Table 5 shows a snapshot of these good practices, where we have specifically indicated the peer-reviewed articles that justified their selection.

Table 5: Summary of the good practices of technology-based services for independent living

#	TECHNOLOGIES	GOOD PRACTICE NAME (ACRONYM)	LEVEL OF NEEDS	COUNTRY	IMPACT ON				Reference of impact
					IL	CP	QOC	S	
1	ASSISTIVE TECHNOLOGY	INTELLIGENT SYSTEM FOR INDEPENDENT LIVING AND SELF-CARE OF SENIORS WITH COGNITIVE PROBLEMS OR MILD DEMENTIA (ISISEMD)	COGNITIVE IMPAIRMENT AND MILD DEMENTIA	DK, FI, EL, UK	✓				Mitseva et al., 2009, 2012
2	ASSISTIVE TECHNOLOGY + TELECARE	HOME AUTOMATION AND ADVANCED TELECARE (ADVANCED TELECARE)	FRAIL OLDER PEOPLE	FR	✓	✓		✓	Tchalla et al., 2012
3	ASSISTIVE TECHNOLOGY (ROBOT)	PARTNER PERSONAL ROBOT (PAPERO)	DEMENTIA	JP	✓				Inoue et al., 2012
4	ASSISTIVE TECHNOLOGY (ROBOT)	ROBOT SUIT HAL-Hybrid Assistive Limb (HAL)	FRAIL OLDER PEOPLE	JP	✓			✓	Watanabe et al., 2012; Yamamaki et al. 2012
5	ASSISTIVE TECHNOLOGY (ROBOT)	ROBOTIC STRIDE ASSISTANCE SYSTEM (SAS)	OLDER PEOPLE WITH POOR WALKING ABILITIES	JP	✓				Shimada et al., 2009
6	SMART HOME	X10 ACTIVEHOMEKIT (HOMEKIT)	OLDER PEOPLE WITH CHRONIC CONDITIONS	US	✓			✓	Tomita et al., 2007; Reeder et al., 2013
7	TECHNOLOGY – BASED HEALTH CARE – TELEHEALTH	TAIWAN'S TELEHEALTH PILOT PROJECT (TAIWAN TELEHEALTH)	OLDER PEOPLE WITH CHRONIC CONDITIONS AND THEIR CARERS	TW		✓	✓	✓	Hsu et al., 2010
8	TECHNOLOGY – BASED HEALTH CARE – TELEHEALTH	KAISER-PERMANENTE TELE-HOME HEALTH RESEARCH PROJECT (KAISER TELEHEALTH)	OLDER PEOPLE WITH CHRONIC CONDITIONS	US		✓	✓	✓	Jonhston et al., 2000; Aanesen et al., 2011
9	TECHNOLOGY – BASED HEALTH CARE – TELEHEALTH	TELEHEALTH - WHOLE SYSTEM DEMONSTRATOR (WSD TELEHEALTH)	OLDER PEOPLE WITH CHRONIC CONDITIONS	UK				✓	Bower et al., 2011; Steventon et al., 2012
10	TECHNOLOGY – BASED HEALTH CARE - TELEMONITORING	TELEMONITORING SERVICE FOR CHRONIC CONDITIONS FROM PRIMARY CARE (TELBIL)	OLDER PEOPLE WITH CHRONIC CONDITIONS	SP				✓	Martin-Lesende et al., 2011, 2013
11	TECHNOLOGY-BASED HOME CARE	ASSISTING CARERS USING TELEMATICS INTERVENTIONS TO MEET OLDER PERSONS' NEEDS (ACTION)	OLDER PEOPLE WITH CHRONIC CONDITIONS AND INFORMAL CARERS	SE	✓	✓	✓	✓	Magnusson et al., 2002; Magnusson and Hanson, 2005; Magnusson et al., 2005; Torp et al., 2008
12	TECHNOLOGY-BASED HOME CARE – TELECARE	WEST LOTHIAN TELECARE	PEOPLE OVER 60 YEARS OLD	UK	✓	✓		✓	Kelly, 2005; Reeder et al., 2013
13	TECHNOLOGY-BASED HOME CARE - TELECARE/TELEHEALTH	NATIONAL TELECARE DEVELOPMENT PROGRAMME (SCOTTISH TELECARE)	ALL OLDER PEOPLE	UK	✓	✓		✓	Beale et al., 2010
14	TECHNOLOGY- BASED WELLNESS SERVICES	BRAIN AGE	ALL OLDER PEOPLE	JP	✓				Nouchi et al., 2012

Notes: DK= Denmark; FI: Finland; EL: Greece; UK: United Kingdom; FR: France, JP: Japan; US: United States of America; TW: Taiwan; SP: Spain; IE: Ireland; PT: Portugal; SE: Sweden. IL: Independent living; CP = Productivity of carers; QOC = Quality of Care; S = Sustainability. Good practices are identified by colours of the typology of technology-based services for independent living. Green for assistive technologies, purple for smart homes, blue for technology-based health care, orange for technology-based home care, and red for technology-based wellness services.

4.1 Overview of the good practices identified

As stated above, we found 14 good practices of technology-based services for independent living for older adults at home. **We see that almost all the types of technology-based services for independent living identified in the typology (see Figure 2) are available as good practices in the literature**. Concretely, as we can see in the table below, we found 5 assistive technologies (ISISEMD, ADVANCED TELECARE, PAPERO, HAL and SAS), 1 smart home (HOMEKIT), 4 technology-based healthcare services (TAIWAN TELEHEALTH, KAISER TELEHEALTH, WSD TELEHEALTH and TELBIL), 3 technology-based home care services (ACTION, WEST LOTHIAN TELECARE and SCOTTISH TELECARE), and 1 technology-based wellness service (BRAIN AGE).

Type of ICT-based service for independent living	#	Practice Acronym
Generic technology-based products, services and applications	**0**	**-**
Assistive technologies	**5**	ISISEMD, ADVANCED TELECARE, PAPERO, HAL, SAS
Smart homes	**1**	HOMEKIT
Technology-based health care	**4**	TAIWAN TELEHEALTH, KAISER TELEHEALTH, WSD TELEHEALTH, TELBIL
Telehealth	3	TAIWAN TELEHEALTH, KAISER TELEHEALTH, WSD TELEHEALTH
Telemonitoring	1	TELBIL
Technology-based home care	**3**	ACTION, WEST LOTHIAN TELECARE, SCOTTISH TELECARE
General	1	ACTION
Telecare	2	WEST LOTHIAN TELECARE and SCOTTISH TELECARE
Medication optimization	0	-
Technology-based wellness services	**1**	BRAIN AGE
Total	**14**	**-**

These technology-based services for independent living cover a wide range of long-term needs of older people. Almost half of them (6: HOMEKIT, TAIWAN TELEHEALTH, KAISER TELEHEALTH, WSD TELEHEALTH, TELBIL and ACTION) are for older people affected by chronic conditions, 3 are addressed to all older people (WEST LOTHIAN TELECARE, SCOTTISH TELECARE and BRAIN AGE), 2 are for older adults with some kind of frailty (ADVANCED TELECARE and HAL), 2 are specifically targeted at older people with cognitive problems or dementia (ISISEMD and PAPERO), and 1 is for older people with poor walking abilities (SAS). Of these 14 technology-based services for independent living, 2 also aim to support informal carers as well as the older people (TAIWAN TELEHEALTH and ACTION).

Needs of older people covered	#	Practice Acronym
Chronic conditions	**6**	HOMEKIT, TAIWAN TELEHEALTH, KAISER TELEHEALTH, WSD TELEHEALTH, TELBIL, ACTION
All older people	**3**	WEST LOTHIAN TELECARE, SCOTTISH TELECARE, BRAIN AG
Frail older people	**2**	ADVANCED TELECARE, HAL
Cognitive problems or dementia	**2**	ISISEMD, PAPERO
Poor walking abilities	**1**	SAS
Total	**14**	-

We found that half of the good practices had been developed within the EU (7), and half outside the EU (7). Concretely, of those from the Member States, 1 good practice was developed in France, 3 in the UK, 1 in Spain, 1 in Sweden and 1 was developed at European level. For those outside the EU, 4 were from Japan, 2 from the USA and 1 from Taiwan. A summary can be found in the table below.

Countries	#	Practice Acronym
Member States	7	ISISEMD,ADVANCED TELECARE, TELBIL, ACTION, WEST LOTHIAN TELECARE, SCOTTISH TELECARE
France	1	ADVANCED TELECARE
UK	3	WSD TELEHEALTH, WEST LOTHIAN TELECARE, SCOTTISH TELECARE
Spain	1	TELBIL
Sweden	1	ACTION
European level	1	ISISEMD
Japan	4	PAPERO, HAL, SAS, BRAIN AGE
USA	2	HOMEKIT, KAISER TELEHEALTH
Taiwan	1	TAIWAN TELEHEALTH
Total	**14**	-

Following the **typology of European long-term care systems** recently proposed by Kraus (Kraus et al., 2010), we tried to obtain a good practice from at least one country per welfare regime. The findings indicate that currently there is scientific evidence for good practices in only two of the four European long-term care systems. These can be found in cluster 2 (Scandinavian system) where the provision of formal care is generous, accessible and formalized (ISISEMD and ACTION), and in cluster 3 where the provision of long-term care is oriented towards informal care with high private financing (ISISEMD, ADVANCED TELECARE, WSD TELEHEALTH, TELBIL, WEST LOTHIAN TELECARE, SCOTTISH TELECARE, BRAIN AGE).

Nature of the System	Countries	#	Practice number
Cluster 1. Oriented towards informal care, low private financing	**Belgium, Czech Republic, Germany, Slovakia**	**0**	-
Cluster 2. Generous, accessible and formalized	**Denmark, the Netherlands, Sweden**	**2**	ISISEMD, ACTION, BRAIN AGE
Cluster 3. Oriented towards informal care, high private financing	**Austria, England, Finland, France, Spain**	**7**	ISISEMD, ADVANCED TELECARE, WSD TELEHEALTH, TELBIL, WEST LOTHIAN TELECARE, SCOTTISH TELECARE, BRAIN AGE
Cluster 4. High private financing, informal care seems a necessity	**Hungary, Italy**	**0**	-

Source: Kraus et al., 2010

In Table 6 we present a **summary of the main characteristics of implementation, aim, services and devices** used by the good practices. The data show that the majority of the good practices are still **in operation** (9: ADVANCED TELECARE, PAPERO, HAL, SAS, HOMEKIT, KAISER TELEHEALTH, TELBIL, ACTION, and BRAIN AGE) and have been in operation for 4 to 35 years. Although we should highlight that two of the non-operating services (WEST LOTHIAN TELECARE and SCOTTISH TELECARE) continue through a wider programme. The good practices have been **implemented** by public authorities (8: ISISEMD, ADVANCED TELECARE, TAIWAN TELEHEALTH, WSD TELEHEALTH, TELBIL, WEST LOTHIAN TELECARE, SCOTTISH TELECARE, BRAIN AGE) or by private companies (5: PAPERO, HAL, SAS, ACTION, BRAIN AGE) and only one has been implemented by a non-profit organisation (KAISER TELEHEALTH). Information on **cost** varies for each practice, as it depends on the availability of information and also on how each practice focuses on the economic data. The general trend is for the technology-based services to be delivered by the implementing organisation in exchange for a fee. In the case of very low cost devices or applications, such as a game (BRAIN AGE) or a home kit (HOMEKIT), the technology-based service or product can be bought directly by the user. In addition, for the good practices where the data are available, the technology-based services for independent living have been widely implemented on more than one **site** and, in some cases, to thousands of **users** (ADVANCED TELECARE, HOMEKIT, T, KAISER TELEHEALTH, WSD TELEHEALTH, TELBIL, WEST LOTHIAN TELECARE, SCOTTISH TELECARE, and BRAIN AGE).

These **services** are generally focused either on controlling the environment of the users in order to avoid emergencies, or to helping them to follow health prescriptions and to carry out their daily activities. Other services focus on monitoring the health of the older people at home, in order to avoid as far as possible their admission to care centre or hospital. Other services include maintaining the user's social life, and supporting communication from home. One of the practices also focuses on training for informal carers. A wide range of available **technologies and devices** are being used to provide these services: internet/websites, cameras, videos, sensors, alarms, alerts, screens, computers, GPS, robots, software, remote controls, home automation, microphones, peripheral devices for health monitoring, games and consoles. The table lists the services and devices by type of technology-based service. As we can see in the table below, both services and devices match the definition of each type of technology-based services proposed in this report (Section 2.3.).

Type of ICT-based service for independent living	Services	Devices
Assistive technologies	• Reminders • Scheduler • Home safety: Alarms (door, cooking, fridge, smoke, fire, flood), night movement detectors, prevention of falls, alerts for abnormal activities, telecare • Outdoor safety • Companion/assistant for daily activities • Communication with carers and video call • Active lifestyle • Memory lane • Brain games • Support walking patterns	• Sensors: flood, pressure, door, smoke, gas, temperature. • Electricity monitors for cooking activity • Light path (automatic system of light) • Shower and bed pulls • Pendant or bracelet • GPS • Home automation • Mobile phone • Touch screen computer • Remote intercom • Web portal access • Robot equipped with different devices and applications: speech and face recognition, mobility and motion, sensors, camera and microphone, robotic legs, mechanical braces, motorised joints, sensors, computer processor, battery power source.
Smart homes	• Control house lights and appliances • Automate the home through schedule	• Remote control for lamps and appliances • Computer interface • Software
Technology-based health care	• Home visit using videoconference • Physiological and facial expressions monitoring and assessment • Medication consultation, monitoring and dispensary • Regular and emergency consultation • Detect health emergency situations • Rehabilitation instructions • Tele-learning • Quality monitoring • Health education and promotion (videos and messages) • Living support such as security and safety	• Long-term care information network • Home video system • Home monitoring system consisting of a base unit with a LCD screen and response buttons. • Personal health care system consisting of a set top box connected to a television. • Peripheral devices: analog stethoscope, digital blood pressure machine, pulse oximeter, glucometer, weighting scales, magnifying lens, and headsets Smart phone personal digital assistant (PDA) • Mobile multiuser telemeter device • Web portal access • ADSL • Linux and Java application
Technology-based home care	• Telecare • Activity monitoring • Online education for carers • Videophone information and support for older people and carers.	• Telecare system • Personal computer • Videophone (with software) • Microphone • Video door entry system • Home alert console • Sensors/detectors: smoke, flood detector, temperature, passive infrared, enuresis, bed occupancy environmental, location, movement. • Assistive devices: window openers, etc. • Alarms • Reminders
Technology-based wellness services	• Brain training	• Console and game

Table 6: Summary of the scope, aim and services of the 14 good practices of technology-based services for independent living

#	Good practice acronym	Country	Years in operation	Type of organisation implementing the practice	Cost information	Scale of implementation	Services	Devices
1	**ISISEMD**	DK, FI, EL, UK	2009-2011	Local or regional government	Co-funded by the European Commission	71 older people and carers in 4 localities (Denmark, UK, Greece, and Finland)	For older people: • Reminders • Memory lane • Brain games • Video call • Outdoor safety For informal carers: • Scheduler • Home safety • Night movement detectors • Alerts for abnormal activities • Alarms (door, cooking, fridge, smoke, fire, flood)	Touch screen computer GPS Flood, pressure, door Sensors Mobile phone for informal carers Web portal access Electricity monitors for cooking activity Smoke alarms
2	**ADVANCED TELECARE**	FR	2010- now	French departments	Unit cost: €1.700 euros for the first year and 700 euros/per year. Investment of 5.7 million euros for 4 years in the Creuse Department coming from national, regional and Europan funds.	2,400 users	Prevention of falls Home safety Telecare	Home automation package: Light path (automatic system of light) Gas sensor Temperature sensor Shower and bed pulls Pendant or bracelet Remote intercom
3	**PAPERO**	JP	2001-now	Private company	€73.40 per unit/month for renting of the Papero petit (small version)	No data	Companion/assistant Remind daily routines Active lifestyle Communication with carers	Robot equipped with speech recognition, speech synthesis, face image recognition, autonomous mobility, head motion, light indication functions, and tactile sensors. It also includes camera, ultrasonic range finders, temperature sensors, microphones

4	**HAL**	JP	2005-now	Private company	€1,130–€1,660 unit/month renting	330 suits in 150 institutions.	The suit helps the wearer to carry out daily activities	Wearable skeleton: 2 robotic legs Mechanical braces Motorised joints controlled by actuators Electronic sensors Computer processor Battery power source
5	**SAS**	JP	1999-now	Private company	No data	No data	Support walking patterns	Control system Waist frame Motor Angle sensor Thigh frame Battery
6	**HOMEKIT**	US	1978- now	Private company	€300 for all the system and other necessary materials (installation and functioning)	Sales since 1978: 15 millions Homes with the system since 2007: 5 millions	Control house lights and appliances Automate the home through schedule	Remote control for lamps and appliances Computer interface Software
7	**TAIWAN TELEHEALTH**	TW	2007-2010	Government	No data	Over 70 health care institutions Used over 700,000 times by their members in 4 years.	Home: Home visit using videoconference Physiological monitoring Living support Health education Community care: Health promotion Dispensary Physiological monitoring Medication consultation Living support Health education Residential care: Regular and emergency consultation Rehabilitation instructions Physiological monitoring Medication consultation Tele-learning Quality monitoring	Long-term care information network Set-top-box attached to TV ADSL Linux and Java application.
8	**KAISER TELEHEALTH**	US	1996-now	Non-profit health care organization	Average cost for functioning, purchase equipment and telecommunication expenses: €1,345 per patient	Kaiser Permanente has 9 million members (2013), and it is serving 8 American regions, serving 9 states and the district of Columbia.	Video visits with home health nurse. Control and assessment of cardiopulmonary status, facial expressions, bowel sounds or	Home video system Peripheral units of the video system: Analog stethoscope Digital blood pressure

							signs of infection, medication dosages	machine Magnifying lens Headsets for nurse
9	**WSD TELEHEALTH**	UK	2008-2009	Government (National health system)	Annual cost (equipment and support): €2,225 per patient	3,230 patients and 179 general practitioners across three sites	Monitoring of health signs remotely. Educational messages Educational videos	On two sites, home monitoring system was installed, consisting of a base unit (small device with a LCD screen and response buttons to allow navigation of symptom questions and educational messages). On another site, personal healthcare system was installed consisting of a set top box connected to a television allowing questions about symptoms, educational videos, graphic history. Peripheral devices: pulse oximeter, glucometer and weighting scales.
10	**TELBIL**	SP	2007- now	Primary health care centre	Total cost of intervention (health care + equipment): €12,997.17 patient/year Cost of equipment (telemonitoring): €1,379 patient/year	The practice is being implemented in 20 health care centres of a region, and can potentially reach 78,000 older adults	Monitor the heath of chronic patients a home Detect health emergency situations	Smart phone personal digital assistant (PDA) Mobile multiuser telemeter device Web manager on the cloud
11	**ACTION**	SE	1997-now	Private companies	Total cost: €2,841 year/family	6 Swedish municipalities 125 families	Multimedia caring programmes: Multimedia educational programmes on caring, physical and cognitive e-training, and online games for leisure and coping programmes Video-telephone to inform, educate and support older people and their carers Videophone to talk with family and professionals Computer education	Personal computer Videophone Microphone Software for videophone

12	**WEST LOTHIAN TELECARE**	UK	1999-2006	Local and national authorities	No data on the cost of the equipment and installation. We know that users were charged of €5.86 per week and user.	1,700 older people in the West Lothian Council.	Telecare	Home alert console Personal trigger Smoke detector Flood detector Extreme temperature sensor Passive infrared detectors Complementary devices: Passive alarms Video door entry system Assistive devices (window openers, bed occupancy monitors, etc.)
13	**SCOTTISH TELECARE**	UK	2006-2010	Regional government	Cost depends on the equipment used. The yearly cost of the maintenance, installation and removal of the telecare equipment is €842,66 ,(door open alert) and the yearly cost of the equipment goes from €48.15 to €10.,535.10 (Environmental equipment)	29,117 people assisted by 31 partnerships.	Telecare	Movement detectors Enuresis sensor Alarms Environmental sensors Reminders Sensory impairment alarms Care's alert Location sensors Activity monitoring
14	**BRAIN AGE**	JP	2005-now	Private company	Game: €23,09 Console: €159,99	Game available in Japan, USA, Canada, Europe and Australia. 19 million pieces of the game sold on 31st March 2013	Brain training with 9 games	Console and game

DK= Denmark; FI: Finland; EL: Greece; UK: United Kingdom; FR: France, JP: Japan; US: United States of America; TW: Taiwan; SP: Spain; IE: Ireland; PT: Portugal; SE: Sweden. Good practices are identified by colours of the typology of technology-based services for independent living. Green for assistive technologies, purple for smart homes, blue for technology-based health care, orange for technology-based home care, and red for technology-based wellness services.

4.2 Evidence of the effectiveness of the good practices

The studies evaluating the effectiveness of the practices have generally been carried out by the organisations implementing the service, or the developers. In 7 of the 14 cases, the evaluation was commissioned by a local, regional and/or national government (ADVANCED TELECARE, TAIWAN TELEHEALTH, KAISER TELEHEALTH, WSD TELEHEALTH, TELBIL, WEST LOTHIAN TELECARE and SCOTTISH TELECARE). In a further 5 cases, the assessment was initiated during the development of the service by its designer or developer (ISISEMD, PAPERO, HAL, SAS and ACTION). The remaining 2 practices were evaluated because they were a general product available on the market and a research team was interested in evidencing the effectiveness of the technology-based service they provided (HOMEKIT and BRAIN AGE). The table below summarises these findings.

Aim of the effectiveness evaluation	#	Practice number
Commissioned by local, regional and/or national government	**7**	**ADVANCED TELECARE, TAIWAN TELEHEALTH, KAISER TELEHEALTH, WSD TELEHEALTH, TELBIL, WEST LOTHIAN TELECARE, SCOTTISH TELECARE**
Initiated by the technology-based service's designer or developer	**5**	**ISISEMD, PAPERO HAL, SAS and ACTION**
Interest of a research team to test a technology-based service available in the market	**2**	**HOMEKIT and BRAIN AGE**
Total	**14**	**-**

The **methodologies** used to study the effectiveness of these 14 good practices were different in each case and they did not follow a similar pattern of evaluation. The *samples* varied in size from only one older person (Practices 3 and 4) to a high number of older people (Practices 9, 11, 12 and especially 13, which had a sample of 29,117 individuals).

Regarding the *research design*, we have identified that:

- 6 of the good practices used experimental design: 5 applied randomised control trial (ISISEMD, HOMEKIT, WSD TELEHEALTH, TELBIL and BRAIN AGE) and one was a quasi-experimental design (KAISER TELEHEALTH);
- 7 used observational studies (ADVANCED TELECARE, HAL, TAIWAN TELEHEALTH, ACTION, WEST LOTHIAN TELECARE and SCOTTISH TELECARE), one was a prospective cohort study (ADVANCED TELECARE) and another was a pilot (TAIWAN TELEHEALTH).
- 2 carried out case studies based on quantitative data (Practices PAPERO and HAL[10]).

The *variables* evaluated and the *instruments* used to evaluate them are also different in each practice: we found no common pattern. In the table below, we list the set of variables used classified by policy objective.

Regarding the **effectiveness** of the technology-based services for independent living, 10 of them were shown to improve the independent living of older people at home (ISISEMD, ADVANCED TELECARE, PAPERO, HAL, SAS, HOMEKIT, ACTION, WEST LOTHIAN TELECARE, SCOTTISH TELECARE, and BRAIN AGE), 6 increased carers' productivity (ADVANCED TELECARE, TAIWAN TELEHEALTH, KAISER TELEHEALTH, ACTION, WEST LOTHIAN TELECARE, and SCOTTISH TELECARE), 3 raised the

[10] Note that good practice 4 has two studies with two different designs.

quality of care (TAIWAN TELEHEALTH, KAISER TELEHEALTH and ACTION), and 10 generated savings for the care system (Practices ADVANCED TELECARE, HAL, and HOMEKIT, TAIWAN TELEHEALTH, KAISER TELEHEALTH, WSD TELEHEALTH, ADVANCED TELECARE, ACTION, WEST LOTHIAN TELECARE, and SCOTTISH TELECARE). Only one achieved improvements in all four policy objectives (Practice ACTION). Studies on assistive technologies, smart homes, technology-based home care and technology-based wellness services were most interested in knowing how these services affect the independence of older adults. This is certainly because they deal with technologies installed at home that support daily life activities and therefore the feeling of being independent and being able to live longer at home. Meanwhile, studies on healthcare technologies are more interested in knowing the savings that these services can generate. Used with chronic patients, they have the potential to reduce the use of institutional services. In addition, these technologies together with telecare also focus their attention in studying whether they increase the productivity of the carers, as their services are specifically designed to support health and social care staff.

In the table below, we summarise the variables assessed in the evaluation of the evidence of the good practice that gives an overview of the indicators used in these studies of effectiveness. We have also grouped together the findings of the evidenced effectiveness.

Policy objectives	Variables	Findings of the practice evidence
Independent living of older adults and carers	**Independent living of older adults:** • falls at home and hospitalisations due to falls. • observation to reaction to the robot prompt. • walking and balance ability. • walking speed • functional status • health status indicators. • blood glucose level control • infection rate. • global cognitive status. • executive functions. • attention. • processing speed. • clinical conditions (health conditions) • independence. • quality of life. • clinical effectiveness of the service (health benefits). • users' perceptions of the impact of telecare. **Independent living of carers**: • anxiety. • experience with caring. • quality of life. • stress of caring/burden. • social support. • health. • change in pressure on informal carers.	The older adults were more independent because they: • were less reliant on informal carers for daily activities. • had fewer falls at home and fewer hospitalizations as a result of falls. • were less affected by depression. • were more active when alone. • had better walking ability, balance and speed. • their physical and cognitive status was better maintained • had better cognitive functions • stayed in their homes • felt safer at home. Informal carers were also more independent in their tasks and responsibility, they felt: • better quality of life. • better health. • more safety • more free and with peace of mind. • less stressed.
Productivity of carers		Carers were more productive because the technology-based services: • saved time and money • facilitated timely medical responses in emergency conditions. • reduced the length of patients´ visits • provided more information on care more time for more needed, • improved carers' satisfaction with the job. • allowed new ways of working • helped them to have more respect towards the independence and dignity of older people. • helped them have fewer worries. • helped them retain their jobs. • supported them to improve their relationship with the older adults.

Quality of care	• Incorrect drug use	More quality of care: • reduction of medication non-adherence • improvement of medication safety • maintainance of quality of care. • increase in the care competence of informal carers. • more client satisfaction with formal carers. • reduction in mortality rate
Sustainability of care system	• Cost description • Direct and indirect costs of using the technology • Use of health resources • Hospital admissions and stays • Emergency room rate • Rehospitalisation rate • Reduction in hospital admission • Reduction care homes admissions. • Financial saving resulting from reduction in admissions.	Cost-effectiveness • low cost of the technology. • reduction in total mean costs of care. • reduction in the use of institutional care • reduction in the use of health care resources. • faster discharge from hospitals • reduction of hospital admissions • avoid nursing home admissions. • 1,700 €/package/first year vs 8,000€ of hospital stay per fall. • cost of staff around 4,000 euros/8 hours day/7day, twice than the rental of the robot. • the use of telemonitoring is cheaper than the usual care (€-2,230,63) • financial benefits of 91 m€ for 2006-2010 because of faster discharge from hospitals, reduction of hospital admissions, and avoidance of nursing home admissions. • the cost for non-equipped was \$2,674 and \$1,948 for equipped. saving of 10,300 euros/family/year/municipality

More details about this information for each good practice are available in Table 7.

