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## Telemedicine Scenario for Elderly People with Comorbidity

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**ABSTRACT**   Progressive population aging is associated with negative social and economic impacts mainly due to its associated comorbidity rather than to aging *per se*. In this regard, information and communication technology resources may provide useful tools to assist the population with comorbidities through the use of telemedicine systems. However, despite their potential, such systems have not yet been effectively implemented due to a number of different reasons: absence of a clear business plan, poor acknowledgment of their clinical usefulness, and ethical and legal issues, among others. An analysis of the current scenario from the point of view of the different actors (patients, health care providers, and health care systems) aimed at identifying the needs to be covered by telemedicine systems that could contribute to overcoming such problems. The present chapter is intended to offer such an analysis.

**KEY WORDS:**   *telemedicine, telehealth, telecare, telemonitoring, remote patient management, older people, comorbidity, health systems, social services.*

## Introduction

Progressive population aging and increasing chronic diseases (WHO 2011) have promoted interest in the development of solutions for the health-related, economic, and social adverse effects of this phenomenon, which are precipitated by aging-related comorbidity rather than by aging *per se*. An important development sector dedicated to researching these solutions focuses on the application of information and communication technologies (ICTs) to providing assistance and medical care to older people, namely, telemedicine, telehealth, or telecare. However, despite the large potential for ICT applications in this field, such solutions have not yet been effectively implemented due to a number of factors: absence of a clear business plan, poor acknowledgment of their clinical usefulness (evidence-based medicine), ethical and legal issues, usability problems with the required devices, failure to meet the actual needs of the target population, and a need for organizational changes in current health systems, among others.

A major step toward overcoming such obstacles is the consideration of the scenario where these technological resources could potentially be introduced. Unfortunately, there

is not a single scenario for the use of ICT due to high variability among both the technological applications and the users.

The goal of the present chapter is to provide a description and analysis of the specific scenario for a telemedicine application to monitor and provide health care to older people with comorbidity. To that end, the main actors in this scenario have to be identified along with the set of technologies included in the telemedicine solution.

As far as the identification of scenario actors is concerned, the Ambient Assisted Living Innovation Alliance (AALIANCE) platform, in the published Ambient Assisted Living Roadmap (AALIANCE 2009), identifies the following actors for the global ambient assisted living (AAL) scenario:

- *Primary stakeholders*—users and caregivers
- *Secondary stakeholders*—organizations offering services
- *Tertiary stakeholders*—organizations supplying goods and services
- *Quaternary stakeholders*—organizations analyzing the economic and legal context of AAL

In this chapter, we use a modified classification adapted to the telemedicine services for the older people:

- *Older patients*—potential end users
- *Health care professionals*—all medical (clinical) and nonmedical professionals involved in providing assistance to the older people
- *Health systems*—health organizations who are potential contractors of telemedicine systems

Furthermore, due to the high heterogeneity of ICT resources, the ones to be included in a particular telemedicine solution should be clearly specified. A definition of telemedicine by the World Health Organization (WHO) states (WHO 1998a), "Telemedicine is 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 enhancing the health of individuals and their communities." [Please provide the page number where the quote was taken.]

The scenario described in this chapter is intended for telemedicine systems aimed at domiciliary remote patient monitoring and assistance (consultation/diagnosis, monitoring/management/surveillance) for older patients with comorbidity by the health care providers involved in their care.

The contents of this chapter are organized into three sections:

- Aging, comorbidity, and target diseases—reviews the impact of comorbidity and its consequences, as well as those conditions that should be covered by telemedicine systems.
- Analysis and description of the scenario for each stakeholder—patients, health professionals, and health systems (organizations).
- Potential situations, scenarios, and use cases for the use of the telemedicine systems covered in this chapter.

## Aging, Comorbidity, and Target Diseases

### Aging and Comorbidity

Progressive population aging is a well-known phenomenon, especially in developed countries, including most of the European countries. Data published in the EUROSTAT 2008 report (Giannakouris 2008) illustrate this demographic phenomenon and its possible socioeconomic consequences in the coming years:

- Population aged 65 years or over will grow from 17.1% in year 2008 to 30% of total Europeans (151.5 million, including Switzerland and Norway) in 2060.
- The current 4:1 ratio of persons of working age (15–64 years) to persons aged 65 or over is expected to decrease to 2:1 by 2060.

Several studies have demonstrated that aging is associated with (different than "being the cause of") an increase in the prevalence\* of different chronic diseases (Guralnik 1996). However, aging is associated not only with an increasing number of persons who suffer from a chronic disease but also with an increasing number of diseases that affect them: 1.88 associated chronic diseases for persons aged 65–69 years and 2.71 associated diseases for persons over 85 years (Wolff et al. 2002). In 1999, 24% of patients over 65, who were managed by the Medicare (United States), had more than four chronic diseases (Wolff et al. 2002). Unlike what used to be the case in past decades, managing patients with coexisting chronic diseases is nowadays the norm rather than the exception (Starfield 2006).

Comorbidity is a term with more than one definition. We take the following as a reference: "comorbidity is the coexistence of two or more diseases diagnosed in the same individual, according to well-established and widely accepted criteria" (Fried et al. 2004).

However, the consequences of comorbidity go beyond the "coexistence" of diseases (Fried et al. 2004; Gijsen et al. 2001; Karlamangla et al. 2007; Valderas et al. 2009). A study by Ettinger et al. (1994) conducted on 4059 patients with either knee arthropathy, cardiac disease, or pulmonary disease revealed that the risk for motor disability was 4.4 in patients with arthritis, 2.3 in patients with cardiac disease, and as high as 13.6 in patients with both conditions. This is due to the *interaction* between different conditions—often apparently unrelated (e.g., arthritis and heart disease)—so that the consequences (in this example, evaluated as motor disability) are not always simply summational (Fried et al. 2004; Gijsen et al. 2001; Karlamangla et al. 2007; Valderas et al. 2009).

A foreseeable consequence of the increasing number of chronic diseases associated with population aging is an increase in health-related costs. Wolff et al. (2002) performed a study on health care costs for 1.2 million persons aged 65 or over, randomly selected from Medicare, for the year 1999. Several observations can be drawn from their study:

- Health care costs increase with an increase in the age and number of coexisting diseases; however, the increase is very much higher in persons with chronic conditions compared to persons without chronic conditions. Costs increase from $195 for a person aged 65 to 69 without chronic conditions to $999 for a person of the same age with one chronic condition.

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\* The proportion of persons that suffer from a certain disease in relation to the total population at a certain moment.

- The number of conditions coexisting in a person influences the health care costs more than their age; thus, health care costs for a person aged 65–69 with two associated chronic conditions are higher ($2055) than those for a person over 85 years with one associated chronic condition ($1579). In other words, health care costs for a person aged 65–69 with one associated chronic condition ($999) rise more if the person develops a second associated chronic condition than when the person simply gets older.

Thus, the comorbidity affecting a certain person is more relevant than their aging *per se.*

## Target Diseases for Telemedicine Systems

It is essential that telemedicine systems are aimed at providing assistance for conditions that are most relevant to older people. In order to evaluate the clinical relevance of diseases, the following main parameters can be used: disease prevalence or frequency, diseases that lead to hospitalization, associated mortality, and associated functional impairment.

The Health Survey for England (HSE) consists of a group of annual studies, each year with special emphasis on a different topic concerning the English Health System. In 2005, these studies were especially focused on older people (The Information Centre 2007). In this study, the most frequently reported diseases (physician-diagnosed chronic conditions reported by the person taking the questionnaire) were cardiovascular diseases (CVDs) for men (37%) and joint diseases (mainly arthritis) for women (47%). Since women outlive men (a finding habitually observed for this age group worldwide), osteoarticular disorders are commonly reported as the one most frequent chronic disease. However, the mortality caused by CVD (stroke, acute myocardial infarction, heart failure, etc.) is usually higher than that caused by osteoarticular disorders (WHO 1998b). In turn, disability produced by osteoarticular disorders is rather important. A study conducted by Boult et al. (1996) on the US population with projections for years 2001 and 2049 predicted that 1% biannual reductions in the prevalence of arthritis would reduce the number of functionally limited older persons more than equivalent reductions in the prevalence of other conditions such as coronary artery disease, stroke, diabetes, cancer, or delirium.

