D1.2 Ethics Framework

Project Acronym:	**MARIO**
Project Title:	**Managing active and healthy aging with use of caring service robots**
Project Number:	**643808**
Call:	**H2020-PHC-2014-single-stage**
Topic:	**PHC-19-2014**
Type of Action:	**RIA**

D1.2

Work Package:	*WP1*	
Due Date:		M6
Submission Date:		31/07/2015
Start Date of Project:		01/02/2015
Duration of Project:		36 Months
Organisation Responsible of Deliverable:		National University of Ireland, Galway (NUIG)
Version:		1.0
Status:		Draft
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Nature:	☒ R – Report ☐ P – Prototype ☐ D – Demonstrator ☐ O - Other	
Dissemination level:	☒ PU - Public ☐ CO - Confidential, only for members of the consortium (including the Commission) ☐ RE - Restricted to a group specified by the consortium (including the Commission Services)	
Project co-funded by the European Commission within the Horizon 2020 Programme (2014-2020)		

Revision History			
Version	**Date**	**Modified by**	**Comments**
1.0.	01.07.2015	Oya Deniz Beyan	Initial Table of Contents and First Draft
2.0.	20.07.2015	Timur Beyan	Second Draft
3.0	27.07.2015	Heike Felzmann	Third Draft
3.2	28.07.2015	Heike Felzmann	Minor Corrections
3.5	30.07.2015	Timur Beyan	Minor Corrections
4.0	31.07.2015	Timur Beyan	Final Document

Executive Summary

In this Deliverable D1.2, we aim to develop an ethical framework that addresses general ethical values of care and applies them to ethical concerns in relation to the intended functionalities and uses of MARIO in the assisted care of older people with potential cognitive impairments.

Robotics technology is transforming the health and social care environment, presenting a new set of technical, social, ethical, and legal challenges. Ideally, the requirements in the domains of law and ethics should overlap, but because both are in rapid development and there is a current lack of clarity on many aspects, there is not always a clear match between identified ethical challenges and the legal situation.

In this work, we evaluated the scientific literature on existing care robots and ambient assisted living projects, as well as the general roboethics debate in care robotics. Analysis of lessons learnt from previous projects, scientific findings and ethical debates resulted in a multi-layered framework that is sensitive to viewpoints of different stakeholders. In this framework, the different aspects of the human-robot interaction are analysed, with particular focus on the threats characteristic of the use of information and communication technologies in this sensitive field, such as data protection and privacy concerns. Consideration of these issues is integrated into the design process.

In the scientific literature, ethical debates about care robots adopt different viewpoints. In order to merge relevant scientific findings and arguments, we aim to develop a deductive (from context to components), comprehensive and structured approach. We evaluated the ethical effects of robots in care contexts in the following layers:

- Integrating care robots into the care process (roles and responsibilities).
- Quality of care in the changing care context (changing quality dimensions/target improvements).
- Robotic functionalities for care improvement (physical, psychological and social assistance and support).
- Robotic core capabilities and design features (design principles, aesthetic features, data and intelligence).

The final effect of all the components is double-edged, i.e. there could be both ethical infringements and improvements. After this general evaluation of the framework, we will focus on dementia cases. Depending on the specificity of the condition or disease, some ethical conflictions or infringements (i.e. disease-specific ethical issues) may be more significant than others.

Because these layers are different reflections of the same reality, our analyses will sometimes overlap and repetitions may occur. However, analysing all of these perspectives in a comprehensive ethical manner may provide us with new opportunities to better understand and determine concerns arising in the field.

At the end of the document, the identified considerations are applied to MARIO use case scenarios and the results are then discussed.

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1. Introduction

The key objective of this work is to develop an ethical framework that addresses general ethical values of care and applies them to ethical concerns in relation to the intended functionalities and uses of MARIO in the assisted care setting of elderly patients with potential cognitive impairments.

The key outcome is a comprehensive and structured ethical framework involving the following layers: Integrating care robots into the care process (roles and responsibilities), quality of care in the changing care context (changing quality dimensions/target improvements), robotic functionalities for care improvement (physical, psychological and social assistance and support), robotic core capabilities and design features (design principles, aesthetic features, data and intelligence), and dementia-specific ethical issues.

1.1. Work Package 1 Objectives

WP1 objectives are:

- To introduce MARIO to the pilot settings.
- To engage stakeholders of various types across different settings to attain the best possible additions to user specifications.
- Using the user specifications, to document the final and best-fit MARIO functionalities. To develop the data management plan and system architecture to support the intended functionalities.
- To develop and document the MARIO Ethical Framework that makes the privacy, security and ethical expectations clear right at the beginning of the project.
- To develop an assessment methodology for assessing the benefits of MARIO solutions.

WP 1 receives as input the background from project partners and input from stakeholders gathered at the various meetings, roundtables, and workshops. WP1 will provide as output the technical, procedural, and assessment requirements and guidelines for all ensuing project activities.

D1.2 Ethics Framework is a short report and guidance on the ethical concerns arising in the MARIO project (including privacy and monitoring, data use and data protection, informed consent, risk, ethical aspects of stakeholder involvement).

1.2. Purpose and Target Group of the Deliverable

In this work, we aim to develop an ethical framework that addresses general ethical values of care and applies them to ethical concerns in relation to the intended functionalities and uses of MARIO in the assisted care setting of elderly patients with potential cognitive impairments.

These concerns include:

- The importance of the autonomy and preferences of end users, their carers and families, and ensuring that their values and concerns will inform and shape the project throughout all of its stages.
- Data protection and privacy concerns regarding devices that collect complex personal, social, behavioural, and health monitoring data.
- The recruitment and consent of vulnerable participants with potentially limited capacity, and potentially requiring assisted/supported decision-making.
- The facilitation of a dynamic informed consent process for users and their families and carers; drawing on principles of assisted/supported decision-making for participants with

limited capacity and understanding the importance of providing an accessible presentation of information.
- Safety and risk considerations regarding the use of novel functionalities.
- The positive and negative effects of replacing direct human care delivery with robot assistance and remote human interaction.

To overcome these concerns, we extensively studied the area of care roboethics in order to underpin the present framework. This framework aims to outline the responsibilities of project researchers and was developed in close consultation with consortium members responsible for the realisation of relevant aspects of the project.

1.3. Relations to other Activities in the Project

WP1 provides the assessment methodology and ethical framework for development and the pilots. WP3 receives as input user requirements, system architecture, information management and ethical framework from WP1. One of the WP8 objectives is to conduct and assess the pilots within the scope of the ethical framework and assessment methodology. WP8 involves evidence regarding ethical claims related to the advantages or challenges associated with the replacement of humans with robots as outlined in the ethical framework.

1.4. Document Outline

In this document, after the introductory chapter (Chapter 2), we briefly explain relevant concepts, approaches and terms in Chapter 3. We evaluated the scientific literature on existing care robots and ambient assisted living projects, as well as the general roboethics debate surrounding care robotics. Analysis of lessons learnt from previous projects, scientific findings and ethical debates resulted in a multi-layered framework that is sensitive to viewpoints of different stakeholders. The literature survey and framework are explained further in Chapter 4. A brief analysis of relevant projects in the area is outlined in Appendix A – Ethical Perspectives on Selected Robot and Ambient Assisted Living Projects.

In this framework, the different aspects of the human-robot interaction are analysed, with particular focus on the threats characteristic of the use of information and communication technologies in this sensitive field, such as data protection and privacy concerns. Consideration of these issues is integrated into the design process.

The identified considerations are then applied to the use case scenarios and presented in Chapter 5.

1.5. About MARIO

MARIO addresses the difficult challenges of loneliness, isolation and dementia in older persons through innovative and multi-faceted inventions delivered by service robots. The effects of these conditions are severe and life-limiting. They burden individuals and societal support systems. Human intervention is costly but the severity can be prevented and/or mitigated by simple changes in self-perception and brain stimulation mediated by robots.

From this unique combination, clear advances are made in the use of semantic data analytics, personal interaction, and unique applications tailored to better connect older persons to their care providers, community, own social circle and also to their personal interests. Each objective is developed with a focus on loneliness, isolation and dementia. The impact centres on deep progress toward EU scientific and market leadership in service robots and a user driven solution for this major societal challenge. The competitive advantage is the ability to treat tough challenges appropriately. In addition, a clear path has been developed on how to bring MARIO solutions to the end users through market deployment.

2. Robotics and Elderly Care

2.1. Emerging technologies and robotics

Mobile robotic agents and other emerging disruptive technologies such as mobile wireless technology, wearable augmentation devices, virtual reality and immersive environments, intelligent software agents, direct brain interface technologies etc. are good candidates to improve effectiveness and efficiency of health and social care services (Rogers, 2004).

With the dramatic development of technological advances, in the near future, assistive and care robotics will join with other assisted living technologies, Internet of Things (IoT) technologies, and cloud robotics. The IoT refers to a world "in which everyday objects such as phones, cars, household appliances, clothes and even food are wirelessly connected to the Internet through smart chips, and can collect and share data" (Kernaghan, 2014).

With the entry of cloud computing in robotics, it may be possible to develop lighter, cheaper, and smarter robots and integrate them based on converged infrastructure and shared services. It allows robots to benefit from the powerful computational, storage, and communications resources of modern data centres (Abidi, 2011).

But all of these developments also means that new challenges arise in terms of data protection, privacy and other ethical values, including non-technologically oriented values of care in society.

According to the Oxford Dictionary of English, a robot is:

- *A machine capable of carrying out a complex series of actions automatically, especially one programmable by a computer;*
- *(especially in science fiction) A machine resembling a human being and able to replicate certain human movements and functions automatically;*
- *A person who behaves in a mechanical or unemotional manner*

(origin from Czech, from robota 'forced labour'. The term was coined in K. Čapek's play R.U.R. 'Rossum's Universal Robots') (Mushiaki, 2013).