Table 7: Summary of the evidence of effectiveness of the 14 good practices

#	Type of technology-based service	Good practice acronym	Aim of the evaluation	Method	Findings	Impact on			
						IL	CP	QOC	S
1	ASSISTIVE TECHNOLOGY	**ISISEMD**	The practice was evaluated as part of a European project. The aim was to demonstrate that older people with cognitive impairments or dementia can live independently longer and safer in their homes through this technological system	71 older people with mild cognitive impairment or dementia and their carers. 45 equipped with the ISISEMD and 26 not equipped. RCT along 15 months, evaluating at baseline, intermediate and final stages: user acceptance and satisfaction, quality of life of informal carers, stress of caring.	<u>More independence of older adults and informal carers</u>: Equipped older adults relied less on informal carers for daily activities. Equipped informal carers saved time and money, had more freedom and peace of mind, and experienced less stress	✓			
2	ASSISTIVE TECHNOLOGY + TELECARE	**ADVANCED TELECARE**	Initiative of the General Council (Corrèze Department to test the potential of the solution). Evaluation in development (ICare and DOMOLIM) to test it at larger scale.	194 older adults, equipped and non-equipped in a prospective cohort study. Evaluation during 12 months at base–line and follow-up: functional status, mental and physical, and falls at home and hospitalisations.	<u>More independence of the older adults</u>: Fewer fallers at home and fewer fallers hospitalized when they fell at home. Less affected by depression. <u>First data on cost-efficiency</u>: 1,700 €/package/first year vs 8,000€ of hospital stay per fall.	✓	✓		✓
3	ASSISTIVE TECHNOLOGY (ROBOT)	**PAPERO**	The practice was evaluated to test the field-base method to develop the information support for people with dementia.	A case study with a woman with dementia. Observation to reaction to the robot prompt was evaluated.	<u>More independence of the older adults</u>: More activity on their own.	✓			
4	ASSISTIVE TECHNOLOGY (ROBOT)	**HAL**	Two studies evaluated the effectiveness of the robot in order to have enough information on the impact to produce and commercialize it. The evaluation was done by the research team of the robot's company.	One research project was with one patient and the collected ten patients. The first study used a case study and the patient received training during 8 weeks and evaluated walking and balance ability. The second one supposed gait training with the robot, and it evaluated the walking ability.	<u>More independence of the older adults</u>: Better physical functioning in terms of walking ability, balance and speed. <u>First data on cost-efficiency</u>: From another source, we obtained the data that the cost of staff is around 4,000 euros/8 hours day/7day, twice than the rental of the robot.	✓			✓

5	ASSISTIVE TECHNOLOGY (ROBOT)	**SAS**	To identify the effects of the practice on walking scores and muscle activities.	15 older women evaluated after a training of 3 months in a walking programme in walking speed.	More independence of the older adults: improvement of walking speed	✓			
6	SMART HOME	**HOMEKIT**	The aim of the evaluation was to test if smart homes maintain better health functions and help older adults to live independently.	46 equipped older adults and 67 non-equipped older adults were evaluated during a 2 years RCT in: functional and health status	More independence of the older adults: maintenance of physical and cognitive status, and more equipped older adults stayed in their homes until the end of the evaluation. Cost-efficiency: low cost of the technology.	✓			✓
7	TECHNOLOGY–BASED HEALTHCARE – TELEHEALTH	**TAIWAN TELEHEALTH**	The Department of Health of Taiwan was interested in exploring the benefits of telecare services to resolve the strong demand for long-term care.	Three pilots were developed: a home telecare with 200 older adults, a community telecare with 152 older adults, and an institutional telecare with 82 adults. Users were evaluated in health indicators, hospitalisation rates and emergency room rates (home telecare), incorrect drug use and blood glucose level control (community telecare), and infection and rehospitalisation rates (institutional telecare).	Carers were more productive: home and community models facilitate timely medical responses in emergencies. More quality of care: reduction of medication non-adherence in the community model, and improvement of medication safety in the institutional model. Cost-efficiency: Reduction on hospital readmissions		✓	✓	✓
8	TECHNOLOGY–BASED HEALTHCARE – TELEHEALTH	**KAISER TELEHEALTH**	The evaluation was organised by one of the medical centres of this private health care company, to test the possibility of replacing in-person visits by health personnel.	Older adults with chronic conditions (112 equipped with a video home healthcare system and 110 non-equipped) were evaluated through a quasi-experimental study during 18 months for quality of care and degree of patient satisfaction. Direct and indirect costs of using the technology were also evaluated.	Carers were more productive: reduction in length of patients" visits, More quality of care: maintenance of quality of care. Cost-efficiency: Reduction in overall mean costs of care. The cost for non-equipped was $2,674 and $1,948 for equipped.		✓	✓	✓
9	TECHNOLOGY–BASED HEALTHCARE – TELEHEALTH	**WSD TELEHEALTH**	The evaluation of the practice was initiated by the UK Department of Health to test the cost-effectiveness and impact on independence and on quality of life of telecare and telehealth.	3,154 patients affected by chronic conditions took part in the study: 1,584 in the control group and 1,570 in the intervention group (telehealth). They were	Cost-efficiency: reduction in the use of institutional care and in mortality rate				✓

				evaluated with a RCT for service utilisation and clinical effectiveness. Carers were also evaluated for anxiety and costs. Cost effectiveness was also assessed.					
10	TECHNOLOGY – BASED HEALTH CARE - TELEMONITORING	**TELBIL**	The evaluation was funded by the Regional Department of Health of the Basque Country in Spain. They wanted to test whether this telemonitoring system could reduce hospital admissions in chronic patients.	43 chronic older adults: 21 equipped and 22 non-equipped were evaluated during 12 months through a RCT for clinical conditions, hospital admissions and stays, use of health resources, quality of life, and functional status. A cost-effectiveness analysis was also done.	<u>Cost-efficiency</u>: Reduction in the use of healthcare resources. The use of telemonitoring is cheaper than the usual care (€-2,230,63)				✓
11	TECHNOLOGY-BASED HOME CARE	**ACTION**	Three studies of European, Swedish and Norwegian projects led by universities to demonstrate the efficacy of the solution (for quality of life and cost-efficiency) to convince municipalities to implement the solution in the care services.	Study 1 (European project) selected a sample of 1,838 older people and their carers using ACTION for 3-4 months in 5 European countries. It used a mixed quantitative and qualitative approach and evaluated independence, quality of life and a cost description. Study 2 (Swedish project) selected 34 dyads (family carers-older people) users of the service. It used a mixed quantitative and qualitative approach and it collected information on costs of the services for a cost assessment. It also studied carers' experience with caring. Study 3 selected 19 family carers. In a pilot intervention study, social support, health and burden were evaluated at base line and after 12 months.	<u>Informal carers had more independence</u> form their tasks and responsibility. <u>Carers were more productive</u>: more information on care, more time to focus on relevant needs, more satisfied with the job. <u>More quality of care</u>: increase in informal carers' competence and more client satisfaction with formal carers. <u>Cost-efficiency</u>: Saving of 10,300 €/family/year/municipality.	✓	✓	✓	✓
12	TECHNOLOGY-BASED HOME CARE – TELECARE	**WEST LOTHIAN TELECARE**	The study was requested by the Council to monitor the implementation of the practice, its impact on quality of life and its value for money.	2,150 older adults were enrolled between 1999 and 2006 through a 6 year community level	<u>Older adults were more independent</u>: they felt safer at home. <u>Formal carers were more</u>	✓	✓		✓

				implementation. Interviews were carried out.	<u>productive</u>: they introduced new ways of working and had more respect for the independence and dignity of older people. <u>Cost-efficiency</u>: reduced the use of institutional services				
13	TECHNOLOGY-BASED HOME CARE – TELCARE/TELEHEALTH	**SCOTTISH TELECARE**	The University of York was commissioned to do the evaluation by the Scottish Government. The aim of this evaluation was to know to what extent the 8 objectives were achieved.	Two evaluations took place, one for the period 2006-2008 and the second one for the whole period of the programme (2006-2011). The data were provided by partnerships in quarterly returns, questionnaires and case studies. The quarterly evaluations focused on reduction in hospital and care home admissions, and financial saving resulting from these admissions. They also included local outcomes and efficiencies, and the telecare equipment procurement process. The questionnaire evaluated users' perceptions of the impact of telecare and quality of care, and any change in the pressure on informal carers. The case studies detailed funding and local experiences.	<u>Older adults were more independent:</u> they had better quality of life, health, safety and independence. <u>Informal carers were more productive and the quality of care was better</u>: the carers were less worried and stressed, retained their jobs, had better relationships with the older adults. <u>Cost-efficiency</u>: faster discharge from hospitals, reduction of hospital admissions, and fewer nursing home admissions. This generated financial benefits of 91 M€ for 2006-2010.	✓	✓		✓
14	TECHNOLOGY- BASED WELLNESS SERVICES	**BRAIN AGE**	The aim was to investigate the effect of this game among healthy older people.	32 older adults were trained with Brain Age (treatment group) and Tetris (control group) and evaluated during 5 months through a RCT for global cognitive status, executive functions, attention and processing speed.	<u>Older adults were more independent:</u> they had better cognitive functions.	✓			

Notes. IL: Independent living; CP = Productivity of carers; QOC = Quality of Care; S = Sustainability. Good practices are identified by colours of the typology of technology-based services for independent living. Green for assistive technologies, purple for smart homes, blue for technology-based health care, orange for technology-based home care, and red for technology-based wellness services. RCT: randomised control trial.

5. CONCLUSIONS

As we have highlighted in this report, **European policy is currently prioritising finding solutions for the increasing need to provide long-term care to the older population**. In 2013, the European Commission launched a new instrument called the Social Investment Package for Growth and Jobs (SIP) to help the Member States address this social issue (European Commission, 2013a, b). In addition, reform of the long-term care systems to make them more efficient has now been included as one of the objectives addressed in the European Semester (European Commission, 2013c) and in the EIP AHA (European Commission, 2012a). In this digital era, European policy-makers, basing their views on the current trends of scientific research, believe that the use of **technologies could be a competitive way of maintaining the independence of older adults at home and addressing the social and economic impact of the increasing needs for long–term care**. However, the Commission needs more data on the effectiveness, the operation and the implementation of technology-based services for the independent living of older adults to be able to recommend them successfully into the current health and social care systems. Learning from the success of others through the **exchange of good practices among Member States is one of the main tools identified by these two European policy instruments (SIP and European Semester)** to obtain more knowledge in various fields, including this one on technology-based services for independent living of older adults at home.

In this framework, **JRC-IPTS was commissioned by DG EMPL to support this policy issue through a research project (ICT-AGE). This project aims to design guidelines for the implementation of technology-based services for the independent living of older adults at home in the European Union**. This report presents the first step in this project: the identification and mapping of good practices in these technology-based services.

In order to identify and map good practices, we had to agree on some **methodological issues**. First, we needed to define criteria to select these practices. We proposed a definition and a typology of these technology–based services for independent living based on a literature review (see Section 3.2 of this report), and we agreed that we would only select studies that had evaluated the effectiveness of these services. Then, we proposed a definition of what we consider, for this study, to be a good practice. Having reviewed the literature, we adopted the definitions of Serrat (2010) and of the U.S. Department of Health and Human Services (2003), and we agreed that good practices would be those that had shown scientific evidence of effectiveness on one or more of the four policy objectives defined in this study and that have been implemented at public or private level. Following this second criterion, we searched articles in a scientific database, and we selected practices implemented from 326 peer-reviewed articles published in scientific journals.

The study obtained a small but representative number of good practices, covering a wide range of mature technology-based services for independent living, which were able to address a set of long-term care needs. We **identified and mapped 14 good practices** which have been related to an increase in the independent living of older people at home, an improvement in the productivity of carers, better quality of care, and the generation of savings for the care system. Almost all the types of technology-based services for independent living are represented among the good practices. Assistive technologies (including robots), technology-based healthcare services (in particular telehealth), and technology-based home care (mostly telecare) are the most common. Morris and colleagues (2012) noticed, as we did in our study, that the field of telehealth for professionals is more developed with comparatively strong evidence for its efficacy for people with chronic conditions. The only technology-based services for independent living that we did not find in our search were generic products, services and applications. This may be due to the fact that these technologies are available to the general public, and are not specifically targeted at older adults. As a result, there has been no specific interest in testing their effectiveness among the older population.

Half the **good practices were implemented in the European Union, and half outside Europe**. In the Member States, most of the good practices we identified are available and being implemented in countries such as the UK, Spain, France and Sweden. It seems that **structured long-term care systems** such as those in Nordic countries or **those oriented to informal care** (compared with long-term care systems very dependent on informal care) are more interested in testing soundly the effectiveness of these technology-based services. Good practices outside Europe have been found in the USA, Taiwan and Japan (4 of the 7 good practices were implemented in Japan). This finding has opened two interesting issues for debate. The first is that Europe and Japan have the two most ageing populations in the world, so they are focused on finding solutions for the increase of long-term care needs in the future, like using technologies. The second is that 7 good practices are very low for Europe. This indicates that Europe needs to do more robust studies to support policy development and implementation in this area.

Most of the good practices are currently in existence (at the date of the study), and have been operating from 4 to 35 years. We understand therefore that a wide range of technology-based services for independent living of this study are already **mainstreamed services** in their region. In some cases, they target large numbers of users: for example the National Telecare Development Programme where 29,117 people were helped by telehealth services, or the Home Automation and Advanced Telecare where 2,400 users are now using it. This wide range of operation and implementation is mainly due to **public sector strategies**, i.e. the public sector put in place the appropriate policy framework, institutional change and funding to support the private sector and the end-users. This funding has helped the private sector with the design and sometimes the implementation of technology-based services for independent living, and has helped end-users (the older adults and their carers) to purchase and use these technology-based services at home. However, organisations in charge of implementing the services usually buy the service/product and embed it into the care system, in order to provide it to the end-users in exchange for a fee. Thus the biggest cost of the service implementation is borne by the implementing organisation.

We have also seen that the good practices available **are able to cover a wide range of long-term care needs of older adults**. They can provide **multiple services** that cover the promotion of health and autonomy, social participation as well as the prevention, monitoring, management and rehabilitation of **long-term care situations**. These services also provide support to carers, giving them some respite from their care tasks and also education to develop their skills. Most of these services are being provided through a combination of **available, regular and commonly-used technologies**, such as: sensors, GPS, mobile phones, touch screen computers, remote intercoms, web portals, cameras, home automation, home video systems, set top boxes, televisions, ADSL, consoles, etc. Robotics is perhaps the least common technology, but robots are increasingly available on the market and will soon be part of our daily lives.

Nevertheless, it is also true that our study shows that, **so far, sound scientific evidence of effectiveness has been found for very few technology-based services**, as we only found 14 cases that met the criteria for good practice defined for this study. These findings are in line with the results of a review carried out by Morris and colleagues (Morris et al., 2012). These authors found gaps in the scientific literature on the benefits of these technologies after reviewing 8,000 papers on smart technologies for older adults. As we did, they pointed out that “despite the large volume of descriptive text, the scientific validation of these technologies is lagging behind” (Morris et al., 2012). This scarcity of scientific evidence of the benefits of technology-based services for independent living has also been indicated in other works (Carretero et al., 2012a, b; Billings et al. 2013). Gathering this type of evidence could be hindered by the **lack of a common methodology**

to evaluate these services, as we have seen in our study. Of course, this assertion needs to be tested, but it is at least a hypothetical explanation for this situation. Moreover, we also observe that the studies on effectiveness of technology-based services for independent living are currently more focused on knowing whether these technology-based services increase the independent living of older adults at home and whether they generate savings for the social and health system. At the same time, the achievement of carer productivity and increased quality of care are under-represented in the impact research on these technology-based services. More research is therefore also needed to fill this gap. This is in fact related to the need to develop and provide **a common methodology for public authorities and researchers to evaluate the effectiveness of these technology-based services**.

To summarise, **this is the first study to collect good practices for independent living of older adults at home where there is sound scientific evidence of their effectiveness in achieving four European policy objectives for long-term care**. These services have been operating for a long time and are currently assisting the older population and carers in Europe and all over the world. They are the basis for the next step of this project (objective 2 – as defined in Section 1) - that is, to study a selection of these good practices in order to understand how they have been created and implemented.

6. ADVANTADGES AND LIMITATIONS OF THE STUDY

The main objective of this deliverable was to identify across the world good practices of technology-based long-term care services that help older adults to live independently at home. In this section, we explain both the advantages and the limitations of the methodology we chose to focus the selection criteria for the services included in this research.

First, as explained in Section 3.1, we defined what we understand in the research as "technology-based services that help older adults to live independently at home" and the typology of these services. This helped us to define the key words to identify the appropriate services. Currently, the literature does not provide a common definition and typology. For this reason, we reviewed the main policy and academic documents available (including those referring to Ambient Assisted Living), which we judged to be sufficient for the objectives of our research. We did not, however, carry out a systematic literature review on these topics. The fact that this definition and typology have not been built on a systematic literature review could be criticised, and improved in the future. In any event, this typology constitutes a first attempt to classify technology-based services for independent living, and is useful for policy, research and practice.

Moreover, we only included in the study those services that complied with our definition and typology. As regards the typology, we decided to exclude telemedicine from "technology-based health care" as these services are delivered by physicians and focused on biological/physiological monitoring and medical intervention.

Second, we also proposed a definition of what we considered, for this study, to be a good practice. Having reviewed the literature, we adopted the definitions of Serrat (2010) and of the U.S. Department of Health and Human Services (2003). We agreed that good practices would be those services, implemented at private or public level, which had shown scientific evidence of effectiveness in at least one of the four policy objectives defined in this study. We therefore selected services which had had positive outputs on independent living, productivity of carers, quality of care, and sustainability of care systems, but did not consider services with other possible effects. In order to ensure that we had scientific evidence of effectiveness, we carried out a search in a scientific database for services which had published positive outputs in peer-reviewed journals. Services which had not published their results in this kind of journal, even though they were effective in the four policy areas, were not included in our research. This last criterion ensured that we only included services which had positive impacts certified by a qualified scientific methodology. Some successful but unpublished services were excluded even though their outcomes had been positively evaluated with a good methodology (for lack of time, confidentiality of the data, etc.). It should also be remembered that the definition of good practices we adopted refers to the success of the good practice based on their outputs (leaving aside evaluation criteria linked to their implementation). This means that though some services could be or have been running successfully for some time, covering a certain number of users, they were not included in this study because they have not been evaluated against the four variables of effectiveness with a scientific methodology.

Finally, we decided to limit searches in the scientific database to peer reviewed articles published in the last 5 years (2008 -2013), about services directed at people older than 64 years. This meant that we selected services for older people which, as well as having had their outcomes reviewed by experts, were more recent and new technology-based. We did not consider less advanced technology-based services, or those that had had their results published in conference proceedings or books, or those that can improve the independence of younger population groups.

We summarise below the methodology criteria used in this study, their advantages and limitations, and what the study includes and does not.

Table 8: Advantages and limitations of the methodology of the study

Methodology criteria	Advantages	Limitations	Included in the study	Not included in the study
Definition and typology of technology-based services that help older people live at home independently based on a review of the main policy and academic documents	The typology constitutes a first attempt to classify technology-based services for independent living, and is useful for policy, research and practice.	We did not carry out a systematic literature review on these topics.	Technology-based services covered by the definition and typology of services agreed.	Any other kind of services not included in the definition and typology. Telemedicine was excluded from the study.
Good practices are those services which have shown scientific evidence of effectiveness in the four policy objectives defined in this study and which have been implemented at public or private level. A search was carried out of evaluation studies published in scientific journals	Services included were those with a positive impact on independent living, productivity of carers, quality of care, and sustainability of care systems and certified by a qualified scientific methodology, Services had been implemented	The definition of good practices adopted is based only on the success their outputs, leaving aside evaluation criteria linked to their implementation.	Implemented technology-based services for independent living with positive effects on independent living, productivity of carers, quality of care, and sustainability of care systems, with impacts published in scientific publications	Technology-based services for independent living with other kinds of positive effects. Services not implemented. Implemented services with unpublished evaluations or no evaluation
Limiting the search to articles published in the last 5 in years, in peer reviewed scientific journals, about services directed at a sample older than 64	The identification of services was more focused	Less advanced technology-based services, for younger people, published in other kinds of scientific publications different from peer-reviewed articles, were excluded from the search.	Innovative services, articles and old sample were included in the search	Less advanced technology-based services, services with results published in conference proceedings or books, and services targeted at younger people were excluded from the search

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ANNEX I: LIST OF ARTICLES

	FIRST AUTHOR	YEAR	TITLE OF THE ARTICLE/JOURNAL
	Aalbers, T.	2011	Characteristics of effective Internet-mediated interventions to change lifestyle in people aged 50 and older: a systematic review. Ageing Res Rev.
	Aanesen, M.	2011	Smarter elder care? A cost-effectiveness analysis of implementing technology in elder care Health Informatics Journal
	Abraham, C.	2011	Transforming healthcare with information technology in Japan: A review of policy, people, and progress International Journal of Medical Informatics
	Agree EM	2011	A quality-of-life scale for assistive technology: results of a pilot study of aging and technology. Phys Ther.
	Akematsu, Y.	2009	An empirical analysis of the reduction in medical expenditure by e-health users Journal of Telemedicine and Telecare
	Akematsu, Y.	2010	An empirical approach to estimating the effect of e-health on medical expenditure. J Telemed Telecare.
	Alemdar, H.	2010	Wireless sensor networks for healthcare: A survey Computer Networks
	Alexander, G.L.	2011	Passive sensor technology interface to assess elder activity in independent living. Nurs Res.
	Andreoni, G.	2012	Ergonomics and design for sustainability in healthcare: ambient assisted living and the social-environmental impact of patients lifestyle Work-a Journal of Prevention Assessment & Rehabilitation
	Angelidis, P.	2011	INDEPENDENT: Technology Supported Autonomous Living Wireless Mobile Communication and Healthcare
	Angius, G.	2008	A tele-home care system exploiting the DVB-T technology and MHP Methods of Information in Medicine
	Antonicelli, R.	2008	Impact of telemonitoring at home on the management of elderly patients with congestive heart failure Journal of Telemedicine and Telecare
	Arazi, B.	2009	Enhancing elderly utilization of social networks International Journal on Disability and Human Development
	Armfield, N. R.	2012	Clinical use of Skype: a review of the evidence base Journal of Telemedicine and Telecare

	Armstrong, N.	2010	Using smartphones to address the needs of persons with Alzheimer's disease Annals of Telecommunications-Annales Des Telecommunications
	Auvinet, E.	2011	Fall Detection With Multiple Cameras: An Occlusion-Resistant Method Based on 3-D Silhouette Vertical Distribution Ieee Transactions on Information Technology in Biomedicine
	Baig, M. M.	2013	Smart Health Monitoring Systems: An Overview of Design and Modeling Journal of Medical Systems
	Bailey, C.	2011	Older adults, falls and technologies for independent living: A life space approach Ageing and Society
	Banos, R. M.	2012	Positive mood induction procedures for virtual environments designed for elderly people Interacting with Computers
	Beale, S.	2010	The initial evaluation of the scottish telecare development program. Journal of Technology in Human Services
	Bendixen, R. M.	2009	Cost Effectiveness of a Telerehabilitation Program to Support Chronically Ill and Disabled Elders in Their Homes Telemedicine Journal and E-Health
	Bennett, K. J.	2012	Lower Rehospitalization Rates Among Rural Medicare Beneficiaries With Diabetes Journal of Rural Health
	Biswas, J.	2010	Health and wellness monitoring through wearable and ambient sensors: exemplars from home-based care of elderly with mild dementia Annals of Telecommunications-Annales Des Telecommunications
	Boquete, L.	2011	User-Friendly Cognitive Training for the Elderly: A Technical Report Telemedicine and E-Health
	Botella, C.	2009	An e-Health System for the Elderly (Butler Project): A Pilot Study on Acceptance and Satisfaction Cyberpsychology & Behavior
	Botsis, T.	2008	Home telecare technologies for the elderly Journal of Telemedicine and Telecare
	Botsis, T.	2008	Current status and future perspectives in telecare for elderly people suffering from chronic diseases Journal of Telemedicine and Telecare
	Bower, P.	2011	A comprehensive evaluation of the impact of telemonitoring in patients with long-term conditions and social care needs: protocol for the whole systems demonstrator cluster randomised trial Bmc Health Services Research
	Brewer, J.L.	2010	Safety assessment of a home-based telecare system for adults with developmental disabilities in Indiana: a multi-stakeholder perspective. J Telemed Telecare.

	Brownsell, S.	2008	An evaluation of second and third generation telecare services in older people's housing. J Telemed Telecare.
	Bruce, C. R.	2012	Informed Decision Making for In-home Use of Motion Sensor-based Monitoring Technologies Gerontologist
	Bui, A. L.	2012	Home Monitoring for Heart Failure Management Journal of the American College of Cardiology
	Burgener, S.C.	2008	Review of exemplar programs for adults with early-stage Alzheimer's disease Res Gerontol Nurs.
	Caine, K.E.	2011	DigiSwitch: a device to allow older adults to monitor and direct the collection and transmission of health information collected at home. J Med Syst.
	Callari, T. C.	2012	Elderly-technology interaction: accessibility and acceptability of technological devices promoting motor and cognitive training Work-a Journal of Prevention Assessment & Rehabilitation
	Cardozo, L.	2010	Telemedicine for Recently Discharged Older Patients Telemedicine Journal and E-Health
	Carelli, L.	2009	Affective robot for elderly assistance. Stud Health Technol Inform
	Casas, R.	2008	ZigBee-based alarm system for pervasive healthcare in rural areas Iet Communications
	Castilla, D.	2013	Process of design and usability evaluation of a telepsychology web and virtual reality system for the elderly: Butler International Journal of Human-Computer Studies
	Cattan M	2011	The use of telephone befriending in low level support for socially isolated older people--an evaluation. Health Soc Care Community.
	Chan, M.	2008	A review of smart homes - Present state and future challenges Computer Methods and Programs in Biomedicine
	Chan, M.	2009	Smart homes - Current features and future perspectives Maturitas
	Chan, M.	2012	Smart wearable systems: Current status and future challenges Artificial Intelligence in Medicine
	Chang, C. P.	2013	Telecare for the Elderly-Community Nurses' Experiences in Taiwan Cin-Computers Informatics Nursing
	Chang, W. W.	2011	A smart medication system using wireless sensor network technologies Sensors and Actuators a-Physical

	Chatterjee, S.	2009	Healthy living with persuasive technologies: framework, issues, and challenges. J Am Med Inform Assoc.
	Chau, J.P.	2012	A feasibility study to investigate the acceptability and potential effectiveness of a telecare service for older people with chronic obstructive pulmonary disease. Int J Med Inform.
	Chen, C. M.	2011	Web-based remote human pulse monitoring system with intelligent data analysis for home health care Expert Systems with Applications
	Chen, M. L.	2011	A TAM-based study on senior citizens' digital learning and user behavioral intention toward use of broadband network technology services provided via television African Journal of Business Management
	Chen, T. L.	2012	Deployment of Secure Mobile Agents for Medical Information Systems Journal of Medical Systems
	Chiu, K. H.	2010	Remote Monitoring of Health Status of the Elderly at Home in Taiwan Telemedicine Journal and E-Health
	Chou, C.C.	2013	Technology acceptance and quality of life of the elderly in a telecare program. Computers, Informatics, Nursing
	Chumbler, N. R.	2010	Study protocol: home-based telehealth stroke care: a randomized trial for veterans Trials
	Chumbler. N.R.	2012	Effects of telerehabilitation on physical function and disability for stroke patients: a randomized, controlled trial. Stroke.
	Cody, M. J.	1999	Silver surfers: Training and evaluating internet use among older adult learners Communication Education
	Courtney, K. L.	2008	Needing smart home technologies: The perspectives of older adults in continuing care retirement communities Informatics in Primary Care
	Crawford, M.	2009	Homes get smarter. New technology a boon for stay-at-home seniors. Health Prog.
	Cridelich, C.	2012	Gerontologic technologies and society. Soins Gerontol.
	Cudennec, T.	2012	Gerontologic technologies and quality of life. When science helps the elderly. Soins Gerontol.