As a reference for conditions most often causing hospitalization, we include information from the Minimum Basic Data Set (MBDS) from the Spanish National Surveillance System for Hospital Data* (Ministerio de Sanidad y Consumo 2006). Major causes of admission to hospital of persons aged 65 or over, reported by the MBDS in 2005 (Table 12.1), include the following five most frequent main diagnoses: heart failure, chronic bronchitis, osteoarthritis and related disorders, pneumonia, and hip fracture.

Notice that cardiovascular, respiratory, and osteoarticular diseases are the most frequent causes of admission to hospital within this age group. Together they account for 18% of total hospitalizations; although apparently low, this proportion is not meaningful without taking into account the long list of different diagnoses (total number 571) and the considerable overlapping of related diagnoses. Grouping diseases into affected organs and systems shows that cardiovascular diseases (including stroke), respiratory diseases, and osteoarticular disorders (including fractures) account for 37% of total admissions to hospital. Hip fracture, being the fifth cause of hospitalization, deserves special attention because of the massive changes in quality of life and functional situation that it usually brings about in

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* Database including 99% of the hospitals belonging to the National Health System (more than 95% of the hospitals in Spain).

**TABLE 12.1**

Hospitalization Causes (Aged 65 and Over, 2005)

| Disease | #(%) |
| --- | --- |
| Heart failure | 68,363 (16.37%) |
| Chronic bronchitis | 63,964 (15.32%) |
| Osteoarthritis and other osteoarticular diseases | 43,647 (10.45%) |
| Pneumonia | 41,075 (9.84%) |
| Hip fracture | 40,934 (9.80%) |
| Colelithiasis | 35,864 (8.59%) |
| Acute myocardial infarct | 35,033 (8.39%) |
| Stroke | 34,290 (8.21%) |
| Cardiac arrhythmia | 28,766 (6.89%) |
| Other lung diseases | 25,650 (6.14%) |
| Total | 417,586 (100%) |

*Source:* Ministerio de Sanidad y Consumo, Conjunto Mínimo Básico de Datos 2005. Spain, 2006. Available at http://www.msc.es (accessed October 17, 2012).

a rather short period of time (one out of five patients dies within a year after the fracture; Cooper et al. 1993; Koike et al. 1999; Walker et al. 1999), and only 40% of patients recover their previous functional situation (Koot et al. 2000). Many of these fractures are the consequence of falls, which are not managed until several hours afterward, due to the fact that 20%–40% of older people are unable to stand up without help after the fall and cannot call for help (Nevitt et al. 1989, 1991; Vellas et al. 1998).

We can conclude that cardiovascular, respiratory (especially chronic bronchitis or chronic obstruction pulmonary disease), and osteoarticular diseases should be particularly regarded, because of the high total burden of morbidity they produce. Other important diseases include stroke and cardiovascular risk factors (mainly diabetes mellitus and hypertension).

## Medical Trends in Telemedicine Research

We conducted a nonsystematic review of studies published in the medical literature (PubMed Database [only *free* access articles were considered]) and two additional journals (*Journal of Telemedicine and Telecare* and *Telemedicine and e-Health*) from 2005 to 2010 on the use of telemedicine systems and services.* The "keywords" were ("Telemedicine" OR "Telehealth") AND ("Heart" OR "Diabetes" OR "respiratory" OR "COPD" OR "Asthma" OR "Psychiatry" OR "Dementia" OR "Neurology" OR "Stroke" OR "Parkinson").

The following findings are derived from our literature search and review (144 studies) for noninvasive remote patient monitoring systems:

Concerning the conditions addressed by this research (Table 12.2), cardiovascular diseases (especially heart failure) and risk factors (hypertension and diabetes) formed the largest group. Respiratory diseases were the second largest group in Europe. A further distinct group of conditions identified in our surveyed studies were psychiatric and neurological diseases (mainly diagnosis and treatment of the acute phase of stroke).

Few studies about telemedicine systems are aimed at treating more than one group of diseases. We just found 20 research articles with such a multidisciplinary assistance

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* Survey performed for enhanced Complete Ambient Assisted Living Experiment (eCAALYX) EU Project Consortium (http://ecaalyx.org); Ambient Assisted Living Joint Programme.

**TABLE 12.2**

Frequency of Telemedicine Studies per Type of Health Disorder

| Type of Health Disorder | Frequency | Percentage |
|---|---|---|
| Cardiac disorders | 50 | 34.7 |
| Respiratory disorders | 24 | 16.7 |
| Psychiatric disorders | 27 | 18.8 |
| Neurological disorders | 23 | 16.0 |
| Diverse health conditions | 20 | 13.9 |
| Total | 144 | 100.0 |

approach, and most of them (7 studies) were focused on combined care for cardiovascular and respiratory disorders involving different diseases. This observation is important because older people usually present more than one of these diseases. Designing individual telemedicine systems for each of these diseases is not practical.

The technologies predominantly used in the reviewed studies were telemonitoring devices such as electrocardiogram (ECG) equipment, blood pressure monitors, weighing scales, and video-conferencing equipment. Furthermore, a number of combinations of these technologies with telephone/mobile phone and the Internet were used.

The typical telemonitoring system generally consisted of a computer or mobile phone equipped with peripheral medical devices for measuring health parameters and submitting the results to a health care or telemedicine center. In most of the reviewed studies, telemonitoring was combined with other technologies, especially with communication technologies: web-based applications (14.6%), standard or mobile telephone (9%), both telephone and web applications (2.1%), or both telephone and web applications plus video-conferencing (4.9%). A clear trend emerged toward the integration of all of the technologies for remote health assistance into a unique system.

Video-conferencing was often used for consultations between a patient and a specialist clinician or between a patient and a nurse. Systems were usually installed at the patient's home or in primary care centers lacking a specialized service. As the search was based on remote patient monitoring systems, video-conference systems used for consultation between physicians ("doc2doc") were not included in this review. In general, the use of different technological solutions appeared to be based on the specific needs associated with different interventions. Thus, interventions aimed at treatment and in-depth follow-up promote the use of telemonitoring; interventions focused on follow-up and keeping contact with the patient promote the use of telephone; and interventions focused on remote consultation promote the use of video-conferencing.

## Scenario for Each Stakeholder of Telemedicine Systems

### Patients Scenario

#### Multimorbidity

Due to increasing life expectancy and improvements in medicine and medical technologies, multimorbidities—two or more diseases—are present in a growing proportion of older people. The cardiovascular, respiratory, musculoskeletal, and metabolic systems

are most frequently affected. However, there are insufficient data and less well designed longitudinal studies on the impact of multimorbidity on the social system as well as the medical (e.g., guideline-based therapy for family physicians, poly-pharmacies) and nursery systems (Schäfer et al. 2009).

The Health Survey for England 2005 (The Information Centre 2007) showed that the proportions of persons in England older than 65 years with two or more diseases were 37% for men and 40% for women; these proportions were larger in the subgroup of persons older than 85 years with 46% of men and 45% of women in that age group having two or more diseases. The average number of diseases per person did not increase significantly with age: 1.8 diseases per person in the group of 65–69 years and 2 diseases per person in the group of older than 85 years.

A telephone-based (GEDA) survey in 2009 in Germany showed similar findings: while only 54.3% of people aged 50–64 years have two or more diseases, nearly 80% of the 75 age group have two or more diseases (30.3% have 5 and more diseases; Figure 12.1; Fuchs et al. 2012).

The "Randomized Controlled Trial of Telemonitoring in Older Adults with Multiple Health Issues to Prevent Hospitalizations and Emergency Department Visits" (Takahashi et al. 2012) focused on these patient groups (older than 60 years with high risk of hospitalization). The vital signs of the weighing scales, blood pressure cuff, glucometer, pulse oximeter, and peak flow meter were overseen by a registered nurse who contacted the patients in case of alerts and assessed the symptoms with the family physicians of the patients. In case of an emergency, the patients were advised to call the emergency department by themselves because the telemonitoring system had no emergency components (e.g., emergency button). Even though the results for the telemonitoring group showed no benefit for the primary nor secondary end points, the trial revealed a research demand for telemonitoring-supported medical care systems within this target group: the direct inclusion of medical and nursing competence for symptom assessments is necessary, and for multimorbidity patients, disease-related experts are also needed for effective clinical intervention, at least with doc2doc communication.