2.2. Care robots and elderly care

2.2.1. Definition of care robots

In its most basic sense, robots can be defined as engineered machines that sense, process complex information, and act. A robot must have sensors, processing ability that emulates some aspects of cognition, and actuators. Sensors are needed to obtain information from the environment. Reactive behaviours do not require any deep cognitive ability, but onboard intelligence is necessary if the robot is to perform significant tasks autonomously, and actuation is needed to enable the robot to exert forces upon the environment. Generally, these forces will result in motion of the entire robot or one of its elements (Lin et al., 2011). In the current literature, the classifications of the different types of robots are somewhat diverse, but the following types of robots can be identified in the field of practice outlined above.

An **assistive robot** is one that gives aid or support to a human user. Assistive robotics includes rehabilitation robots, wheelchair robots and other mobility aides, companion robots, manipulator arms for the physically disabled and educational robots (Feil-Seifer & Mataric, 2005). The term **socially interactive robotics** describes robots whose main task is some form of interaction and is different from social interaction from teleoperation in human-robot interaction (Feil-Seifer & Mataric, 2005). **Socially assistive robotics** (SAR) is the intersection of assistive robotics and socially interactive robotics and the goal of SAR is to create close and effective interaction with a human user for the purpose of giving assistance and achieving measurable progress in convalescence, rehabilitation, learning, etc. (Feil-Seifer & Mataric, 2005).

A **service robot** is a robot that performs useful tasks for humans or equipment excluding industrial automation application. A **personal service robot** or a **service robot for personal use** is a service robot used for a non-commercial task, usually by lay persons. Examples are domestic servant robots, automated wheelchairs, personal mobility assist robots, and pet robots. A **professional service robot** or a **service robot for professional use** is a service robot used for a commercial task, usually operated by a properly trained operator. Examples are cleaning robots for public places, delivery robots in offices or hospitals, fire-fighting robots, rehabilitation robots and surgery robots in hospitals. In this context an operator is a person designated to start, monitor and stop the intended operation of a robot or a robot system (International Federation of Robotics [IFR], 2012).

Generally speaking, service robots are differentiated from socially assistive robots. Whereas service robots assist humans with specific everyday tasks (like vacuum cleaning), socially assistive robots (SAR) are primarily aimed at aiding human users with special needs in their daily activities, for example assisting the elderly, physically impaired populations, those in rehabilitation therapy, individuals with cognitive disabilities or persons with developmental and social disorders or impairments. Whereas service robots primarily target behaviour-oriented agency aspects, socially assistive robots target a mixture of behaviour-oriented agency aspects and the experiential aspects of social interaction, responsiveness to needs, and feelings of belonging. As a subcategory of socially assistive robots, **emotional robots** almost exclusively fulfil the experiential aspects of belonging as well as specific psychological needs, such as interaction, communication, and companionship (Kolling et al., 2013).

A Care robot (carebot) is a robot designed for use in home, hospital, or other settings to assist in, support, or provide care for the sick, disabled, young, elderly or otherwise vulnerable persons (Vallor, 2011). The tasks for which the care robot is used can be classified in terms of either providing assistance in caregiving tasks, monitoring a patient’s health status and/or providing social care or companionship (Sharkey & Sharkey, 2012a).

Depending on the use of the robot and its capabilities the care robot may be further defined as a service robot working in a formalised care context or a personal robot residing in the home of a patient or user (van Wynsberghe, 2013a).

Different types of care robotics have been developed. For example, the Care-O-Bot is a mobile robot with certain humanoid features that can be employed in a variety of service contexts for a wide range of supportive and social interactive functions, including deployment in care of older people. A very different type of a care robot is Paro, a robotic baby seal that has been developed for patients suffering from more severe stages of dementia. Paro is the first commercially available care robot (Goeldner et al., 2015), and has received wide dissemination and much attention in the literature.

Care robots may help to improve the working conditions of care recipients and thereby will presumably positively affect not just the users’ well-being but also the health and work satisfaction of care recipients. An example for this case is RIBA, the carrying robot. RIBA is developed by RIKEN in Japan, a major national research institute. RIBA is operated by a nurse while carrying a patient on the basis of touch sensors which are activated by the guiding nurse (Goeldner et al., 2015).This robot allows care workers to reduce the burden of heavy lifting and thereby has the potential to prevent common workplace injuries of care staff.

Care robots are receiving growing interest in the public and industry and a number of factors speak in their favour. For example, many industrialized countries like Japan or Germany today observe an accelerated aging of their populations. The rapidly growing percentage of people aged 65 or older on the one hand and the shrinking birth rates on the other hand will have major impacts on both the society and the economy of each of the affected countries. Coupled with the decreasing size of the working-age population, we can expect a serious bottleneck in the area of elderly care in the coming decades, with the number of people developing age-related dementia increasing significantly and the number of available caregivers will not be able to keep pace with that increase. Apart from that, the current elderly generation has more money to spend compared to earlier generations and invests in products and services designed to improve their lives and prolong their autonomy. Products and services, including robots, will likely enable people to retain or (re-)gain autonomy and to live a “normal life”. Furthermore, the health-care costs of caring for elderly people are constantly increasing. Currently the expenses for nursing one person at home are in the range of between $30,000 and $60,000 per annum, much exceeding the likely costs for currently tested care robots. These expenses have more than doubled in the last decade. Consequently researchers and engineers in public and private organizations in different parts of the world are involved in projects targeted at developing cost-effective but satisfactory solutions to correspond to the various needs of different potential user groups (Goeldner et al., 2015).

Comparing care robots to other automatized appliances such as “household robots”, there are a number of differences that cause demand for dedicated care-robot research. Care robots incorporate diverse and often complex functions when interacting with humans. For example care robots may have to manoeuvre stairs in senior homes and robotic devices that pick up and move immobile people have to be much more reliable compared to a robotic vacuum cleaner. Furthermore, care robots have to conform to stringent safety regulations in order to comply with different national legal requirements. Care robots are not just in close physical contact with individuals, but they also socially interact with people. If they do not function reliably they could cause additional types of harm, from giving inappropriate or risky instructions to allowing privacy breaches (Goeldner et al., 2015).

2.2.2. Aging and care robots

Because of decreased birth rates and increased life expectancy, the populations of developed countries are aging rapidly. Elderly people have various degrees of physical, cognitive and social limitations and may require support by caregivers. The mobility problems of older people can mean that they need help to perform daily tasks in the home, and that they are not able to go out shopping or allowed to visit people. Some form of memory loss is inevitable with increasing age, and dementia is a prevalent problem. As well as lacking the physical ability to perform tasks, elderly people may need to be reminded of the need to perform various activities, or reminded of the locations for, and components of, those activities. Elderly people can be in danger of falling over, or becoming ill, or confused, or lost. They also need company, love and attention (Sharkey & Sharkey, 2012a).

According to the 2012 Ageing Report, one in three Europeans will be over 65 by 2060. The inactive/ working ratio will double by 2060. We are threatened by the lack of health and social caregivers and this chasm will increase. In parallel, total government spending on pensions, healthcare, long-term care, unemployment benefits and education will increase by almost 20 percent, while expenditures for long-term care will also likely double. Japan and the United States are facing similar aging population problems (DG ECFIN, AWG, 2012).

Care robots might provide potential solutions for these challenges of elderly care, especially to assist elderly and/or carers in their tasks, monitor elderly persons’ health and behaviour, and provide companionship and facilitate social connectedness (Nylander et al., 2012).

2.2.3. Possible functions and benefits of care robots

The potential benefits of care robots are identified and classified under three headings: assistance, monitoring, and companionship. Assistance robots support some of the daily tasks involved in eldercare. Monitoring robots have been developed for monitoring the health, well-being and safety of elderly people. Companionship robots are designed to provide company, distraction, and to be social and interactive in general (Sharkey & Sharkey, 2012a; Borenstein & Pearson, 2012) (see Table 2.1.)

Table 2.1. Various examples of care robots (Sharkey & Sharkey, 2012a)

Robot	Developer	Functionalities
Assistance robots		
My Spoon	Secom, Japan	Eating assistance
Bestic	Bestic AB, Sweden	Eating assistance
Electric bathtub robot	Sanyo, Japan	Automatically washes and rinses
Riba (Robot for Interactive Body Assistance)	Riken, Japan	Lifting up from a bed, Transfer to/from a bed from/to a wheelchair
Hybrid Assistive Limb suit (HAL)	Cyberdyne, Japan	Cyborg-type robot, by which a wearer's bodily functions can be improved, supported and enhanced
Walking assist device with stride management system, Bodyweight support assist	Honda, Japan	Walking support for weakened lower extremity muscles and supports a portion of person's bodyweight
Monitoring robots		
Pearl	Carnegie Mellon University, US	Nursebot. Reminds patient about daily routine activities and guide through their environment
uBot5 robot	University of Massachusetts, Amherst	Monitor elderly person for signs of a fall and stroke, social telepresence, and is remote-controlled to perform tasks in the home
Wakamura	Mitsubishi Heavy Industries	Monitoring the elderly, delivering messages and reminding about medicine. companion
CareBot	Gecko Systems International Corp	A personal robot equipped with multiple vital sign sensors, that can follow an elderly person in their home
RoboSoft	RoboLAB10	A home-assistance robot designed to physical and cognitive assist in the home care of the elderly
Sincere Kourien	Matsushita Electrics	Robot teddy bears that monitor patients' response times to spoken questions
Remote Presence robots (RP-6 and RP-7)	Intouch Health, California, US	Telepresence (virtual visit of elderly people by medical professionals)
CareBot™	Gecko Systems, US	The family care and personal assistance robot
Companionship robots		
Paro	AIST, Japan	Fur covered robotic seal, specifically designed for therapeutic uses with the elderly
AIBO robotic dog	Sony, Japan	Entertainment and companionship robot
NeCoRo	OMRON, Japan	Robotic cat covered in synthetic fur
My Real Baby	iRobot, US	Interactive emotionally-responsive doll
Pleo	Innvo Labs, Hong Kong	A robotic dinosaur, entertainment and companionship robot
Ifbot	Business Design Laboratory, Japan	Entertainment and companionship robot for elderly people
Primo Puel	Bandai Co., Ltd, Japan	Interactive doll, popular with elderly women in Japan

Care robots for elderly care can also be classified in terms of their functionalities as physical supporter, non-physical supporter, and non-specified supporter. **Physical supporters** physically support the user with activities such as standing up, fetching and carrying objects, carrying objects, walking, climbing stairs, washing, dressing, eating, drinking, preparing meals, and cleaning. **Non-physical supporters** have various functionalities such as reminder, monitoring, information provider and assistant for social interaction and entertainer. Functions in the **non-specified class of assistance** support additional activities which cannot be classified as clearly physically or non-physically supportive. For example, supporting daily life, medication, healthcare, self-care, doing housework (Bedaf et al., 2015) (see Table 2.2.).