	Damianakis, T.	2010	The Psychosocial Impacts of Multimedia Biographies on Persons With Cognitive Impairments Gerontologist
	Dang, S.	2009	Evaluating the Evidence Base for the Use of Home Telehealth Remote Monitoring in Elderly with Heart Failure Telemedicine Journal and E-Health
	Dar, O.	2009	A randomized trial of home telemonitoring in a typical elderly heart failure population in North West London: results of the Home-HF study European Journal of Heart Failure
	Davenport, R.D.	2007	Pilot live-in trial at the GatorTech smarthouse Topics in Geriatric Rehabilitation
	de Bruin, E. D.	2010	Use of virtual reality technique for the training of motor control in the elderly Some theoretical considerations Zeitschrift Fur Gerontologie Und Geriatrie
	De Ruyter, B.	2010	Ambient assisted living research in the CareLab GeroPsych: The Journal of Gerontopsychology and Geriatric Psychiatry
	de Veer, A. J. E.	2011	Successful implementation of new technologies in nursing care: a questionnaire survey of nurse-users Bmc Medical Informatics and Decision Making
	Del Prato, S.	2012	Telecare Provides comparable efficacy to conventional self-monitored blood glucose in patients with type 2 diabetes titrating one injection of insulin glulisine-the ELEONOR study. Diabetes Technol Ther.
	Demiris G	2008	Technologies for an aging society: a systematic review of "smart home" applications. Yearb Med Inform.
	Demiris, G.	2008	Senior residents' perceived need of and preferences for "smart home" sensor technologies International Journal of Technology Assessment in Health Care
	Ding D	2011	Sensor technology for smart homes. Maturitas.
	Dommes, A.	2012	Can simulator-based training improve street-crossing safety for elderly pedestrians? Transportation Research Part F-Traffic Psychology and Behaviour
	Doukas, C.	2011	Digital cities of the future: Extending @home assistive technologies for the elderly and the disabled Telematics and Informatics
	Dow, B.	2008	Rural carers online: A feasibility study Australian Journal of Rural Health
	Duclos, C.	2012	Dynamic stability requirements during gait and standing exergames on the wii fit (R) system in the elderly Journal of Neuro-engineering and Rehabilitation

	Duff, P.	2007	Cost-benefit analysis of assistive technology to support independence for people with dementia – Part 2: Results from employing the ENABLE cost-benefit model in practice Technology and Disability
	Duff, P.,	2007	Cost-benefit analysis of assistive technology to support independence for people with dementia - Part 2: Results from employing the ENABLE cost-benefit model in practice Technology and Disability
	Duff, P.,	2007	Cost-benefit analysis of assistive technology to support independence for people with dementia - Part 1: Development of a methodological approach to the ENABLE cost-benefit analysis Technology and Disability
	Duque, G.	2013	Effects of balance training using a virtual-reality system in older fallers Clinical Interventions in Aging
	Duursma, F.	2011	Study protocol: optimization of complex palliative care at home via telemedicine. A cluster randomized controlled trial Bmc Palliative Care
	Edwards, J. D.	2008	Acceptability and validity of older driver screening with the DrivingHealth (R) Inventory Accident Analysis and Prevention
	Egede, L. E.	2009	Rationale and design: telepsychology service delivery for depressed elderly veterans Trials
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	Waterson, P.	2012	Using HIT to deliver integrated care for the frail elderly in the UK: current barriers and future challenges Work-a Journal of Prevention Assessment & Rehabilitation
	Weber, S. A.	2010	Remote Wound Monitoring of Chronic Ulcers Ieee Transactions on Information Technology in Biomedicine
	Weinstock, R. S.	2011	Lessened decline in physical activity and impairment of older adults with diabetes with telemedicine and pedometer use: results from the IDEATel study Age and Ageing
	West, S. P.	2010	Goal Setting Using Telemedicine in Rural Underserved Older Adults with Diabetes: Experiences from the Informatics for Diabetes Education and Telemedicine Project Telemedicine Journal and E-Health
	Wiemeyer, J.	2012	Serious games in prevention and rehabilitation-a new panacea for elderly people? European Review of Aging and Physical Activity
	Wilkinson, N.	2008	Online video game therapy for mental health concerns: A review International Journal of Social Psychiatry
	Willems, C. G.	2011	Activity monitoring to support independent living in Dutch homecare support Assistive Technology Research Series
	Wong, L.	2012	The Rowland Universal Dementia Assessment Scale (RUDAS) as a reliable screening tool for dementia when administered via videoconferencing in elderly post-acute hospital patients Journal of Telemedicine and Telecare
	Woodend, A. K.	2008	Telehome monitoring in patients with cardiac disease who are at high risk of readmission Heart & Lung
	Wray, L. O.	2010	The Effect of Telephone Support Groups on Costs of Care for Veterans With Dementia Gerontologist
	Wu, P.	2005	Results from a field study: The need for an emotional relationship between the elderly and their assistive technologies Foundations of Augmented Cognition, Vol 11
	Yamada, M.	2011	The Reliability and Preliminary Validity of Game-Based Fall Risk Assessment in Community-Dwelling Older Adults Geriatric Nursing
	Yamaguchi, T.	2012	A Dual-Modal Virtual Reality Kitchen for (Re) Learning of Everyday Cooking Activities in Alzheimer's Disease Presence-Teleoperators and Virtual Environments

	Yamawaki, K.	2012	Application of robot suit HAL to gait rehabilitation of stroke patients: A case study. *ICCHP 2, volume 7383 of Lecture Notes in Computer Science*
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	Zao, J. K.	2008	Activity-oriented design of Health Pal: A smart phone for elders' healthcare support Eurasip Journal on Wireless Communications and Networking
	Zaslavsky, O.	2012	The Role of Emerging Information Technologies in Frailty Assessment Research in Gerontological Nursing
	Zeyfang, A.	2010	Technology working for the elderly Diabetologe
	Zhang, Q.	2013	HONEY: A Multimodality Fall Detection and Telecare System Telemedicine and E-Health
	Zwijsen, S. A.	2011	Ethics of using assistive technology in the care for community-dwelling elderly people: An overview of the literature Aging & Mental Health

ANNEX II: TEMPLATE FOR THE COLLECTION OF DATA

NUMBER	A number was assigned to each good practice to help to follow an order.
TYPE OF TECHNOLOGY	Type of technology according to the typology defined in this report for this study (see figure 2 above).
NAME OF THE PRACTICE	It refers to the complete name of the practice, with its acronym in brackets in case of having it.
LEVEL OF NEEDS COVERED	It refers to the specific conditions of the older people that the good practice has been developed for.
COUNTRY	This information geographically localize where the good practice is being or has been developed and implemented
TYPE OF LONG – TERM CARE SYSTEM	Typology of long-term care system that inform about the approach on the use and financing of care of countries. The taxonomy used in this study is based on a recent clustering of long-term care provision from Kraus et al. (2010, 2011).
WEBSITE	It gives the information on the URL address of the good practice.
PRACTICE OVERVIEW	
Years in operation	Specifying the starting year and, in its case, ending year, with the total of years.
Type of organization implementing the practice	Referring if it has been implemented by a public, private and non-profit organization.
Cost information	Approximate costs of the practice including year and units if available.
Scale of implementation	The number of individuals served and number of location implemented.
Aim and characteristics of the practice	
Devices (Technological components)	
EVIDENCE OF EFFECTIVENESS	
Aim of the evaluation	
It refers to the aim of the evaluation to provide information to understand the reasons that this good practice was scientifically evaluated.	
Method	
It collects the information on the research methodology used to evaluate the effectiveness of the practice. Concretely, it specifically details the sample, the research design, the variables collected and the instruments, and the procedure for the data collection. **Sample**: **Research design**: **Variables and instruments:** **Procedure for data collecting:**	

Findings of the practice effectiveness
We have organized the information on the effectiveness of the practice according to the objectives defined in the project and in the SIP, that is: ○ Independent living. ○ Productivity of carers. ○ Quality of care. ○ Sustainability.
INDEPENDENT LIVING
PRODUCTIVITY OF THE CARERS
QUALITY OF CARE
SUSTAINABILITY
Evaluation references
It refers to the bibliography of the references where evidence of effectiveness has been published and retrieved.
OTHER SOURCES
Other sources used to collect the bibliography to complete the template.

ANNEX III: Individual Analysis of the 14 Good Practices organized per type of Technology-based

Assistive Technologies

INTELLIGENT SYSTEM FOR INDEPENDENT LIVING AND SELF-CARE OF OLDER PEOPLE WITH COGNITIVE PROBLEMS OR MILD DEMENTIA (ISISEMD)

NUMBER	1
TYPE OF TECHNOLOGY-BASED SERVICE	ASSISTIVE TECHNOLOGY
NAME OF THE PRACTICE	INTELLIGENT SYSTEM FOR INDEPENDENT LIVING AND SELF-CARE OF SENIORS WITH COGNITIVE PROBLEMS OR MILD DEMENTIA (ISISEMD)
LEVEL OF NEEDS COVERED	OLDER PEOPLE WITH MILD COGNITIVE IMPAIRMENT OR MILD DEMENTIA.
COUNTRY	DENMARK, FINLAND, GREECE, AND UK
TYPE OF LONG-TERM CARE SYSTEM	Cluster 2: Generous, accessible, formalized. Cluster 3: Oriented towards informal care, high private financing
WEBSITE	http://www.isisemd.eu/
PRACTICE OVERVIEW	
Years in operation	2009-2011 (The practice ended because the project duration and funding ended)
Type of organization implementing the practice	Local or regional government
Cost information	Co-funded by the European Commission, through the programme of ICT Policy Support Programme Call:CIP-ICT-PSP-2008-2, Funding scheme: Pilot Type B - CIP-ICT-PSP-PB, Duration: 30 months, Activity: ICT-PSP-2-Theme-1 - ICT for user friendly administrations, public services and inclusion
Scale of implementation	71 older people and 71 informal carers in 4 sites: Frederikshavn (Denmark) Belfast (UK) Trikala (Greece) Lappeenranta (Finland)

Aim and characteristics of the practice

The Intelligent System for Independent living and Self-care of Seniors with Cognitive Problems or Mild Dementia (ISISEMD) is a technological platform with scalable services to support the independent living of the older people and to improve their quality of life and those of their carers. The project was a European pilot project that started in March 2009 and ended in 2011. The ISISEMD offers existing commercial components over this platform:
 	
• To help older people with mild cognitive impairment and dementia to be more independent and safe at home.
• To support formal carers to remotely control their customers.
• To allow informal carers to communicate with and support their relatives.
 	
An application service provider owns and offers the ISISEMD services. This provider is usually a municipality or a care organisation for older people.
 	
The ISISEMD platform offers a possibility of 17 services through different technological components that communicate with each other and interoperate on the platform. The devices, integrated into the service platform, operate automatically and intelligently, recognizing patterns of behavior (e.g., sleep habits and average room temperature) and noting fluctuations that may signal a change in status or a potential danger. The technology of service platform is an integration of systems from Hewlett Packard (Italy), Alcatel-Lucent (Italy), Converge ICT Solutions (Greece), Eltronic A/S (Denmark) and Socrate Medical (Italy). The different services can be selected and added at any time depending on older people and informal carers' needs.
 	
Concretely, the <u>services for older people</u> include (Mitseva et al., 2012):
 	
• Reminders on Carebox. The Carebox Touch screen computer is installed in the older people's house. The Carebox displays text with reminders and relays attention sounds or prerecorded audio messages. These reminders, sounds and messages alert about upcoming appointments, meals, medications, or tasks. These alerts can also prompt older people to carry out the task. The service is automatic and the user can immediately alert the texts and sounds for the activity. This enforces the structure of the daily routine. Reminders can be automatically repeated multiple times, at short intervals. The Carebox is also automatically showing the next two events that older people need to perform under a list of next events, but never more than 2 events at a time to avoid invoking anxiety or confusion. Caregivers and the older people can change the schedule or enter new reminders and events at any time. There is also an option for informal carers to request a confirmation to a specific reminder/activity, such as taking medications. In this case another soft button appears on the Carebox screen and if not pressed, the system automatically sends information to the informal carer (Figure 6). Moreover, the Carebox always displays the date and time to help orient older people.
 	
To accommodate different user needs, there are three levels of interaction of the older people with the Carebox:
 	
    • No interaction at all: the older people don’t need to press any button; they just need to notice the screen from time to time.
    • Some interaction via “soft button”, in this case, older people can activate a different Help Button shown on the Carebox.
    • More advanced interaction: the older people can activate an additional “soft button” to confirm an activity or to play a brain game. There is also the possibility to add the Memory Lane service (picture slide show) and a video-call service.
 	
The view of the Carebox possesses a high level of flexibility and individualization, where different services can be removed. Figure below depicts the Carebox view with the highest level of interaction (Mitseva et al., 2012).

Figure 6: Carebox of ISISEMD platform at the highest level of interaction

FIGURE 1: Screen shot of the Carebox with the Help and Confirmation button from the Reminders Service and Memory Lane and Brain Game.

Source: Mitseva et al., 2012

- Memory Lane with Personal Pictures on Carebox. This is a picture slide show that is shown on the upper right corner of the Carebox. The informal carers upload pictures, and they can add a title to each picture and adjust the speed of the picture show.
- Brain Games on Carebox. This service provides the older people the possibility to play brain games on the Carebox, such as word finds, appropriate puzzles, etc. The type of game can be selected by formal or informal caregiver via the web portal.
- Video-Call Service. This service is mainly initiated by a caregiver—when a video call is displayed as incoming on the touch screen, older people can hear a traditional telephone ringing sound and can accept the call simply by pressing one "soft button" on the screen. The older people can also use this service to make calls.
- Outdoor Safety with the Lommy GPS Device. The required technologies for this service are a GPS positioning system and GPRS communication. This device is about the size of a deck of cards and it helps the older people to be located and contacted by their informal carers outside their home. The GPS is activated when the older people leave the home, and the caregiver can see their positioning on a map by logging into the ISISEMD portal. The Lommy has only a red button that generates an alarm when the older people press it. By pressing the red button, the Lommy sends a sms with the current position or directly calls the informal carers; alternatively, informal carers can call back the Lommy as a regular telephone number and the older people only need to press the red button to activate the communication.

<u>Services for the informal cares</u> include (Mitseva et al., 2012):

- Scheduler. The scheduler enables informal carers to define the parameters (time period, temperature, dangerous versus harmless behaviours, acceptable distance or time away from the home, etc.) to activate alarms according to the needs of their relatives.
- Home Safety. This application use home automation through alarms and sensors at the home for the home safety. This service also included kitchen equipment (stove and oven) control, flood, smoke and fire sensors, and sensor in front door, and other equipment or situations that may pose physical threat. For example, the electric cooking guard keeps measurements of the time and temperature of the stove and oven. This gives the consumer a predefined time span to use the stove, after which, an alert is shown on the Carebox screen and a voice notifies the older people about the cooking activity, giving them the chance to react. If the cooking activities have not stopped after another predefined time period, the system automatically sends an alarm to the informal carers.
- Night Movement Detectors. The bed occupancy sensor generates an alarm if an user is out of bed a longer period of time than normally according to their individual habits.
- Alerts. An alert is when the caregivers are notified about an abnormal activity of the older people, but a response is not urgent. For example, the fridge or the front door has been left open, water was left running, the stove has been left on, or the older people was out of bed for several hours during the

night. This information allows the informal carers to following-up their relatives' activities, and to detect abnormal activities from normal activities to detect new needs and therefore provide the appropriate assistance.

- Alarms. Alarms are sent to carers in case of events that need an urgent response. The alarm can be activated automatically and on demand and a message informs the users about the nature of the alarm. The carers can schedule other alarms and message flows with escalation for special cases (e.g., the relative is traveling abroad or is unavailable on their mobile phone). The alarm service is not only a simple event, notification or message, it can be an overall history of such messages that provides valuable information to the carers.

  Alarms that require immediate action include:

  Door alarms: the house can be equipped with door alarms which can send an alert when the front door is opened (e.g., if the older people are not safe to leave the home alone) or if there is unusual activity with the door (e.g., if the older people leave the home at odd hours, such as the middle of the night).

  Refrigerator monitoring alarms generate an audio alarm for the older people when the refrigerator door has been left open for a specific period and automatically sends an alarm to the informal carers if the door is not closed within a specific period from when the audio alarm is generated. The audio alarm is only generated for a specific period and stops once the alarm has been sent to the carers. This also enables the recording of a pattern of opening and closing the fridge to know the daily habits, for example, if EP is eating meals at appropriate times.

  The cooking monitoring alarm is similar to the refrigerator one. After detecting that the stove is on longer than the predefined time period, the system displays an alarm message on the Carebox screen, to allow older people to react and turn off the stove or oven. The caregivers receive an alarm only when the cooking appliances are still not turned off.

  Smoke, fire, and flood alarms generate immediate audio alarms in the older people home and to the carers

The ISISEMD platform has been accommodated to the differences of the models of care, culture and payment schemes of the European countries. For this purpose, their services are offered in three bundles (Mitseva et al., 2009) (Table 8).

- Service bundle A is centred on primary end-users living in their own homes. It is based on the assumption that they live alone and the system helps them to avoid dangers in the home, reinforces their daily routine and offers cognitive stimulation. There is no interaction with carers, except in emergency situations.
- Service bundle B is an upgrade of services offered by bundle A to involve carers. It includes information flow from the client's home to informal and professional carers for events involving the client. It also gives options for transfer of responsibility among the carer groups and for direct videophone communication.
- Service bundle C includes both bundles A and B, and it also ensures the client's safety outside their home by informing appropriate professionals about the client's current location in case the older people get lost. Advanced services for professional carers highlight deviations of the patient from their normal lifestyle pattern, enables health parameters monitoring, a medication assistant, emergency care, remote doctor consultation, etc.

Table 9: Services included per bundle for the ISISEMD platform

Service Bundles	Services Included
Bundle A: The primary user should be able to live autonomously and safely at home without major involvement of caregivers. No alarm will go out of the house, except for emergency situations	• **Home safety** – kitchen equipment safety, flood, fire/smoke detection, smart door lock • **Reminders** for daily routine, date, to-do list • **Positioning** of personal belongings • **Cognitive stimulation** with memory games
Bundle B: The primary user is supported by regular assistance from caregivers. Alarms and notifications are addressed to the caregivers (both ICG and FCG), also alarms from bundle A services	• **Motion detection/sleeping activit**y analysis • **Intelligent front door** – notification for time the person spends outdoors • **Videophone** for communication with caregivers • **Memory Lane** – for memory training with personal photos and video clips • **Medication assistant** – for medicine compliance support and feedback • **Alarms for some events from Bundle A**
Bundle C: The primary user needs tele-health services because of other chronic conditions or danger of wandering	• **Outdoor guard** – notification of current position of the person in case he/she is lost; panic button • **Remote doctor consultation and diagnostic** and multimedia exchange of data • **Everyday Activity Pattern** – detects abnormalities in living activities, e.g. sleeping less during the night

ICG = Informal caregiver, FCG = Formal caregiver

Source: Mitseva et al., 2012

Devices (Technological components)

Two categories of devices provided the services in the ISISEMD person: interactive and non-interactive devices:

- The interactive devices are those which exchange contents when prompted by the user and are under the users' control. Examples of interactive devices are the mobile phone for the informal carer, the web portal access on a computer, the older people's GPS device and a touch screen.
- The non-interactive devices are those that, once installed by a technician, do not require any user manipulation. They include the temperature and flood sensors, smoke alarms, electricity monitors for cooking activity, pressure sensors to determine sleeping patterns, and front and fridge door sensors. Carebox Touch Screen serves as the graphical user interface to provide information to older people at home.

The majority of the devices are non-interactive. In particular, the devices that the older adult with cognitive impairment operates require minimal interaction or no interaction at all.

EVIDENCE OF EFFECTIVENESS

Aim of the evaluation

The aim of this impact evaluation was to demonstrate that older people affected by cognitive impairments or mild dementia can independently live longer and safer in their own home environment through the assistive technologies like the ISISEMD platform.

For this reason, the study of the impact hypothesises that the use of the ISISMED platform:

- Improves the quality of life and feelings of safety and maintains cognitive ability among those with cognitive impairments or mild dementia.
- Increase the feelings of safety and reduce care related stress among the informal carers.

The impact of the ISISMED platform was evaluated through a controlled study across four European countries (Denmark, Finland, Greece, and UK) in real-life situations for 15 year, at 3 time points: base line, intermediate and final stage. The results published in peer review journal are only available for baseline and intermediate baseline. They are the findings we present here: for details see Mitseva et al., 2012.

Method

Sample:

The eligible population of older people were people over 60 years of age diagnosed with stage two (Age Associated Memory Impairment) to four (Mild Dementia), according to the GDS, with corresponding to the Mini Mental State Exam (MMSE) scores of 19–26 and living in their own homes.

The eligible population of informal caregivers was adults over 18 years and they were recruited based on their relationship with an older adult test participant.

The sample was collected from the cities of the four countries participant in the study: Frederikshavn (Denmark), Lappeenranta (Finland), Trikala (Greece), and Belfast (UK).

The study collected a sample of 80 older patients with mild cognitive impairment (MCI) or mild dementia (MD) across the four regions—20 per trial site (10 intervention and 10 control participants) with respective number of informal caregivers.

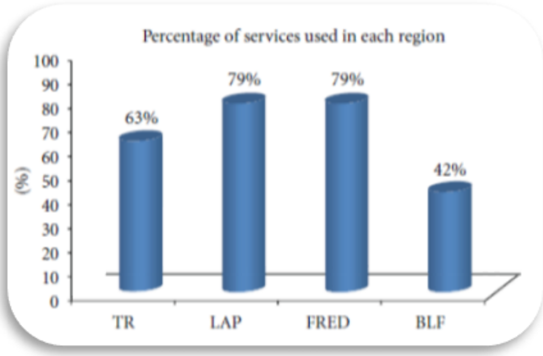
In total 71 informal carers were recruited in the control and in the intervention groups: 45 in the intervention group and 26 in the control group.

Research design:

ISISEMD-controlled study on intelligent systems for dementia home care is a randomized control trial along 15 months. Allocation concealment was implemented in order to assign the patients in the intervention and in the control arm of the study. The intervention/test group was provided the ISISEMD telecare platform while the control group received standard care services through their ICGs and municipality.

From all services offered via ISISEMD service platform and available during the test period of the controlled study, not all of the services were tested in each home because each older people received a subset of all services deepening on his and relative's individual care needs. Figure 7 shows the average use of the services in the four sites. To identify which service each older adults needed at baseline, an evaluation of basic activities of daily living (ADL) and the instrumental activities of daily living (IADL) was carried out, together with an interview with the informal caregivers about their needs and if the older adults had any incidents recently (such as being lost, any falls, cooker turned on and forgotten).

Figure 7. Average use of the services in the four cities N= 31



Source: Mitseva et al., 2012

Variables and instruments:

- User Acceptance and Satisfaction of the ISISEMD platform were collected through interviews to older people and their informal carers. These interviews were built based on two instruments: the Quebec User Evaluation of Satisfaction with Assistive Technology (QUEST 2.0) (Demers and Vincent, 2001; Demers et al., 2002), and the Everyday Technology Use Questionnaire (ETUQ) (Rosenberg, 2009). These tests were only administrated to the intervention group (those using the ISISMED platform).
- Quality of Life for Informal Caregivers was evaluated through the Scale of Quality of Life of Caregivers (SQLC) (Glozman et al., 1998). This tool covered 3 domains: professional activities, social and leisure

activities and responsibilities of caregivers to help patients in everyday living. SQLC scoring provides 4 categories of Caregivers' adaptation: full psychosocial adaptation (141–145), mild disturbance (100–140), moderate disturbance (86–99) and severe disturbance (<85).

- Stress of Caregiving was evaluated through the Zarit Burden Interview (ZBI) short version (Bédart et al., 2001). Questions are on caregiver's health, psychological wellbeing, finances, social life, relationship between carer and patient, and a lower score indicates lower perceived stress.

Procedure for data collecting:

The data were collected at three stages: at baseline, at intermediate, and at final stages. The pilot started in May, 2010, intermediate evaluation in February 2011, and final data collection took place in June, 2011. The same ratings scales and questionnaires were administered to intervention and the control groups of older people and their informal carers, except the user satisfaction and acceptance. Concretely, the rating scales for SQLC and ZBI for informal carers were administered at baseline, intermediate and final stage for the intervention group, while for the control group—the same rating scales but only at baseline and final stage.

The participants from the four countries were recruited using different channels. The majority of referrals were contacted via memory clinics or by the home-care personnel. But TV and radio channels to announce the pilot study and attract interested participants were also used. Participants were also recruited with the aid of general and nurse practitioners, memory and dementia clinics, and regional organizations working with dementia populations.

All required approvals from data protection agencies and ethical regional committees were obtained. Consent forms were signed by all persons in the study and details of the main person to contact from the social care provider organization were provided to all study participants.

Findings of the practice effectiveness

INDEPENDENT LIVING

Older people:

More independent living: As secondary outcomes, the study detected that the older people went out more frequently, they reduced the number of times per day they call the informal carers, and they asked them less for future events and for day/time orientation (Mitseva et al., 2012).

Informal carers:

More independent living: Informal carers inform that the use of the ISISEMD platform give them the possibility to save time and money on travel and phone calls to the older, gives them more freedom for their personal life and free-time interests, reassurance and peace of mind (Mitseva et al., 2012).

Maintaining of the quality of life: The mean score of the informal carers' quality of life evaluated through SQLC passed from 81.96 at baseline (without ISISEMD) to 73.46 at intermediate level (after 9 months). This means that, on average, the adaptation of the carers is within the same range—but that range is also the lowest, showing severe disturbance to informal carers' quality of life. Nevertheless, these differences were not statistically significant (Mitseva et al., 2012).

Maintaining in the stress level: After using 9 months the ISISEMD platform, the mean score of the informal carers 'stress level decreased from 31.82 to 14.83. This means that informal carers pass from moderate to little or no caregiving related stress (Mitseva et al., 2012).

PRODUCTIVITY OF THE CARERS

There is no data

QUALITY OF CARE

There is no data

SUSTAINABILITY

There is no data

Evaluation references
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HOME AUTOMATION AND ADVANCED TELECARE (ESOPPE PROJECT)

NUMBER	2
TYPE OF TECHNOLOGY-BASED SERVICE	ASSISTIVE TECHNOLOGY AND TELECARE
NAME OF THE PRACTICE	HOME AUTOMATION AND ADVANCED TELECARE (ADVANCED TELECARE)
LEVEL OF NEEDS COVERED	FRAIL OLDER PEOPLE
COUNTRY	FRANCE
TYPE OF LONG-TERM CARE SYSTEM	Cluster 3: Oriented towards informal care, high private financing
WEBSITE	Corrèze Department: http://www.correze.fr/personnes-agees-et-handicapees/les-personnes-handicapees/tele-assistance-et-domotique-personnes-handicapees/
PRACTICE OVERVIEW	
Years in operation	• 2013- still operating (Corrèze Department) • 2010- still operating (Creuse Department) • In testing phase (Haute-Vienne Department)
Type of organization implementing the practice	Department (between regional and municipality)
Cost information	According to the data of the Department of Corrèze, the cost of the home automation and advanced telecare system has been calculated to be around 1,700 euros per unit for the first year and 700 euros for the following years. The total investment in the Creuse department to develop and implement this service in the department is 5.7 million euros for 4 years. The funding comes from: • Creuse General Council. • European Commission through the European Regional Development Fund (ERDF) (2007-2013) programme. • the Limousin Region, through the framework “Contrat de Projets Etat-Région 2007-2013 – Volet Handicap et Dépendance”. • the French Government, concretely by the “Fond National d’Aménagement et de Développement du Territoire" (FNADT) in the framework of the " Contrat de Re-dynamisation du Site de Défense de Guéret”.
Scale of implementation	The service is implemented in two of three Departments of the Limousin Region: Corrèze and Creuse Departments. In the third Departmenty (Haute-Vienne Department), the implementation is still in a pilot phase. The number of users per Department is:

- Corrèze Department: 300 users
- Creuse Department: 1,850 users.
- Haute-Vienne Department: 250 users

Aim and characteristics of the practice

The home automation with advanced telecare is aimed to allow older people to live independently at home, preventing them from accidents and keeping them safe at home. The system uses available devices, concretely sensors and light paths. These devices are installed at their home and they are connected through a bracelet or a pendant to a telecare system. The telecare system is available 24h/24 and 7 days/7 and it can be activated either by the older adults in case of care need or automatically in case of accident through the sensors, allowing professionals to appropriately intervene.

Devices (Technological components)

The solution "home automation with advanced telecare" is composed by the two following elements:

1.- A home automation package installed at the older people's home, that includes the following equipment:

- A light path consisting of an automatic system of light located on the most frequent way in the home: The light path is a 1.5 m device installed near the bed that turns automatically on when the person sets foot on the ground. It can provide adapted visibility by showing the right path and improving consciousness. This helps in preventing falls for people who need to wake up for eating or urinating at night

Source: Web page of the system

- A gas sensor
- A smoke sensor that detects smoke in a room and sends an alert to the platform

Source: Web page of the system

- A temperature sensor that detects abnormal variations of temperature at home
- Several complementary systems of emergency (shower and bed pulls) and communication (pendant or bracelet with a medallion and a dialer) to be used in case of fall.

  Regarding the emergency devices, the shower pull is installed in the shower and allows the people to contact the telecare centre in case of emergency or difficulties during the shower. The bed pull is installed over the bed and allows the people to contact with the telecare centre from their bedroom.

  On communication systems, the pendant or bracelet is the transmitter that works linked to a radio with the terminal and allows the users to send an emergency signal to the platform from every room.

- The electronic bracelet or pendent also links to "Quiatil+" and when the button is pressed on the device an immediate connection is established with the telecare platform, which assesses the situation and responds appropriately (e.g. by reassuring the older person, calling the emergency contacts or the ambulance, or the fire brigade, etc.).

Source: Web page of the system

- These elements are connected to a device – the "Quiatil+" terminal - to the telecare call centre (located at Corrèze department). This terminal communicates using the house's telephone line.

Source: Web page of the system

2.- An advanced system of telecare assured a remote assistance 24h/24 and 7 days/7 through a call centre (located at the city of Naves). The call centre is composed by professional operators, trained in communication and management of emergency and psychological and medical situations. The call centre receives the phone calls or the alarms from the equipment linked to the terminal, and it also ensures a direct contact with the users. The operators can also contact the carers, the doctor or the ambulance.

EVIDENCE OF EFFECTIVENESS

Aim of the evaluation.

A preliminary study called the ESOPPE project evaluated the efficacy of home automation and advanced telecare system. This evaluation was initiated by the General Council of the Corrèze Department[11] and the Fondation Caisse d' Epargne pour la Solidarité[12]. ESOPPE tested the efficiency of the light path coupled with the telecare service for preventing unintentional falls at home in a frail older population in the district of Corrèze of the Limousin Region (Tchalla et al., 2012).

The authors hypothesized that the light path could reduce falls because it is better adapted to vision-dysfunction due to age showing the right path to the toilets and improving consciousness. The telecare service is effective 24 h a day, 7 days a week, and allows older people to activate an alarm inducing fast care to the fallen persons at home and preventing falls at home by facilitating movements and thus participate in eurosensorial and mobility preservation.

Method

Sample: The study included 194 adults aged 65 and over living at home. 94 were equipped with light path coupled with telecare service and 96 were unequipped, over a period of 12 months. The sample was randomly selected using minimization method to identify participants for exposed and unexposed group and meeting necessary criteria. Concretely, people included were older people with reduced independence at home (levels 2-4 on the AGGIR scale - the French scale used for grading the degree of an individual's dependency). People eligible for inclusion in the study were aged 65 years and over living at home and were registered on a list of

[11] The legislative body of the department of Corrèze

[12] The Fondation Caisse D'Épargne pour la Solidarité (Saving Banks Foundation for Solidarity) is recognized of public utility by decree in 2001. It is a private and non-profit social and health care foundation , with an intermediate organisatoon model between public and private for-profit institution.

frail older people. People with severe dementia or already in fall prevention rehabilitation were excluded.

Research design: The study used a prospective cohort design. The study was carried out from 1st July 2009 to 30 June 2010 in the Corrèze Department in the Limousin area. The exposed group was equipped with light path coupled with telecare service and the unexposed group remained unequipped. Concretely, participants in the exposed group were equipped with the home automation and advanced telecare system detailed above, although not all the elements were included. It included the home-based technology with the light path coupled with telecare. Each participant had the electronic bracelet with a medallion and a dialer.

Variables and instruments:

The variables evaluated at baseline and their instruments were:

- Socio-demographic data: age, gender, marital status, education, presence of carer and residence.
- Medical history of previous falls, comorbidities and medications.
- Functional autonomy status using Iso-SMAF classification. This classification has 14 profiles based on the 5 dimensions of the Functional Autonomy Measurement System (SMAF scale) : Activity of Daily Living (ADL), mobility, communication functions, mental functions, and Instrumental Activity of Daily Living (IADL) (Dubuc et al., 2006).
- Frailty status according to Fried Frailty criteria. The tool measures five components of the frailty syndrome: unintentional weight loss, depression scale, weakness, slow walking speed, and low physical activity (Cesari et al.,2006).
- Cognitive status using Mini Mental Status questionnaire (Pfeiffer, 1975),
- Nutrition status evaluated through the Mini Nutritional Assessment (MNA) (Rubenstein et al., 1999).
- Depression status using the Geriatrics Depression Scale (GDS) (Yesavage et al., 1982).
- Arterial hypertension.
- Existing illnesses, visual and hearing impairment, incontinence and orthostatic hypotension.