From these results, it can be concluded that telemedicine systems aimed at the older population should be capable of monitoring several diseases rather than one specific disease, but with the inclusion of medical and nursing disease-related specialists. Standard
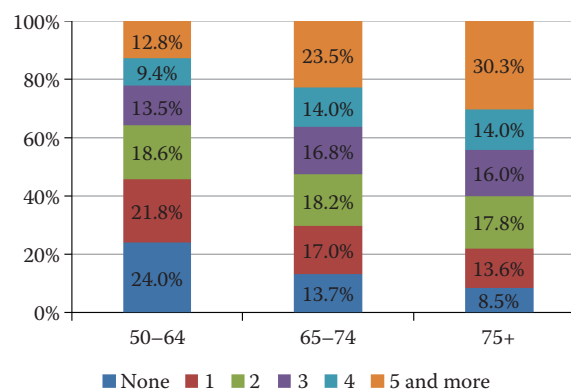


**FIGURE 12.1**

operating procedures in medical services are necessary to perform effective telemedical care as well as to assess the medical benefits.

Furthermore, telemedicine systems could be useful to support physicians in different disease interventions particularly in the case of multimorbidity whereby medical interventions for one disease have to consider the impact for other diseases and the interactions of different medications.

### Sensory Capabilities and Impairments: Vision and Audition

All domains of a patient's personal life are affected by the deleterious effect of comorbidity associated with aging and result in important barriers, e.g., functional and mental limitations, and social needs. Many older users have limited short memory, poor coordination ability, poor sensory capability, and slower ability to react (Dong et al. 2002). Moreover, they often also have visual and hearing impairments, reduced tactile senses, impaired balance, and higher susceptibility to falls (Gaßner and Conrad 2010). Additional physical and psychological health barriers are pain, fall-related injuries, loneliness, cognitive impairment, and adverse drug reactions.

Even considering the use of visual and hearing aids, 12% of older people (65–74 years) and 24% of people over 75 years in Germany have visual impairment, and 12.5% of older people (65–74 years) and 22.3% of people over 75 years have hearing-related impairments (Table 12.3; Robert Koch Institute 2008).

These characteristics of the population should be taken into account when developing telemedicine systems for older people.

### Need of Care and Age Target for Telemedicine Systems

As sensory and mental abilities decline and the possibility of developing one or more chronic diseases increases, the need for aid for activities of daily living (ADL) and care for older people increases.

The predominant model of support for older people is family or ambulatory nursing services (Robert Koch Institute 2008). While persons (aged 65–69 years) who need care in most cases get cared for at home by family members, with further aging, the majority of care is provided by nursing homes. Home care by ambulatory nursing services is relatively constant across all ages. With the growing trend to have fewer children and single generation/households, family support is entering a state of crisis. Additionally, the demographic change will lead to a lack of formal support in the future. The gap between the desire to

**TABLE 12.3**

Exemplary Limitations (Visual, Auditive, Cognitive)

| | |
|---|---|
| Visual limitation | Aging is associated with a decline in the ability to discriminate color as well as contrast sensitivity and limitations in motion perception and peripheral vision. |
| Auditive limitations | Aging can affect the hearing function as well as the ability to concentrate on audio and text at the same time. Most likely there could be impairments in absolute sensitivity, sound localization, and speech recognition. |
| Cognitive impairments | Aging can affect the information-processing capacity (speed, longer thinking time, loss of memory) and reduces the ability to perform information selection and extraction from a display as leading to a decline of spatial and working memory, which in turn leads to difficulty with learning. |

*Source:* Robert-Koch-Institute (RKI), 2008, Gesundheit und Krankheit im Alter. Berlin.

live at home and the lack of family and ambulatory support might be compensated for by home care solutions and assistive technology. AAL technologies and services may help older people live independently and autonomously in their domestic environment and postpone placing older people into the unfamiliar and anonymous environment of nursing homes.

In contrast to telemedicine-based care for secondary and tertiary prevention, primary prevention of illness when the person is healthy or telemonitoring for lifestyle, fitness, and wellness is not very well accepted. The fear of surveillance ("big brother") is higher than the potential of support. Also primary prevention is difficult to justify because the disease may never occur (Rogers 2003). For this reason, the monitoring of older patients with important comorbidity looks most promising.

### Attitude toward the ICTs

According to the German SENTHA Study (Mollenkopf 2006), ICT devices are perceived as a support for independence by 67% of older German people. Fears of ICT were expressed by 15% of the respondents; nearly 50% said they liked to use ICT while 45% prefer to use it as little as possible. These findings support the European study MOBILATE (enhancing mobility in later life; Mollenkopf et al. 2005), which showed that access to modern technologies in general depends on age, income, education, gender, experience, and attitudes. Negative acceptance factors can be described as fear of the new, lack of motivation for use, unwillingness to try out ICT and its specific functions, ease or complexity of use, and lack of advice, training, and encouragement.

*Actual Situation*

An important aspect for the acceptance of telemedicine systems in general is the acceptance/use of the Internet; however, currently the use of the Internet in the target group of AAL (65 years and older) in Germany is under 40%. The proportion of persons of age 70 years and older using the Internet was only 28.2% (INITIATIVED21 2012), and the average age of "offliners" (persons who do not use the Internet) was 62.5 years (INITIATIVED21 2011).

While the older people of tomorrow will have more experiences in technologies than today's older people, the actual technical developments have to take into account the user-specific requirements of the older people today to achieve accessibility, usability, and acceptance in usage; as shown in the section Sensory Capabilities and Impairments: Vision and Audition, this is especially important for older people with impairments, e. g., in sight, hearing, or ability to control ICT equipment.

The potential and interest for telemonitoring devices for persons aged 65 years or older are high. But individual adaption or tailoring of the systems is necessary (e.g., volume of signals) to prevent feelings of stigmatization. Older people also ask for TV programs on health-related issues and news (e.g., healthy nutrition, diseases, function of medical examination devices, etc.), because interest in health and disease is very high in this age group.

### Design Requirements for Telemedicine Systems for Older People

The "success of AAL solutions greatly depends on an effective design" (Leonardi et al. 2009). All home devices have to be selected and designed for use by patients above the age of 65 with little or no previous technical background and with poor health (sensory/perceptual and psychomotor abilities) and mental/cognitive conditions.

Along with impairments to older people, trust (access just for persons with appropriate reason) and security (prevention of unauthorized access) are other major concerns that affect ICT acceptance, especially in sensitive areas such as banking and health information/provision of medical care.

The needs and desires of older people are the focus of accessible design, which is well defined in the specialized literature and addresses requirements for system interface (including web-based text and graphics design), support and training of users, content, and security.

Table 12.4 shows examples for the correlation between healthy needs, desires, and design outcomes (Bernard et al. 2001; Dong et al. 2002; Edwards and Englehardt 1989; Hartley 1994; Hawthorn 2010).

These physical and cognitive impairments are often combined with inexperience in computer use as described previously. The aim of a web-based information system is to increase the functional accessibility in order to maximize the number of potential users who can easily use the system (Demiris et al. 2001).

Because of the desire for mobility, the mobile phone is a central element in telemedicine systems. A study on older people and their requirements regarding mobile phones showed very different results depending on physical abilities (Glende et al. 2008). Active older people asked for the Global Positioning System (GPS) for hiking tours and an integrated flashlight. Older people with vision impairments asked for an integrated electronic magnifier and a reading function or the possibility to expand the mobile phone should such functions become necessary. Also an easy-to-use reminder for medication or an emergency button to call for help or put off an attacker was requested. Besides these requirements, the desire for getting a nonstigmatizing handset for seniors was emphasized. The mobile phone should be easy to use and fault-tolerant.