Table 2.2. A functional classification of elderly robots (Bedaf et al., 2015).

Category	**Function and example**
Physical support	Standing up, fetching and carrying objects, carrying objects, walking, climbing stairs, washing, dressing, eating, drinking, preparing meals, and cleaning
Non-physical support	
Providing reminders	Carrying out daily routines: Agenda function Maintaining one's health: Reminder for medication/health measurement Acquisition of goods and services: Support shopping cognitive
Monitoring user/environment	Carrying out daily routines: monitoring daily activities Walking: fall detection Managing diet and fitness: coaching/monitoring exercise Maintaining one's health: reminder for medication/health measurements Maintaining one's health: monitoring medication intake Home security: unspecified, tele-presence
Providing information	Coaching/advice services, providing information
Control equipment	Maintaining one's health: Doing health measurements Using household appliances: Control domestic applications/infrastructure, emergency call/message
Social interaction	Interpersonal interaction and relationships: Facilitate communication Interpersonal interaction and relationships: Companion/social interaction
Providing entertainment	Recreation and leisure: Provide entertainment Recreation and leisure: Provide cognitive stimulation
Non-specified support	Support daily life, support medication, support healthcare, support self-care, doing housework

3. Ethical Aspects of Care Robotics

3.1. General considerations

Robotics technology is transforming the health and social care environment, presenting a new set of technical, social, ethical, and legal challenges (Riek & Howard, 2014). Ideally, the requirements in the domains of law and ethics should overlap, but because both are in rapid development and there is a current lack of clarity on many aspects, there is not always a clear match between identified ethical challenges and the legal situation (Sullins, 2015). In the following, we will focus primarily on the ethical consideration; however, the application of the ethics framework in the future also requires the careful consideration of the legal situation.

In the roboethics literature, Isaac Asimov's laws of robotics is the first modern discussion about the ethics of human-robot interaction (Riek & Howard, 2014) but the term of "roboethics" was first coined by Gianmarco Veruggio, in the *First International Symposium on Roboethics* in 2004 (Mushiaki, 2013). The term roboethics refers to the intersection of robotics and ethics.

Today, the ethical discourse on robotics is an increasingly active field of debate, but is still in a "brainstorming phase" and especially well designed empirical research is still required on various aspects of the use of robots (Salvini, 2015). There are currently no widely accepted and specific guidelines or standards for the design of robots outside factory settings. Although the International Organization for Standardization (ISO) has currently drafted standards for the design of personal robots, these are nevertheless classified differently from medical use robots. As a result, designers are given no guidelines pertaining to the inclusion of socially sanctioned ethical principles like safety and/or efficiency, principles which designers strive for but do so without being able to rely on any standardized means (van Wynsberghe, 2013a).

In this chapter, we explain some foundational concepts related to roboethics in relation to care robotics. First, some frequently used terms in the roboethics domain are defined in the Table 3.1.

3.2. Ethics theories and robotics

Various ethical theories are used to explain ethical values and issues in roboethics e.g. consequentialism (utilitarianism), deontology, virtue ethics, etc. In practice, all these theories are potentially usable and give opportunities to represent and support different perspectives for robot design (Sullins, 2015). In the design of robots, care should be given in order to take into account a wide range of ethical perspectives.

The **consequentialist or utilitarian ethics** evaluates actions and technologies with regard to their consequences, not the nature of the act itself. If the greatest number of people enjoy the highest beneficial outcome, then the action is good. For example, the Utilibot is a decision-theoretic autonomous mobile robot and is guided by the utilitarian notion of the maximization of human well-being (Cloos, 2005). However, utilitarian considerations can be conceived in varying degrees of complexity, from simple understandings of pleasure and pain to complex understandings of preference satisfaction.

Deontology focuses on moral duties and responsibilities, often in the shape of clear rules. In its classical form it interprets moral rules as absolute, and disregards consequences. For example, lying is considered wrong, regardless of any potential positive results of lying. Kant's theory is a core proponent of a deontological ethics. A rule-based ethical theory is suggested as a good example of the practical reasoning of machine ethics (Powers, 2006).

Table 3.1. Frequently using terms and their definitions	
Ethics	Ethics is defined in its most general sense by Webster's Third International Unabridged Dictionary of the English Language as "the discipline dealing with what is good and bad or right and wrong or with moral duty and obligation." Ethics is a part of philosophy, not science (Barger, 2008), but ethical considerations can be applied to different scientific and technological domains. To perform ethical reflection effectively in such specific domains requires interdisciplinary collaboration between philosophers and experts in that domain. It frequently results in the emergence of domain-specific concepts and considerations in each application area.
Roboethics	Roboethics is an applied ethics whose objective is to develop scientific, cultural, and technical tools pertaining to the area of robotics that are acceptable to individuals from different social groups and with differing beliefs. These tools aim to promote and encourage the development of robotics for the advancement of human society and individuals, and to help prevent its misuse against humankind, for example by violating important ethical values in human life (Veruggio & Operto, 2008).
Machine ethics	This is a field of applied ethics that has grown rapidly in the last decade, pertaining to ethical issues arising in the use and design of machines. Increasingly advanced autonomous robots have expanded the focus of machine ethics from issues regarding the ethical development and use of technology by humans to ethical dimensions of complex machines themselves. This is indicated by the fact that machine ethics is sometimes referred to as "machine morality" or "artificial morality", where the focus has shifted to the potential ethical behaviour of the machines, rather than merely the ethical behaviour of humans manufacturing and using the technology in question (Johansson, 2011).
Care ethics	Care ethics is an area of ethics that is focused on the realisation of values of care. Instead of focusing primarily on the ethical responsibilities of individuals considered in isolation, care ethics focuses on the interpersonal relationship in its own right. Care ethics identifies responsibilities of those responsible for care vis-à-vis those being cared for; accordingly caring robots are assessed with regard to how well their use realises qualities of a caring relationship for the recipient of care as well as those persons who are responsible for delivering care via the use of robots.
Care values	Care values are those values that are characteristic of a well-functioning caring relationship. They include whether care delivery achieves the person's physical and emotional well-being, safeguards and supports their autonomy, and shows responsiveness to personal and interpersonal needs of the persons who are cared for. In relation to care robotics, the use of robotics should support such values of care and their use should not stand in the way of realising these values.
Built-in (embedded) value	It is possible to identify tendencies within a computer system or software that promote or demote particular moral values and norms. These tendencies manifest themselves through the consequences of using the object. When said technology is capable of imposing a behaviour on a user, or is a consequence of using it, the imposing force within the technology is considered a ''built-in'' or ''embedded'' value (or alternatively, a disvalue if the computer system hinders the promotion of a value) (van Wynsberghe, 2013a).

Virtue ethics concentrates on the character of the moral agent, through the development of beneficial traits and habits of interaction. The core assumption is that action in practical contexts is characterised by so many different features that clear-cut rules are often no help in coming to valid decisions; instead a person with good character will be best able to identify salient ethical issues and respond to them adequately despite uncertainty. Especially when no clear established guidance exists for new technologies, the moral character of the researchers gains prominence as a source of ethical guidance (Sullins, 2015).

Roboticists also need to consider **fairness and social justice** with regard to the likely use of their robotic systems, because all human beings deserve to be treated equally and with respect. There are many and divergent theories of justice, but some core concepts are particularly prominent in this domain. The notions of disadvantage, facilitating social participation, and the responsibility of addressing needs are core concepts in this context. The use of technology needs to be responsive, for example, to an appropriate balance between benefits and burdens for users and non-users of technologies, and to considerations of vulnerability, marginalisation and social exclusion, with the aim of using technology for example to support the worst off, or address and remedy pre-existing imbalances (Sullins, 2015).

3.3. Computer and information ethics

Disruptive information and communication technologies such as future robots are not ethics-free technical instruments and instead of merely addressing vulnerabilities with positive consequences for the technology user, they may be creating further vulnerabilities (Coeckelbergh, 2013). Because robots are a kind of interface between the digital world and the physical world, computer and information ethics share some important information-related principles such as data security, integrity, and accessibility, as well as principles relating to physical or interpersonal impact, for example physical safety or health (Sullins, 2015).