The variables evaluated at follow up were:

- Cumulative incidence rates of falls at home over the period of 12 months following inclusion in the study.
- Cumulative post-fall hospitalizations for fall at home.
- Acceptability: the acceptance rate for home automation system, calculated as the ratio of people who initially choose to use the home automation equipment and the number of patients who accepted the equipment.

Procedure for data collecting:

A researcher physician and a social worker visited eligible participants at home to explain the purpose of study, to obtain written informed consent, and to collect baseline data each 6 months during a period of 12 months.

The confidentiality of the data was ensured, and the study protocol was accepted by the National Committee for the Protection of the Computerized Data DR-2010-329 (CNIL, Commission Nationale Informatique et Liberté) and the local ethics committee. The written informed consents were obtained from all participants involved in the study (for persons with cognitive impairment, a family member or carer had provided a written consent).

Findings of the practice effectiveness

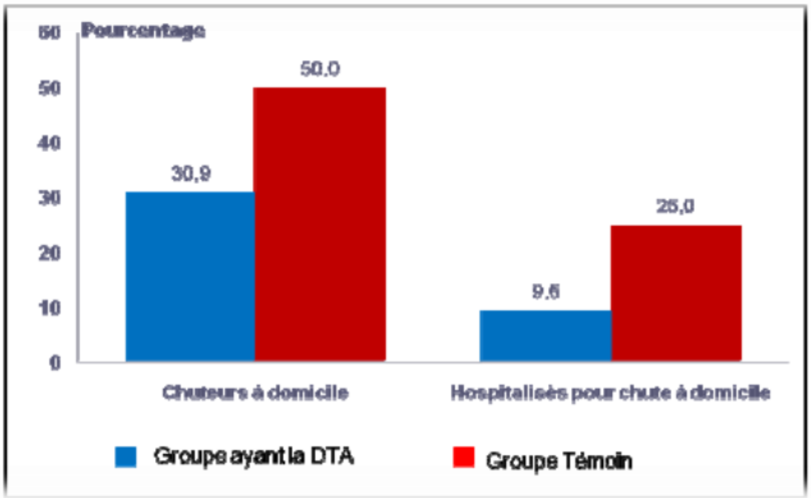
INDEPENDENT LIVING

Reduction in falls:

At home. 30.9% of older people equipped and 50.0% of non-equipped fell at home in 12 months. This reduction was statistically associated with the use of the equipment.

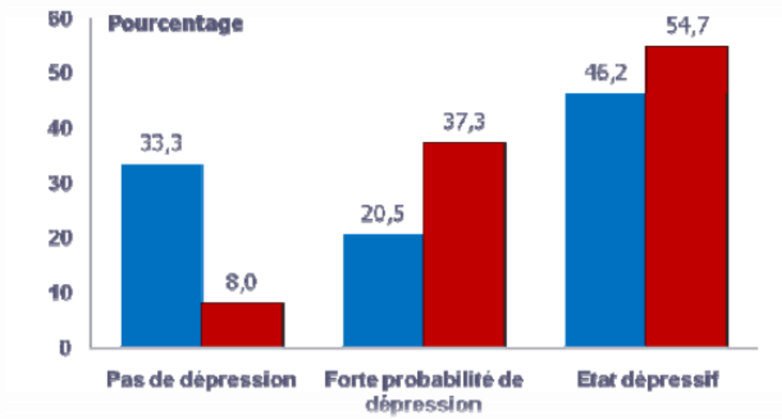
Hospitalisation for falling at home: 9.6% of equipped older people and 25.0% of those non-equipped were hospitalised due to falls at home in 12 months. This reduction was statistically associated with the use of the equipment.

This supposes a reduction in falls by a factor of 1.6 and reduction in hospitalizations by a factor of 2.6, respectively.

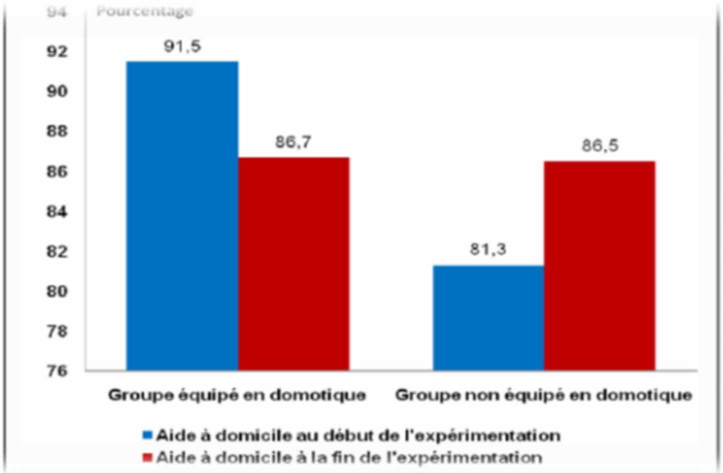


Source: Dantoine, 2010

Reduction in depression. There was a significant difference in the decrease of the number of depressed older adults among equipped and non-equipped. There was a reduction of 26% of depressed older users among equipped and of 10% among non-equipped.



Source: Dantoine, 2010

PRODUCTIVITY OF THE CARERS
Reduction in carers time: Equipped older people received 5% less care at home after 12 months, while non-equipped older people received 4% more care at home after the same period. There is no information about the statistical significance of this difference.  Source: Dantoine, 2010
QUALITY OF CARE
There is no data
SUSTAINABILITY
Cost efficiency: the package costed €1,700 the first year and €700/year the following years; while the average cost of a hospital stay per fall was calculated to be € 8,000. The number of hospitalisations is reduced due to the reduction of the number of falls at home. The authors of the study informed that there is therefore a saving of €6,300 per patient the first year and €7,300 per patient the following years, due to the number of falls prevented, because of the use of the system.
Evaluation references
Tchalla, A.E.; Lachal, F.; Cardinaud, N.; Saulnier, I.; Bhalla, D.; Roquejoffre, A.; Rialle, V.; Prieux, P.M. and Dantoine, T. et al. (2012).. Efficacy of simple home-based technologies combined with a monitoring assistive centre in decreasing falls in a frail older population (results of the Esoppe Study). Archives of Gerontologly and Geriatrics, 55, 683-689.
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D´Antoine, T. (2010) Expérimentation de domotique et téléassistance avancée chez des personnes âgées en perte d'autonomie sur le département de la Corrèze. Note de synthèse de l'étude. Presentation available at: http://www.cg19.fr/fileadmin/user_upload/videos/domotique/Eval_DTA_CTA_Esoppe_note_executive_101110.pdf Généralisation et Développement du Pack "Domotique à Domicile" en Creuse. Article in the journal « Numerique et Séniors », available at http://www.themavision.fr/jcms/rw_261832/generalisation-et-developpement-du-pack-domotique-a-domicile-en-creuse?id=rw_261832&portal=j_55&src=c_48846&printView=true Web page of the system in the Corrèze Department: http://www.correze.fr/fr/actions-sociales-sante-et-familles/les-personnes-handicapees/tele-assistance-et-domotique-personnes-handicapees/index.html

PARTNER PERSONAL ROBOT (PAPERO)

NUMBER	3
TYPE OF TECHNOLOGY-BASED SERVICE	ASSISTIVE TECHNOLOGY (ROBOT)
NAME OF THE PRACTICE	PARTNER PERSONAL ROBOT (PAPERO)
LEVEL OF NEEDS COVERED	DEMENTIA
COUNTRY	JAPAN
TYPE OF LONG-TERM CARE SYSTEM	Not applicable
WEBSITE	http://jpn.nec.com/robot/ (In Japanese)
PRACTICE OVERVIEW	
Years in operation	2001- now
Type of organization implementing the practice	Private company
Cost information	Papero petit: $100 per unit and month (€73.40 Unit/month) for the renting
Scale of implementation	No data

Aim and characteristics of the practice

The Partner Personal Robot (PaPeRo) is a robotic assistant/companion for older people manufactured by NEC Corporation (NEC, 2012). This robot is currently used mainly as a research platform and for entertainment. The key functions of the robot are to prompt actions/activities in users, to attract the attention of users, and to communicate with users through interactive conversation (Figure 8). For example, the robot can remind people of their daily routines, like taking medication. It can also connect with other devices like a pedometer to encourage a more active lifestyle by announcing how far people walk, and can take measurements like blood pressure. NEC has developed recently the Papero Petit. This version is also able to detect people, looks in their direction and recognises faces and speeches, as well as helps older people to communicate with carers.

Figure 8. Concept of the robot system

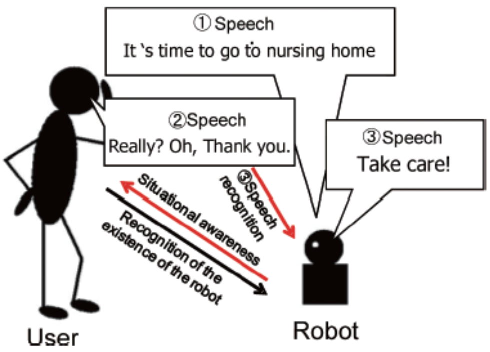

Fig. 2. Concept of the robot system. (Colours are visible in the online version of the article; http://dx.doi.org/10.3233/TAD-120357)

Source: Inoue et al., 2012

Devices (Technological components)

Papero is equipped with the following technological elements:

- Speech recognition
- Speech synthesis.
- Facial image recognition.
- Autonomous mobility.
- Head motion
- Light indication functions.
- Tactile sensors.

More information on the specifications of the robot is in the table below.

Table 1
Specifications of the communication robot "PaPeRo"

Dimensions	Height: 385 mm Width: 282 mm Depth: 251 mm
Weight	Approximately 6.5 kg
Wheels	It has a total of three wheels: two in front and one in back. The two front wheels are driven by two motors. The maximum speed of movement is 20 cm/s.
Head	Moves up and down, and turns left and right with two motors.
CCD camera	Using CCD camera embedded in both of its eyes, it walks around objects, measures distances and approaches people, follows people, remembers people, and differentiates among them.
Sound direction detection microphone	There are three microphones: one on the front, and one each on the left and right. PaPeRo estimates the direction of sounds by means of the difference in time for sound to arrive at the respective microphones, and it looks back in the direction of the sound.
Speech recognition microphones	One directional microphone is installed in the head. PaPeRo speaks while facing a person by means of image recognition, and thus, the microphone points toward the person as well. There is another microphone for noise cancellation, which enables PaPeRo to hear in noisy environments.
Touch sensors	There are nine touch sensors that detect human touch using capacitance sensors: five on the body and four on the head.
Status display	LEDs on the chest indicate what PaPeRo is doing and how PaPeRo is feeling. LEDs on the mouth and cheeks indicate its facial expressions. LEDs on the ears indicate when the robot hears human speech, and LEDs around the eyes indicate when it sees people. The eye LEDs blink green when it is searching for people, and when it locates them, the green light shines stably. When it sees a person's face, the green changes to orange.
Battery	Lithium-ion battery; continuous operation time: Approximately 110 min Battery charging time: Approximately 150 min (when power is off)
External interface	2 USB ports (USB2.0) Auxiliary microphone input AV output (video, stereo audio) 1 Compact Flash slot (CFA Type I) Display output (Analog RGB, mini D-sub 15 pins) Power input (DC19.5V) Self-charge power input

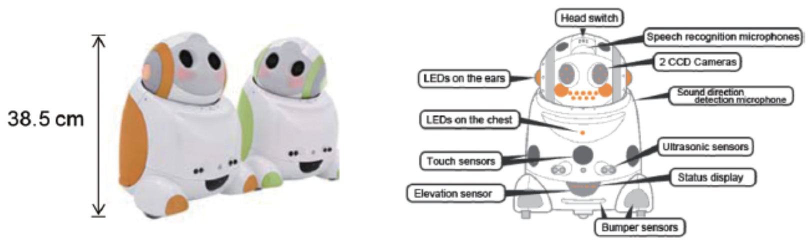

Fig. 1. PaPeRo(NEC) [14]. (Colours are visible in the online version of the article; http://dx.doi.org/10.3233/TAD-120357)

Source: Inoue et al., 2012

Papero Petit stands 24 centimetres tall and weighs 1.3 kg. It combines multiple sensors (cameras, ultrasonic range finders, temperature sensor and microphones) for the detection of people and communication.

EVIDENCE OF EFFECTIVENESS
Aim of the impact evaluation.
PaPero was tested with people with dementia and the impact evaluation was aimed to confirm the field-based method through the development of an information support robot for persons with dementia (Inoue et al., 2012).
Method
Sample: A 97-year-old woman affected by dementia, with problems in her daily life caused mainly by not remembering the time she would be going to the daytime nursing home. **Research design**: Case study. **Variables and instruments:** Observation to reaction to the robot prompt. **Procedure for data collecting:** An evaluation was carried out with a second prototype developed after improvements with the test of a first prototype with 5 people with dementia in their own homes. This second prototype was targeted to resolve problems in daily living of an older people affected by dementia. Her specific problem was caused by not remembering the time she would be going to the daytime nursing home. To solve these problems, contents to provide information that consisted of the following two consecutive steps were created: • A prompt to go to the bathroom 10 min before it was time to leave home for the daytime nursing home. • A prompt to go to the entrance when the doorbell rang. • These prompts were provided for 3 days. The total number of information prompts was 6: 3 times for the bathroom and 3 for the doorbell.
Findings of the practice effectiveness
INDEPENDENT LIVING
Improve the independent living: The support from the robot improved the autonomy of a person with dementia, who was encouraged to act from her own will. Moreover, the robot could prompt behaviours of a person with dementia. The study also demonstrated that the information support provided by the robot also has the potential to improve their autonomy.
PRODUCTIVITY OF THE CARERS
There is no data
QUALITY OF CARE
There is no data
SUSTAINABILITY
There is no data
Evaluation references
Inoue, T., Nihei, M., Narita, T., Onoda, M., Ishiwata, R., Mamiya, I., . . . Kamata, M. (2012). Field-based development of an information support robot for persons with dementia. *Technology and Disability, 24*(4), 263-271.
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ROBOT SUIT HAL-5 (HYBRID ASSISTIVE LIMB)

NUMBER	4
TYPE OF TECHNOLOGY-BASED SERVICE	ASSISTIVE TECHNOLOGY (ROBOT)
NAME OF THE PRACTICE	Robot Suit HAL-5 - Hybrid Assistive Limb- (HAL)
LEVEL OF NEEDS COVERED	FRAIL OLDER PEOPLE
COUNTRY	JAPAN
TYPE OF LONG-TERM CARE SYSTEM	Not applicable
WEBSITE	http://www.cyberdyne.jp/english/robotsuithal/
PRACTICE OVERVIEW	
Years in operation	2005- now
Type of organization implementing the practice	Private company (spin-off from the University of Tsukuba)
Cost information	According to CYBERDYNE policy, HAL-5 may not be purchased. It can be only rented, under a rental system for medical/welfare facilities for domestic users in Japan. The monthly rents are about: • $2200 for the two-leg solution (around 1,660 euros, using the change rate of December 2013). • $1500 for the one-leg version (around 1,130 euros, using the change rate of December 2013).
Scale of implementation	CYBERDYNE has leased around 330 suits to 150 hospitals, welfare and other facilities in Japan since 2010
Aim and characteristics of the practice	
HAL-5 is a wearable robot suit able to help older people as well as paralyzed persons walk and lift heavy objects by transforming brain signals sensed through the skin into motion. By this technology older people can be able to keep their physical activity for longer, preserving and extending their independence at home. The HAL-5 exoskeleton can help the wearer to carry out a variety of everyday tasks, including standing up from a chair, walking, climbing up and down stairs, and lifting heavy objects.	
Devices (Technological components)	
The Robot Suit HAL (Hybrid Assistive Limb) is a wearable exoskeleton consisting in two robotic legs able to sustain the whole weight of the wearers and implement in real time the movements they desire to do, just interpreting the brain signals sensed through the legs' skin. It is composed by mechanical braces, motorised joints controlled by actuators, electronic sensors, a computer processor that synchronise the movements and a battery power source. Sensors are attached to the surface of the wearer's skin, and braces and joints are attached to the wearer. Each time a person attempts to move, his brain sends a signal to the muscles to be involved in the movement through nerve communications. Then the muscles transform the received signals in movement by applying their contracting strength to the skeleton system. HAL sensors along the skin of the wearer detect these weak bio-signals and the processor elaborates them in real time in order to control the power unit and move the joints unitedly with the wearer's muscle movement (or potential). In other words the CPU interprets the wearer's intentions and the exoskeleton supports them actuating the desired movement through the electromechanical structure. In the case bio-electrical signals are no good or not detectable due to some problems in the central nervous system, in the brain or in the muscles, HAL will automatically use, once the user starts moving, a particular control system called Robotic Autonomous Control System. In this alternative control, the wearer's intended	

movements are assembled as a mosaic of small parts (elemental movements) from the HAL internal database which is automatically augmented by the few information that sensors are able collect from the body. Using the database HAL autonomously coordinates each motion to be assisted by power units. This possibility to have a hybrid control is the origin of the suit name, in fact HAL stays for Hybrid Assistive Limb.

In HAL suit two systems works closely together:

- The first one is dedicated to monitor electric currents known as electromyogram (EMG), signals on the wearer's body. It collect signals flowing along muscle fibres, when a person intends to move, through the sensors attached to the wearer's skin near the shoulders, hips, knees, and elbows, and send them to the control computer, which then triggers the actuators in the joints to move the robotic limbs.
- The second control system is dedicated to the movement of the suit. It stores walking patterns generated the first time a new user tries out the suit and uses that information to synchronize the suit's limbs with those of the wearer. The fine tuning of this system is essential to tailor HAL, and it can take 2 months of continuous calibrations, mostly for people who have one leg less capable than the other.

Currently the robot suits available on the market are only the bipedal model and single leg model. The full-body, single joint, or upper body type are in their final phase of development and will be soon available. Different sizes are available to make HAL fine adjustable and fit to the wearer. The full specifications list is reported in the table below:

HAL-5 Type-B Specifications				
	S	M	L	Adjustment Range
Applicable height	145-165cm	150-170cm	165-185cm	-
Upper thigh length	35-39,5cm	36,5-41cm	39,5-44cm	4 steps of 1,5cm
Lower leg length	33-40,5cm	34,5-42cm	37,5-45cm	6 steps of 1,5cm
Shoe size	22-28cm			
	M		W	
Hip width	31-35cm		37-42cm	
Movable range	Hip joint: extension 20°, flexion 120° Knee joint: extension 6°, flexion 120°			
Weight	Full Body Type: approx. 23kg Lower body Type: approx 15 kg (12kg without battery pack)			
Strength increasing	Increase human strength from 2 to 10 times stronger			
Operating time	About 2 hour 40 minutes (standard operation time), but varies with the conditions			
Operating environment	Temperature: 5-35°C Humidity:<75% (no condensate)			
Battery	Lithium polymer battery (rechargeable with AC100V adaptor)			
Program	Brought by Asaby Beer and Madza			

Table 1 - HAL-5 Full specification list [59]

Source: Hanlon and Ferulli, 2011

EVIDENCE OF EFFECTIVENESS

Aim of the impact evaluation.

Two studies have evaluated the impact of HAL, with the following aims:

- To evaluate efficacy of HAL locomotor training for a chronic stroke patient (Yamamaki et al. 2012).
- To investigate the possibility of using HAL for clinical rehabilitation (Watanabe et al., 2012).

Method

1.- Yamamaki et al. (2012) used the following methodology:

Sample: HAL was applied to a 74 year old male patient with hemiplegia on the left side due to a cerebral infarction that occurred three years before.

Research design: It is a case study where the older person received locomotor training with the HAL twice a week for eight weeks. The duration of each training session was around 20 minutes.

Variables and instruments:

- Mean angles of the left hip joint with and without the HAL for a gait cycle, calculated as the average of ten gait cycles. The angle was set to 0 degree in the standing posture and considered positive during flexion.
- Walking ability was evaluated by means of a 10 m walking test (10MWT).
- Balance ability was assessed using a functional balance scale (FBS).

Procedure for data collecting: These variables were collected before and after the eight week rehabilitation period with the HAL.

2.- Watanabe et al. (2012) used the following methodology:

Sample: Ten patients participated in this study.

Research design: Subjects performed gait training for 20-30 minutes using HAL®.

Variables and instruments: Ten-meter comfortable and maximum walking speed times were measured.

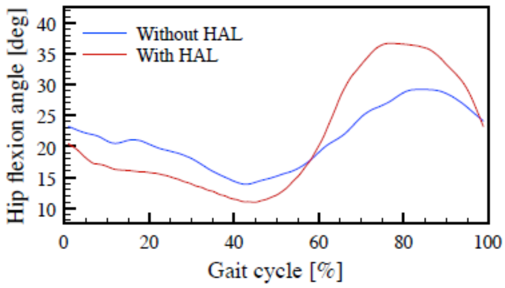
Procedure for data collecting: Ten-meter comfortable and maximum walking speed times were measured before and after HAL® training.

Findings of the practice effectiveness

INDEPENDENT LIVING

Improvement in walking ability: Wearing the HAL increases the motion range of the left impaired hip joint (Figure 9) (Yamamaki et al., 2012).

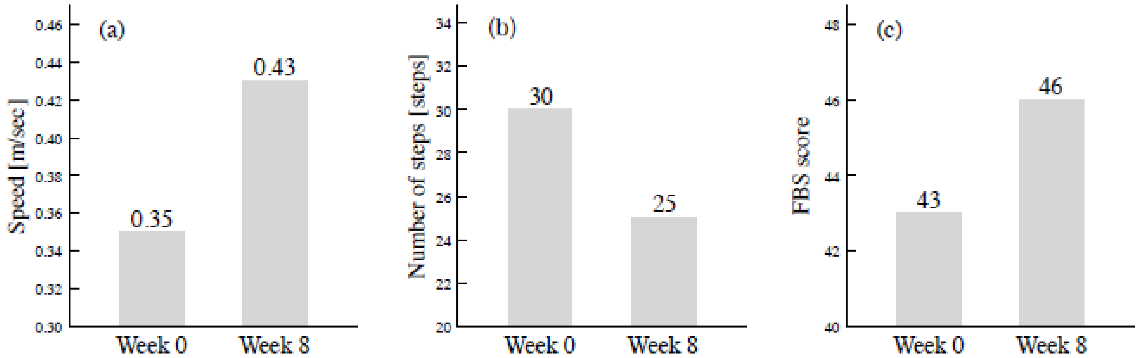
Figure 9: Left hip joint angles with and without the HAL during walking



Source: Yamawaki et al. 2012

A case study with a patient that was rehabilitated with HAL during 8 weeks, 20 minutes per session, showed an increase in gait speed, a decrease in the number of steps after the HAL training, and an increased walking balance – Figure 10 - (Yamawaki et al., 2012).

Figure 10: Change in walking speed (a) and number of steps (b) for 10 MWT, and FBS score (c) before and after the 8-weeks locomotor training period with HAL



Source: Yamawaki et al. 2012

Another study with 10 patients that trained for 20-30 minutes with HAL also improved their 10-meter walking speed times (Watanabe et al., 2012).
PRODUCTIVITY OF THE CARERS
There is no data
QUALITY OF CARE
There is no data
SUSTAINABILITY
Cost-efficiency: The cost of caring an older user at home completely unable to stand up and walk has been calculated around spending about €4,000 to provide assistance for 8 hours per day and 7 day per week (based on calculation of €17 per hour). This amount is more than twice the rent of the Robot Suit HAL (Hanlon and Ferulli, 2011).
Evaluation references
Watanabe, H., Tanaka, N., Kanamori, T., Saitou, H., Nagasawa, T., Koseki, S., . . . Yanagi, H. (2012). Clinical application of ROBOT SUIT HAL®(hybrid assistive limb®) for rehabilitation case study. *Rigakuryoho Kagaku, 27*(6), 723-729 Yamawaki, K., Ariyasu, R., Kubota, S., Kawamoto, H., Nakata, Y., Kamibayashi, K., . . . Ochiai, N. (2012). *Application of robot suit HAL to gait rehabilitation of stroke patients: A case study. ICCHP 2, volume 7383 of Lecture Notes in Computer Science, page 184-187. Springer*
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Hanlon, A.O and Ferulli, D. (2011). Deliverable D3.2. – Report on business case studies. Value Ageing. Available at http://www.valueageing.eu/wp-content/uploads/2012/03/D3.2_FINAL.pdf Obi, T., Ishnatova, D. and Iwasaki, N. (2013). Promoting ICT innovations for the ageing population in Japan. International Journal of Medical Informatics, 82, e47-e62. Usui, C. (2009). Japan's demographic changes: social implications and business opportunities, in Kohlbacher, F. and Herstatt, C (Eds), the Silver Market Phenomenon Business Opportunities in an Era of Demographic Change, vol. XXXVI, pp. 71-82. Webpage of Cyberdyne: http://www.cyberdyne.jp/english/customer/index.html

ROBOTIC STRIDE ASSISTANCE SYSTEM (SAS)

NUMBER	5
TYPE OF TECHNOLOGY-BASED SERVICE	ASSISTIVE TECHNOLOGY (ROBOT)
NAME OF THE PRACTICE	ROBOTIC STRIDE ASSISTANCE SYSTEM (SAS)
LEVEL OF NEEDS COVERED	OLDER PEOPLE WITH LOW WALKING ABILITIES
COUNTRY	JAPAN
TYPE OF LONG-TERM CARE SYSTEM	Not applicable
WEBSITE	http://corporate.honda.com/innovation/walk-assist/
PRACTICE OVERVIEW	
Years in operation	1999 (start research) – now
Type of organization implementing the practice	Private company
Cost information	There is no data
Scale of implementation	There is no data

Aim and characteristics of the practice

The Walking Assist Device with Stride Management Assist is a robot developed and commercialised by Honda R&D. This robot aims to improve the walking patterns of adults with low walking abilities such as age-related short stride lengths and inefficient walking patterns.

Devices (Technological components)

A motor helps lift each leg at the thigh as it moves toward and backward. This helps lengthen the users'stride, making easier to cover longer distances at a greater speed. A lightweight and simple design with a belt worn around the hips and thighs was created to reduce the wearer' load and to fit different body shapes. Specifications are below in table 9 and the components in figure 11.

Table 10. Specifications of the Walking Assist Device with Stride Management Assist

Specification	
Weight	2.8kg (including batteries)
Drive system	Brushless DC motor x 2
Battery	Rechargeable lithium ion battery
Single-charge operation time	Approx 2 hours (while walking at 4.5 km/h)
Sizes Space between motors (MM)	Small(S) (S)312 Medium(M) (M)342 Large(L) (L)372

Source: Retrieved from http://corporate.honda.com/innovation/walk-assist/StrideManagementAssist.pdf

Figure 11. Components of the Walking Assist Device with Stride Management Assist

Source: Retrieved from http://corporate.honda.com/innovation/walk-assist/StrideManagementAssist.pdf

EVIDENCE OF EFFECTIVENESS

Aim of the impact evaluation.

To identify the effects of an automated stride assistance system on walking scores and muscle activities in the lower extremities of older people.

Method

Sample: For 3 months, 15 women (72–85 years old) performed the walking exercise twice weekly for 90 min/session. None of the subjects admitted to the study had severe diseases and all were capable of independent mobility outdoors.

Research design: Individuals participated in a 3-month walking programme using the stride assistance system, involving two 90-min supervised sessions per week. More characteristics on the specific model used for this research is on figure 12 below.

Figure 12. The stride assistance system used in the Shimada's study (Shimada et al., 2007)

Figure 1 The stride assistance system. Electrical actuators were equipped with angular sensors to monitor cadence, angular velocity and the degree of extension and flexion of the hip joints. The system weighed 2.4 kg and was positioned so that both actuators were located above the greater trochanters. Battery power was sufficient for approximately 2 h of independent activity.

Source: Shimada et al., 2007

Variables and instruments: Walking speed was used as a measure of gait performance. The study assessed walking for 5 m at a comfortable speed before and after the intervention.

Results were expressed as walking speed (m/s), step length (m) and cadence (steps/min). The distance covered during a 50-min walk was used as an index of walking endurance. Distance was measured by investigators who followed the subjects during the 50 min FDG PET assessment. The walking aid was not used during the walking tests (Shimada et al., 2009).

Positron emission tomography with [18F]fluorodeoxyglucose (FDG) was used to assess muscle activity during an unassisted 50-min walk. The subjects walked for 50 min at a comfortable speed on a 940-m circular indoor walking track that was marked at 1-m intervals. The protocol involved a 30-min walk followed by i.v. injection of FDG, a 20-min walk, and a PET scan. On average, PET scans were conducted at a mean interval of 60 min (49–71 min) after the FDG injection. The subjects refrained from consuming food and drink containing sugar for at least 6 h before FDG PET assessment and from strenuous physical activity for at least 2 days before FDG PET assessment.

Procedure for data collecting: The subjects were asked to walk on a flat surface at their “comfortable walking speed”. Two marks were used to delineate the start and end of a 5-m path. The start mark was preceded by a 3-m approach to ensure that the subjects achieved their pace of comfort before entering the test path. The subjects were also instructed to continue walking past the end of the 5-m path for a further 3 m to ensure that their walking pace was maintained throughout the test path. The time taken to complete the 5-m walk, and the number of steps made and their length were measured by three investigators.

Findings of the practice effectiveness

INDEPENDENT LIVING

Improvement of walking performance: Walking speed was improved by the intervention by 7 m/min (10%) in the older adults with history of falls. FDG uptake (used to assess muscle activity) by the gluteus minimus, gluteus medius and rectus femoris, and pelvic muscles (iliacus and gluteus muscles) were reduced. These results suggestED that a walking intervention program using an applied robotic system is useful for improving the walking ability and the efficiency of muscle activities during walking in the older adults.