**TABLE 12.4**

Requirements Relating to Impairments

| Physical Limitations (Visual, Auditory, Tactile) | Cognitive Limitations |
|---|---|
| • High-contrast colors<br>• Font size of at least 14 points<br>• Antiglare displays<br>• Avoidance of sound effects and background noise<br>• Provide text equivalent to auditory and visual content lower frequencies<br>• Large buttons and enough space between them<br>• Buttons labeled according to functionality | • Clear, comprehensible, readable language<br>• Simple menu/low hierarchy<br>• Show only necessary information, highlighting important information<br>• Show error messages with explanation of its cause and offering possible solution<br>• Context sensitive<br>• User manual with images and examples<br>• Intuitive use |
| **Safety Needs** | **Desires for Functionality** |
| • High reliability (functional safety)<br>• Robust system<br>• Fast and secure error diagnosis and removal<br>• Guarantee of data protection and transparency of the data use<br>• Emergency call button | • Comfortable to wear<br>• Individualized and targeted for specific groups<br>• Record of medication compliance<br>• Require little space/small devices and less sockets |

*Source:* Bernard M et al., 2001, The Effects of Font Type and Size on the Legibility and Reading Time of Online Text by Older Adults. Available at http://psychology.wichita.edu/hci/projects/elderly.pdf (accessed October 17, 2012); Dong H et al., 2002, Accommodating older users' functional capabilities. *Proceedings*, Vol. 2. London; Edwards R and Englehardt KG, 1989, *International Journal of Technology and Aging* 2: 56–76; Hartley J, 1994, *British Journal of Educational Technology* 25 (3): 172–188; Hawthorn D, 2010, *Interacting Computers* 12 (5): 507–528.

Please provide complete proceeding title.

Research showed that the user model of older people, e.g., in browsing the web, differs from that of other regular users. The user model is based on prior experience and expectations, limitations, and capabilities. But consideration of usability only for older people—barrier free, accessible design, assistive technology—often yields stigmatizing and separate (noninclusive) solutions. For this reason, the concept of "design for all" has been developed, which is related to the political concept of an information society. This concept consists of three strategic requirements (Malanowski et al. 2008):

- Usable services and products regardless of physical and mental abilities, age, and context of use
- Easy adaption to a different user
- Standardized interfaces that also cater for special users

It is a balancing act to consider the specific requirements of older people and not develop a stigmatizing product. Usability tests during the development stage with the target groups will help to understand their requirements.

### Other System Requirements from Older People for Telemedicine Systems

Users' awareness and purpose of technology affect user acceptance (Mackie and Wylie 1988), and the perception of an ICT system as a useful tool depends on the ability to perform tasks without errors in a reasonable time ("fault-tolerant").

Despite the mobile applications of technology, the main area of use remains the patient's home. A home is much more than a building to live in with furniture; a home has personal meanings such as familiarity and long-established neighbors (Kellaher 2001; McCreadie and Tinker 2005). The interdependence of pleasures, esthetics, and emotions with utilitarian and functional dimensions leads to a desire to live at home for as long as possible. Home becomes the "emotional centre of older peoples' life" (Leonardi et al. 2009), which also means stability and safety. The issue of safety is complex because some places feel more comfortable, safer, and emotionally important than others. While bedrooms and leisure rooms are places associated with safety, intimacy, and closeness, the bathroom is related to accidents (more than the kitchen). For this reason, the acceptance of safety-related technologies depends on the patient's own characterization of the home as well as the role of the telemedicine technology. The acceptance may increase in non-emotional places such as kitchen or bathroom and when the technology is not defined as embarrassing, disrupting, complex, or intrusive (Leonardi et al. 2009).

While technology use in general declines with age, it is necessary to design more established and easier-to-use technology and to create a positive attitude toward technology as useful and useable. If older people have a positive attitude toward technology in general, they will be more likely to use a specific device. Therefore, communication on the usefulness and the advantages of telemedical technologies is very important. A study on digital pens for pain assessment showed that when the technology is accepted, patients can take a greater role in managing their own health care, develop better contact with their caregivers, and feel an increased sense of security (Lind et al. 2008).

In the case of telemedicine system acceptance, this can be stimulated by user-friendliness of the sensors, user-friendliness of the mobile device (phone), user-friendliness of the user interface, and alleviation of the personal fears of data abuse as shown before.

### Self-Empowerment

Besides the successful use of telemedicine devices, a further aim of telemedicine is to empower patients by helping them understand their disease and participate in decision-making processes, as well as encouraging them to influence their health status ("self-empowerment"; Bruegel 1998). Education has a major role to play in the process of providing help for self-care (prevention and treatment). The importance of health literacy for patients with heart failure was proven in a retrospective cohort study of 1494 patients (Peterson et al. 2011). Low health literacy was associated with a significant increase in risk of overall mortality (low vs. adequate health literacy: 17.6% vs. 6.3%; HR, 1.97 [95% CI, 1.3–2.97]). An influence on hospitalization could not be shown.

Telemedical technology could involve the patients in their own medical care and improve their health literacy as the first step for improving their self-empowerment.

## Health Professionals Scenario

### Trigger Factors Causing Care Demand for Older People

A study by Brownsell et al. (2007) presents a literature review aimed at identifying trigger factors associated with an increase in older patients' need for support and care. Identified trigger factors were then classified into a priority ranking by a group of experts, mainly composed of workers of the social services, housing, health, and voluntary services. Older persons also participated in the ranking by responding to postal questionnaires; 107 trigger factors were initially identified, and 36 of them were selected for a second evaluation and ranking by the group of experts with the participation of older persons through the postal questionnaires. At the end, 12 factors were selected and ranked as follows:

- A major health event—such as support following a stroke or hip replacement
- Cognition impairment (e.g., dementia)
- Deteriorating physical functioning
- Inability to care for self at home
- Mobility problems
- Needing assistance with personal care, hygiene, bathing, washing, dressing
- Occurrence of falls
- Presence of chronic diseases
- Difficulty in toileting/continence management
- Consequences of admission to hospital
- Depression, mental breakdown, or deterioration
- Inability to cope with independent ADL

Notice that these factors are heterogeneous in nature and involve medical, cognitive-emotional, functional, and social situations.

### Medical and Nonmedical Health Professionals for Older People Care

Following from the section Trigger Factors Causing Care Demand for Older People, it can be concluded that health care services for older people require the involvement of not only
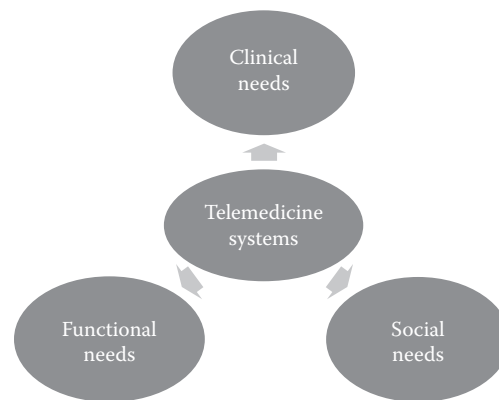
**FIGURE 12.2**

physicians and nurses but also other groups of clinicians such as physiotherapists, occupational therapists, and social workers. Usually, these geriatric service groups work in an interdisciplinary manner and have regular meetings to discuss various aspects related to the patient's health: clinical problems, functional and cognitive status, destination upon discharge, etc. Telemedicine systems could provide an important platform to allow home use not only for strictly clinical objectives (such as monitoring vital signs) but also to meet the needs of other health care groups involved (Figure 12.2).

### *Older People Information That Should Be Monitored*

Independent of patients' diagnosis, health professionals dedicated to older people care need to know information that includes not only physiological parameters (heart rate, respiratory rate, temperature, etc.) but also knowledge about functional status, ability to perform basic activities of life, cognitive status, and other details. This information is collected from geriatrics through "comprehensive geriatric assessment" (CGA) and includes mainly the evaluation of clinical, functional, cognitive, and social aspects of the older person. The CGA has been demonstrated to improve the diagnosis and treatment of older people with comorbidity in different settings (e.g., urgency services and hospitalization units). More importantly, it is more useful when the patient's case is more complex from a medical point of view. Not using formal CGA may result in mistakes in diagnosis or prescription of inappropriate treatments to older patients (Ellis et al. 2011a,b; Stuck et al. 1993; van Craen et al. 2010).