The area of computer and information ethics was first developed when Wiener (1950) explored the impacts of information technologies on central human values (e.g. life, health, happiness, security, freedom, knowledge, opportunities, and abilities). In the mid-1970s, Walter Maner developed an experimental “computer ethics” course for students of computer science. In the late 1990s, “value-sensitive computer design” emerged, especially through the work of Batya Friedmann. In the late 1990s and early 2000s, Luciano Floridi proposed Information Ethics theory as a basis for computer ethics. Since 1995, computer and information ethics developments have exponentially developed, with differentiation into many different application domains in roboethics, online ethics, cyborg ethics, and global information ethics (Bynum, 2008).

Possible ethical issues in relation to ICT are related to the evolution of technological characteristics and depending on technological development they may change significantly over time. In the 1980s, privacy, accuracy, property and accessibility (summarized as PAPA) were considered as the major ethical issues (Mason, 1986). These items were then also accepted as ethical problems for the ICT aspect of roboethics (Veruggio, 2006) (see Table 3.2).

Table 3.2. Definition and scope of the PAPA (Mason, 1986; Veruggio, 2006)

Privacy	What information about one's self or one's associations must a person reveal to others, under what conditions and with what safeguards? What things can people keep to themselves and not be forced to reveal to others?
Accuracy	Who is responsible for the authenticity, fidelity and accuracy of information? Who is to be held accountable for errors in information and how is the injured party to be made whole?
Property	Who owns information? What are the just and fair prices for its exchange? Who owns the channels, especially the airways, through which information is transmitted? How should access to this scarce resource be allocated?
Accessibility	What information does a person or an organization have a right or a privilege to obtain, under what conditions and with what safeguards?

In time, with the advent of new information and communications technologies, including ubiquitous computing, social media and big data analysis, new areas of concern have been emerging. New visions and possibilities, such as the increased communication rate, massive data storage, data sharing between computers and stakeholders, transnational spreading, and endlessly replicated data, all raise their own challenges (Barger, 2008).

Availability, **accessibility** and **accuracy** of informational resources, ethical problems concerning **information privacy** and **confidentiality** (right of individuals and companies to deny or restrict the collection and use of information about them), **authorization and hacking** (the unauthorised access to a computerised information system), **digital vandalism** (e.g. the creation and intentional dissemination of software viruses), **security**, **monitoring and control**, **freedom of expression**, **censorship**, **filtering** and **contents control**, the debates about **information ownership** and **intellectual property** (the rights to which creators are entitled to their work)**, fair use**, **piracy** (a common infringement of copyright), the **development and support of open source software,** and **green computing** (reducing the electricity and environmental waste while using a computer) affect both users and producers ethically, while shaping their informational environment (Floridi, 2011; Shelly & Vermaat, 2012).

There are various codes of ethics relating to computing and information systems such as ACM (Association for Computing Machinery) Code of Ethics and Professional Conduct and the Software Engineering Code of Ethics and Professional Practice (Barger, 2008). Despite many areas of continuity, the fast pace of development in this field can make it more problematic to rely on codes of practice as they may not always accurately reflect the nature of current ethical challenges.

3.4. Human-robot interaction

Human-Robot Interaction (HRI) is a relatively young discipline and aims to understand, design, and evaluate robotic systems for use by or with humans. Interaction requires communication between robots and humans. There are two generic forms of communication affected by the spatiotemporal proximity of the human and the robot, i.e. remote and proximate interaction. The goal of HRI is to understand and shape the interactions between one or more humans and one or more robots. Essentially, a designer can affect various attributes to affect these interactions such as the level and behaviour of autonomy, the nature of the information exchange, the structure of the team, the adaptation, learning, and training of people and the robot, and the shape of the task (Goodrich & Schultz, 2007).

HRI research should pay attention to human values and ethical principles including respect for human autonomy, respect for human bodily and mental integrity, and the affordance of all rights and protections ordinarily assumed in human-human interactions. The robot actor is expected to behave in a manner at least as respectful of human personhood as human actors, to the extent that is feasible (Riek & Howard, 2014). What is particularly important ethically in this domain is the consideration of the realisation of the HRI on the human participant; continuities and discontinuities between interpersonal interaction and HRI need to be considered carefully, and scientific empirical evidence is needed to be able to assess the ethical significance of such concerns realistically.

3.5. Value sensitive design (VSD) in care robotics

The **value-sensitive design** is defined as ‘‘a theoretically grounded approach to the design of technology that accounts for human values in a principled and comprehensive manner throughout the design process’’ (Friedman & Kahn, 2003).

The starting point of value-sensitive design is Nissenbaum’s embedded values concept (2001) from the field of computer ethics. This concept emphasises the relationship between the design of artefacts and the resulting ethics throughout the design and implementation process (van Wynsberghe, 2013a).

The Care Centred Value Sensitive Design (CCVSD) is a response to the need for including ethics earlier on in the design process of robots in healthcare contexts. It is an elaborated and modified form of traditional value-sensitive design (by Friedman) to incorporate and translate care ethics into a tangible tool to be used in the design process of future robots (van Wynsberghe, 2013b).

The CCVSD approach consists of a framework of components for the evaluation of a care robot: the context of use, the care practice, the actors involved, the type of care robot (its capabilities, appearance, etc.) and the list of values involved for the described practice in the stated context (i.e. the interpretation and prioritization of care values) (see Table 3.3.) (van Wynsberghe, 2013b).

Table 3.3. Framework for the ethical evaluation of care robots (van Wynsberghe, 2013b).

Context	Hospital (and ward) vs nursing home vs home setting, etc.
Practice	Lifting vs bathing vs feeding vs delivery of food and/or sheets, social interaction, playing games
Actors involved	Nurse and patient and robot vs patient and robot vs nurse and robot
Type of robot	Assistive vs enabling vs replacement
Manifestation of moral elements	Attentiveness, responsibility, competence, reciprocity

For the CCVSD approach, during the idea generation phase, the ethicist try to understand care in **context** and observe how values are translated and ranked in context. The next step is to **select a practice** for which a care robot may be designed. For this, the ethicist must elaborately describe the care practice in meticulous detail to uncover: how values are manifest through the actions and **interactions of actors** (human and non-human); how a particular practice is related to other practices and to the overall care of a patient; areas in which a **robot** may provide the possibility to re-introduce certain care values; and, elements that ought to remain intact if not strengthened through the use of the robot. With this information, the ethicist collaborates with the design team to brainstorm the care robot in terms of its capabilities, features, appearance and functioning (van Wynsberghe, 2013b).

There are some critics about the fuzziness of the concept of “care” and the receiver oriented interpretation of this concept rather than the giver (Johansson, 2013). However, care ethics provides some valuable resources for understanding the interpersonal context of care and the roles and interaction of both caregivers and care receivers that other approaches do not generally focus on.

3.6. Capability approach

In the draft report of the NHS Confederation, Age UK, and the Local Government Association (2012), the need for patient centred care and recognising the needs and preferences of the elderly person are emphasised for dignity. The capability approach may provide particularly valuable conceptual resources for a framework to evaluate the requirements for ensuring a life with dignity (Sharkey, 2014).

The capability approach is based on the theories of the economist Amartya Sen and the philosopher Martha Nussbaum. Its main principle is to promote and preserve human flourishing. This approach was recently discussed as an appropriate framework for describing and evaluating “both the promises and the ethical worries concerning the use of information technology in elderly care” (Coeckelbergh, 2012b).

According to this approach, care robots should be evaluated on the basis of their ability to promote human capabilities and its primary concern should be the impact on the capabilities of the care-receiver (see Table 3.4). If the use of robot caregivers is also efficient and convenient for professional and informal human caregivers, those are acceptable and desirable side-effects, but having them as the sole or main impetus for using robot caregivers is likely to produce undesirable wider ethical and social outcomes (Salvini, 2015).

These criteria can be used to help determine what elderly care should aim for, and what the minimum thresholds might be for the achievement of each capacity. This approach allows us to analyse and evaluate elderly people's capabilities given their specific conditions (including age and culture) and in particular contexts and circumstances (Misselhorn et al., 2013).

Table 3. 4. A list of central capabilities drawn from Nussbaum (Coeckelbergh, 2012b)
Life: *Being able to live to the end of a human life of normal length; not dying prematurely, or before one's life is so reduced as to be not worth living.* ***Bodily health:*** *Including nourishment and shelter.* ***Bodily integrity:*** *Free movement, freedom from sexual assault and violence, having opportunities for sexual satisfaction.* ***Being able to use your senses, imagination, and thought:*** *Experiencing and producing culture, freedom of expression and freedom of religion.* ***Emotions:*** *Being able to have attachments to things and people.* ***Practical reason:*** *Being able to form a conception of the good and engage in critical reflection about the planning of one's life.* ***Affiliation:*** *Being able to live with and toward others, imagine the other, and respect the other* ***Other species:*** *Being able to live with concern for animals, plants and nature.* ***Play:*** *Being able to laugh, to play, to enjoy recreational activities.* ***Control over one's environment:*** *Political choice and participation, being able to hold property, being able to work as a human being in mutual recognition.*

3.7. Some other approaches

An ethical framework based on Beauchamp and Childress' model was developed to evaluate ethical perspectives of socially assistive robots. This model involves four principles: Beneficence (caregivers should act in the best interest of the patient); non-maleficence (the doctrine, "first, do no harm," that caregivers should not harm a patient); autonomy (the capacity to make an informed, un-coerced decision about care); and justice (fair distribution of scarce health resources) (Feil-Seifer & Mataric, 2011b).

The Santa Clara University's concept is based on five complementary criteria to be used and adapted for an ethical assessment grid, including: legal aspects, utility, equity, common sense, and virtue (Riek & Howard, 2014).

Another method focusing on utility and acceptability of technologies is based on the unified theory of acceptance and use, so called UTAUT, matching behaviour theory and technologies acceptance (Cornet, 2013).