PRODUCTIVITY OF THE CARERS

There is no data

QUALITY OF CARE

There is no data

SUSTAINABILITY

There is no data

Evaluation references

Shimada, H., Hirata, T., Kimura, Y., Naka, T., Kikuchi, K., Oda, K., . . . Suzuki, T. (2009). Effects of a robotic walking exercise on walking performance in community-dwelling elderly adults. *Geriatrics & Gerontology International, 9*(4), 372-381

OTHER SOURCES

Sheet information of the Walking Assist Device with Stride Management Assist: http://corporate.honda.com/innovation/walk-assist/StrideManagementAssist.pdf

SMART HOME

X10 ACTIVEHOME KIT

NUMBER	6
TYPE OF TECHNOLOGY-BASED SERVICE	SMART HOME
NAME OF THE PRACTICE	X10 ACTIVEHOME KIT (ACTIVE HOME)
LEVEL OF NEEDS COVERED	OLDER PEOPLE WITH CHRONIC CONDITIONS
COUNTRY	UNITED STATES
TYPE OF LONG-TERM CARE SYSTEM	Not applicable
WEBSITE	http://www.x10.com/
PRACTICAL OVERVIEW	
Years in operation	1978 – now
Type of organization implementing the practice	Private company
Cost information	No house incurred more than $400 (around €300 – change of December 2013) for the X10 products and other necessary materials.
Scale of implementation	More than 15 million of systems have been sale since 1978 and in 2007, 5 million homes have the system installed.
Aim and characteristics of the practice	
X10 ACTIVEHOME KIT is a home automation solution. It was the first home automation system launched in the mid 90a. The system allows people to control their home's lights and appliances in any room through the PC, to automate the home through a custom schedule create on the PC, to turn things on and off, or to dim/brighten lights based on schedules.	
Devices (Technological components)	
The X10 ActiveHome kit (Figure 13) includes products that can be used with either a remote control or computer software: • A 5-in-1 remote control for lamps and appliances using radio frequency. • A plug-in 2-prong lamp module. • A 3-prong appliance module. • A key chain remote. • A 2-way transceiver module that receives radio frequency commands from remote controls to operate lamps or appliances plugged into it. • A computer interface that works with the transceiver module to control the on/off timing of lamps and appliances. • The ActiveHome software for Windows. The computer software provides centralized and automated control of electric devices.	

Figure 13: Image of the X10 ActiveHome kit

Source. Image retrieve from Ebay: http://www.ebay.com/itm/Activehome-x-10-/151119784035

The simplified working process of X10 technology is illustrated in Figure 14.

Figure 14: Working process of X10 technology

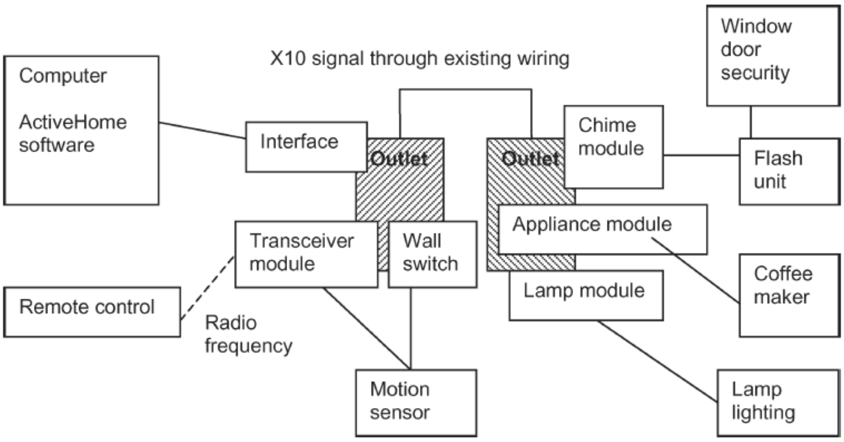


Figure 1. Working process of X10 technology.

Source: Tomita et al., 2007

The X10 technology is sold as a product where installation is rather simple even for people with little experience in smart homes, compatible with many products available in the market. The home networking solutions can be integrated with an IBM or compatible computer equipped with Windows, and a CD ROM drive. The initial installation takes 3 to 9 hours depending on the size of the dwelling.

EVIDENCE OF EFFECTIVENESS

Aim of the evaluation.

A research led by Tomita et al. (2007) tested the X10 ACTIVEHOME KIT on functional status and sustainability of community living along 2-years intervention. The aims of the impact evaluation were to analyse if, over 2 years, older adults living in smart homes compared with those not living in smart homes:

- Maintain better physical and cognitive functions.
- Live more independently.

Method
Sample: The participants in this study lived in Western New York and were selected with a consecutive sampling method. The inclusion criteria were a minimum 60 years of age, living alone, having difficulty in activities of daily living (ADL) or instrumental ADL (IADL) due to chronic health conditions without cognitive impairment, and having an interest in using a computer. 46 participants were randomly assigned in the treatment group and 67 in the control group. At the 2-year intervention, there were 34 participants in the treatment group (26% attrition) and 44 in the control group (34% attrition). Over the 2-year period, there were 35 losses. **Research design**: A 2-year randomized controlled trial. Participants in the treatment group used the X10 ActiveHome kit completed with stand-alone products, including door and window sensors, a motion sensor, a power flash that acts as an interface between the security system and an alarm (chime), and a wall switch for manual control for lighting connected to a motion detector. **Variables and instruments:** Functional status was evaluated through 5 instruments: • Functional Independence Measure (FIM) for ADL (Centre for Functional Assessment Research, 2002). • The Duke Older Americans Resources and Services Procedures' (OARS') IADL (Fillembaum, 1988). • Mobility subsection of Dysfunction section of Sickness Impact Profile (SIP) (Bergner et al., 1981). • Craig Handicap Assessment and Reporting Technique (CHART) Mobility for handicap measure (Whiteneck et al., 1988) • Mini-Mental State Examination (MMSE) (Folstein et al.,1988). Health status: number and type of illnesses, number of medications, and use of health institutions and medical treatment, as well as nurse aide hours were recorded by a monthly interview. The participants also provided a self-evaluation of their computer use and smart home functions at the end of 2 years. **Procedure for data collecting:** An occupational therapist or a nurse carried out first a home assessment to the participants, and a computer engineer visited the house/apartment of participants who were assigned to the treatment group. For participants with arthritis in the fingers or a problem with fine motor control, a trackball rather than a mouse was provided and for some participants with vision impairment, an enlarged keyboard was provided. A computer and/or Internet were provided to participants in the treatment group who did not own them along with computer training. A computer use monitoring software called Boss EveryWare was installed into the participant's computer after obtaining a consent form. The software collects information such as the application file name being used, active window, and duration, and saves it to a dbase III+ log file. It has the ability to filter data and export it to other programs such as Excel and text editors. Every 6 months, participants' log files were copied and transferred to the investigator's computer. Some of the data were filtered in dbase and then converted to XLS. Time spent in a particular application category was reported for each participant, including ActiveHome operation, games, e-mail, and Internet use.
Findings of the practice effectiveness
INDEPENDENT LIVING
Maintenance of physical and cognitive status: Older people using the smart home system had stayed with the same level of level of dependency for instrumental activities of daily life for 2 years and they have a significantly higher cognitive level than people that do not use it (Tomita et al., 2007; Reeder et al., 2013). **Live more independently**: Users and non-users of the smart homes were significantly different in terms of their living status: 80.4% of the treatment group participants were living at their own home at the end of the study period, whereas only 65.7% of the control group participants were living at their own home at the end of the study period (Tomita et al., 2007; Reeder et al., 2013).

PRODUCTIVITY OF THE CARERS
There is no data
QUALITY OF CARE
There is no data
SUSTAINABILITY
Low cost of the technology: an existing home can be converted using commercial off-the-shelf technology for less than $400 (Tomita et al., 2007; Reeder et al., 2013).
Evaluation references
Reeder, B., Meyer, E., Lazar, A., Chaudhuri, S., Thompson, H. J., & Demiris, G. (2013). Framing the evidence for health smart homes and home-based consumer health technologies as a public health intervention for independent aging: A systematic review. *International Journal of Medical Informatics, 82*(7), 565-579 Tomita, M. R., Mann, W. C., Stanton, K., Tomita, A. D., & Sundar, V. (2007). Use of currently available smart home technology by frail elders: Process and outcomes. *Topics in Geriatric Rehabilitation, 23*(1), 24-34
OTHER SOURCES
García-Muñoz, L-A. and Maldonado-Gonzaga, G.A. (2007). Evaluación económica, financiera y de mercado para la comercialización de equipos domóticos que utilizan Protocolo X10 Active Home Pro. (Undergraduate thesis). Available at http://www.cib.espol.edu.ec/Digipath/D_Tesis_PDF/D-36625.pdf. García-Muñoz, L.A. Maldonado-Gonzaga, G.A.; and Cervallos, H. (2007) Evaluación económica, financiera y de mercado para la comercialización de equipos domóticos que utilizan Protocolo X10 Active Home Pro. Article Available at http://www.dspace.espol.edu.ec/handle/123456789/1065h

TECHNOLOGY-BASED HEALTH CARE

TAIWAN'S TELEHEALTH PILOT PROJECT (TTPP)

NUMBER	7
TYPE OF TECHNOLOGY-BASED SERVICE	TECHNOLOGY-BASED HEALTH CARE - TELEHEALTH
NAME OF THE PRACTICE	TAIWAN'S TELEHEALTH PILOT PROJECT (TTPP) – Home care model (TAIWAN TELEHEALTH)
LEVEL OF NEEDS COVERED	OLDER PEOPLE WITH CHRONIC DISEASE AND THEIR CARERS
COUNTRY	TAIWAN
TYPE OF LONG-TERM CARE SYSTEM	Not applicable
WEBSITE	http://doh.telecare.com.tw/eng_Index.htm
PRACTICE OVERVIEW	
Years in operation	2007-2010 (The programme ended after these 4 years plan, and to further enhance the development of telecare in Taiwan, the department of health claims for a need to amend the policies and regulations for the innovative service)
Type of organization implementing the practice	Initiated and operated by the Taiwan's government (Department of Health)
Cost information	No data
Scale of implementation	Over seventy healthcare institutions formed the tele-healthcare service network, used over 700,000 times by their members within the four year project term.

Aim and characteristics of the practice

Taiwan's government is developing since 2007 the Taiwan's Telehealth Pilot Project (TTPP) to face the current population ageing and its consequent increase of health care costs. The goal of the TTPP IS to deliver health and living services, health advice, emergency consultation services, and other needed healthcare services with the use of technology (Hsu et al., 2010). TTPP included telemedicine, telehealthcare and living support service developed by hospitals, such as safety and security (Doh, 2012). The system also networks with existing health information systems, long-term care networking platform and other telecare stations. The TTPP relies on the digital transmission of medical data collected from patients in community health centres, private homes and nursing homes.

As we can see on figure 15, the system has three different models: the home-care, the community-care, and the residential care model to assist the older people in the pursuit of better healthcare and improved quality of life (Hsu et al., 2010). A telehealth central station (TCS) and an information platform integrate the systems. The TCS is responsible for the administration, coordination, and management of health information to facilitate data and record archiving, exchange, and transmit them. It also served as a 24-h service call centre that deals with emergency consultations for daily health and lifestyle problems.

Figure 15. The functional structure of Taiwan's Telehealth Pilot Project

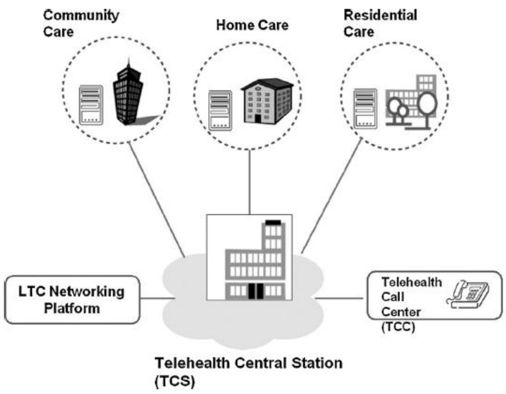


Fig. 2 – The functional structure of Taiwan's Telehealth Pilot Project.

Source: Hsu et al., 2010

The **home-care model** telemonitors physiological parameters (blood pressure and/or blood sugar) at home, providing health information and medication instructions to the older people and offerings consultations with healthcare professionals (dieticians, therapists, pharmacists, and nursing professionals) by videoconferences. The data collected with the telemonitoring system are uploaded by the older people or their carers to a central data base with an automatic alert system placed in the telehealth central station. The frequency to upload the data is determined by the patients' physicians. The telehealth central station staffs are in charge of responding to any critical values and to remind the patients or their carers if they do not upload the data as the frequency set by the physicians. The data are also integrated into a hospital's computerized physician order entry (CPOE) system, where the clinicians might directly retrieve the data in the hospital information system (HIS).

Older people included for the home-care model are those whose Barthel's index are equal or below 90 or who has diabetes mellitus or hypertension.

The **community-care model** provides health and living services, including professional healthcare and local community services (such as laundry, haircut, and meal delivery services). The goal of this model is to let the older people be cared and supported in the community. This model allows the older adults to access appropriate care services in a familiar context.

The services delivered are similar to those of the home-care model, except that the operations of the telemonitoring are accomplished by the trained-staff in the community-care station instead of the older people or their carers in their home. Concretely, the community-care stations are set up to offer the older people the services such as telemonitoring as that of the home-care model, including healthcare information and medication instructions. This model also uses localization services for the older people with dementia through a global positional system (GPS). As aforementioned in home-care model, the physiological data are integrated to the hospital's CPOE system, and the physicians might retrieve the data directly in the HIS.

Older people included in the community-care model are those who are living alone, or who has dementia, hypertension, or diabetes mellitus. The patients in this model can visit the community-care stations independently or with the assistance of their carers.

The **residential-care model** involves a tele-consultation infrastructure that links the long-term care units and hospitals with the assistance of the telehealth service centre. The staff at long-term care units can use this infrastructure to request help from the specialists of the corresponding tertiary acute care hospitals.

The residential-model helps to build the communications between the residents in the long-term care units and medical professionals in the hospital.

To be included for the residential-care model, older people need to be residents of the nursing homes.

Table 10 lists inclusion criteria and core services of the three (home care, community care and residential care) models. Figure 16 shows the model of provision of care of the TTPP. For this study, we will focus only in the home care model.

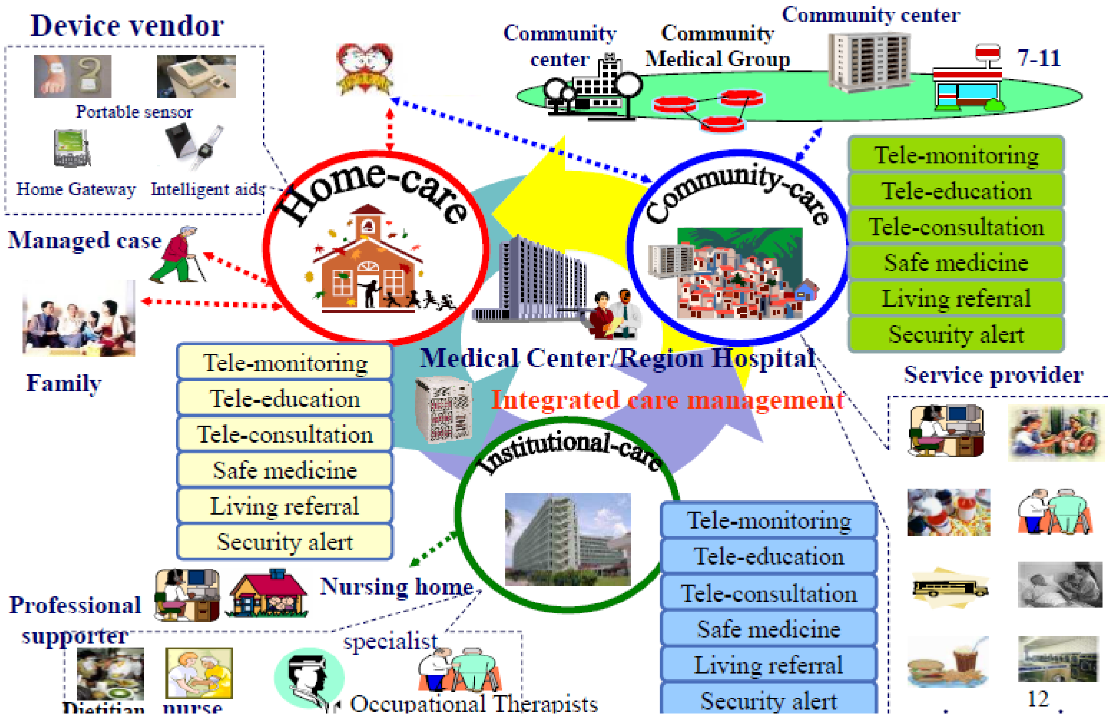
Table 11: Inclusion criteria and core services of the three models of telehealth

Table 1 – Inclusion criteria and core services of the three care models of Taiwan's Telehealth Pilot Project.

	Home care	Community care	Residential care
Inclusion criteria	Current home care enrollees Caregivers with chronic disease Low to moderate-grade disability	Cardiovascular diseases Diabetes Dementia Low-grade disability Seniors living alone	Moderate to high-grade disability Intermediate care
Core services	Home visit using videoconference Physiological monitoring Living support Health education	Health promotion Dispensary Physiological monitoring Medication consultation Living support Health education	Regular and emergency consult Rehabilitation instruction Physiological monitoring Medication consultation Tele-learning Quality monitoring

Source: Hsu et al., 2010

Figure 16: Model of provision of care of the TTPP



Source: Liou

Devices (Technological components)
The system used in the TTPP is based on a long-term care information network established in 2003 using information technology to efficiently combine resources for long- term care from both governmental and private institutions in 25 counties and cities (Figure 17). Based on this network and other established networks such as the National Health Informatics Project (NHIP), Taiwan's government executed the Taiwan's Telehealth Pilot Project (TTPP).

Figure 17. The long-term care information network in Taiwan

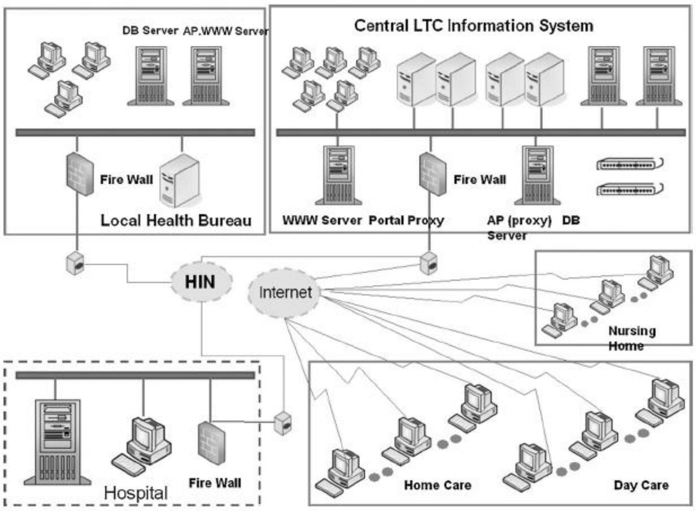


Fig. 1 – The long-term care information network in Taiwan.

Source: Hsu et al., 2010

In the home care model, the services are delivered through a set-top-box which is attached to a television. The set-top boxes in patients' homes are connected to the telehealth service centre through asymmetric digital subscriber line (ADSL). ADSL is a high-speed digital telephone connection that operates over an existing copper telephone line, allowing the same line to be used for voice calls and data transmission. The operating system of the set-top-box is Linux and all the applications are developed by Java with Open Service Gateway Initiative (OSGi) compliance. This type of set-top-box is also used in the community-care and residential-care models.

Set-top Box

Source: Liou (see other sources for link to the presentation)

EVIDENCE OF EFFECTIVENESS

Aim of the evaluation.
In 2007, the Department of Health financed a 'Telehealth Pilot Project' to explore the benefits of telecare services and to resolve the strong demand for long-term care (Ho and Lai, 2008; Chen et al., 2008). The Municipal Wan Fang Hospital was responsible for executing the pilot project.

Method
Sample: The home-care pilot study included 50 families, and 200 participants. The sample was conveniently selected (non-randomized). To be included for the home-care model were the older people whose Barthel's index was equal or below 90 or who had diabetes mellitus or hypertension. **Research design**: Pilot study, with no more information on the research design used. The services received by the sample included: • telemonitoring physiological parameters (blood pressure and/or blood sugar), • providing the relevant health information and medication instructions, and • offering consultations with healthcare professionals such as dieticians, therapists, pharmacists, and nursing professionals by videoconferences. In telemonitoring, the patients' physician determined the data upload frequency. Relevant services were delivered through a set-top-box which was attached to a television. **Variables and instruments:** Functional limitation in activities of daily life was evaluated at base line with the Barthel's Index **Outcomes measures:** • Hospitalization rate. • Emergency room rate. **Procedure for data collecting:** The whole system was managed from one Telecare Service Center that employs a Telecare Information Platform (TIP). The Telecare Service Center provided 24-hour customer consulting service, emergency reports, and handling of abnormalities to ensure service quality. All the data were uploaded to the central data base with an automatic alert system in telehealth service center. The on duty staffs in the Telehealth Central Station would respond to any critical values and reminded patients or carers if they did not upload the data as the frequency set by the physicians. The datawere also integrated into the hospital's computerized physician order entry (CPOE) system. And the clinicians might retrieve the data in the hospital information system (HIS) directly. The project includes interoperable electronic care records exchange and certification mechanisms. Patients and staff access the services through building-bound or mobile Internet connectivity. If a change in health status requires a different care, continuity of care is guaranteed. In addition the project aims at demonstrations to enhance the diffusion of the telecare service model to other regions.
Findings of the practice effectiveness
INDEPENDENT LIVING
No data
PRODUCTIVITY OF THE CARERS
Timely responses by formal carers: The results revealed both the home-care facilitated timely medical responses if the enrolled patients had emergent conditions.
QUALITY OF CARE
No data
SUSTAINABILITY
Reduction of readmission: the hospital readmission rate was reduced from 8.19% to 3.17%, and the hospital visit rate was decreased from 2.95% to 2.90%.

Evaluation references
Hsu, M. -., Chu, T. -., Yen, J. -., Chiu, W. -., Yeh, G. -., Chen, T. -., . . . Li, Y. -. (.). (2010). Development and implementation of a national telehealth project for long-term care: A preliminary study. *Computer Methods and Programs in Biomedicine, 97*(3), 286-292
OTHER SOURCES
Huang, C-R.; Chang, J.-Y. and Chaing, C-L. (2008). Telecare and Telehealth care network in Taiwan. The 6th Conference of the International Society for Gerontechnology (ISG08), Telemonitoring and Telecare 3, Pisa, Tuscany, Italy, June 4–6, 2008 (2008), pp. 1–5 Available at http://www.gerontechnology.info/Journal/Proceedings/ISG08/papers/105.pdf Huang, V. (2009). Healthcare close to home. Taiwan Review. Available at http://taiwanreview.nat.gov.tw/ct.asp?xItem=70396&CtNode=1446 Lin, C.H. (2010). Telecare projects in Taiwan. *Gerontechnology* 9.3, 400-407. Liou, D.M. The development of telecare service in Taiwan. Presentation available at http://fp7rise.cs.nccu.edu.tw/ac/sites/default/files/14DerMingLiu.pdf Po,R-W.; Lin, F-R.; Chuang, B-K. and Shaw, M.J. (2013). Exploring Trust-Based Service Value Chain Framework in Tele-healthcare Services. 46th Hawaii International Conference on System Sciences, 1327-1336. Taiwan's Telehealth Pilot Project website. Page in English: http://telecare.com.tw/eng_Index.htm

KAISER PERMANENTE TELE-HOME HEALTH RESEARCH PROJECT

<table>
<tr><td>NUMBER</td><td>8</td></tr>
<tr><td>TYPE OF TECHNOLOGY-BASED SERVICE</td><td>TECHNOLOGY-BASED HEALTH CARE - TELEHEALTH</td></tr>
<tr><td>NAME OF THE PRACTICE</td><td>KAISER PERMANENTE TELE-HOME HEALTH RESEARCH PROJECT (KAISER TELEHEALTH)</td></tr>
<tr><td>LEVEL OF NEEDS COVERED</td><td>OLDER PEOPLE WITH CHRONIC CONDITIONS</td></tr>
<tr><td>COUNTRY</td><td>USA</td></tr>
<tr><td>TYPE OF LONG-TERM CARE SYSTEM</td><td>Not applicable</td></tr>
<tr><td>WEBSITE</td><td>https://healthy.kaiserpermanente.org/html/kaiser/index.shtml</td></tr>
<tr><td>PRACTICE OVERVIEW</td><td></td></tr>
<tr><td>Years in operation</td><td>We didn’t find specific data on the year that this practice started. But we know that it was presented at least in 1996, as it was when the first data on cost were collected.</td></tr>
<tr><td>Type of organization implementing the practice</td><td>Non-profit health care organisation</td></tr>
<tr><td>Cost information</td><td>The average costs of remote video technology in tele-home health, including cost for purchase equipment and telecommunication expenses, are $1,830 per patient (around €1,345/patient – currency rate of December 2013)</td></tr>
<tr><td>Scale of implementation</td><td>In 2013, Kaiser Permanente had more than 9 million members, and chronic patients represented around 5-10% of the members (450,000 to 900,000 members).

Kaiser Permanente is in 8 American Regions, serving 9 states and the District of Columbia.</td></tr>
<tr><td colspan="2">Aim and characteristics of the practice</td></tr>
<tr><td colspan="2">Kaiser Permanente (KP) is a large non-profit health maintenance organization in the US. It provides comprehensive health care benefits to more than 9 million Americans. As part of the KP services, patients receive video visits in addition to in-person and telephone visits. This care includes initial assessment in the home, and in-person and follow-up visits by the nurses to the patients’ homes or video visits from the Home Health Department. The video gives patients access to a home health nurse 24 hours a day. After normal working hours, these patients have access to the oncall home health nurse by having the Home Health Department contact the patient using the remote video equipment. This process allows KP professionals for immediate in-depth assessment and triage without patients having to leave home. Installation and teaching of the home video system by a nurse case manager required about 30 minutes. The home video system allows the nurse and patient to see and talk with each other in real time.</td></tr>
<tr><td colspan="2">Devices (technological components)</td></tr>
<tr><td colspan="2">The video equipment is an American Telecare PTS 100 home video system from American Telecare Inc, Minneapolis (Minnesota). The video is equipped with peripheral devices to enables nurses to assess cardiopulmonary status, visualize facial expressions, and evaluate bowel sounds or signs of infection. The peripheral units of the video system includes:

• An analogue stethoscope. The stethoscope is placed by the patients or their carers at sites requested by the nurse. Patients are given a diagram of the chest and lung fields with sites marked to guide them in placing the stethoscope correctly. The nurse can see where the patient is placing the stethoscope and recommends adjustments in positioning as necessary. There is a second phone line necessary for using</td></tr>
</table>

the analogue stethoscope.

- Digital blood pressure machine.
- A magnifying lens attached to the camera for close-up viewing. The nurse has a headset at the receiving station to hear lung, cardiac, or bowel sounds that eliminates extraneous sounds and allows them clear auscultation. The magnifying lens is used to assess correct medication dosages when patients were being taught how to draw up medications such as insulin.

EVIDENCE OF EFFECTIVENESS

Aim of the impact evaluation.

The use of remote video technology in the home health care setting was evaluated by the Kaiser Permanente Medical Centre of Sacramento in California. KP operates in 11 home health care agencies in northern California. The mean monthly number of referrals to KP's Sacramento Home Health Department rose from 320 in 1996 to more than 680 in 1997. Most of these referrals were given for patients with chronic illnesses. This evaluation was published by Johnston and colleagues (2000) and it aimed mostly to assess the quality, use, patient satisfaction, and cost savings from this technology. The goal was to replace some in-person visits with remote video visits without compromising patient care or raising home health care costs.

Method

Sample: Patients diagnosed as having chronic diseases, e.g. chronic obstructive pulmonary disease (COPD), were eligible for the study, and those selected were patients newly referred to home care at one of Kaiser Permanente's home care agencies for a limited period of at least four weeks. The average age of patients was 70 years. Patients were randomly assigned to a control (n= 110) and an intervention group (n = 102). Both groups had access to routine home care and the intervention group received video visits in addition.

Research design: Quasi experimental study conducted from May 1996 to October 1997. The control and intervention groups received routine home health care (home visits and telephone contact). The intervention group also had access to a remote video system that allowed nurses and patients to interact in real time. The video system included peripheral equipment for assessing cardiopulmonary status. Both groups received an initial assessment at home as well as a standardized care plan within 24 to 48 hours after receiving the referral. The number of home visits to be made was based on individual patient needs as assessed by the home health nurse case manager in collaboration with the primary care physician.

Variables and instruments:

- Quality of care. The 3 quality indicators—patients' compliance with medication regimen, knowledge about their disease, and ability to move toward self-care—were evaluated from abstracts of medical records and were routinely collected as part of a patient's standardized care plan.
- Degree of patient satisfaction. The patient satisfaction survey was given to each patient at discharge from home health care. The survey was developed for this project and was designed to emphasize the technology and in-person encounters. The survey addressed ease of use, system reliability, effectiveness and degree of provider interaction, confidence in providers' ability to assess health condition remotely, appropriate levels of care, convenience, access to care, and preferences.
- Direct and indirect costs of using the remote video technology. The data used to derive costs included direct costs for pharmacy services, laboratory, physician visits, emergency department visits, and inpatient treatment. Home health care costs included direct costs for payroll, benefits, travel, and cellular phone usage. In the intervention group, additional costs included capital equipment and telecommunication charges.

Procedure for data collecting: The data were collected between May 1996 and October 1997 at the Home Health Department at KP Medical Center in Sacramento, which serves a large metropolitan and rural population. Cost data were collected during the time patients were in the study. Data for this analysis were collected from patient interviews and surveys, from medical record audits, and from KP's computer databases.