Often, information for CGA is obtained by applying medical scales to patients (for example, the Barthel index for functional status evaluation), and these scales are specifically validated for older people. These may also be applied by a telemedicine system, and its use may improve patient monitoring. Thus, according to the monitored clinical parameter, a telemedicine system's "sensors" might include (Figure 12.3)

- A technological/electronic medical device: an ECG monitor, a blood-pressure meter, a weighing scale, etc.
- A medically validated questionnaire: pain-intensity scale, Barthel's scale of functional performance, Yesavage's scale of depression, etc.
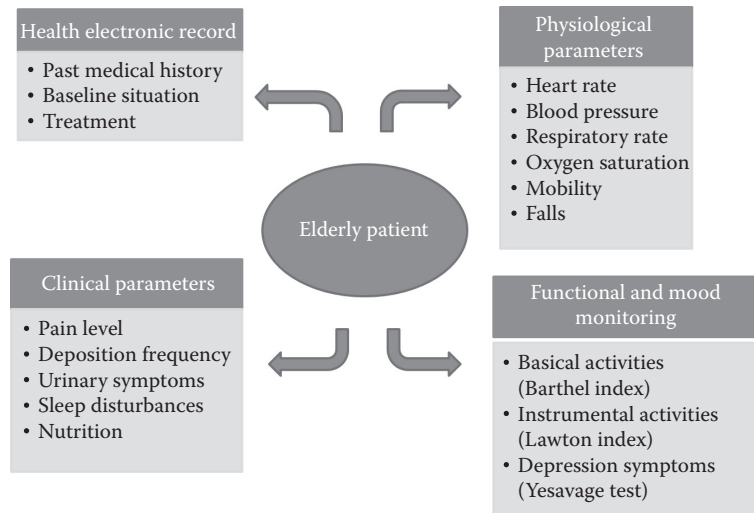
**FIGURE 12.3**

### *Potential Uses for Telemedicine Systems during Treatment and Follow-Up*

Target situations where telemedicine systems could be implemented correspond either to short time periods—during which the health provider considers them to be important to evaluate certain health parameters for suitable follow-up—or to longer periods for the same purposes, where home stay is promoted and visits to the emergency department, justified or not, are prevented.

One of the most clearly suitable situations for home monitoring with telemedicine systems corresponds to the so-called postdischarge period, namely, patient leaving the hospital after a short or a long intervention. Currently, the postdischarge situation is managed through postdischarge visits or telephone follow-up. Through telemedicine system, health professionals from primary care services could have access to certain health parameters of patients at home, and then visits to the hospital would be reduced, thus saving usually dramatic and complicated journeys.

### *Structure and Plasticity of Telemedicine Systems for Older People*

As described in the section Multimorbidity, a large proportion of older patients have two or more diseases, so that a telemedicine system specifically focused on one disease would probably not be suitable. Telemedicine systems for this population should be able to monitor at a minimum the most significant group of conditions, such as cardiovascular (including stroke and cardiovascular risk factors such as diabetes mellitus and hypertension), chronic respiratory, and osteoarticular diseases. For this reason, telemedicine systems should have extensive interfaces to include/exclude monitoring devices independent of the patient's condition.

A telemedicine system that monitors more than one disease is feasible, since the control or monitoring of several conditions usually requires information from some common clinical parameters. Thus, a patient with heart failure would probably need to have their weight, blood pressure, ECG, heart rate, oxygen saturation level, exercise tolerance level,
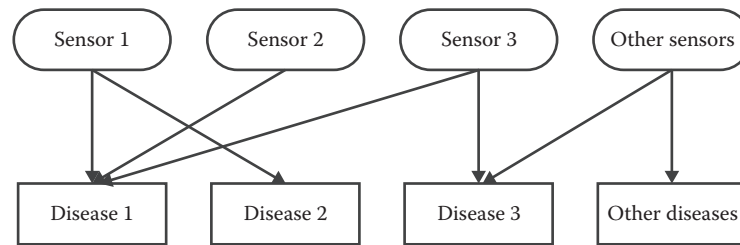
**FIGURE 12.4**

and other data monitored; while a patient with a chronic respiratory disease (e.g., chronic obstructive pulmonary disease) would need their oxygen saturation level, blood pressure, heart rate, and exercise tolerance level monitored, as well as their respiratory symptoms and statistics tracked. Notice that certain identical clinical parameters are monitored in the control of both conditions: blood pressure, heart rate, and oxygen saturation and exercise tolerance levels. Alternatively, the same technological resources could obtain information on more than one clinical parameter: the patient's functional capacity could be monitored, or a check of sleep patterns or urinary symptoms could be carried out by remote usage of clinical questionnaires or scales administered through a computer and the Internet.

Another important aspect of telemedicine systems is the plasticity or flexibility needed with regard to choosing and programming the different clinical parameters to be monitored. Physicians should be able to choose the most relevant clinical parameters according to the pathologies they wish to monitor in their patients (Figure 12.4), and they should be able to modify the alert levels of the sensors or algorithms implemented in the system.

### *Others System Requirements from Health Professionals for Telemedicine Systems*

As a part of a research project of the AAL program,* we organized two focus groups (medical and nonmedical health professionals) with the aim of analyzing the opinions of health care providers on the requirements that telemedicine systems should meet in order to be accepted and used in monitoring older patients with comorbidity. These focus groups provided the following relevant information on telemedicine systems:

- The telemedicine system has to work 24 h, 7 days a week: "there should always be someone (a person) at the other end of the system."
- The system must be able to send automatic alerts (without false positives).
- The system should be easily incorporated into the patient's daily life. It should not significantly change the patient's routines or home environment.
- The system should complement and not replace the health care that patients routinely receive.
- Access to the patient's medical record through the system is considered very useful.

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* Enhanced Complete Ambient Assisted Living Experiment (eCAALYX) EU Project Consortium (http://ecaalyx.org); Ambient Assisted Living Joint Programme.

- There was conflict on the question whether patients should or should not have access to their measured vital sign values. Some physicians thought this property may cause undesirable alarms to the patients. The system has to show vital sign data without causing unneeded and undesirable alarm to the patients.
- System configuration (choice of sensors, etc.) should be performed by medical physicians according to the clinical profile of their patients.
- For nonmedical health professionals, the issues that they considered important to monitor are medication compliance, monitoring nutrition, fall detection, and GPS tracking of patients with cognitive impairment.
- The system should allow nonmedical health professionals more freedom of action, when they detect certain risk situations, e.g., poor medication adherence, neglecting nutrition, etc. The possibility of using the telemedicine system as a means of direct communication between this group and the group of medical professionals is very important.

**Health System Scenario**

The most significant and vital aspects of health care systems that are required to successfully implement telemedicine systems aimed at the comorbid older population are analyzed next.

Before describing the determining factors, it is important to define telecare and telehealth services and their scope. Therefore, in this chapter, we use the following definitions (Kamel Boulos 2009):

- Telecare involves monitoring patients' daily activity and the safety of their home environment with mechanisms such as panic buttons, fall sensors, furniture occupancy sensors, movement detectors, fire/smoke and flood detectors, dangerous gas sensors, room temperature sensors, property exit detectors, intruder alarms, etc., which are connected to a 24/7 emergency call and response service. Additionally, these services may be classified as follows:
  - First-generation telecare refers to user-activated—e.g., push button, pendant, wristbands—telealarm calls to a control center, where a call handler can organize a response, usually via a neighbor, a relative, or a care service provider.
  - Second-generation telecare evolved on the basis of telealarms, though incorporating other components, such as smoke alarms, fall sensors, and others.
  - Third-generation telecare is focused on identifying risk situations in order to anticipate adverse situations, usually by evaluating behavior patterns (e.g., low water intake, reduced mobility detected by door sensors, etc.).
- Telehealth is the remote monitoring of vital signs and other clinical indicators, such as body temperature, heart rate/ECG, respiratory rate, blood pressure, pulse oximetry, blood glucose, body weight, etc., by remote clinicians who can then send instructions to the patient on medication, diet, or lifestyle, or call them in for consultation.

Also the remote patient monitoring systems can be defined in several generations by the type of data transfer, the sensor platform, and the integration level in primary care (Anker et al. 2011):

- In the first generation, only a few measurements (e.g., ECG event recorders) were asynchronously transmitted to the primary care physicians or nurses who can only react within consultation hours.
- The second-generation systems are using synchronous data transfer to a tele-medicine center with medical staff assessing the measurements. But also this care model is depending on office hours of the telemedicine center.
- The third generation uses remote patient management systems with constant medical assessment by specialized nurses (e.g., heart failure nurses) and physicians 24/7.
- The fourth-generation systems are an extension of the third-generation systems and are providing fully integrated remote management systems using data from invasive (e.g., defibrillator or point-of-care for biomarkers) and noninvasive tele-medical devices.

Important in this regard is the research report on the state of the art of ICTs, entitled *ICT & Ageing. European Study on Users, Markets and Technologies. Final Report* (Kubitschke et al. 2010). This review analyzes the current situation of telecare and telehealth resource implementation and the main factors (drivers and barriers) involved in this. With regard to the more advanced telecare and telehealth services, this review describes the issues that are shown in Table 12.5.