It is also possible to draw on the principles contained in national and international charters and treaties concerning the promotion and protection of fundamental rights and shared values (Salvini, 2015).

3.8. Ethical Perspectives of Selected Projects

In the last 10 years, many robotics, roboethics and ambient assisted living projects were started and completed. To exploit the ethical approaches and learnt lessons from these projects, these projects were reviewed and analysed in addition to the scientific literature survey (see Table 3.5.)

Table 3.5. Selected projects for ethical analysis

ACCOMPANY (Acceptable roboticCs COMPanions for AgeiNg Years)
CompanionAble (Integrated Cognitive Assistive & Domotic Companion Robotic Systems for Ability & Security)
MOBISERV (An Integrated Intelligent Home Environment for the Provision of Health, Nutrition and Well-Being Services to Older Adults)
GiraffPlus
ALIAS (Adaptable Ambient LIving ASsistant)
KSERA (Knowledgeable Service Robots for Aging)
Florence (Multi-Purpose Mobile Robot for Ambient Assisted Living)
ExCITE (Enabling SoCial Interaction Through Embodiment)
Hobbit (The Mutual Care Robot)
ROBO M.D.
SRS (Multi Role Shadow Robotic System for Independent Living)
DOMEO (Domestic Robot for Elderly Assistance)
JAMES (Joint Action for Multimodal Embodied Systems)
Projet Romeo
Robot Companions for Citizens (CA-RoboCom)
Alfred (Personal Interactive Assistant for Independent Living and Active Ageing)
Silver (Supporting Independent LiVing for the Elderly through Robotics)
ROBOT-ERA (Implementation and integration of advanced Robotic systems and intelligent Environments in real scenarios for the ageing population)
SERA (Social Engagement with Robots and Agents)
RAPP (Robotic Applications) project

ICT & Ageing Projects:

- MINAmI Project
- ENABLE project
- ASTRID
- In-home Monitoring of Persons with Dementia
- American Telemedicine Association Guidelines
- Mental welfare Commission of Scotland
- The Friendly Rest Room Project
- North Lanarkshire Council's Best Practice Policy

EURON Roboethics Roadmap
ETHICBOTS (Emerging Technoethics of Human Interaction with Communication, Bionic and Robotics)
ETHOS (Ethical Technology in the Homes of Seniors)
RoboLaw (Regulating Emerging Technologies in Europe: Robotics Facing Law and Ethics)

A brief analysis of core features of these projects is included in Appendix A - Ethical Perspectives of Selected Robot and Ambient Assisted Living Projects.

4. Care Robots: Double Edged-Swords

4.1. A literature survey

When discussing ethics and care robots, authors assess a variety of perspectives and considerations, such asdifferent ethical values; concepts and theories (capability approach, VSD); effect of individual characteristics (age, gender, culture, health state); robot types (companionship, assistive, care robots); and features and capabilities of the robot (aesthetic, functional, technological).

4.2. A structured framework for ethical analysis

Scientific advances in different areas of health and social care bring ethical challenges that can affect patients, their families, care professionals and society as a whole. These challenges result from the complexity of care involved, scientific uncertainty as to outcome, lack of medical and social consensus on ethical standards, or inadequate social, emotional, physical and financial resources (Preto & Mitchell, 2004).

In the scientific literature, ethical debates about care robots adopt different viewpoints. In order to merge relevant scientific findings and arguments, we aim to develop a deductive (from context to components), comprehensive and structured approach.

We evaluated the ethical effects of robot on care context regarding the following layers (see Figure 3.1):

- Integrating care robots into the care process (roles and responsibilities),
- Quality of care in the changing care context (changing quality dimensions/target improvements),
- Robotic functionalities for care improvement (physical, psychological and social assistance and support),
- Robotic core capabilities and design features (design principles, aesthetic features, data and intelligence),
- Disease/condition specific ethics values and concerns.

It is clear that the addition of the robot changes the roles, processes and interactions in the health and social care contexts where they are deployed. To evaluate these changes regarding ethical values and concerns, we used the WHO Health Systems Framework as a starting point. This framework identifies a care system as the complex collection of organizations, people, and actions. in this framework, there are several building blocks (leadership, financing, workforce, medical products and technologies, information and research, service delivery) and goals (quality of care) (World Health Organisation, 2010).

After care robots become introduced to the care context, the traditional role of carers will change, and new work-sharing approaches will appear. This will also affect the quality of the care of the system as a whole. Evaluating the dimensions of the quality of care could give us valuable information about the whole of the system. We evaluate the changing quality dimension due to care robots in terms of the ethical values.

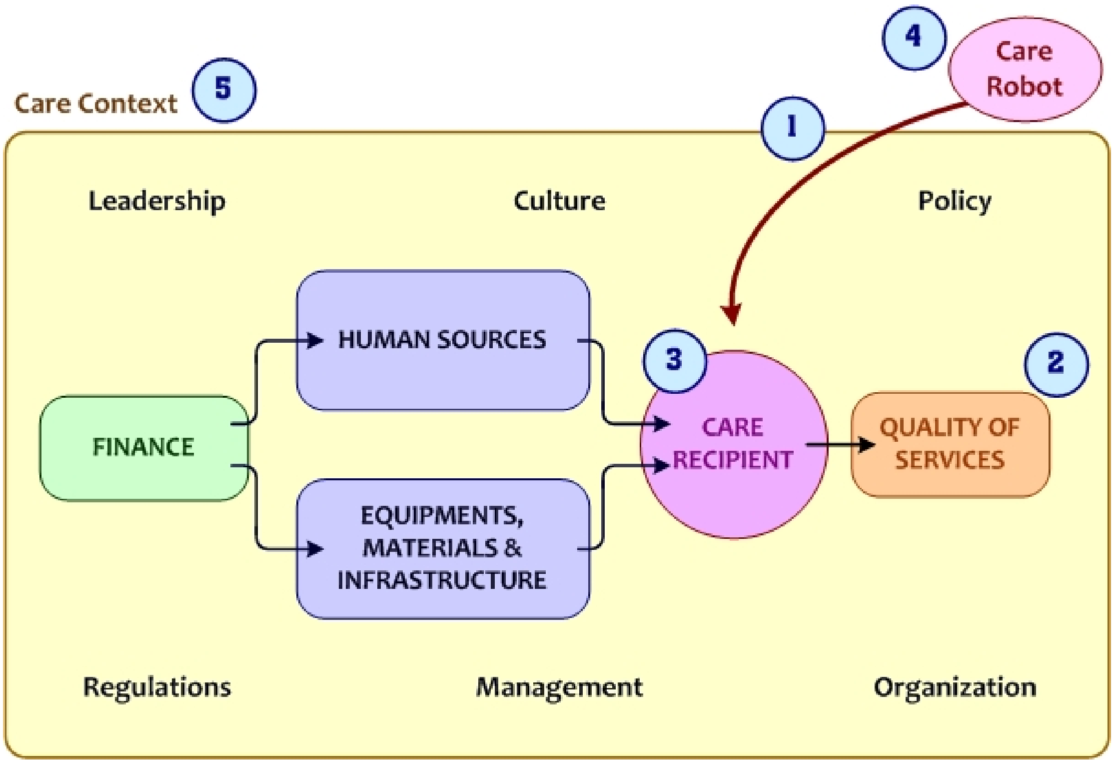

Figure 3.1. *A structured framework for care robot ethical analysis. 1: Integrating the care robot into the care process; 2: Quality of care in the changing care context; 3: Robotic functionalities for care improvement; 4: Robotic core capabilities and design features; 5: Disease/condition specific ethical issues.*

Care robots can have many different functions such as autonomously navigating and guiding; regular health monitoring (blood pressure, body temperature, heartbeat rate and regularities, and pulse oximetry); reminding users and carers regarding some situations and requirements; providing video and audio connection; transporting objects; monitoring and managing external intelligent systems (detect intrusions, detection of fire and smoke, tuning room temperature); and entertaining people.

Design features of the robot consist of another layer. Regarding data processing, intelligence capabilities and aesthetic features the ethical concerns may change with design changes. While intelligence gives more flexibility to handle care issues, it may be a reason for autonomy and privacy infringements at the same time. Care robots' functions that intended to improve human capabilities, may affect three aspects of human integrity understood according to the biopsychosocial model, i.e. physical, psychological and social. Design and implementation decisions must be made in ways to promote their health (Pearson & Borenstein, 2014; Riek & Howard, 2014) (see Figure 3.2).

In the context of care robots, there are two different ethical bases: human rights and shared human values. Regarding human rights, the importance of physical and psychological welfare for everyone is emphasised in the Charter of the United Nations, and the Universal Declaration of Human Rights. Elderly people, like everyone else, have the right to a standard of living adequate for health and well-being; to private and family life; to freedom from torture and inhuman or degrading treatment; and to freedom from discrimination (Sharkey & Sharkey, 2012a).