The KP Medical Care Program Northern California Region Internal Review Board approved the study protocol and informed consent was obtained. Following the consent process, patients were randomly assigned to an intervention or control group.

Findings of the practice effectiveness

INDEPENDENT LIVING

There is no data

PRODUCTIVITY OF THE CARERS

- **Reduction in patient's visit**. The mean length of time was 45 minutes to provide an in-person visit and 18 minutes for a remote video visit. The current productivity standards allow one nurse to visit 5 to 6 patients per day. Although not demonstrated, a time study indicated that remote video visits allow 15 to 20 video visits per day.

QUALITY OF CARE

- **Maintain the quality of care.** At discharge from home health care services, patients in the control and intervention groups did not differ in their compliance with medication regimen, knowledge about their condition, or ability to move toward self-care (Table 12).

Table 12: Patients' response regarding quality of care received in home setting

Table 3. Patients' Responses Regarding Quality of Care Received in Home Setting

Quality Indicator	Patient Group, No. (%) Intervention (n = 102)	Control (n = 110)	Fisher Exact Test*
Medication complications			
Yes	101 (99)	107 (97)	0.623
No	1 (1)	3 (3)	
Knowledge regarding disease process			
Yes	102 (100)	108 (98)	0.498
No	0 (0)	2 (2)	
Patient/family achieved self-care			
Yes	92 (90)	101 (92)	0.811
No	10 (10)	9 (8)	

*Fisher exact test used due to 2 cells having less than expected count.

Source: Johnston et al., 2000

SUSTAINABILITY

Reduction in total cost of care. For home health services, the average direct costs, including cost for purchase of capital equipment and telecommunication expenses, were $1,830 in the intervention group and $1,167 in the control group. The total mean costs of care, excluding home health care costs, were $1,948 in the intervention group and $2,674 in the control group. This reduction in total mean costs, excluding home health care services, was most attributable to hospitalization costs, which were $1.087 in the intervention group and $1940 in the control group. Outpatient costs did not vary materially between the 2 groups.

Evaluation references

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TELEHEALTH (WHOLE SYSTEM DEMONSTRATOR PROJECT)

NUMBER	9
TYPE OF TECHNOLOGY-BASED SERVICE	TECHNOLOGY-BASED HEALTH CARE - TELEHEALTH
NAME OF THE PRACTICE	TELEHEALTH (WHOLE SYSTEM DEMONSTRATOR PROJECT) (WSD TELEHEALTH)
LEVEL OF NEEDS COVERED	COPD, HEART FAILURE, DIABETES
COUNTRY	UK
TYPE OF LONG-TERM CARE SYSTEM	Cluster 3: Oriented towards informal care, high private financing
WEBSITE	http://3millionlives.co.uk/about-telehealth-and-telecare
PRACTICE OVERVIEW	
Years in operation	May 2008- November 2009 (The programme only lasted one year because it was an evaluation programme)
Type of organization implementing the practice	National Health System
Cost information	The average annual cost per participant for telehealth equipment and support was estimated as €2,225 (standard error €14)
Scale of implementation	It involved 3,230 patients and 179 general practitioners across three sites Newham, Kent and Cornwall.

Aim and characteristics of the practice

In 2006, the Department of Health in England published a white paper that included a focus on health and social care for people with long term needs (Department of Health, 2006). The strategy proposed a series of demonstrator pilots to drive whole systems redesign, supported by advanced assistive technologies. These technologies included telehealth and telecare. The result was the Whole System Demonstrator project, funded by the Department of Health, which tested the benefits of integrated care supported by telehealth and telecare in three sites in England (Cornwall, Kent, and Newham) (Steventon et al., 2012).

The announcement of the Whole System Demonstrator pilots led to the subsequent award of funding to teams in three areas of England (Kent, Newham and Cornwall) to implement service redesign to support individuals with long-term and complex health and social care needs. This 'whole systems redesign' was designed to create multidisciplinary teams in health and social services and the development of integrated care plans to deliver care more effectively to these patient populations. An important part of the 'whole systems redesign' was the introduction of telemonitoring technology in the home to support the provision of these new services and serve as an 'effect multiplier' for changes in service delivery (Bower et al., 2011).

In this example, we are only focused on the teleheath service, as telecare has not demonstrated to have an impact on the older people and on the system (Steventon et al., 2013).

Telehealth refers here as electronic sensors or equipment that monitors vital health signs remotely, e.g. in the patients' the own home or while on the move. These readings are automatically transmitted to an appropriately trained person who can monitor the health vital signs and make decisions about potential interventions in real time, without the patient needing to attend a clinic (Department of Health, 2011).

Devices (Technological components)

The telehealth service evaluated where those in the counties of Cornwall, Kent and Newham. We describe then only the characteristics of this service in these locations.

In Cornwall and Kent, the telehealth is a home monitoring system comprising a base unit (the Tunstall RTX 3370 or the Viterion V100 respectively), which is a small device with an LCD screen and response buttons to allow navigation of symptom questions and educational messages to be transmitted to participants, together with up to four peripheral monitoring devices.

In Newham, telehealth is the Philips Motiva Personal Healthcare System comprising a set top box that connects to a television allowing symptom questions, educational videos and a graphical history of recent clinical readings to be accessed via a dedicated channel, plus an equivalent range of peripheral monitoring devices. Sites used different protocols for allocating peripheral devices but across all sites the critical devices by condition were a pulse oximeter (for COPD), a glucometer (for diabetes) and weighing scales (for heart failure). Participants with multiple conditions received multiple peripheral devices (Bower et al., 2011).

EVIDENCE OF EFFECTIVENESS

Aim of the impact evaluation.

The Whole System Demonstrator trial is a strategy established in 2006 by the Department of Health in England. The aim is to drive whole care systems redesign, supported by advanced assistive technologies (Department of Health, 2006), through the evaluation of telehealth and telecare for people with long-term conditions. This trial tested whether telehealth can provide cost-effective care to improve outcomes, maintain independence, achieve significant gains in quality of life and reduce unnecessary acute hospital use and costs (Bower et al., 2011). In this specific case, it is focused on the impact of telehealth. The findings has been published by Bower and colleagues (2011) and Steventon and colleagues (2012).

Method

Sample: A final total of 179 general practices took part in the trial (from a starting point of 239 potential practices) from across Kent, Cornwall and Newham. A total of 3,154 patients were analysed as part of this trial. These individuals were split into two groups, 1,584 in the control group (usual care, without telehealth) and 1,570 in the intervention group (telehealth). To be a participant in this trial patients had to be over 18, and have a clinical diagnosis of chronic obstructive pulmonary disease (COPD), heart failure or diabetes (or a combination of more than one of these long term conditions).

The telehealth trial involves three separate clinical populations, and the differential impact of telehealth in these different clinical populations are used using a pre-specified subgroup analysis across conditions (including a group with co-morbidities).

Carers of service users in the trial were identified by sites usually at the 'light touch' visit, either by the carer expressing an interest or via snowball sampling (i.e. asking participants if they had an informal carer at the baseline interview).

Research design: The proposed trial is a large scale, pragmatic health technology assessment trial, designed to randomise suitably large numbers of patients and assess the impact of a broad class of telemonitoring technologies in the context of routine delivery of NHS care (Schwartz and Lellouch, 1967; Roland and Torgerson, 1998).

The proposed trial used a cluster randomised trial design. General practices were randomised so that eligible patients within their populations would receive access to telehealth or telecare. Each practice would thus provide intervention participants for one technology (e.g. telehealth) and control participants for the other technology (e.g. telecare) or vice versa.

Participants in practices allocated to the control group were given usual care, which reflected the range of services available in the trial sites, excluding telehealth, and were offered telehealth or telecare at the end of the trial, if they were still eligible at that point (Steventon et al., 2012)

The telehealth service evaluated where those in the counties of Cornwall, Kent and Newham. We describe then only the characteristics of this service in these locations.

Interventions groups from Cornwall and Kent received telehealth composed by a home monitoring system comprising a base unit (the Tunstall RTX 3370 or the Viterion V100 respectively), which is a small device with an LCD screen and response buttons to allow navigation of symptom questions and educational messages to be transmitted to participants, together with up to four peripheral monitoring devices. In Newham, telehealth is the Philips Motiva Personal Healthcare System comprising a set top box that connects to a television allowing symptom questions, educational videos and a graphical history of recent clinical readings to be accessed via a dedicated channel, plus an equivalent range of peripheral monitoring devices.

Sites used different protocols for allocating peripheral devices but across all sites the critical devices by condition were a pulse oximeter (for COPD), a glucometer (for diabetes) and weighing scales (for heart failure). Participants with multiple conditions received multiple peripheral devices. Participants were asked to take clinical readings up to 5 days per week at the same time each day but the frequency was adjusted according to their individual history (e.g. a participant with diabetes and well controlled blood glucose would be asked to take readings less frequently than one with poorly controlled blood glucose). In Cornwall and Newham the base unit or set top box provided a visual and audio reminder when readings were due. At the end of each session data from clinical readings and symptom questions were sent to a monitoring centre via a secure server either automatically (in Cornwall and Newham) or following participant authorisation (in Kent).

<u>Variables and instruments:</u>

Service utilization:

These data were collected from administrative datasets with the aim of tracking service use for (a) up to three years pre-intervention and (b) 12 months post intervention. It will include an assessment of:

- Hospital utilisation, including emergency and elective inpatient admissions, inpatient bed day use, outpatient attendances and accident and emergency visits.
- Primary care utilisation, including GP encounters, prescription drugs and community matron visits.
- Social care utilisation such as the use of domiciliary and residential care.
- Costs will be attributed to activity using national Payment by Results tariffs and reference costs.

Clinical effectiveness:

It included a comprehensive assessment of patient reported outcome measures (PROMs) and health utilisation measures at 3 and 12 months, including:

<u>Older people outcomes</u>:

- General quality of life assessed with the ICECAP (Coast et al., 2008). ICECAP scores at each time point will be presented for all three time points.
- Disease- specific quality of life (teleheath only), through the following instruments.
    - ✓ Minnesota Living with Heart Failure Questionnaire measure of the effects of congestive heart failure on their lives (Rector et al., 1987).
    - ✓ CRQ- Chronic Respiratory Questionnaire, measure of quality of life for patients with chronic lung disease (Guyatt et al., 1987).

  DHP – Diabetes Health Profile, measure of diabetes – specific quality of life (Meadows et al., 2000).
- Psychological well-being:
    - ✓ Measure of anxiety, through the Brief STAI (Marteaux and Bekker, 1992).
    - ✓ Measure of depression through the CES-D (Andersen et al., 1994).
- Perceived acceptability of telemonitoring devices.
- Use of telehealth and telecare.
- Attitudes, self-efficacy and self-care behaviours:
    - ✓ EHFSCB – European Heart Failure Self Care Behaviours Scale (Jaarsma et al., 2003).
    - ✓ SDSCA – Summary of Diabetes Self-Care Activities Measure (Toobert et al., 2000).
    - ✓ Generalized Self Efficacy Scale (Schwazer and Jerusalem, 1995).
    - ✓ Subjective Norms (Francis et al, 2004).
- Clinical outcomes (for telehealth participants).
- Social networks, assessed through the Social Network Assessment Instrument (Wenger and Tucker, 2011).
- Illness burden, evaluated through the Illness Scale (Klimidis et al., 2001).
- Disability, evaluation based on the Townsend Disability Scale (Towsend, 1979; Bowling et al., 1991).

- Health care and social services utilisation:
    - ✓ Adult Social Care Outcomes Toolkit measure of social care related quality of life (Netten et al., 2006).
    - ✓ Client Services Receipt Inventory (CSRI) user and carer schedule (Beecham and Knapp, 2001).
    - ✓ Data on health care utilisation were collected via interview.

<u>Carer outcomes</u>:

- Carer anxiety and strain, evaluated with the Caregiver Strain Index (Robinson, 1963; Thornton and Travis, 2011).
- Carer costs include carer time spent in providing care to the participant as well as lost productivity.

Cost-effectiveness of the telehealth evaluated through:

- The QALY constructed from the EQ-5D health state classification (Euroqol Copyright Group, 1990) scored using established algorithms (York Tariff) (Dolan, 1997). QALY scores will be calculated for the baseline, 3 month and 12 month follow-up points.
- Incremental cost effectiveness ratios (ICER) will be calculated at the 3 month and 12 month follow up points. The ICER will be defined as the difference in mean costs incurred by the treatment groups over the previous 3 month period, divided by the difference in mean QALY gain between those treatment groups.
- A cost-effectiveness acceptability curve (CEAC) will be produced, based on the results of a model of net monetary benefit for clustered data. The CEAC allows the decision-maker to see what is the likelihood of telehealth being cost-effective at different monetary values of increments of improvement in the chosen outcome

<u>Procedure for data collecting:</u>

General practices were approached by letter inviting them to take part in the trial. Once a practice had consented, potential participants for telehealth were identified in each site using existing registers of patients with long-term conditions in general practice. To meet ethical obligations, patients were asked to complete and return a 'data sharing letter' if they consented to their data being shared with the research team. Once this letter was received, patients received a 'light touch' visit from a member of the project team in each site, where consent was taken to participate in the main trial and the questionnaire study.

Participants who agreed to take part in the questionnaire study were subsequently contacted by a market research company to arrange a convenient time for the baseline interview. At this interview, patients received information about this part of the study and signed consent.

The baseline assessment varied by participant status (i.e. COPD, heart failure, diabetes, telecare, carers) but each comprised a core of standardised PROMs. The PROMs were self-completed by the participant with the researcher on hand to explain or clarify. The average total time for assisted baseline interview completion was 80 minutes.

Each practice was allocated to groups via a centrally administered minimisation algorithm. The allocation determined the technologies available to each practice (i.e. either telehealth or telecare) and their associated patients. Following installation of the technologies, participants were follow-up for 12-months. After 12-months, the 'usual care' groups were eligible to receive the appropriate interventions.

Findings of the practice effectiveness
INDEPENDENT LIVING
There is still no data
PRODUCTIVITY OF THE CARERS
There is no data

QUALITY OF CARE
There is no data
SUSTAINABILITY
Less use of institutional care: 11% fewer admissions for the patients using telehealth than for the individuals within the control group. Of the intervention participants, 42.9% were admitted to hospital during the 12 months of the trial, compared with 48.2% of controls. This difference was statistically significant. 14% reduction in the number of patient bed days. The intervention and control groups spent an average of 4.87 and 5.68 days in hospital, respectively. This difference remained significant. 20% reduction in emergency admissions. The mean number of emergency admissions were 0.54 per person in the intervention group (with telehealth) compared to 0.68 in control group. This equates to 20.6% less emergency admissions for those people with telehealth. 14% reduction in elective admissions. 15% reduction in emergency department visits. On average, intervention participants attended emergency departments 0.64 times per head during the trial, compared with 0.75 for controls. This difference was significant. **Reduction in mortality rate:** 45% reduction in mortality rates. Intervention patients were significantly less likely to die within 12 months than controls. 4.6% of the intervention group (with telehealth) died over a 12 month period, compared with 8.3% of control group. This is statistically significant and 60 fewer intervention patients died compared with the control group.
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TELEMONITORING SERVICE FOR CHRONIC CONDITIONS FROM PRIMARY CARE (TELBIL)

NUMBER	10
TYPE OF TECHNOLOGY-BASED SERVICE	TECHNOLOGY-BASED HEALTH CARE - TELEMONITORING
NAME OF THE PRACTICE	TELEMONITORING SERVICE FOR CHRONIC CONDITIONS FROM PRIMARY CARE (TELBIL)
LEVEL OF NEEDS COVERED	CHRONIC CONDITIONS
COUNTRY	SPAIN
TYPE OF LONG-TERM CARE SYSTEM	Cluster 3: Oriented towards informal care, high private financing
WEBSITE	
PRACTICE OVERVIEW	
Years in operation	2007-now
Type of organization implementing the practice	Primary health care centre or private health insurance company
Cost information	The average cost of the intervention in the evaluation study of TELBIL was €12,997.17 for one year referring to health care and telemonitoring. The average cost of the telemonitoring was equal to €1,379 per patient for one year,
Scale of implementation	We know that it has been implemented in 20 primary health care centred of Bilbao. These centres cover 78,000 people older than 60 years old. We do not have data about how many older adults are using TELBIL.

Aim and characteristics of the practice

TELBIL is a home telemonitoring system that monitors the health of chronic patients (affected by heart failure and chronic lung diseases) at home and detects emergency situations in their health. TELBIL consists of a Personal Digital Assistant (PDA) terminal that controls the vital signs of the patients. The system collects biometrical data and uses questionnaire to obtain qualitative health data. These data are remotely sent to a web manager accessible to primary care professionals (GPs and nurses who regularly see the patients in the health centres or at home) to follow-up and monitor the patients in real time.

The system also sends an alert or an email in case of detecting problems in the vital signs of the patients. The telemonitoring system includes personalised alerts set for each patient, with messages being sent to the Web platform when the recorded parameters fall outside the pre-established limits (which could be adjusted over time). The established threshold values are essential for the monitoring of the patients' condition and for the detection of unusual changes. When the measurements fell outside the established limits, alerts are triggered via the PDA terminal and the clinical staff acted according to the medical condition of the patients. Real alerts are differentiated from false alarms through the assessment of all the clinical information and the health status questionnaire received through the telemonitoring system. Therefore, even if an alarm is triggered for a specific clinical parameter, it is the patients' overall health status that is taken into consideration by healthcare professionals, before taking any further action. Patients are advised to call the health care emergency services through the telemonitoring system at weekends and at times when the primary health care centres are closed.

TELBIL has been implememted in 20 primary health care centres of Bilbao (Spain). Sanitas, a private health insurance company in Spain, also offer the service addressed to the monitoring of diabetes patients.

Devices (Technological components)
TELBIL uses a device called Careline Home, commercialised by the private Spanish Company Saludnova, consisting of a PDA communicated through wireless with a set of biometrics sensors installed at patients' homes. The system sends the health data to a web manager. This manager can be accessed by internet.
EVIDENCE OF EFFECTIVENESS
Aim of the impact evaluation.
The main objective of the study was to assess the effect of a primary care-based telemonitoring system on the number and length of hospital admissions in patients with heart failure and/or chronic lung disease at 12 months post-randomisation compared with the standard health care practice. The telemonitoring system used was Careline Home provided by Saludnova. The study was funded by the Health Department of the Autonomous Country of the Basque Country.
Method

Sample: Fifty-eight in-home patients, diagnosed with heart failure and/or chronic lung disease , aged 14 or above and with two or more hospital admissions in the previous year were recruited. 58 patients were selected and randomly allocated to intervention and control groups: 28 patients from 14 different health centres tool part of the intervention group and 30 patients from 6 different health centres to the control group. The 12-month follow-up was completed by a total of 43 patients: 21 patients in the intervention group and by 22 patients in the control group.

Research design: A randomised controlled trial was carried out with a one-year follow-up (February 2010 – August 2011) with analysis at 3, 6 and 12 months post randomisation. The trial was carried out across 20 health centres in Bilbao (Basque Country, Spain). The intervention group was carried out with the telemonitoring system called Careline Home (provided by Saludnova), including daily patient self-measurements of respiratory-rate, heart-rate, blood pressure, oxygen saturation, weight, body temperature and the completion of a health status questionnaire using PDAs. Alerts were generated when pre-established thresholds were crossed. The control group received usual care.

All health professionals participating in the study for both intervention and control groups received training aimed at strengthening and standardising the management of the clinical conditions under study.

Variables and instruments:

Initial assessment and baseline data:

- Patient's socio-demographic data: date of birth and age, gender, health centre, assigned GP and nurse, level of education, social and family characteristics.
- Clinical data were also recorded:
    - ✓ Diagnosis of Heart Failure or Chronic Lung Disease, based on the computerised primary care registry and hospital medical records, specifying the aetiology, degree of severity of the disease (based on the FEV1 – forced expiratory volume in one second – for COPD and on the NYHA – New York Heart Association – classification and the ejection fraction for Heart Failure).
    - ✓ Requirements of home oxygen therapy.
    - ✓ The Charlson comorbidity index score (Farrero et al., 2001).
    - ✓ Regular medication: taken from medical records and confirmed by health professionals and/or patients themselves or their relatives.
    - ✓ Treatment adherence measured using the Morisky Adherence Scale (Pare et al., 2006).
    - ✓ The Barthel Index (BI) (Mahoney and Barthel, 1965).
    - ✓ The EuroQol questionnaire (EQ-5D) (Badía et al., 1999 ; Herdman et al., 2001 ; Oppe et al., 2007).
    - ✓ the Zarit Burden Interview (ZBI) (Zarit et al., 1995; Martín et al., 1996; Izal et al., 1994).
    - ✓ The number of hospital admissions noting whether they were cause-specific, that is, related to

the conditions under study and the mean duration of the hospital stay.

- ✓ The use of other healthcare resources during the year prior to the inclusion in the study: emergency department attendances; appointments with specialists; home visits, including both scheduled visits and those prompted by the telemonitoring of the patient; and other contacts with health centre professionals by telephone or face-to-face, even if patients themselves did not attend, for administrative tasks, follow-up, prescriptions, etc..

Outcome measures:

Primary outcomes measure: Number of hospital admissions that occurred in a period of 12 months post-randomisation.

Secondary outcomes measures:

- Duration of hospital stay: number of bed-days for emergency admissions with a primary diagnosis of HF, CLD (i.e., COPD, asthma and other respiratory conditions) and other causes during 12 months after randomisation.
- Number of hospital admissions due to exacerbation of Heart Failure and Chronic Lung Disease (i.e., COPD, asthma and other respiratory conditions) that occurred in a period of 12 months postrandomisation.
- Mortality rate: number of all-cause deaths at 12 months. Cause of death will be taken from the primary and/or secondary care clinical records.
- Level of use of health resources measured during a period of 12 months after randomisation:
    - ✓ Number of emergency department visits for a cardiac or respiratory cause and for all causes.
    - ✓ Number of home visits (by their GP or nurse).
    - ✓ Number of primary care visits.
    - ✓ Number of telephone contacts with primary health care professionals.
    - ✓ Number of visits to the specialist doctors.
- Cost-effectiveness analysis. The costs associated with the health care resources used was estimated based on the following variables:
    - ✓ Duration of hospital stay.
    - ✓ Use of emergency services.
    - ✓ Purchase and maintenance of telemonitoring devices.
    - ✓ Number of consultations and time of the health care personnel.
    - ✓ The time dedicated by the health care professionals to use the telemonitoring equipment.
    - ✓ The effectiveness was expressed in Quality-Adjusted Life Years (QALY) and was calculated from the data of the Health Related Quality of Life (HRQL) obtained from the generic EQ-5D questionnaire.
- Health related quality of life (HRQL). The validated Spanish version of the EQ-5D questionnaire was used for the quality of life assessment (Badía et al., 1999; Herdman et al., 2001 ; Oppe et al., 2007). This questionnaire describes the health status in five dimensions (mobility, self-care, usual activities, pain/discomfort, and anxiety/depression) with three possible responses for each item and using the visual analogue scale (VAS) ranging between 0 and 100.
- Other variables of clinical efficacy: number of episodes of worsening of the pulmonary and/or heart condition.
- Functional status. The Barthel Index (BI) (Mahoney and Barthel, 1965) was used to measure Activities of Daily Living (ADL).
- Carer burden. The burden of the family/caregiver will be measured using a validated Spanish version of the Zarit Burden Interview (ZBI) (Zarit et al., 195; Martín et al., 1996; Izal et al., 1994).. The score ranges from 0 (no burden) to 88 (highest level of burden).
- Degree of acceptance and satisfaction of patients and health professionals. The degree of satisfaction of the patients with the telemonitoring intervention was assessed using a questionnaire based on validated published surveys adapted for this study (Bakken et al., 2006; Demiris et al., 2001; Yip et al., 2003).
- Evaluation of the technical performance and compliance with the telemonitoring system. Compliance with

telemonitoring was evaluated through the analysis of the frequency of data transmitted by patients and the number of times that health care professionals access the telemonitoring Web-platform.

- Additionally, the reliability and performance of the telemonitoring system was assessed (malfunctions of the system, problems concerning the transfer, reception and visualisation of data). The security of the system was evaluated (external attacks to the transmission system or server, etc.).
- The reasons for the losses occurred during the study were recorded. It was envisaged that such losses may include patients moving house or dying, failure to correctly manage the system, technical problems, requirements for specific health care (for example, patients in need of palliative care at home) and institutionalisation. Additionally, data concerning eligible patients or professionals who declined to participate in the study and the reasons for not participating in the study was recorded.

Procedure for data collecting: All the outcomes measures were collected after 3,6 and 12 months of follow-up. The study was approved by the Ethics Committee for Scientific Research (CEIC, Basurto University Hospital, Bizkaia). Patients or relatives gave written informed consent prior to participating in the study. Patients' identity was preserved at all times during the course of the trial.

Findings of the practice effectiveness

INDEPENDENT LIVING

There is no data

PRODUCTIVITY OF THE CARERS

There is no data

QUALITY OF CARE

There is no data

SUSTAINABILITY

Reduction in use of health care resources (Figure 18, Table 13) :

Reduction in the number of hospitalisations. After 12 months, 42.9% of patients in the intervention group completed the follow-up without any hospital admissions, and such figure was significantly different from the rate of 13.6% among the patients in the control group.

Increase of phone contacts and decrease of appointments with doctors. A significant increase in the number of telephone contacts in the intervention group in the follow-up period was also found. Moreover, the study also found a significant decrease in the number of appointments with the specialists and the number of appointments at the primary care health centres; such changes were statistically different with respect to the changes in the means that occurred among patients in the control group.

Figure 18: Comparison of resource use at health centres in the intervention and control groups.

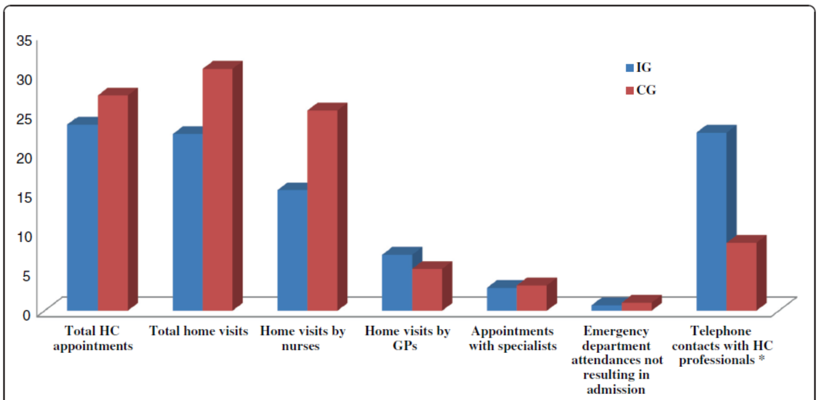

Figure 2 Comparison of resource use at Health Centres in the IG and CG. The figures presented were calculated considering the mean per patient among those who completed the 12-months of follow-up. * The only statistically significant difference was found for telephone contacts (p = 0.001). IG: intervention group; CG: control group; HC: health centre.

Source: Martín-Lesende et al., 2013

Table 13: Difference in healthcare resource use between the year prior to inclusion and the follow-up period

Table 3 Difference in healthcare resource use between the year prior to inclusion and the follow-up period[I]

	IG (n = 21) median (IQR)	p value[II]	CG (n = 22) median (IQR)	p value[II]
All-cause hospitalisations	−2 (−3 to −1)	0.042	−1 (−3 to 0)	0.033
Cause-specific hospitalisations	−2 (−2 to −1)	0.086	−0.5 (−1 to 0)	0.244
Length of stay[III]	−0.4 (−3.8 to 1.6)	0.733	−1 (−5.5 to 5.3)	0.798
Health centre appointments[IV]	−11 (−16 to 0)	0.015	2 (−6 to 6)	0.801
Total home care visits	−1 (−2 to 12)	0.734	5 (−4 to 8)	0.152
Home visits by doctors	0 (−3 to 3)	1	0 (−2 to 2)	0.745
Home visits by nurses	2 (−2 to 4)	0.281	1 (−5 to 9)	0.384
Telephone contacts*	10 (6 to 24)	<0.001	3 (0 to 6)	0.147
Emergency department attendances	0 (−1 to 0)	0.210	0 (−1 to 1)	0.981
Appointments with specialists*	−1 (−2 to 0)	0.033	0 (0 to 1)	0.607

IG: intervention group; CG: control group; IQR: interquartile range.

[I] A positive/negative difference in the means indicates an increase/decrease in use of the corresponding healthcare resource in the 12-month follow-up period compared to the 12 months before the study.

[II] Wilcoxon signed-rank test assessing whether the differences between the 12-month prior to inclusion and the 12-month follow-up period were statistically significant, in each group (IG and CG).

[III] Mean length of stay per admission (hospitalisation), considering only patients who were admitted at least once (12 in the IG and 19 in the CG).

[IV] Appointments with doctors and/or nurses at the health centre concerning the participating patients, even if the patients themselves were not present.

* Statistically significant differences between the two groups in terms of changes from the year prior to inclusion to the follow-up year: total health centre appointments, p = 0.035; telephone contacts, p < 0.001; and appointments with specialists, p = 0.033. No other statistically significant differences were found.

Source: Martín-Lesende et al., 2013

Cost-efficiency: The cost-effectiveness analysis showed that the telemonitoring intervention from primary care in home care patients with cardiac insufficiency and/or bronchial disorders was cheaper (-2,230.63€) and more effective (0.06415 QALY) compared with the usual procedure (control group). The Incremental Cost-Effectiveness Ratio (ICER) obtained was -34,772.10 €/QALY. The cost efficiency acceptability curve indicated that for an acceptability threshold of 20,000 €/QALY the probability of the telemonitoring procedures being cost-effective would be 60.2%, increasing to 63.3% and 72.4% for threshold of 30,000 €/QALY and 120,000 €/QALY, respectively.