Another important review on this topic was carried out for the European Commission: European Countries on Their Journey towards National eHealth Infrastructures—Evidence on Progress and Recommendations for Cooperative Actions—Final European Progress Report (Stroetmann et al. 2011). In this report, telehealth services are emphasized as one of the key fields of eHealth (together with computerized records and electronic prescriptions) in Europe.

In the following, some of these factors are analyzed individually, and the analysis is adapted to the scenario of older people with comorbidity.

### *Perception of Usefulness*

Developing the necessary technological infrastructure for implementation of advanced telecare (second and third generations) and telehealth is not enough to ensure successful take-up of these services. Major barriers for the implementation of these services by the practitioners are the poor perception of their usefulness and the suspicion of trends toward high-tech medicine with less human support and substitution of the current out-patient care; physicians are also afraid that telemedicine-based care is negatively influencing their daily work and patient contact by substitution of their medical care and treatment authority (this is opposite to what occurred with first-generation telecare services; Percival and Hanson 2006).

Technologies of second- and third-generation telecare and telehealth are perceived as expensive and with a poor cost/benefit ratio by potential payers. This perception is most probably influenced by the general view that technological innovations are expensive while in-depth health economic analysis is lacking and depends on country-specific conditions of the health system. Information exchange between countries in the European area and large-scale studies were proposed as tools to overcome cost–benefit and usefulness-related barriers.

**TABLE 12.5**

Drivers and Barriers for More Advanced Telecare and Telehealth Services

| | **Drivers** | **Barriers** |
|---|---|---|
| More advanced telecare services | There is a lack of a common pattern discernable across countries as regard market drivers.<br>Many countries have the infrastructural potential in place.<br>Combination of product innovation and social care service receptivity is the key to market takeoff.<br>Public provision and/or reimbursement seem to be a key facilitator of market development. | Significant variability across countries on infrastructural readiness.<br>Fragmentation of the provision/reimbursement situation and uncertainty about who should be responsible and who should pay for installation.<br>The lack of a demonstrated "business" and/or "quality" case.<br>Nature of the response delivery system seems to be a critical issue from the market point of view (reliance on family caregivers or formal care staff to provide the response).<br>Concern on distribution of payments and benefits between community care and institutional care providers. If the main benefit of telecare services were to be in delaying a move to institutional care, then the main costs might accrue to community social care services, and the main savings would be in terms of reduced institutional care costs.<br>The challenge of transitioning from pilots to mainstream.<br>Organizational changes that are needed to get a successful implementation of telecare services (and social/professional resistance in some cases).<br>Concerns about privacy, data access, sharing, and ethical/regulatory issues. |
| More advanced telehealth services | The extent of mainstreaming is very limited to date.<br>In the forerunner countries, somewhat different specific drivers have been apparent:<br>– United States: transparent and accepted cost–benefit rationale (savings in health care costs).<br>– Germany: home telehealth has emerged in the context of a new approach to provision of integrated care and emerging reimbursement of this by insurers (this makes the German "market" one of the most likely for more widespread mainstreaming in the near future). | Lack of a recognized "business case" in Europe (in contrast to the United States).<br>Lack of a generally accepted "clinical case" for home telehealth.<br>Perceived lack of awareness at the policy/funding level.<br>The generally poorly developed "continuity of care" structures and processes in many health care systems, as well as the typically episodic-based payment models in many systems.<br>The administrative fragmentation on delivery of health services (regional and even local level) makes it difficult to implement coordinated national policy in this field.<br>Medicolegal uncertainties in relation to home telehealth (in some countries).<br>The difficulties of scaling up/moving beyond the local level.<br>Current technology limitations can also be a barrier, and the lack of interoperability between the many different devices and systems emerging on the marketplace. |

*Source:* Kubitschke L et al., 2010, ICT & Ageing. European Study on Users, Markets and Technologies. Final Report. Available at http://ec.europa.eu/information_society/activities/einclusion/library/studies/docs/ict_ageing_final_report.pdf (accessed October 17, 2012).

The usefulness of these services, as managed by health providers (physicians, nurses, etc.), is also not clear, despite the abundant related literature, including specific journals (e.g., *Journal of Telemedicine and Telecare*, *Telemedicine Journal and e-Health*, etc.) indexed in main databases (MEDLINE, etc.). This finding leads to the conclusion that these communication media are not sufficient or adequate, since most people in the medical community probably ignore the current state of technological developments or even their existence. Habitual resistance to adopt technological innovations is a relevant factor that needs to be taken into account.

Options for self-managed health care, offered by some telehealth solutions, are not always perceived as adequate by health providers.

As an example of medical benefit through telemedical treatment, heart failure is one of the conditions most frequently studied. In total, 33 randomized controlled trials (RCTs) with telemedical interventions for heart failure were published since 1999. Two meta-analyses of remote patient monitoring (telemonitoring or telephone support; Inglis et al. 2010; Klersy et al. 2009) showed significant reduction in mortality and/or hospitalizations. At present, a definition of the relevant parameter of the used devices is not presented.

The Telemonitoring to Improve Heart Failure Outcomes (Tele-HF) Study (Chaudhry et al. 2010) examined the influence of telemonitoring systems in 1653 patients with heart failure. The intervention was described as daily telephone calls from the patient to an automated interactive voice response system to answer standardized questions about the health status, symptoms of the disease, and weight. Every 30 days, a screening on depression was performed. The study centers evaluated the answers every weekday for patient-related changes and missing data transfer. The trial results showed no significant difference for the overall mortality between the control and intervention groups.

> Change "standardized" to "standard"

The Telemedicine to Improve Mortality in Heart Failure (TIM-HF) trial (Koehler et al. 2010, 2011) involved 710 patients with chronic HEART FAILURE and New York Heart Association class II-III. The follow-up of this RCT was at least 12 months (median 26 months). The intervention consisted of daily monitoring of ECG, weight, blood pressure, self-assessments, and a weekly 6 min walk test. After 12 and 24 months, the Patient Health Questionnaire (PHQ-9) and the questionnaire for physical life quality (SF36) were used. The results showed no reduction in all-cause mortality but an increase in life quality. Furthermore, a patient subgroup (LVEF ≤ 25%, depression score about ≤10) showed significant reductions in loss due to death or heart failure hospitalization.

Although no significant benefit for all heart failure patients has been shown in these trials, a specific group of patients has been identified who have benefited from telemedical intervention. These results need further investigation. While the compliance in TIM-HF was, at 81%, very high (Koehler et al. 2010), one reason for the results of TELE-HF could be the decreasing compliance rate to 55.1% at the end of the 6 month follow-up (Everett et al. 2011).

The *Whole System Demonstrator (WSD)* program (funded by the Department of Health; http://www.dh.gov.uk/health/2011/12/wsd-headline-findings/) was launched by the United Kingdom's Department of Health in May 2008 with 3230 people with diabetes, chronic obstructive pulmonary disease, or heart failure, recruited from 179 general practices in three areas in the United Kingdom. The trial has already finished, and the first results show reductions in mortality, the need for admissions to a hospital, the number of bed days spent in the hospital, and the time spent in A&E (Health 2011; Steventon et al. 2012).

At the European level, the RENEWING HEALTH (Regions of Europe Working Together for Health; http://www.renewinghealth.eu/) project, which is partially supported by the European Commission (Competitiveness and Innovation Framework Programme),

is almost finished and has implemented large-scale real-life test beds for the validation and subsequent evaluation of innovative telemedical services using a patient-centered approach and a common rigorous assessment methodology. In nine of the most advanced regions in the implementation of health-related ICT services, service solutions are already operational at the local level for the telemonitoring and the treatment of chronic patients suffering from diabetes, COPD, or CVD diseases.

### Technological Infrastructure

Most countries have the necessary technological infrastructure for the application of first-generation telecare services (social alarms) to a considerable level of implementation. This has often been considered as a platform for the implementation of more developed services. However, implementation of the additional infrastructure necessary for these more advanced services varies highly across European countries and even across different regions of certain countries. Overcoming such difficulties requires considerable effort by both public and private actors, an effort that is subordinated to the perceived value of the new services. Public–private joint initiative has been proposed, where the public sector would offer the service to potential clients and the private sector would provide the technological resources. Promoting investment in basic infrastructures (where these are not developed at a country-wide level) by the EU Structural Funds has also been proposed.