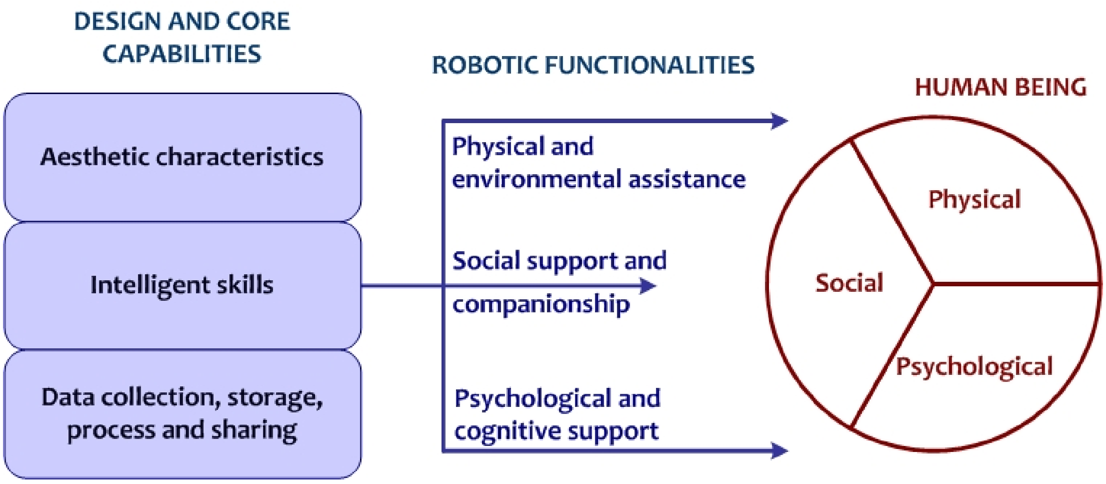

Figure 3.2. *A structured approach for ethical evaluation of human-robot interaction. Robots have design features and core capabilities e.g. aesthetic characteristics and capabilities as an information and communication system. Robotic functionalities support care recipients' physical, social and psychological aspects.*

Roboethics is a different domain than information and computer ethics but tightly connected because of the core functionalities of the robots. In information and computer ethics, a technological design involves 12 human values i.e. human welfare; ownership and property; privacy; freedom from bias; universal usability; trust; autonomy; informed consent; accountability; identity; calmness; and environmental sustainability (Friedman & Kahn, 2003).

In the robotics literature, authors mainly elaborate particular ethical issues pertaining to the use of care robots for elderly care such as objectification, freedom, autonomy, dignity, privacy, social contact, deception and infantilisation etc. (Vallor, 2011). These ethical factors will appear regarding the specific characteristics of the care context. Additionally, various issues should be evaluated e.g. responsibility, accountability (Sharkey & Sharkey, 2012a) and, financial and political vulnerability (Coeckelbergh, 2013; Riek & Howard, 2014) etc.

Robots will interact and change the care context with their existence and capabilities, perhaps fundamentally so. Some of these changes are concrete and easily understandable. Others are related to the interaction of the different elements in the care context and appear as a reflection of changing quality of services. The final effect of all components is double-edged i.e. there could be both ethical infringements and improvements (see Figure 3.3.).

After a general evaluation of the framework, we can focus on particular cases. Depending on the specificity of the condition or disease, some ethical conflictions or infringements may be more significant (disease-specific ethical issues, DSEIs) than others (Knüppel et al., 2013). At the end of the study, we evaluate dementia-specific ethical concerns and emphasize the most prominent issues on this topic.

Because these layers are different reflections of the same reality, our analyses sometimes will sometimes overlap, so some repetition may occur. But, analysing all of these perspectives comprehensively in ethical terms will provide us with new opportunities to better understand and determine possible concerns arising in the field.

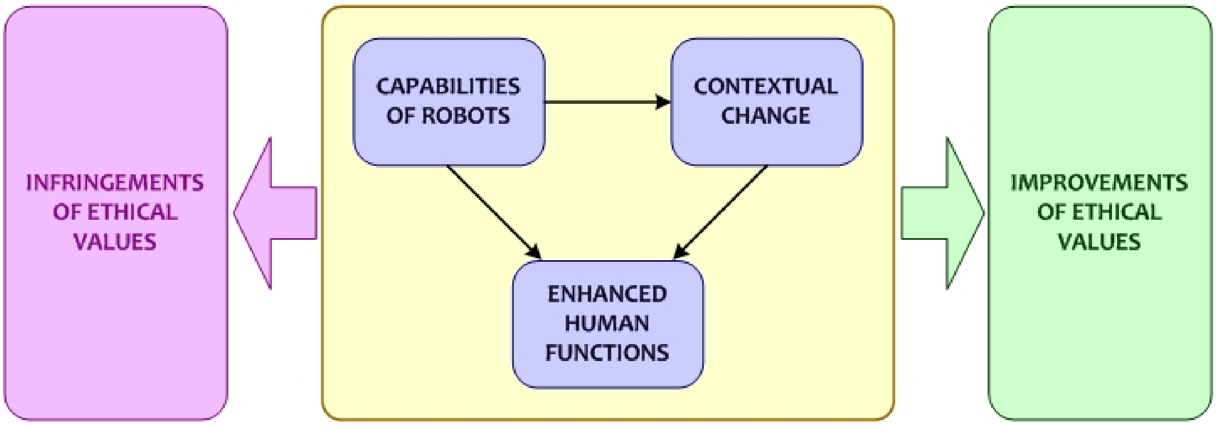

Figure 3.3. *Relationships between human-robot-context space, ethical value and concerns. Care robots will enhance human functionalities and change the quality of service by transforming all elements and relations of care context. Additionally, due to the core technical capabilities (data collection, sharing, and artificial intelligence), robots are sources of ethical concerns. The final effect of all components is double edged i.e. both infringement and improvement and a balance is needed.*

4.3. Integrating care robots into the care process

In the care context, many different components interact with each other such as care recipients and their families, different types of human sources (caregivers, managers), equipment and materials, and financial flow.

After a robot is introduced into a care context, the structure of this context may become deeply transformed. Care robots are not humans but can imitate them by handling some care functions which are today accomplished by human caregivers. Also, we cannot simply accept them as only ordinary equipment due to the profound emotional effects arising from the functional interaction between robots and humans.

It is clear that once care robots become an essential feature of the care context, the traditional role of the carer will change, and new work-sharing approaches will appear. To prevent possible role conflicts, new policies will need to be formulated on the basis of available considerations, and human cares need to be educated and upskilled on the basis of such evidence.

Then, what will be the role of care robots in this context, namely replacement or assistance of the caregivers? Why? How will care robots affect the position of the caregivers in care setting? What will be the effects of care robots on care recipients, especially in terms of ethical values? How will care robots transform the classical caregiver-care receiver relationship? If these robots are not human and ordinary care equipment, then who will be responsible for the results of their accidental actions, especially if negative effects occur?

4.3.1. Role of care robots: Replacement or assistance

If robots are designed to take over the roles of humans, there is the possibility that they might replace a lot of human jobs (Sparrow & Sparrow, 2006, p. 145; and Coeckelbergh, 2010, p. 185). If a robot replaces the need for a human carer then it must be assessed whether or not they can bring about the same type and quality of care as a human caregiver, and if these differ it has to be carefully assessed whether such change is overall ethically desirable (van Wynsberghe, 2013a, p. 427). However, we are a long way from robots replacing human care (Prescott, 2013; and Borenstein & Pearson, 2010).

Today, robots are still not designed to be more than assistive to the carers' roles (Moon et al., 2012, p. 2; Roy et al., 2000, p. 4; and Mast et al., 2010) or be a resource for users within the home (Sorell & Draper, 2014, p. 188). For now, it is important not to view robots as a replacement for quality human care, but as an assistive tool to enable an already overworked staff to deal with their workload and prevent negative impacts from arising from overworked carers (Sorell & Draper, 2014; Mast et al., 2010; Moon et al., 2012;Roy et al., 2000).

Robots will not entirely replace carers for the following reasons:

1. Caregivers will still be required to maintain or control, clean, and look after the robots (Yakub et al., 2014). For example, after the feeding by robots, carers need to help them to clean the plates and patients (Nylander et al., 2012, p. 5; Borenstein & Pearson, 2012).

2. The robots' capabilities do not match up to our expectations or promises by the manufacturers and for now they cannot provide deep care for human beings (Coeckelbergh, 2010). Especially, the most important factors of care such as empathy, and gentle persuasion are aspects that the robot will be ill-equipped to perform (Draper & Sorell, 2014).

3. There is the problem that if robots are substituted or used by carers then there is no chance for the virtue of reciprocity to take place in these settings. The social interaction of reciprocating care to another is a fundamental benefit of care settings, and to relinquish this would negatively impact not just the person cared for, but also the carer by removing or reducing their chance to reciprocate with the persons who are being looked after (Vallor, 2011, p. 258).

SUMMARY: Ethical evaluation for care robots in terms of role of care robots	
Effect on humans	***Results***
Robots cannot provide deep care for human beings. Especially, the most important factors of care such as empathy, deep interpersonal respect and gentle persuasion based on a holistic understanding of personal care needs are aspects that the robot will be ill-equipped to do.	*Potential alienation*
If robots are substituted or used by carers then there is no chance for the virtue of reciprocity to take place in these settings.	*Isolation and moral neglect*
Today, robots are still not designed to be more than assistive to the carers' roles or be a resource for users within the home.	

4.3.2. The impact of changing relationships

There are various aspects in the care robot-caregiver relationship such as the perception of the care robots and its roles, effects of care robots on caregivers' feeling and values, support of care robots and conflicts with care recipients. Shifting from human-care recipient to the robot-care recipient relationship is a source of much potential ethical concern and infringement.

4.3.2.1. Changing actors and perceived benefit

Giving orders to humans instead of robots may give a greater sense of autonomy and control over one's life and decisions (Sparrow & Sparrow, 2006, p. 152), although the perceptions of control differ. The use of robots instead of human carers may lead patients to feel they have even less control over their lives rather than more (Bogue, 2013, p. 544) and people may say that they will not want robots as it was a sign that they have no control over their lives and decisions anymore (Wu et al., 2014, p.8). Despite this, patients may benefit from robots that take orders rather than ones that work autonomously (Mast et al., 2010).

The perceived benefit of being in a relationship with the robot mediates the effects of the caregiving role on relationship satisfaction with the robot (Kim et al., 2013). People will have different perceptions of the benefits of robots and how they affect their autonomy, and it will often change from person-to-person, so a generalised assessment is not possible (Decker, 2008).