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Saludnova website: www.saludnova.com

TECHNOLOGY- BASED HOME CARE

ASSISTING CARERS USING TELEMATICS INTERVENTIONS TO MEET OLDER PERSON'S NEEDS (ACTION)

NUMBER	11
TYPE OF TECHNOLOGY-BASED SERVICE	TECHNOLOGY-BASED HOME CARE
NAME OF THE PRACTICE	Assisting Carers using Telematics Interventions to meet Older Person's Needs (ACTION)
LEVEL OF NEEDS COVERED	Older people with chronic conditions and informal carers
COUNTRY	SWEDEN
TYPE OF LONG-TERM CARE SYSTEM	Cluster 3: Oriented towards informal care, high private financing
WEBSITE	http://www.actioncaring.se/ http://www.actioncaring.se/Eng/EngDefault.htm (English version)
PRACTICE OVERVIEW	
Years in operation	1997-now
Type of organization implementing the practice	2 private companies: a care provider and a research company.
Cost information	The total cost of ACTION is 25,800 Swedish Crowns (SEK) per year and family – 2,841 euros/year/family (2,150 SEK per month and family or 237 euros/month/family)
Scale of implementation	ACTION is currently running as a mainstream service in the Borås municipality in western Sweden, with implementation projects in an additional twenty municipalities across Sweden. Around 125 families are using the service: • City of Borås: 50 families • Municipality of Huddinge: No data of users • Municipality of Härnosand: 7 families. • Municipality of Järfälla: 20 families. • Municipality of Oskarshamn: 20 families. • City of Västerås: 28 families.

Aim and characteristics of the practice

ACTION is aimed to increase the autonomy, independence and quality of life of frail older people and their family carers, and more concretely:

- To help frail older people gain more knowledge and feel better prepared to manage their own care; to have more control over their own situation and to help reduce the risk of being lonely and isolated
- To help family carers gain more knowledge and feel better prepared to care, to have more control over their caring situation, to help to maintain or improve their relationship with the one they care for and to help reduce the risk of being lonely and isolated

- To help health and social care staff experience more job satisfaction and have opportunities for personal development in their work
- To help health and social care providers to secure an increased quality of everyday life and increased social inclusion for its elder citizens and their family carers whilst helping to reduce health and social care costs.

These objectives are reached providing a self-care and family care support service with access to information, education and support for end-users via the use of Information and Communication Technology (ICT) in their own homes (Magnusson and Hanson, 2005).

In particular, ACTION consists of a range of four integrated multimedia caring programmes that families access via their TV sets (in the EU project) and subsequently via their personal computers (in the Swedish project) (Magnusson et al. 1998; Hanson and Magnusson, 2011):

1.- Multimedia educational programmes, based on carers' and older people's needs identified from the empirical literature and extensive user consultation in the EU and Swedish ACTION projects. These programmes are: caring skills in daily life; planning ahead; respite care; economic support; a service guide; coping strategies; living with dementia; and life after a stroke. Additionally, there are programmes for physical and cognitive training and online games for leisure, and coping programme.

2.- ACTION call centre with video-telephony is used to inform, educate and support older people and their family carers. Videophone facilities enabled families to have visual and oral contact with professional carers and other families involved in the project. ACTION call centre staff helps to create informal support networks amongst ACTION users. They are also responsible for introducing and teaching new users about the service together with regular follow-up of their situation. The ACTION call centre is staffed by health and social care personnel that have been educated and certified by ACTION Caring. The ACTION call centre is run by practitioners with experience in caring for older people and their families. They maintain regular contact with families to ensure that they are managing their situation as well as providing advice and support on an as need basis. They are also responsible for computer education and facilitate and maintain informal networks between users.

3.- ACTION computer with videophone which is placed in the older people's home. Internet videophone facilities are provided via a small web camera placed on top of the computer screen and an integrated user-friendly videophone programme installed in the computer. Users have access to the ACTION programmes via their ACTION computer and they can talk with other families and to health and social care staff via the videophone and camera. Word programme and email facilities are also included which facilitates contact with their relatives and friends. Computer security is guaranteed via VPN (Virtual Private Network), anti-virus programme and firewall function. All functions start automatically. This enables families to have visual and oral contact with other participant families, as well as with care practitioners at a dedicated call centre. (Hanson and Magnusson, 2011).

4.- Education and supervision. Families are invited to take part in an initial education programme to learn how to use the ACTION service, as the majority of users are predominantly computer novices. This programme consists of a series of small group 'hands on' computer education sessions during which participants get to know each other and subsequently initiate videophone contact. Additionally, the education, follow-up and certification programme, including regular supervision, is targeted at care practitioners working in the ACTION call centres in the municipality.

Typical users initially access the multimedia programmes to increase their knowledge and caring skills, and referr to them again as their caring situation changed. They have frequent contact via the videophone with other families to exchange news and to support each other. They also have regular contact with the call centre nurses to share how they feel and to ask for advice on an 'as needed' basis. During spare moments, they surf the Internet and email their children/grandchildren, who live some distance away (Magnusson and Hanson, 2005)

ACTION concept builds upon Nolan, Grant and Keady's (1996) temporal model of family caring. This model stresses the importance of providing appropriate support at key transitions in the caring trajectory, whilst recognizing family carers as 'experts' about their particular caring situation. In the Swedish study, ACTION also incorporates elements of the PREP model of interventions to enhance carers' level of preparedness (Pr), to enrich (E) their care-giving relations, and to help carers the better to predict future demands (P) (Magnusson, Hanson and Nolan 2002; Magnusson et al., 2005).

ACTION is currently running as a mainstream service in the Borås municipality in western Sweden, with implementation projects in an additional twenty municipalities across Sweden. ACTION Caring co-operates with Telia Sonera (a communication technical provider) to be able to offer ACTION service with a high degree of accessibility and reliability. ACTION Caring is a company which is connected to the University College of Borås.

Devices (Technological components)

Families access to the multimedia caring programmes via their personal computers. No advanced technique is needed to use ACTION. The only things needed are a computer with screen, keyboard, mouse and a videophone and a microphone. The videophone is a software application, specially developed to be easy to use. This software also works as a browser which gives the opportunity to take part of the caring and compassion programs without having to switch focus in the computer. The information programmes are reconstructed as normal webpages with abilities to adjust text and colour, to give as high level of readability as possible for users with special needs and desires.

Broadband connection is also a requirement. Computer security is guaranteed via VPN (Virtual Private Network), anti-virus programme and firewall function

EVIDENCE OF EFFECTIVENESS

Aim of the impact evaluation.

ACTION has been evaluated, in order to show:

- If ACTION helps to maintain the autonomy, independence and quality of life of frail older people and their family carers, it is user friendly and acceptable to the users, and cost effective. This objective was addressed in a study published in 2002 by Magnusson and colleagues (Magnusson et al., 2002).
- Whether the use of ACTION by participating families will reduce their potential use/costs of other services whilst maintaining or enhancing their quality of life. This objective was addressed in a study published in 2005 by Magnusson and Hanson (2005).
- If family carers benefit from the use of ACTION. This objective was addressed in a study published in 2005 by Magnusson and colleagues (2005).
- If ACTION enables family carers to establish an informal support network, and if it helps to reduce carers' stress and mental health problems. This objective was addressed in a study published in 2008 by Torp and colleagues (2005).

Method

1.- For the first study mentioned, Magnusson et al. (2002) developed the following methodology:

Sample: The sample was composed by 1,838 frail older people and their family carers using the whole ACTION system and services in their home for a minimum period of 3–4 months. Family carers should be caring for a relative over the age of 60 years. They were users from the countries involved in the European project, concretely from England (n= 328), Northern Ireland (n = 445), Republic of Ireland (n = 206), Portugal (m = 410), and Sweden (n = 449). The older people and their carers were recruited at the health care centres by community nurses.

Research design: This study was a multi-method, pluralistic approach, and it used both quantitative and qualitative research methods.

Variables and instruments:

Autonomy, independence and quality of life of older people and their family carers: this information was collected using an interview, through a conversational approach, following the work of Bury and Holme (1991), where participants talk freely about their experiences.

Cost factors associated with the ACTION system and services: it consisted in a cost description of the ACTION system and services. This description was carried out through focus groups with care providers, administrators and managers.

Procedure for data collecting: The data on autonomy, independence and quality of life were collected using an interview to the older people and their family carers. When it was not possible to get the information from the older people, the information was obtained from the informal carers. Informed consent was gained from all family carers. Ethical approval from a local medical ethics committee was gained in all partner countries prior to the evaluation phase.

The data on cost description were collected through focus groups at the end of the demonstration phase.

2.- Magnusson and Hanson (2005) used the following methodology:

Sample: The sample for the cost description study was purposive and the ACTION call centre nurses were asked to select five participating families for whom they considered ACTION had a major impact in preventing increased care costs. The five families were selected from a total of 34 who participated in the ACTION project. The costs for these five families were used to calculate the final average hypothetical cost saving calculations for the total sample. Families were recruited from two municipalities in West Sweden.

Research design: The cost analysis work was conducted in Autumn 2002. It was a sub-study within the overall Swedish ACTION project, and it was in essence a cost description. A cost description is defined as 'a measurement of the costs of one thing, or of more than one, in a way which allows an explicit or implicit comparison of costs' (Øvretveit 1998). A case study design was employed for the cost description analysis, which means that each selected family represented a case and the descriptive data concerning care service costs and the ACTION intervention costs was analysed with regard to the family's perceived benefits of ACTION, resulting in a hypothetical cost assessment of usual service costs. In this way, the method of the instrumental case study was employed.

Variables and instruments: The following variables were evaluated:

Preliminary cost analysis for 5 families based on:

- A description of the family and their caring situation. These data were collated with the families' consent from existing general background demographic project data.
- The description of the families' perceived benefits from ACTION. This information was obtained from project interview data with the families.
- An assessment of the number of care services needs for the five families without ACTION and their costs. This was carried out by the needs assessors, and validated by a joint meeting in the family's own home between the family, the needs assessor, the first author of this study and an ACTION call centre nurse. The costs for different kinds of usual care services were obtained from the financial departments in the two participating municipalities.
- The ACTION service costs, based on real actual costs for equipment, communication, technical support and the ACTION call centre. The use and cost for telecommunication and Internet were based on information from the telecom company's invoices for the period July 2001 to June 2002. The costs for development and maintenance of the ACTION programmes were based on estimations from previous experience within the ACTION project.

Based on the results of these hypothetical cost assessments, an estimate of the average cost saving per family based on the total sample of 34 ACTION families was made.

The costing are presented in Swedish Crowns (SEK) and the exchange rate on 28 June 2002 was 9.08 SEK for €1, 14.01 SEK for one British pound £1 and 9.16 SEK for $1.

Procedure for data collecting: The information was collected by the needs assessors who knew the families involved, together with the ACTION call centre nurses.

3.- Magnusson et al., 2005 used the following methodology:

Sample: The sample was composed by a total of 34 caring dyads. The participating families were recruited from two municipalities in the west of Sweden. Moreover, data were collected from two groups of professionals.

Research design: A qualitative study was carried out where the ACTION system and services was tested in the caring dyads' homes for approximately three months to a maximum of one year.

Variables and instruments: A multi-method pluralistic evaluation model was used, which captured the views of family and professional cares, through a carer questionnaire and interviews. A modified version of the PREP evaluation questionnaire was used with family carers (Bond, 2000). It is composed by 40 statements that explore the PREP domains of preparedness for, predictability of, and rewards and satisfaction with caring.

Procedure for data collecting: The families were interviewed after the field tests about their experience and evaluation of the ACTION services. Similar interviews were conducted with the call-centre staff on the benefits of the project for the participating families and its impact on their ways of working. Three focus group interviews were also carried out with staff from the participating care settings about their experiences of using ACTION with older people, family carers and other care staff.

View of professionals was held through individual in-depth interviews with the two assistant nurses and the district nurse who were most closely involved in the call centres. Focus-group interviews were also conducted with various professionals who worked in several care settings where ACTION was installed.

4.- Torp et al. (2008) used the following methodology:

Sample: 19 older spousal carers were recruited from two municipalities in eastern Norway was referred to the project from general practitioners, hospital physicians, and community care nurses, or self-referred, having learned about the project from a local voluntary organisation and/or newspaper advertisement. The project started in January 2004. All the 19 recruited carers cared for a husband or a wife. At baseline, they participated in the individual interviews and filled out the self-administered questionnaire. At follow-up (12 months later) all the carers took part in a focus group interview, and 18 filled out the questionnaire.

Research design: A multi-method evaluation model was used to collect both quantitative and qualitative data.

Variables and instruments:

- Socio-demographic data of the spousal carers. In the baseline interview information regarding age, housing, education, occupation, public services, and when the cared-for person received their current diagnosis where collected.
- ICT use through the items 'To what extent have you previously used a computer/PC at home or at work?' at the baseline, and How often have you used the computer in the last 3 months?' at follow-up.
- Knowledge about chronic disease and caring, through the items 'What need do you have for information regarding the cared for person's disease and how to best takes care of him/ her?'.
- Social network, measured by the Family and Friendship Contacts Scale developed by Andersson (1984).
- Social support, measured with a 20-item scale developed by Russel et al. (1980).
- Burden of care, assessed by the 15-item Relative Stress Scale (Greene et al., 1982).
- Mental health, evaluated with the 20-item version of the General Health Questionnaire (GHQ-20) (Goldberg, 1985; Malt, 1989; Goldberg and Williams, 1991).
- Carers' experiences of the intervention (use of ACTION) were collected through focus group interviews. A semi structured interview guide was developed to collect more in-depth information regarding the same topics as in the questionnaire, namely knowledge, social contact and support, stress and health.

Procedure for data collecting: Initially, the participating family carers were individually interviewed by use of a structured interview guide. They also completed a self-administered questionnaire at baseline and after 1 year. In addition, they were interviewed in focus groups after participating in the study for approximately 6–8 months. Logging data of the carers' use of ICT was collected and interviews were carried out with professionals participating in the project. The interviews took place in a rehabilitation centre well known to the participants, and with the carers' permission the sessions were tape-recorded. The interviews were of approximately 1–2 hours' duration each.

The Research Committee for Medical Research Ethics in southern Norway and the Norwegian Data Inspectorate assessed and approved the study. During the entire research project, due consideration was given to respecting the rights of participants with regards to informed consent, confidentiality, anonymity and appropriate data storage (Research Committee for Medical Research Ethics, 2006).

Findings of the practice effectiveness
INDEPENDENT LIVING
<u>Informal carers:</u> <u>More supported</u>: Family carers considered that ACTION helped to support them in a variety of ways with regard to their caring situation. In particular, ACTION reduced the sense of isolation, created a sense of presence, and provided them easier access to care professionals (Magnusson et al., 2002). There was a positive and significant change in scores with regards to contact with family and friends and a sense of social support from other persons (Torp et al., 2008).
PRODUCTIVITY OF THE CARERS
<u>Informal carers:</u> **Empowering family carers**. Participants recognized that ACTION helps to empower family carers by enabling them to readily access the information they require without always necessarily having to go through a professional (Magnusson et al., 2002). **<u>Formal carers</u>**: **Save time**: Professional carers acknowledged that the videophone could enable them to save travelling time if they had follow-up consultations via the videophone (Magnusson et al., 2002). **More time for more needed**: Community nurses recognized that videophone would also allow them more time to visit those patients with more intensive nursing care needs (Magnusson et al., 2002). **More job satisfaction**: ACTION call centre practitioners highlighted that they experienced improved job satisfaction as a result of working in partnership with families to help empower them in their situation (Magnusson et al., 2005). **Better work environment:** The service represents a more environmentally friendly way of working for staff as they use the video-system when contacting service users, thus there is a reduced need for staff to travel and carry out home visits to clients (Magnusson et al., 2005). **More cooperation formal-informal care:** ACTION raised the awareness of the need for professional and family carers to work in partnership. The staff reported new insights into the situation of family carers, into the interdependencies in caring relationships, into the knowledge and expertise held by carers, and into their own potential to enhance these caring resources (Magnusson et al., 2005).
QUALITY OF CARE
<u>Informal carers:</u> **More competence:** Family carers explained that ACTION had improved their competence with regard to their caring role because it has improved their knowledge and skills so that they were able to care more effectively for their relative (Magnusson et al., 2002). **Better care:** ACTION had the potential to empower older people and their carers and to enrich the caring relationship (Hanson et al. 2002). ACTION call centre practitioners highlighted that they experienced improved client satisfaction as a result of working in partnership with families to help empower them in their situation (Magnusson et al., 2005). ACTION had a moderately positive effect on the preparedness, rewards and satisfaction of caring (Magnusson et al., 2005). The scheme encouraged carers to continue in their role by enabling them to feel more prepared and confident (Magnusson et al., 2005). At follow-up carers reported less need for information about the cared-for person's illness and caring. The analysed focus group data revealed that the carers acquired relevant carer information from the information programs, other carers, and the Internet (Torp et al., 2008).

SUSTAINABILITY
Cost savings: A specific study with 34 family carers recruited from two municipalities in West Sweden calculated an average saving of €10,300 per family and year for the municipality as a result of reduced use of home help services and delayed entry to nursing home (Magnusson and Hanson, 2005).
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WEST LOTHIAN TELECARE

NUMBER	12
TYPE OF TECHNOLOGY-BASED SERVICE	TECHNOLOGY-BASED HOME CARE - TELECARE
NAME OF THE PRACTICE	WEST LOTHIAN TELECARE
LEVEL OF NEEDS COVERED	PEOPLE OVER 60 YEARS OLD
COUNTRY	UK
TYPE OF LONG-TERM CARE SYSTEM	Cluster 3: Oriented towards informal care, high private financing
WEBSITE	-
PRACTICE OVERVIEW	
Years in operation	1999-2006 (This programme ended because it was further developed as the National Telecare Development Programme)
Type of organization implementing the practice	Local authority and National Health Division
Cost information	There is no data on the cost of the equipment and installation. We know that users were charged of €5.86 per week and user.
Scale of implementation	1,700 older people in the West Lothian council

Aim and characteristics of the practice

West Lothian Council and its local National Health System Health Division took in 1999 the innovative step of mainstreaming telecare within its healthcare and social care provision for older people. The West Lothian Telecare was a support service for older people consisting of a basic package of technology installed at home, connected with a call centre through a home alert console to allow them to live independently at home. People with care and support needs received the package following a community care assessment, which looked at their individual needs.

The home alert console was connected to the specialist Call Centre. These operators had previously received training in working with older people, including instruction in the principles behind the new model of care. The operators was in charge to respond to calls according to an individual protocol for each person. The protocol identifies action to be taken in response to calls. Usually, the first step was to ring the older people themselves and checked what has happened. Then, the protocol lists what help should be provided. In addition to the technology package, clients received hours of formal support and care according to their individually assessed needs. They also had other assistive devices if they need them.

The core package was offered to everyone over the age of 60 living alone or with a partner.

The staff teams were composed by 23 people from a range of backgrounds: occupational therapy, nursing and personal care. Their job was to support individual clients and provide rapid response and rehabilitation. They were also trained to install the equipment and configure the individual devised to meet the wishes of their clients.

Devices (Technological components)

The telecare system was equipped with the following elements:

- A home alert console, which links sensors to the call centre when they were triggered.
- Two passive infra-red (PIR) detectors to monitor activity and potential intruders.
- Two flood detectors, activated by leaking pipes, overflowing baths, etc..
- One heat extreme sensor, sensitive to both high and low temperatures.

- One smoke detector.

All the devices were wireless. The home alert console simply plugs into a conventional telephone socket, so the packages could be installed with minimum disruption.

In many cases, the basic package was augmented by additional technological devices. These could include, among others:

- Further passive alarms, such as a device alerting that the front door had been opened at night or a fall detector, or active devices such as a pendant alarm requiring the user to press a button.
- Video door entry systems, which showed a picture of a caller on the television and opened remotely the front door.
- Assistive devices such as window openers, bed occupancy monitors, and many others. For example, the bed monitor detected the absence of the occupants. It was put under the mattress and set between 10pm and 7 am. If the occupants got out of the bed and did not return within a set time then this piece of equipment was configured to dial carers' mobile phone and alert them. Carers were then able to phone their parent's house to alert or to give a recommendation.

Furthermore, the system could be connected with lifestyle monitoring systems such as MIDAS (Modular Intelligent Domiciliary Alarm System – Doughty et al., 1999; Fisk, 2001), which was used in a limited way in the housing with care developments, and health monitoring equipment.

A specification of core package, additional items and general conditions of usability are detailed in table 14.

Table 14: West Lothian Telecare: Specification of core package, additional items and general conditions of usability

CORE PACKAGE	
Product	**Description**
Home alert console – Tunstall Lifeline 4000	This unit provides personal and emergency communication, wireless monitoring of a range of sensors. It can transmit data from each sensor automatically by telephone. It provides full duplex speech with a remote party and is capable of being used with a fixed line handset, in hands free mode, and as a reception for a cordless phone. The console is capable of being programmed to enable different responses to different alerts, i.e. it can call different destinations in response to alerts from different sensors and triggers. The calls may all go to the monitoring centre or some may call a neighbour, friend or family carer to identify that the householder is at risk.
Personal trigger	These personal radio triggers allow the users to raise an alarm call within the home. These triggers have a simple button operation and provide a range of wearing options.
Smoke detector	Smoke detectors operate with a normal alarm signal within the home and have wireless data transfer capabilities to send the alert via the Home Alert Monitor to monitoring centre.
Flood detector	Flood detectors monitor the bathroom and kitchen floors for water. They trigger an alarm call within the home and send an alert to the monitoring centre.
Extreme temperature sensor	These detectors are capable of providing an alert if there is extreme heat, such as from a cooker hob being left on. These detectors can monitor both high and low temperatures in the home so that it cannot only detect the risk of fire but also the risk of hypothermia and freezing pipes. The sensor can raise an alarm call in the home and transmit an alert call to the monitoring centre.
Passive infrared detectors	Intruder detection is provided by two passive infrared (PIR) detectors which are linked to the Home Alert Console. The detectors can raise an alert within the home or, if there is a reason to avoid alerting the intruder, they can operate silently and transmit the alert to the monitoring centre. The detectors can also be programmed to raise an alert in the event of prolonged periods of inactivity.
MENU AND SPECIFICATION OF ADDITIONAL ITEMS	
Product	**Description**
Pull cord	This is an alarm trigger that calls assistance when the cord is pulled. A communication link with the Home Alert Console is opened and this connects the alarm signal to the monitoring service or other designated telephone number.
Visual call indicator	This device provides an alternative visual alarm signal for people who have hearing impairment and cannot hear the telephone or other audible alarm.

Fall detector	This sensor can be worn by the user and will automatically detect a fall.
CO detector	Carbon monoxide detection is similar to smoke detection but this device monitors hazardous levels of carbon monoxide emissions.
Bed occupancy detector	This device monitors a person's bed occupancy at night and can trigger an alarm via the Home Alert Console according to pre-set exception rules (for example, if a person gets out of bed at night and does not return within a period of 30 minutes). It works via a telecare interface module.
Wandering detector	This device monitors a person's entry/exit door during a pre-set period when the service user may be at risk. If the sensor is triggered, for example, at 2am in the morning, a carer or the monitoring station would be alerted that the door has been opened. It works via a telecare interface module.
Incontinence detector	A sensor which can monitor bed wetting will alert a carer via the Home Alert Console when timely intervention/ support is required. It works via a telecare interface module.
Internet access via TV	A set-top box can be provided to enable internet, email and web access via the user's television. The user operation is via a laptop infra-red linked keyboard.
Epilepsy alarm	A sensor for people who may have an epileptic seizure in bed. It detects rapid movements and transmits an alert to a carer or the monitoring station as desired.
Video door entry	An entry phone that has video capability, two way conversation between service user and caller and remote control of door lock by service user. The entry phone has a video output and it can be connected to a TV so that the caller's face can be viewed on a larger screen.
Infra-red and radio frequency controllers	These are programmable controllers for remote control of other appliances and can be used in conjunction with equipment such as door openers/closers, window and curtain operators and lighting controllers, lifts, TV and door entry phones.
Remote controlling of lighting	Lighting can be controlled by means of infrared or wireless remote controllers.
Automatic control of lighting	Lighting can be switched automatically by an activator such as when a person gets out of bed at night to light the way to the toilet and then to automatically switch off the lights on return to bed.
Monitor activities of daily living to assess a person at risk	Sensors can be used to determine the time and frequency of certain everyday activities being carried out and software that can analyse the data to determine if a person is at risk. Sensors might record the use of kitchen appliances such as fridge and kettle, bathroom facilities such as toilet flush and other services in the home such as switching of lighting. The information gathered can identify that a person has departed from their regular routine and is at risk or needs assistance.
Curtain, window, door openers	Doors, windows and curtains can be opened and closed by remotely controlled actuators.

Source: Bowes and McColgan, 2006

EVIDENCE OF EFFECTIVENESS

Aim of the impact evaluation.

The evaluation team and the funding of the evaluation study (Nuffield Foundation and the Health Foundation) were independent of the West Lothian Council. The series of interim reports (Bowes and McColgan 2002, 2003, 2005) were used by the Council to support the further development of the programme (Kelly, 2005).

The overall aims of the evaluation were:

- To monitor development of West Lothian Council's 'Opening Doors for Older People' (ODOP) initiative longitudinally, by exploring the experiences and views of stakeholders, older people themselves, carers, care staff, professionals and care planners.
- To examine the implications of the project for the quality of life of older people, especially in terms of maintaining them at home.
- To explore the value for money offered by the project for the user, the local authority and government.
- To compare the care provided and the requirements of service users with those in other forms of care and other forms of supported housing provision.
- To consider the implications of the initiative for all stakeholders.
- To identify best practice for dissemination nationally, whilst also producing early feedback to inform the development of the ODOP project.

Method
Sample: The West Lothian project was rolled out in three phases: In phase 1 (1999), a telecommunications company and a local government agency formed a partnership to pilot smart home technology in 75 residences. In phase 2 (March 2003), the smart home technology was rolled out to 1,200 households where older adults were receiving home-based care services. In phase 3 (December 2003), smart home technology and support were offered to all adults over the age of 60 in the local jurisdiction, including healthy older adults. As of August 2006, the program had enrolled 2,150 older adults. **Research design**: 6 year community-level implementation that involves a wireless core home safety package with a lifeline communication unit, 2 flood detectors,2 PIR sensors, an extreme heat detector and a smoke detector provided to anyone over 60 years of age. **Variables and instruments:** • Interviews with older people receiving the services, including: ✓ 44 people who had smart technology packages installed in their own homes, both following comprehensive community care assessments and as part of the roll out of the Home Safety Service. ✓ 29 people who moved into two of the new housing with care complexes. • A questionnaire for people receiving the Home Safety Service. This received 89 responses. • Interviews with 11 informal carers. • Interviews with 79 staff from a range of disciplines, including managerial staff; members of the new Health and Care team; call centre staff; medical personnel including geriatricians, GPs, community nursing staff; social workers; housing staff at managerial and front line levels; and occupational therapists. • A study in a comparator local authority, which included: ✓ Comparison of local statistics on demography and care and support services for older people ✓ Comparison of a sample of individuals receiving care and support over time ✓ A small interview study, to provide qualitative comparisons between the new model in West Lothian and a more traditional approach. This element included 9 staff, 7 clients and 6 informal carers. • A value for money study, exploring the costs of providing care and support for older people in West Lothian, and comparing these with other Scottish local authorities. **Procedure for data collecting:** Interviews, questionnaires and comparison of statistics
Findings of the practice effectiveness
INDEPENDENT LIVING
More independent living, and safety and security: A large group of respondents living at home, both older people and informal carers, reported the positive impact of the smart technology as supporting safety and security both of the person and the home, and thus as helping people to stay in their own homes.
PRODUCTIVITY OF THE CARERS
New ways of working: Smart technology was integral to the new ways of working. It presented its own challenges, and one of its key impacts for staff was to catalyse the process of change in ways of supporting older people and working with other staff. There was a new focus on promoting independence for older people, and providing 'support' rather than 'care'. Staff saw this as a positive development, in particular because it moved away from old fashioned residential care regimes. They illustrated a strong sense of respect for the dignity and independence of the older people with whom they worked.
QUALITY OF CARE
There is no data

SUSTAINABILITY
Reduced use of institutional services: • 20 delayed-discharge patients in West-Lothian instead of over 70 of previous years. • The average length of stay in a nursing home has dropped from around 18 months in 2004. • The proportion of people over the age of 65 blocking beds in West Lothian is 1.4 per 1,000, compared with a Scottish average of 2.74 and a Lothian average of over four. • The mean duration of length-of-stay by someone blocking a hospital bed is 30 days, compared with a Scottish average of 112 days. • The local consultant geriatrician estimated that 3,000 hospital bed days were saved in the first year of operation either by early discharge or by avoiding admissions to hospital because of the care teams 'rapid response and use of the technologies as part of a model of care.
Evaluation references
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Bowes, A. and McColgan, G. (2006). Smart technology and community care for older people: innovation in west Lothian, Scotland. Scotland, Age Concern Scotland, Edinburgh, 2006.