### The Current Marketplace

First-generation telecare services can be considered as implemented in most countries of the European Union, since they are regularly provided (with some exceptions) in all of these countries. Regarding second- and third-generation services, none of these countries provides them on a regular basis, with the United Kingdom being the closest to this goal. In terms of telehealth implementation, northern countries are the most advanced (Stroetmann et al. 2011). For instance, Scotland has already started to offer eHealth services to its population. The Scottish Government of Health Department started a strategy in 2009 (http://www.sctt.scot.nhs.uk/strategy.html) to introduce these kinds of technologies gradually, and now they are offering services such as video-conference and remote patient monitoring (http://www.sctt.scot.nhs.uk/stories.html). After WSD's trial results, there is a plan to extend these services to 3 million people in the 2012–2017 period ("Three Million Lives" campaign; http://www.dh.gov.uk/health/2011/12/wsd-headline-findings/). At the same time, in the region of Lombardy, Italy, after the success of the pilot Telemaco (http://www.ajmc.com/articles/Healthcare-Continuity-From-Hospital-to-Territory-in-Lombardy-TELEMACO-Project), a Chronic Disease Management platform is under deployment. Spain has a lot of pilots going on around the country, but real implementation has not been documented (http://ec.europa.eu/information_society/apps/projects/factsheet/index.cfm?project_ref=225025; Nexes Project, Remote Monitoring Market; http://www.caalyx-mv.eu/project).

In Germany, some health insurance companies signed integrated health care contracts with hospitals and medical caretakers for providing telemedical services for heart failure patients (e.g., AOK Nordost 2011 for the South-Brandenburg; IKK Südwest 2012).

The poor implementation of these services does not imply poor market potential. The profile of users who may benefit most from these services is described in the above sections. Telehealth systems have been mainly developed for monitoring patients with chronic diseases, especially heart diseases, respiratory diseases, and diabetes mellitus. Estimates

Please specify the section titles here.

suggest a potential use of these services by 25%–60% of these patients (Empirica and Work Research Center [WRC] 2005). On this basis, a potential of 3.3 million to 10.9 million users can be estimated in the European Union (Kubitschke et al. 2008).

### Ethical and Regulatory Issues

Ethical and regulatory issues must also be considered in order to prevent barriers to implementation of these technologies.

No major problems are expected in relation to second- and third-generation telecare. However, some concern has been expressed in certain countries in relation to privacy protection and the role of sensor monitoring. Greater difficulties are expected in this regard as third-generation products and continuous monitoring systems become more affordable and also with the increasing importance of cloud computing. A forum for information exchange among European member countries has been proposed. Taking telephone and e-mail medical consultations as an example, noticeable differences across countries can be expected in terms of regulation and practice.

The legal validity of "remote" (not "face-to-face") consultation between a patient and a physician is a further topic to be taken into account (especially in some countries such as Austria and Poland; Stroetmann et al. 2011). In Germany, some trends indicate a willingness among the medical fraternity as well as the legislative organs to face these challenges; for example, in Germany on the 113th German Medical Assembly, a catalog about inner medical and legal requirements (liability, data protection, professional law) for the telemedical patient care was decided (Deutscher Ärztetag 2010). In the 114th German Medical Assembly, the amendment of the professional law was carried out. Although this amendment enables physicians for remote care via print and communication media, a direct care (via face-to-face) communication of the patients has to be ensured ("ban on remote treatment"; Deutscher Ärztetag 2011). Remote patient management must only be considered as an addition to usual medical services but not as a substitution.

### Incentives for Technology Development

Availability of financial incentives (for hospitals, physicians, social services, primary care teams, etc.) as well as the quality of such incentives is important. Evidence indicates that incentives are not adequate enough for health care providers working in the health and social services of several EU member countries. Furthermore, currently available incentives might discourage rather than encourage implementation of advanced telecare and telehealth.

Although current development of systems' technology and components is rather advanced, some aspects still need to be reinforced:

- Mobile devices and monitoring services.
- End-user devices for telecare and telehealth.
- Monitoring and processing systems for telecare and telehealth centers.
- Clinical support systems to give relevant information and guidance to health and social care providers. Data are unlikely to be useful without a filtered presentation that allows providers to extract value from huge amounts of monitoring data.
- Improved interoperability between the various system components and the different products and services on the European marketplace.

### *Organization*

Implementing services such as telemedicine services has important organizational implications. Providing innovative systems for simultaneous health and social care requires high-level coordination between health services and social services, which might be difficult to achieve in some European countries. These services are usually managed by different, not always collaborating organizations. Implementing collaborative work may need restructuring of the involved organizations, as well as training staff in the use of the new systems—technical and also on the different kind of care (e.g., communication training), all of which may be received reluctantly. Fortunately, initiatives for integration of health services and social services are being undertaken in some European countries (e.g., in England, through the Care Trusts).

Heterogeneity of the social and health care providers (public, private, mixed) is a further factor to be taken into account. Implementation also requires agreement between involved organizations in terms of funding.

Responding to a system alarm requires coordinated action, since different causes may need different agents to respond: caretakers, relatives, health care providers (ambulance, emergency practitioners, etc.), social services, or external service providers.

## Potentials Scenario for Telemedicine Systems

The potential scenarios or situations where telemedicine systems can be used with the comorbid older population arise from interaction with the key players involved, the health care actions required, and the locations where these could be carried out. The following section describes examples of possible use of these systems. [Please specify the section titles here.]

[Edits OK?] Below are examples implying the use of a telemedicine system followed by its components and/or features:

- The patient's physician (usually the family GP or medical specialist), who has access to the system.
- A qualified teleoperator (nurse or physician) in a telemedical center, who is available 24 h, 7 days a week for patients being monitored. The teleoperator has access to the data gathered from the patients by the sensors and receives any alarm signals sent by the system. The teleoperator can send notes to the patient's physician and notify the patient as well as emergency services with regard to patient transfer, etc.
- The patient has a telemedicine system at home that includes
  - Vital signs sensors for blood pressure, heart rate, breathing rate, temperature, blood glucose, etc.
  - A mobile phone for mobile relaying (uploading) of measured vital signs and GPS localization.
  - A computer or other similar device, which allows video-conferencing and where the patient receives instructions sent by the teleoperator or GP. This would include changes to treatments, completion of medical scales or questionnaires, appointments for medical checkups, etc.

**Telemedical Care by Telemedical Centers in Hospitals**

1. If a GP or a specialist decides that a patient needs a telemedicine system, he or she speaks with his or her patient about this option. When the patient agrees, the GP contacts the telemedical center that is responsible for telemedical treatment in this region/for this disease.

2. The patient gets the necessary devices/sensors for his/her home by post for installing alone or with the help of a technician. The patient also gets a manual for using the sensors and devices (plug-and-play). If the patient needs (re-)training in using the device, a nurse visits him/her. This nurse can also take other information about the patient (relatives, environment, need for help, etc.), as well as help in building the patient's confidence and trust with regard to the new technique and to telemedicine in general.

3. Besides the sensors, the patient gets the contact number of the telemedical center where the patient can call 24 h per day for emergency, questions, or any other problems. If the patient needs help, he/she shall at first contact the caretaker in the telemedical center.

4. Every day in the morning, the patient measures his/her vital parameters (determined by the family physician and/or caretakers), and the measured values are then sent to the electronic patient record. In the telemedical center, the measured values will be assessed by a caretaker. If the sensors detect a change, the caretaker calls the patient and speaks about the cause of this change. The caretaker (a physician or a suitable person with direct access to a physician) can decide to change the treatment or the medication, or give an appointment for visiting the family physician/specialist.

5. In case of an emergency, the caretaker calls the emergency service. If there is deterioration in the course of the patient's disease, the family physician will be advised about the situation and sent all information. The family physician can inquire at any time for information at the telemedical center and can get it by phone, fax, e-mail, or post. When the patient visits his/her family physician, he/she can get a list of the measured values by the telemedical center. With telemedicine systems, it should be possible to log in on a webpage to see the electronic patient record when the patient has agreed for this access.

6. When necessary, the caretaker may suggest that the patient makes a video-conference call to speak about his/her actual state/problems (perhaps once a month). If the patient asks for a video-conference, the caretaker arranges an appointment depending on the urgency of the situation, within the same or the next day.