People may view the use of robots as autonomy-enhancing, particularly the more intelligent and autonomous the robot is itself (Gunkel, 2015). Some people consider robots as friends or companions and get an increase in autonomy and control over their lives through this relationship. Others also see the robot as a lesser of two evils, the other one being forced to enter a nursing home where they have very little control and have to do everything according to a strict schedule. However, others may view the introduction of robots as taking away their autonomy and control in their lives. They may feel that they can no longer look after themselves, and that is why they are forced to have a robot take care of them (Wu et al., 2014).

By providing physical or cognitive support, care robots can improve autonomy and self-respect, and relieve care recipients from dependence on the help of others, such as toileting or bathing, which may be a cause of embarrassment or distress, especially in cultural contexts where shame is a prominent concern (Sparrow & Sparrow, 2006; Salvini, 2015; Sharkey, 2014).

While using care robots, some activities of patients may be restricted. For example, a robot could predict a dangerous situation and warn the person to stop engaging in a potentially dangerous activity. But, trusting the robot’s autonomous sensing and classification to determine what is a dangerous activity is a potentially problematic devolution of human judgement. It is also problematic if safety features are restricting activities that are of particular importance or enjoyable for a person (Sharkey & Sharkey, 2012a). It is a slippery slope if robots start prohibiting patients from doing certain activities for reasons of their well-being. For example, is it okay to stop an elderly person from drinking alcohol in case they become intoxicated and cause harm to themselves, or should this be considered an inappropriate infringement? (Sharkey & Sharkey, 2012c, p.272).

Robots may not understand instructions as quickly or easily as a human carer, and such difficulties in communication may either infuriate the users or negatively affect their self-respect by increasing a feeling of lack of self-efficacy. Therefore, patients must be informed about the robot’s limitations and learn to not get frustrated or angry at the robots (Decker, 2008).

4.3.2.2. Meaning of the robot and dignity

Dignity depends on the realisation of both physical and psychological conditions and the interaction between them (Riek & Howard, 2014).

There appears to be a level of uncertainty about whether or not patients perceive robots as harmful to their dignity. In some studies, users claimed that using robots would be undignified and would essentially mean that they are giving up on life. They viewed robots as indicating the user was old, lonely, and fragile (Wu et al., 2014, p.8). If the robot moves the person without their permission, the dignity can also be impacted negatively (Sharkey, 2014, p.66). It may be a minority of individuals that feel that their dignity is affected through the use of robots; although the perceptions of those users need to be taken seriously. If the patient does not feel like they lose their dignity during robotic use, then there is no reason to prevent robots from being used on users that are comfortable with them (Borenstein & Pearson, 2012, p.255).

Indeed, a robot may be used to remain independent from external help and allow the patient greater control over their lives and, as a result, maintain their dignity in the decisions that they make. There is less likelihood of a robot disrespecting a person's dignity as much as a human carer; slapping, shouting, condescending, and rough behaviour towards the patient are not uncommon among human carers who look after vulnerable persons (Sharkey, 2014). Unfortunately, the importance of dignity and compassion are often overlooked in the robot design process (van Wynsberghe, 2013a, p.418). Robots could in principle be designed to show more respect to users in their interactions than regular caregivers. This has the potential to increase the dignity of the user and their own peace of mind (Sharkey, 2014, p.66).

But, viewing people as a problem that needs to be dealt with by robotics is perhaps intrinsically disrespectful (Sparrow & Sparrow, 2006, p.142). By replacing human carers with robotic carers, care recipients may feel that they themselves have also become objects (Decker, 2012, p.185). If robots are used insensitively by presenting elderly people as ‘‘problems’’ to be solved by technological means, their use could affect their personal dignity, but it also may lead to a more general societal sense of objectification of this group of persons. For example, if robots are used to lift or move people around without consulting them, users could feel that they are not treated with sufficient respect or even become helpless objects of robot actions over which they have no control (Sharkey & Sharkey, 2012a; Sparrow and Sparrow 2006; Sharkey and Sharkey 2010). However, some may argue that being treated like an object by a human is worse than being treated like an object by a robot which is merely a machine after all (Coeckelbergh, 2010, p.186).

Nevertheless, often patients will not know how they feel about robots until they start using them. Therefore, we cannot say in advance whether all patients' dignity will be harmed by using robots (Borenstein & Pearson, 2010). Once these robots are deployed in the field, it would be essential to conduct more comprehensive empirical research on this aspect to achieve a well-grounded understanding of the issue.

4.3.2.3. Mistrust and deception

Care robots might be deceptive in the sense of being deliberately designed to induce inappropriate expectations as to what kind of being they are, or the nature of their interaction and relationship with their users. This deception can be based on different aspects such as appearance, functions and capabilities. Deception concerns, in particular, those robots that show a high level of similarity with human beings or animal behaviour and morphologies (Salvini, 2015), or are deliberately designed to induce emotional bonding. It is deceptive to allow elderly patients perceive that robots care for them emotionally (Sparrow & Sparrow, 2006, p.154). In caring for elderly people, particularly those with dementia, the effectiveness of robot companions depends on deceiving these people with the illusion of reality. One view is that such deception is immoral and constitutes “disrespectful deceit”. Another view is that currently this is a rather minor concern with regard to deception, however it may become more prominent if commercial companion robots enter the field, and such robots may be designed to inappropriately incentivise users to buy products, services or applications that they do not need (Sullins, 2015).

Patients may view robots as real humans or animals, and this has been mentioned as a concern for carers when they use robots in care facilities (Kidd et al., 2006; Taggart et al., 2005). It is deceptive if robots are designed so that patients perceive them as fully autonomous, as a real animal or person. Especially in the context of eldercare, offering opportunities of robot companionship to people who are frequently relatively starved of human companionship may support such misconceptions (Floridi, 2011).

Resulting attachment has the potential to cause emotional harm to the patient (Sparrow & Sparrow, 2006, p.6; Sharkey & Sharkey, 2012b). In the assessment of robots’ effects in the field, patients may not always give their real opinion about robots, therefore it is important for carers to monitor how patients react to them in practice (Wu et al., 2014).

Some researchers suggest that robots should not appear too human-like because this may give a false impression about their abilities (Shibata, 2012; Stahl et al., 2014; Feil-Seifer et al., 2007; Koay et al., 2014; Stahl et al., 2014). Others deny the ethical significance of deception in these cases and argue that having a robot appear human-like to a person with dementia is no more deceptive than a dementia patient viewing care staff as a family member (Coeckelbergh, 2012a). In this context it has also been argued that robot companions, if used cautiously, can provide positive experiences in the lives of elderly persons and promote increased social interaction (Kernaghan, 2014); this might counterbalance the concerns related to deception.

It has been argued that carers should not treat robots like human colleagues so that patients are not deceived about their functions and capabilities (Feil-Seifer & Mataric, 2011a); however, there is currently little evidence that this is a likely problem with the robots that are available. The possibility that care-givers deceive patients by allowing them to believe that robots can sense and fully understand them is a related problematic issue within robot ethics (Metzler & Barnes, 2014), especially if this leads to the assumption that robots may experience deep personal care for patients (Coeckelbergh, 2010, p.186). However, some researchers propose that current care of the elderly by humans in many institutions has significant deficiencies and often does not correspond to the idealised picture often assumed in the literature. It is frequently claimed that care elderly persons receive is not deep either, so it would not necessarily mean replacing such care by robots would be worse. However, it is significant that humans do have the capacity to provide deep care, whereas robots do not (Coeckelbergh, 2010, p.183).

There are other problems with deceiving a patient into believing that the robot is similar to a doctor or nurse; for example they may disclose valuable information to the robot and not their healthcare professional, but such information may not be properly recorded (Feil-Seifer & Mataric, 2011a, p.28). However, in some cases, interaction with the robot with regard to certain sensitive or emotional topics might be easier for patients so that such a phenomenon would not necessarily always be problematic.

Because their capabilities do not match up to expectations (Tapus, et al., 2007; Decker, 2012), there is also the fear that some patients may feel embarrassed to have misunderstood the nature of the robot after they find out that what the robot's capabilities are (Riek & Howard, 2014, p.3).

The possible mistrust amongst the elderly about robots can be alleviated if given adequate information, and their concerns are listened to (Broadbent et al., 2012, p. 115). At this point in particular, it is important for the roboticist not to be deceptive (Martin et al., 2013, p.198). Because design choices generate expectations about the abilities that a robot possesses, they must be compatible with how a robot will be used. Also, users should be provided with a clear explanation of the robot’s role, abilities, and limitations (Pearson & Borenstein, 2014).

4.3.2.4. Bonding and dependency

Elderly robot users may start forming deep emotional bonds with their robots (Rabbitt et al., 2015; Kemna & Does, 2006; Borenstein & Pearson, 2010).

Bonding in the context of care robotics is an affective or emotional attachment of human beings to care robots (Mushiaki, 2013). When the patient is emotionally bonding with a robot, if robots are taken away from the patient it may cause them distress because of the emotional and psychological connection they created with the robot. In robot-dependent therapies, sometimes intense psychological bonds with the robot can develop and at the end of a project, sudden withdrawal of the robot can have serious harmful effects on the subject. Any human-robot interaction research must address this possibility and identify how resulting needs by the subject can be met (Riek & Howard, 2014).

In one study, it was shown that patients were keener to use robots if there was the appearance of a mutual co-dependency with the robot; they felt the relationship was mutual and more respectful because they felt like they were helping the robot and not just the robot helping them (Lammer et al., 2014). This approach has been called the “mutual care” paradigm. If patients view robots in this manner, it will likely provide greater benefit for them. There is proof that when we help one another within a group we feel more useful, and that this increases our wellbeing. Also, when people see robots as primitive humans, but then these roles are not fulfilled satisfactorily, they get frustrated towards the robots and an overall negative experience results (Lammer et al., 2011).