NATIONAL TELECARE DEVELOPMENT PROGRAMME

NUMBER	13
TYPE OF TECHNOLOGY-BASED SERVICE	TECHNOLOGY-BASED HOME CARE - TELECARE/TELEHEALTH
NAME OF THE PRACTICE	NATIONAL TELECARE DEVELOPMENT PROGRAMME
LEVEL OF NEEDS COVERED	ALL OLDER PEOPLE
COUNTRY	UK
TYPE OF LONG-TERM CARE SYSTEM	Cluster 3: Oriented towards informal care, high private financing
WEBSITE	http://www.jitscotland.org.uk/action-areas/telecare-in-scotland/
PRACTICE OVERVIEW	
Years in operation	2006-2011 (The programme is continuing now under the 2012-2015 Scottish Assisted Living Programme)
Type of organization implementing the practice	Scottish Regional Government
Cost information	Cost depends on the telecare equipment and the needs of the older adults. The costs per unit and year of each equipment are the following: Smoke detector: £55.00 (€66.20) Gas detector: £98.00 (€118.00) Door open alert: £40.00 (€48.15) Internal alert system: £846.00 (€1,018.42) Environmental control equipment: £ 2,776.00 – £8,752.00 (€3,341,76 – 10,535.70) Cognitive support device: £869.00 (€1,046.11) Telecare equipment maintenance, installation and removal: £700.00 (€842,66) (Currency change as for December 2013)
Scale of implementation	Looking across the whole period of TDP funding to 31 March 2010, 29,117 people had been assisted via TDP money, with 21,796 people (75%) still in receipt of a service of some kind as at March 2010. It was implemented in 31 partnerships of the Region of Scotland: • Aberdeen city • Aberdeenshire • Angus • Argyll & Bute • Clackmannanshire • Dumfries and Galloway • Dundee • East Ayrshire

	- East Dunbartonshire - East Lothian - East Renfrewshire - City of Edinburgh - Falkirk - Fife - Glasgow city - Highland - Inverclyde - Midlothian - Moray - North Ayrshire - North Lanarkshire - Orkney Islands - Perth & Kinross - Renfrewshire - Scottish Borders - Shetland Islands - South Ayrshire - Stirling - West Dunbartonshire - Western Isles - West Lothian

Aim and characteristics of the practice

The Scottish Telecare Development Programme (TDP) was launched in August 2006 with the following aim: "To help more people in Scotland live at home for longer, with safety and security, by promoting the use of telecare in Scotland through the provision of a development fund and associated support" (Joint Improvement Team, 2006a).

The TDP adopted a definition of telecare taken from the "Shared Vocabulary" agreed and published by the Scottish Government: "*Telecare is the remote or enhanced delivery of health and social services to people in their own homes by means of telecommunications and computerized systems. Telecare usually refers to equipment and detectors that provide continuous, automatic and remote monitoring of care needs, emergencies and lifestyle changes, using information and communication technology (ICT) to trigger human responses, or shut down equipment to prevent hazards*" (Joint Improvement Team, 2006b; Scottish Government, 2008)

The TDP, which is managed by the Scottish Executive's Joint Improvement Team (JIT), has eight objectives. These are to (Joint Improvement Team, 2006b; Beale et al., 2006):

- Reduce the number of avoidable emergency admissions and readmissions to hospital.
- Increase the speed of discharge from hospital once clinical need is met.
- Reduce the use of care homes.
- Improve the quality of life of users of telecare services.
- Reduce the pressure on informal carers.

- Extend the range of people assisted by telecare services in Scotland.
- Achieve efficiencies (cash releasing or time releasing) from investment in telecare.
- Support effective procurement to ensure that telecare services grow as quickly as possible.

Devices (Technological components)

All sensors or detectors need to be connected to a Telecare control box to enable them to alert help. The different types of sensors and detectors are:

- Movement detectors: They are useful for older adults prone to falls or experience confusion. Sensors can be used to detect if older people are in or out of your bed or chair. Sensors can also be placed by doors to monitor how much movement there is in a room, or when the people are leaving a building. Other sensors use pressure mats that can be placed by beds, for example, to detect if older adults have fallen down. Fall detectors can also be worn on clothes during the day. Sensors can be linked to other electrical equipment in the house, such as bed occupancy sensors that link to the bathroom light switch when older people get out of bed. This can help reduce falls and prevent confusion.
- Enuresis (bed-wetting) sensor: These sensors detect moisture and can be placed between the mattress cover and the sheet.
- Alarms: Alarm buttons or cords can be placed around older people's home or care home, so that they are easily accessible if they need to call for help. Alarms can also be worn as a watch or pendant. They have alarm buttons on them so that older people can press it for help if needed. Alarm systems can also be used to provide support against bogus callers or intruders.
- Environmental sensors: These are sensors that detect gas (if a cooker has been left on unlit), water (if a tap has been left on or there is a water leak), heat detectors (to detect fires), extreme temperature detectors (to detect if it's very hot or cold), and carbon monoxide and smoke detectors. Sensors in more sophisticated systems can link to automatic systems that could shut off the gas supply, as well as alerting older people, their carers and/or a response centre.
- Reminders: These include medicine dispensers. They use a sound alert to remind older people to take their medicine, and the compartments of the medicine holder will open at the right day and time of day. Older people, their carers or care worker (or in some cases, their pharmacist) would need to fill the medicine holder beforehand. Other voice message reminders are available, to ask if medicine, or lunch have been taken, for example. All of these reminders can be set so that if older people don't respond, an alarm would be raised.
- Sensory impairment alarms: If you have a sensory impairment, these sorts of devices sound, flash or vibrate to tell you if the alarm has been raised. For example, if you are hearing impaired and there is a fire, you could be alerted by seeing a light flashing. These sorts of alarms can also vibrate and be placed under pillows, which may be helpful at night if you have hearing and/or visual impairments. There are also beacons which can show you visually that the alarm has been raised, as well as inductive loop systems to help you hear the operator clearly during alarm calls.
- Carer's alerts both sound and vibrate to alert carers if the alarm has been raised, if the person they care for leaves their bed for a longer period of time than is normal to use the bathroom, for example.
- Location sensors. These are used outside the house to either call for help while out, or to be traced if older people get lost.
- Activity monitoring - telecare and non-telecare systems. These systems monitor the movement and activities of older people's household during the day and may not raise the alarm. Instead, they give useful information on older people needs; and show whether their care package is working, or whether problems may be emerging. They can be used by social services professionals to tailor a care package to their needs. Older people need to consent for being tracked and monitored in this way. Other systems allow carers (friends or relatives) who don't live with the older people to monitor their activity to make sure that they are, for example, moving around their homes and using their kitchen at meal times. Other systems may ask older people to press a button at specific times in the day to confirm that they are ok. If older people don't press the button at the allotted time, then staff from a response centre will phone them to check if they are ok. Not all activity monitoring systems are connected to response centres or available 24 hours a day.

EVIDENCE OF EFFECTIVENESS

Aim of the impact evaluation.

Researchers at York Health Economics Consortium (YHEC), a health economics research and consultancy company owned by the University of York, were commissioned by JIT to carry out an evaluation of the TDP. The evaluation focused primarily on considering the extent to which the eight TDP objectives were achieved during 2006–2008 and on the whole period 2006-2011 (Beale et al., 2006).

The evaluation considered the impact of the TDP as a whole rather than the performance of individual projects. It comprised three main elements: use of data provided by the partnerships via quarterly returns, postal questionnaires that were distributed to service users and informal carers, and case studies.

Method

Sample: Looking across the whole period of TDP funding to 31 March 2010, 29,117 people had been assisted via TDP money, with 21,796 (75%) still in receipt of a service of some kind as at March 2010 (The Scottish Government, 2010) – Table 15 -.

Table 15: TDP funded telecare service users

Table 1: TDP Funded Telecare Service Users

	2007-8	2008-9	2009-10	Total
New Clients (gross)	7,902	8,580	12,635	29,117
Stopped receiving a service	679	1,819	4,823	7,321
Net new clients	7,223	6,761	7,812	21,796
Turnover rate (%)	8.6	21.2	38.2	25

Source: The Scottish Government, 2010

Quarterly returns covering the 2007–2008 financial years were received from a total of 32 partnerships. Not all partnerships were operational for the full year due to delays in implementing services and, in total, only 25 partnerships were able to provide four returns during 2007–2008 (Beale et al., 2006)

Research design: Benefits found are based on the growth of telecare through TDP funding, based on quarterly reports submitted over the five year period by Scottish local care partnerships (Beale et al., 2009; Chianti et al., 2011; Newhaven Research, 2011; Cenderello et al., 2013).

Variables and instruments: Information on variables were obtained through quarterly reports, questionnaires and 5 case studies:

Quarterly Returns:

- Reduction in emergency admissions to hospital, performance information identified by the JIT.
- Reduction in delayed discharges from hospital, performance information identified by the JIT.
- Reduction in care home admissions, performance information identified by the JIT.
- Estimate of the duration of each admission or delayed discharge avoided, based on local knowledge (including clinical knowledge) of the circumstances of individuals. Where only the numbers of admissions or discharges avoided were supplied, the researchers derived an estimate of the length of such episodes from aggregated national data.
- Estimates of the financial savings resulting from avoided admissions and discharges. These data were derived by applying unit costs to health and care home admissions. Where local costs were not available costs were extracted from the "Costs Book 2008" (ISD Scotland, 2009) or estimated based on data

submitted by other partnerships.

- Local outcomes and efficiencies (e.g., sleepover care, home check visits, waking night cover).
- Demographic details of clients
- Information about the telecare equipment procurement process.

Questionnaires (developed for this study):

- Users' perceptions of the impact of telecare on their health and quality of life.
- Change in pressure on informal carers.

Case Studies:

- Detailed assessment of how TDP funding had been used to help people to live at home for longer with safety and security.
- Detailed feedback on local experiences of developing and implementing telecare services.

Procedure for data collecting:

For the quarterly returns, the partnerships in receipt of TDP funding were required to submit information on performance toward TDP objectives and locally identified outcomes and efficiencies to JIT on a quarterly basis. The quarterly returns asked them to evaluate individual user-level data to determine whether the presence of telecare had resulted in improvements in care.

In case of the questionnaires, they were distributed toward the end of the evaluation period. In some instances partnerships distributed the questionnaires along with additional questions that sought information to inform local telecare related planning decisions.

For the case studies, five partnerships, implementing a range of different projects, were invited to participate as case studies. Site visits allowed the researchers to carry out face-to-face interviews with a range of local managers and operational staff, met some service users and their carers, and saw local facilities for demonstrating relevant equipment.

Findings of the practice effectiveness

INDEPENDENT LIVING

Independent living of older people at home:

- Older people have reported a significant improvement of their quality of life. 60.5% of users felt that their current quality of life was either "a bit better" or "much better" than before they had their equipment. Concretely:
- Maintained or improved health. Over half (55.2%) felt that their health had not changed, while slightly more than half of the other respondents (27.1% of the total) thought that their health had improved.
- Felt safer: Almost all (93.3%) respondents felt safer.
- Felt more independent. Over two thirds (69.7%) felt more independent.

PRODUCTIVITY OF THE CARERS

- 100% of carers report a positive experience of the telecare solutions, quoting benefits such as reduced worries and stress, the ability to retain paid employment, the opportunity to reduce some caring tasks and an improved relationship with the person they cared for.
- 74% of carers reported reduced stress.

QUALITY OF CARE

There is no data

SUSTAINABILITY

Reduction in the use of health and social care services (Table 16):

- Faster discharge from hospitals. During 2006–2010, over 1,500 delayed discharges were avoided as a result of telecare, leading to an estimated saving of over 16,000 bed days.

- Reduction of hospital admissions. During 2006–2010, total of over 6,600 unplanned hospital admissions were avoided as a result of telecare, and duration of avoided admissions ranged from 2 days to 30 days. 65,000 hospital bed days were avoided through facilitated discharges and unplanned admissions avoided, this lead to 49,000 hospital bed days saved.
- Avoided admissions to care homes. During 2006-2010, 2,650 admissions to care homes had been avoided over the course of the evaluation. These were associated with the avoidance of a significant length of stay and a reduction in 346, 000 care home beds purchased.

Table 16: TDP outcomes 2006-2010

Table 4: TDP Outcomes 2006-10

	PARTNERSHIP EXPECTATIONS		PARTNERSHIP ACHIEVEMENTS	
	2009/10	2006-2010	2009/10	2006-2010
Reduction in delayed discharges from hospital	967	1,804	611	1,505
Reduction in the number of unplanned hospital admissions	1,088	3,803	2,793	6,594
Reduction in the number of care home admissions	2,036	3,025	1,190	2,655

Sources: 2006/7 and 2007/8 expectations are from JIT (2007). Expectations for 2008/9 and 2009/10 were provided by JIT from data provided by partnerships. Achievements up to 31 March 2008 are from YHEC (2009c). Achievements for 2008/9 and 2009/10 are from relevant quarterly monitoring returns.

Table 5: TDP Outcomes 2006-10

	PARTNERSHIP EXPECTATIONS		PARTNERSHIP ACHIEVEMENTS	
	2009/10	2006-2010	2009/10	2006-2010
Number of hospital bed days saved due to reduction in number of delayed discharges	10,674	45,104	7,013	16,360
Number of hospital bed days saved due to reduction in number of unplanned hospital admissions.	10,922	35,330	23,747	49,033
Reduction in number of care home bed days purchased	43,313	188,099	205,308	346,292
Number of nights sleepover care saved	16,902	55,427	12,895	35,470
Number of home check visits saved	85,778	614,983	50,472	410,685

Sources: 2006/7 and 2007/8 expectations are from supporting spreadsheets to JIT (2007). Expectations for 2008/9 and 2009/10 were provided by JIT from data provided by partnerships. Achievements up to 31 March 2008 are from YHEC (2009c). Achievements for 2008/9 and 2009/10 are from partnership relevant quarterly monitoring returns.

Source: The Scottish Government, 2010

- Cost savings generated for the social and health care budget as a result of telecare were significant: the gross value of financial benefits arising from TDP expenditure for the entire 2006-2011 period was approximately £ 79 million (at current prices)/ €91 million. The majority of savings result from avoiding unplanned hospital and care home admissions, although notable savings also resulted from a reduced demand for home check visits and the reduction in delayed discharges.

Evaluation references
Beale, S., Truman, P., Sanderson, D., & Kruger, J. (2010). The initial evaluation of the scottish telecare development program. Journal of Technology in Human Services, 28(1), 60-73.
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Beale, S.; Sanderson, D.; and Kruger, J. (2009). Evaluation of the Telecare Development Programme. Final report. Cenderello, A.; Gallasso, G.; Gargaro, F.; Miele, M.; Zamora, D.; Millard, J.; Carpenter., G. and Pedesen, K. (2013). Study on business and financing models related to ICT for ageing well. Final report (D8) on ICTechnolage. Joint Improvement Team (2011). Telecare and Telehealth: What It Is and How to Get It. Available at http://www.jitscotland.org.uk/downloads/1296040167-telecare-and-telehealth-what-it-is-and-how-to-get-it-guide-6%5B1%5D.pdf Joint Improvement Team. (2006a). National telecare development programme: Glossary of terms and conditions. Available from http:// www.jitscotland.org.uk/action-areas/telecare-in-scotland Joint Improvement Team. (2006b). Proposal: Telecare development programme. Retrieved February 12, 2010. Available from http://www.jitscotland.org.uk/downloads/ 1208770769-Telecare%20Development%20Programme%20Proposal%20May% 202006.pdf Scottish Government (2010). An assessment of the development of telecare in Scotland 2006-2010. Available at http://www.scotland.gov.uk/Resource/Doc/328586/0106225.pdf

TECHNOLOGY-BASED WELLNESS SERVICES

BRAIN AGE

NUMBER	14
TYPE OF TECHNOLOGY-BASED SERVICE	TECHNOLOGY-BASED WELLNESS SERVICES - SERIOUS GAMES
NAME OF THE PRACTICE	BRAIN AGE
LEVEL OF NEEDS COVERED	ALL
COUNTRY	JAPAN, USA, CANADA, EUROPE AND AUSTRALIA
TYPE OF LONG-TERM CARE SYSTEM	ALL
WEBSITE	http://www.nintendo.com/games/detail/Y9QLGBWxkmRRzsQEQtvqGqZ63_CjS_9F
PRACTICE OVERVIEW	
Years in operation	2005- now
Type of organization implementing the practice	Private company
Cost information	The game cost in Amazon: €23,09 (consulted on 08/01/2014) To play the game the console Nintendo 3DS is needed. The cost of the console is €159,99 (checked on Amazon Spain on 08/01/2014)
Scale of implementation	The game is available in Japan, USA, Canada, Europe and Australia. By 31st March 2013, Nintendo has sold 19 million pieces of the game.

Aim and characteristics of the practice

Brain Age is published by Nintendo as a game which participants in the brain training group played. Brain Age is a popular brain training games. It was developed based on the previous findings of a cognitive training program for the older people (Uchida and Kawashima, 2008).

Source: retrieved from http://www.nintendo.com/games/detail/Y9QLGBWxkmRRzsQEQtvqGqZ63_CjS_9F on 17/10/2013

It was first released in Japan, and was later released in North America, Europe, Australia, and South Korea. It was followed by a sequel titled *Brain Age 2: More Training in Minutes a Day!*, and was later followed by two redesigns and *Brain Age Express* for the Nintendo DSi's DSiWare service which uses popular puzzles from these titles as well as several new puzzles.

Brain Age features a variety of puzzles, including stroop tests, mathematical questions, and Sudoku puzzles, all designed to help keep certain parts of the brain active. *Brain Age* uses the touch screen and microphone for many puzzles.

Brain Age has nine games:

1.- Calculation X 20: players are required to answer a total of 20 simple arithmetic calculations as quickly as possible. The questions include addition, subtraction, and multiplication. One question will appear on the top screen, and the player must hand-write the answer on the touch screen.

2.- Calculation X 100: players are required to answer a total of 100 questions as quickly as possible. The questions include addition, subtraction, and multiplication.

3.- Reading Aloud: which gives the players an excerpt from a classic story such as *The Legend of Sleepy Hollow* or *Little Women*, and task them with reading the story aloud to see how quickly they can do it. The player progresses through the excerpt by pushing Next, until they reach the end of the excerpt. If the players push Next too quickly, the puzzle will end prematurely.

4.- Low to High features several boxes on both screens, each in the same pattern as each other. The game will count down at varying speeds, and when it hits zero, numbers will appear in these boxes for a short period of time. Afterwards, the players must touch the boxes on the touch screen from lowest number to highest by memorizing the numbers on the top screen. Afterwards, the game will introduce one puzzle after the other in a similar fashion. The quantity of boxes to memorize increases after each correct answer, and decreases after each incorrect answer, with the minimum quantity of boxes being four.

5.- Syllable Count shows several phrases, one after the other, on the top screen, and the player must write the number of syllables in each phrase on the touch screen.

6.- Head Count features a group of people on the top screen (e.g. 4). After a few seconds to allow the player to count the number of people, a house falls over them. The player must watch the screen carefully, as the people inside will leave the house and more people will enter the house. This will eventually cease, and the game asks the player to write down how many people are currently in the house. The puzzle gets more difficult as the player progresses in it. There is also a hard mode in which people also come in and out of the chimney.

7.- Triangle Math has a series of mathematical equations that the player must solve. It is designed similarly to the Calculation puzzles, in that the equation appears on one screen, and the player writes the answer on the touch screen. The equations involve three numbers and two mathematical operations (e.g., 3 + 4 + 8 or 3 − 4 + 8), and are solved by performing the first operation, and then the second. This also features a hard mode where an extra tier is added to the triangle.

8.- Time Lapse displays two analog clocks (e.g. one at 2:45 and one at 7:30), and requires the player to calculate the difference in time between these clocks.

9.- Voice Calculation, which is similar to the Calculations puzzles. However, this puzzle requires the player to speak the correct answer into the microphone instead of write it on the touch screen, similar to the Stroop Test.

Included in the North American, European, and Australian versions of this game is a Sudoku mode, which features more than 100 puzzles across three different modes – Beginner, Intermediate, and Advanced. Sudoku involves a 9x9 grid with numbers in every square. Some of these numbers are visible, while others are not. The objective is to fill in the hidden numbers using the visible numbers as hints. Each row, column, and 3x3 grid has nine squares in it, and each must contain each number in the range from 1 to 9.

Brain Age is designed to be played a little each day. The Nintendo DS is held on its side, with the touch screen on the right for right-handed people and the left for left-handed people. The game is entirely touch and voice-controlled – the player either writes the answer to the puzzle on the touch screen or speaks it into the microphone. Before the players can begin a Brain Age session, they must input information. First, players must confirm the date and select which hand they write with. The players then input their name and date of birth.

At the end of all Brain Age Check puzzles, Training puzzles, Quick Play puzzles, and Sudoku puzzles, the players are shown how quickly they completed it, the players' speed (according to metaphors such as "bicycle speed" and "jet speed", the highest being "rocket speed"), and a tip for either improving the players' brain or a game-related tip. If the players' time or score in Brain Age Check or Training is high enough, it will appear on one or both of the Top Three. The Top Three shown is the player's own top three attempts at a puzzle, while they can also compare the top three with those of other saved players.

While the players are navigating the menus outside of the puzzles, Professor Kawashima appears to prompt and encourage the user. *Brain Age* allows up to four players to save profiles on one DS game card, and these players can interact with each other in several different ways. There are five modes of play – Brain Age Check, Training, Quick Play, Download, and Sudoku.

When starting a session, Kawashima may ask the player to participate in a Picture-Drawing Quiz, which requires the players to draw a person, place, or thing by memory using the touch screen. After the players have done all three, the game will compare their drawing to an example created by the game developers, along with advice of what to emphasize on below its image. If more than one player profile is saved on the game card, images for the day can be compared to those of other players.

Kawashima may also ask the player to participate in a Memory Quiz, which requires the player to recall a recent event, such as what the player ate or the most interesting thing seen on television the day before. Several days later, it will ask for the answer originally provided, and will then compare the answer given several days ago and the answer given on the current day to test the player's recollection skills. The player is not scored on his or her ability to remember.

The game includes four modes: Brain Age Check, Training, Quick Play, and Sudoku. The Brain Age Check gives the player three puzzles to complete. The first is usually a Stroop test, although the player can choose to skip the Stroop test if he or she is not in a quiet environment or is otherwise unable to speak into the microphone. At the end of the Brain Age Check, the game reports on the players "brain age", a theoretical assessment of the age of the player's brain. The higher the brain age, the worse the player performed. The best possible score is 20, according with Kawashima's theory that the brain stops developing at 20. The player may replay the Brain Age Check, but it will not change the brain age for the day.

Once the player confirms whether or not he or she can speak into the microphone, Professor Kawashima will describe the first puzzle. If the player answered that they can speak, the game begins with a Stroop test; if the player cannot use the microphone, the game picks a random puzzle from the following: Calculations X 20, Word Memory, Connect Maze, Number Cruncher, and Speed Counting.

During the Stroop Test, the game will display one of four words: blue, black, yellow, and red. A random word will appear on screen, one after another, each appearing in a random colour (which may not match the colour denoted by the word). The player is instructed to say the colour of the word, rather than its semantic meaning (e.g., if the word Yellow appears in blue letters, the player should say "blue" –).

In Speed Counting, which requires speaking but does not use the microphone, the players count up from one to 120 as fast as they can without slurring the names of numbers.

Word Memory gives the player a list of 30 four-letter words. The player is given two minutes to study the list and memorize as many words as possible. After the two minutes are up, the player must write down as many words as he or she can in three minutes. Another puzzle called Connect Maze gives players a randomly created group of circles, with letters and numbers in them. There is one circle for every letter in "A" through "M", as well as a circle for every number from 1 to 13. The player must then connect a line between a letter and a number, starting with "A". The player must connect the letter "A" to the number one, and then connect it to the letter "B" and then the number two, and so on until the player reaches 13.

Calculations X 20 presents the player with 20 mathematical equations, including addition, subtraction, and multiplication. On the top screen are the questions, which scroll up as they are answered (whether correctly or incorrectly), while the touch screen is used to write out the answer.

In Number Cruncher, the player is presented with a series of screens displaying several numbers, which vary in their appearance and on-screen behaviour. For instance, a screen may display five blue numbers, three red numbers, and one moving yellow number, and above it is a question, such as "how many blue numbers are there?", which the player must answer as quickly and accurately as possible.

The Training mode allows the player to play a variety of puzzles, with all but one of the puzzles being exclusive to the Training mode. Once the player completes at least one puzzle, Kawashima awards him or her with a stamp, which he places on the current date. If the player places at least three puzzles, the stamp will expand in size. After accumulating a certain number of stamps, Kawashima will award him or her with a new puzzle, difficulty mode, or additional feature under the Options menu. Each puzzle can be played as many times as the player likes, although only the first play-through of the day will count in the graph for that puzzle.

Quick Play can be played by anyone, whether they a saved file or not. Quick Play allows the players to play three modes – Quick Brain Age Check, Quick Training, and Quick Sudoku, all only providing the player with one of the easy puzzles in each of these modes to try. Quick Brain Age Check only allows the players to play the stroop test. In Quick Training, the game only allows the players to play Calculations X 20. And in Quick Sudoku, the play may only play the easiest Sudoku puzzle available. At the end of each session, the player's brain age

Devices (Technological components)

The game required a console Nintendo 3DS to play.

EVIDENCE OF EFFECTIVENESS

Aim of the impact evaluation.

The goal for this study was to investigate the beneficial effect of a brain training game in the healthy older adults. To examine this issue, the researchers adopted the brain training game called Brain Age published by Nintendo in 2005.

Method

Sample: 32 older volunteers were recruited through an advertisement in the local newspaper and randomly assigned to either of two game groups (Brain Age, Tetris). This study was completed by 14 of the 16 members in the Brain Age group and 14 of the 16 members in the Tetris group. To maximize the benefit of the interventions, all participants were non-gamers who reported playing less than one hour of video games per week over the past 2 years.

Research design:

This randomized controlled trial was conducted between March 2010 and August 2010 in Sendai city, Miyagi prefecture, Japan. Brain Age of Nintendo was used to assess the impact of the brain training game on the older people. The researchers used a double blinded intervention. Participants were blind to the treatment (Brain Age) and control (Tetris) designations of these two groups, and were informed only that the study was designed to investigate the effects of two different training programs. Testers were blind to the group membership of participants. The researcher randomly assigned participants to either of two groups (Brain Age, Tetris) by the random draw using a computer.

The researchers used Brain Age published by Nintendo as a game which participants in the brain training group played. This game has 9 games, and this study 8 training games with the exception of Voice Calculation, because Voice Calculation is similar to Calculation X 20 and Calculation X 100. Participants were asked to train for 15 minutes a day, five times a week during the 4 weeks. Each group played for a total of about 20 days.

Variables and instruments:

To evaluate the effects of the brain training game, a broad range of the cognitive functions were assessed:

- Global cognitive status was measured by Mini-Mental State Examination (MMSE) (Folstein et al., 1975), the most widely used screening instrument for the detection of cognitive impairment in older people.
- Executive functions were measured by Frontal Assessment Battery at bedside (FAB) (Dubois et al., 2000), and Trail Making Test- B (TMT-B) (Reitan, 1958).
- Attention was measured by Digit Cancellation Task (D-CAT) (Hatta et al., 2006), Digit Span Forward (DS-F) (Wechsler, 1997) and Digit Span Backward (DS-B) (Wechsler, 1997).
- Processing speed was measured by Digit Symbol Coding (Cd) (Wechsler, 1997) and Symbol Search (SS) (Wechsler, 1997).

Procedure for data collecting: The participants played video games on the portable console, Nintendo DSi, at their homes. Game performance was recorded for each participant. At the end of each training day, participants reported the scores of the played games. The Brain Age group listed the titles of trained games and a score for each trained game at the end of each training day. The Tetris group only reported the best total score at the end of each training day. The measures of cognitive functions were conducted before and after training. On the first day of training (pre), all participants were tested on a series of neuropsychological and behavioural tests. After these tests, participants received the instruction to play one of the games for 30 minutes. To play the video game, participants were provided the portable console (Nintendo DSi) and one of the video games (Brain Age or Tetris). The following day, participants started 4 weeks video game training. After 4 weeks of training (post), all participants were re-examined on some neuropsychological and behavioural tests. Finally, the portable console and the video game were returned at the end of the study.

The procedures for this study were approved by the Ethics Committee of the Tohoku University Graduate School of Medicine. All participants provided informed consent to participate in this study.

Findings of the practice effectiveness

INDEPENDENT LIVING

Improvement of cognitive functions: The results showed that playing Brain Age for 4 weeks improved cognitive functions (executive functions and processing speed) in the older people (Table 17).

Table 17. The score of change in cognitive functions measures of both groups

Table 3. The score of change in cognitive functions measures of both groups.

	Brain Age Group		Tetris Group			
	Mean	SD	Mean	SD	Effect size (η^2)	*p*-value
Executive function						
FAB (score)	1.79	(1.58)	0.07	(1.21)	0.13	0.001
TMT-B (seconds)	−24.00	(22.81)	−4.57	(22.32)	0.13	0.006
Attention						
D-CAT (number)	2.57	(4.36)	1.43	(3.11)	0.06	0.277
DS-F (low score)	0.07	(1.94)	−0.07	(1.86)	0.00	0.717
DS-B (low score)	0.00	(1.41)	−0.07	(1.90)	0.00	0.683
Global cognitive status						
MMSE (score)	0.36	(1.28)	0.29	(1.33)	0.00	0.631
Processing speed						
Cd (number)	8.29	(7.03)	−0.93	(8.08)	0.19	0.005
SS (number)	7.43	(4.91)	3.21	(5.13)	0.12	0.014

Change scores were calculated by subtracting the pre-cognitive measure score from the post-cognitive measure score. The Executive functions were measured by frontal assessment battery at bedside (FAB) and trail making test type B (TMT-B). The processing speeds were measured by digit symbol coding (Cd) and symbol search (SS). The global cognitive status was measured by mini-mental state examination (MMSE). The attention was measured by digit cancellation task (D-CAT), digit span forward (DS-F) and digit span backward (DS-B). We report eta square (η^2) as an index of effect size. It is a standardized difference in the change score (post-training score minus pre-training score) between intervention groups (Brain Age, Tetris). $\eta^2 \geq .01$ is regarded as small effect, $\eta^2 \geq .06$ as medium effect, and $\eta^2 \geq .14$ as large effect. SD means standard deviation.
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Source: Nouchi et al., 2012

PRODUCTIVITY OF THE CARERS

There is no data

QUALITY OF CARE

There is no data

SUSTAINABILITY

There is no data

Evaluation references

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