**Chronic Monitoring of Patients with Heart Failure and Respiratory Disease**

*Scenario*: A patient with a history of previous hospitalizations for heart failure and/or chronic respiratory disease exacerbation, who is at a high risk of decompensation and has been recently discharged.

1. The family physician decided that the patient needs a telemedicine system. He/she contacts the telemedical center and speaks with the caretakers about the needed sensors and the following treatment. The medical personnel in the telemedical

center monitor the course of the disease of the patient and advise the family physician in case of deterioration. The physician gets all information about any emergency. When the patient visits his/her family physician, he/she can get a list of the measured values from the telemedical center.

2. The system allows the patient's family physician to select the sensors that will be used to monitor the patient, to exclude sensors considered unnecessary, or to reintroduce initially excluded sensors. Furthermore, the physician may modify the alert threshold or the monitoring frequency of each sensor (the system notifies the patient of such changes, so that the physician does not need to contact the patient).

3. The physician may request evaluation of the functional performance by completion of the Barthel's scale every 4 weeks. The system will notify the patient of such a request.

4. The physician may request a video-conference at any time. The system will notify the patient of such a request. Alternatively, the physician may fix a date and time for a visit. The system will notify the patient of the appointment details.

5. Treatment changes scheduled by the physician—on the basis of the evolution of the system-measured patient's vital sign values—are introduced into the system, which will in turn notify the patient of such changes.

## Patient with Decompensated Cardiac/Respiratory Disease, Who Visits the Emergency Department

*Scenario*: The emergency physicians consider that further hospitalization is unnecessary if the patient is monitored at home. They prescribe outpatient treatment and discharge the patient during the night. Thus, the family physician/telemedicine physician is in charge of controlling and monitoring the patient.

1. The emergency physicians notify the caretaker of the patient's discharge from the emergency department. The caretaker notifies the family physician if the physician has not been already notified (e.g., patient discharged during the night).

2. The family physician contacts the patient through video-conference and requests a scanned copy of the emergency report and prescribed treatment.

3. The family physician reviews the report and accordingly selects the most suitable monitoring sensors, alarm thresholds, and monitoring frequencies.

4. The patient progresses favorably, and thus the physician changes the sensors' monitoring frequency and modifies the treatment through the system. The system communicates such changes to the patient and the caretaker provides assistance if necessary.

5. The physician arranges a visit for examining the patient, if necessary. The system notifies the patient of the date and time.

## Patients with Osteoarticular Disease and Poor Control of Pain

*Scenario*: Patient with gonarthrosis and moderate associated pain that impairs the gait. The patient decides to consult the caretaker.

1. The caretaker notifies the family physician of the patient's poor control of pain. The family physician contacts the patient through video-conference and evaluates the intensity of pain through the Face Pain Scale and the impact on functional performance through the Barthel's scale.

2. The physician adjusts the analgesic treatment and advises the patient that the system will periodically (e.g., every 48 h) request completion of both scales or of other scales without the need to contact the patient again. The patient completes the requested scales without the need to contact the physician (although a caretaker may provide help if necessary).

3. The physician may access the pain measurement results and adjust the corresponding analgesic treatment without contacting the patient. Treatment changes are recorded and communicated to the patient by the system. To solve possible queries about the submitted treatment schedule, the patient may contact a caretaker (who would in turn contact the physician if necessary).

4. The physician may change the frequency of pain evaluations according to the progression of pain. The system will notify the patient of such changes.

5. The physician may request an evaluation of the patient's functional performance (by using the Barthel's scale, gait speed, etc.) together with the pain evaluation; otherwise, the physician may request both evaluations some time after a certain change in the analgesic treatment has been introduced.

6. Patient's queries or comments intended for the physician will be first screened by the caretaker.

7. The physician may resume direct communication with the patient at any time through video-conference (the system will notify the patient of the physician's request to communicate with him/her). Alternatively, the physician may schedule a video-conference at a certain time or make an appointment for the patient to visit (the system will notify the patient of the appointment details).

**Patients with Diabetes Mellitus**

*Scenario*: Patient with diabetes mellitus and poor control of glycemia despite prescribed treatment.

1. After an initial physician–patient interview, the physician sets a glycemia-control schedule with measurements on Tuesdays and Saturdays, before and after breakfast, lunch, and dinner. The system notifies the patient of this schedule and delivers reminders of the controls. The glucometer automatically enters the measured results into the system, where the physician may access them at any time.

2. The physician reviews the measured glycemia values in the following days and modifies the antidiabetic treatment accordingly. Such changes are recorded and notified to the patient by the system. To solve possible queries about the submitted treatment schedule, the patient may contact a caretaker, who would in turn contact the physician if necessary.

3. According to the progression of glycemia, the physician modifies the days and/or daily frequency of controls (e.g., only before breakfast, 2 days per week; days may be arbitrarily chosen by the physician or the patient).

4. The physician considers that the patient should follow a certain diet and exercise schedule and sends the patient illustrative videos. The system notifies the patient of the indication to watch the videos and to follow the prescribed schedule. The system allows the physician to know whether or not the patient has watched the videos.

### Patients Assisted by Persons Designated by the Social Services

*Scenario*: Patient in social frailty (living alone, without reference relatives) with mobility difficulties due to severe osteoarticular disease, regularly visited by a worker of the Social Services, who helps in doing the shopping and the household chores.

1. During the visits, the Social Services worker identifies situations that should potentially be communicated to the patient's family physician (e.g., development of skin lesions, onset of cognitive deterioration, behavioral alterations, physical worsening, etc.). Thus, the social worker joins the system or notifies the caretaker of such situations. The caretaker evaluates them and communicates the relevant ones to the physician.

## Conclusions

### Aging, Comorbidity, and Target Diseases

- Comorbidity and the effects thereof are more significant than aging *per se* in terms of adverse impact on health associated with the progressive aging of the population.
- Cardiovascular, chronic respiratory, and osteoarticular diseases have the greatest impact on the older people in terms of mortality, morbidity, dependency, and hospitalization.

### Patients Scenario

- Currently, most telemedicine projects are exclusively aimed at monitoring a single disease such as heart failure or chronic obstructive respiratory disease. However, one of the characteristics of the older population is that they often suffer from more than one chronic, major illness (pluripathology). This means that telemedicine systems must be able to monitor several major diseases simultaneously.
- Telemedicine systems must be principally aimed at the secondary and tertiary prevention of the disease.
- The design of the involved devices should take into account relevant characteristics of the older population such as hypoacusism, vision impairment, and others. However, devices should not stigmatize patients, as this could significantly influence their acceptability. The "design for all" strategy should be kept in mind.

- The older population's demand for assistance or health care services may increase through reasons that are not strictly clinical but rather of a social nature. In this regard, telemedicine systems can be a useful tool for integration and cooperation between health care and social services.

## Health Professionals Scenario

- The important clinical information required to monitor the older population includes not only vital physiological signs (blood pressure, heart rate, etc.) but also information about their functional situation, affective state, and pain levels, among other data. This information can be gathered through questionnaires or scales normally used in clinical practice but applied in a telematic manner.
- Telemedicine systems must have great plasticity due to the wide variability in patients' clinical profiles and diseases. A patient's physician should be able to configure the system according to the patient's needs of devices and alert levels ("individualized medicine").
- Assessment and submission of "raw" measurements obtained through the devices can result in information overload or raise false alarms among health providers. These systems should carry out a preliminary processing of the information gathered by sensors (e.g., through the use of medical algorithms), so that they only warn of relevant clinical situations. The caretakers should be able to add individual algorithms for the patient.
- The telemedicine system should be available continuously for patients on a 24/7 basis.
- These systems should be viewed not as replacing clinicians but as a tool to aid them in their work ("additional care").

## Health System Scenario

- There is a considerable potential market for telemedicine systems involving telecare and telehealth services.
- The perception of usefulness by clinicians and institutions is an important topic to be developed. Clinical trials have to be performed for evidence-based medicine.
- Implementing telemedicine systems could require significant organizational changes with regard to health systems: social and health care services integration, changes in clinicians' working methods, etc.

## Other Requirements (Technical)

- For compatibility, the system should have extended interfaces.
- Especially for rural areas but also for mobility reasons, telemedicine systems should focus on mobile data transmission.
- To perform the balancing act of technical developments (design for all vs. including specific requirements of older people), usability tests with focus groups are recommended.

## Acknowledgments

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