A contrasting point has also been highlighted, insofar as users may start treating their robots like slaves (Koay et al., 2014; Petersen, 2012), and that this might have a negative impact on their general social skills. Accordingly, it has been suggested that robots could be designed to ensure that their users employ their usual social skills and for example should not react to commands if they do not meet usual norms of politeness or social adequacy.

4.3.2.5. Privacy issues

The privacy of persons should be respected; Article 12 of the Universal Declaration of Human Rights states, ‘‘No one shall be subjected to arbitrary interference with his privacy, family, home or correspondence, nor to attacks upon his honour and reputation. Everyone has the right to the protection of the law against such interference or attacks’’. Privacy can be expressed both as a right, but also as a recognised human value.

For the roboethics domain, privacy could be considered to be constructively supported by robots when they are designed to fulfil tasks where human beings tend to feel shame if another human being performs that function for them. Information and communication technologies (ICT) have the potential to facilitate improved functioning while preserving privacy, because sensitive data could be securely collected, stored and processed, and no human is involved (Coeckelbergh, 2010 p.186).

Robots may allow patients to ensure their privacy, where otherwise the dependence and assistance of a family member would be required (van Wynsberghe, 2013a, p.428). Instead of being fed by a carer during meal-times (therefore preventing private conversations during this time), they can use an assistive robot while still having the conversation they want to without the fear of privacy infringements. However, some patients will prefer to omit certain levels of privacy (such as being bathed by a carer) for the emotional connectedness and social interaction during these activities (Nylander, et al., 2012; Moon, et al., 2012).

A robot may give more privacy to a care recipient because it is easier to tell a robot to leave a room than it would be for them to communicate the same message to a human carer (Feil-Seifer, et al., 2007 p.430; Lowet & van Heesch, 2012, p.24). In a study, one patient said that he would talk to the robot about his problems and concerns before he would talk about them with a human being because of privacy concerns and fear the human would judge him (Turkle, 2006).

However, at the same time there is a risk of privacy infringements in a human-robot interaction that involve intimate activities such as bathing and sanitation and direct physical contact such as lifting patients due to the monitoring and sensing functions of the robot which make such intimate information potentially available to others (Sharkey & Sharkey, 2012a).

Additionally, when caregivers are replaced by a robot, patients may still end up feeling embarrassed (Riek & Howard, 2014); they also may share valuable information to the robot instead of a doctor or nurse (Feil-Seifer & Mataric, 2011a); or they may believe the robot can interpret their feelings instead of disclosing it to their carer (Luxton, 2014).

Different studies found different outcomes for how patients perceived a robot as affecting their privacy. In one study patients were paranoid and hid things when they were around the robot so it could not detect those (Caine, et al., 2012), while in another study patients said that they did not worry about privacy concerns when around the robot (Mast, et al., 2010). Patients may not view any privacy threats with the use of robots until possible privacy breaches are mentioned to them. Even then they may be not too concerned as they believed it was something that would get protected (Mast, et al., 2010, p.5). Some patients may implement privacy enhancing behaviours in order to protect their privacy from the robot, perceiving the robot as spying on them and altering their behaviour around it whether intentionally or not (Caine, et al., 2012, p.347).

The design of robots must consider the privacy rights of clients, such as the deactivation of video monitors during intimate procedures, and care must also be taken with protocols for touching (Riek & Howard, 2014). Privacy with regard to further assistive functions also needs attention insofar as it is not just intimate bodily functions that provide potentially embarrassing information, but a large range of information might constitute embarrassing or personal information.

4.3.2.6. Changing the nature of social interaction

One of the problems of aging is that it often results in a loss of social life and human contact, independently from the environment or context in which the elderly person lives. Research shows both the beneficial effects of social contact and that a cognitive decline depends on the loss of social interaction. In the robotic care context the most widespread feeling is that the use of robots may worsen this problem by replacing human interaction with robot interaction and thereby depriving the elderly person further of much needed human interaction (Salvini, 2015).

In the use of robot care, with the decreased necessity of involving human carers in care procedures, opportunities for human social contact could be reduced, and rather than being better cared for, people might become further neglected by society and their families. If carers use robots to carry out assistive functions, then there is also the possibility of a loss of social interaction and human connection such as eye contact, touch, and conversation during the operation of the robot (Parks, 2010; van Wynsberghe, 2013b). If robots substitute a carer's social interaction with patients, it may lead to drastic changes in how we perceive empathy, the practice of reciprocity, and care itself (Vallor, 2011).

However, it is also possible, and there is some evidence to this effect, that some robots could act as social facilitators, and lead to increased interactions with other people. Also, robot-facilitated virtual family visits might alleviate loneliness. However, these functions could be used, inappropriately, as an excuse for leaving the elderly person without a physical visit for longer and it has been claimed that virtual visits, while valuable, would not be an adequate substitute for a living relative sharing your physical and psychological spaces (Coeckelbergh, 2013; Sharkey & Sharkey, 2012a).

SUMMARY: Ethical evaluation for care robots in terms of changing relationships	
Effect on humans	***Results***
The use of robots that are less responsive to human needs instead of human carers may lead patients to feel they have even less control over their lives.	*Lack of autonomy and control*
People may view the use of robots as autonomy-enhancing when understanding them primarily as tools at their own disposal.	*Improved autonomy and control*

SUMMARY: Ethical evaluation for care robots in terms of changing relationships (… continued)	
By providing physical or cognitive support, care robots can improve autonomy and self-respect, and relieve patients' from dependence on the help of others.	Improved autonomy, dignity and self-respect
By providing non-human care the performance of intimate, often shame-related functions may be more comfortable for patients	Improved dignity
Robot may restrict some potentially dangerous activities of patients.	Devolution of human judgement to robot, lack of autonomy/ paternalism
Robots may not understand instructions as quickly or easily as a human carer.	Negative effect on self-respect by increasing a feeling of lack of self-efficacy
Some patients perceive robots as indicating the user was very old, lonely, and fragile.	Decreased dignity and self-respect.
A robot may be used to remain independent from external help and allow the patient greater control over their lives.	Improved dignity
Removing human carers and use robotic carers that don't meet emotional needs and needs of affiliation, patients may feel themselves have become objects.	Objectification, decreased dignity, isolation
It is deceptive to allow elderly patients believe that robots care for them emotionally.	Deception, decreased dignity, infantilisation
It is deceptive if robots are designed so that patients perceive them as fully autonomous, a real animal or person.	Deception, decreased dignity Safety issues
Human-like robots may give a false impression that their abilities match their humanoid form.	Deception, decreased dignity Safety issues
Carers might treat robots like human colleagues so that patients may be deceived about their functions and capabilities.	Deception, decreased dignity Safety issues
If the robot's capabilities do not match up to expectations, some patients may feel embarrassed at having been "taken in" by the robot.	Decreased dignity
Elderly robot users may start forming deep emotional bonds with their robots and disruptions of this relationship may cause emotional harm to the patient.	Affective bonding / emotional attachment, emotional harm
If users treat their robots like slaves, this might have a negative impact on their general social skills.	Social interaction, moral decline
Some patients prefer to make compromising on privacy for gains in emotional connectedness and social interaction.	Social interaction
It is easier to tell a robot to leave a room than it would be for them to communicate the same message to a human carer.	Improved privacy
Due to the monitoring and sensing functions of the robot, intimate activities and direct physical contact make this information potentially available to others.	Privacy infringements
When caregivers are replaced by a robot, patients may end up feeling less embarrassed.	Improved privacy

SUMMARY: Ethical evaluation for care robots in terms of changing relationships (... continued)	
Effect on humans	**Results**
Patients may share valuable information with the robot instead of a doctor or nurse; whether this is detrimental or beneficial for care depends on why the patient does not disclose to the team (e.g. inadequate assumptions about abilities of robot), whether the information reaches the care team and how the patient reacts to the care team's knowledge of information shared with robot	*Potential improvement of care, but also potential deception, decreased trust and privacy*
Patients might believe the robot can interpret their feelings better than their carers	*Deception*
The use of robots may decrease social contact by replacing human interaction with robot interaction.	*Reduced social interaction*
Elderly persons might become further neglected by society and their families when these feel that all care needs have been taken care of by robots.	*Reduced social interaction*
Some robots could act as social facilitators, and lead to increased interactions with others.	*Improved social interaction*
Robot-facilitated virtual family visits may reduce loneliness.	*Improved social interaction*

4.3.3. New roles and positions of caregivers

It is important to note that displacement of workers is related with ethical values and concerns (van Wynsberghe, 2013b), potentially negatively or positively.

Robot use might increase both carers' and care-receivers' well-being and self-respect. Care robots could be used to carry out the menial, boring, and disrespectful jobs that caregivers currently have to carry out, and as a consequence they may have greater resources, time, and personal interaction to give towards patients (Salvini, 2015; Borenstein & Pearson, 2012; Feil-Seifer, et al., 2007).

However, even in this context, if caregivers are used to clean up after robots they might see themselves as mere cleaners or service staff of robots. Also, carers need to be provided with the adequate resources and training in order to be able to use and apply robotic usage efficiently (Roger, et al., 2012; Rabbitt, et al., 2015; Dahl & Boulos, 2013).

Using robots and replacing human caregivers by robots will have a dramatic effect on the dignity of the caregiver because their role is devalued, and they are seen as replaceable by robots. Robots may be seen as being free from error while in contrast human carers may increasingly be seen as their second-choice error-prone counterparts. If presumably error-free robots were seen as potentially better types of caregivers, then this would dramatically alter/negatively impact the relationship between the human caregiver and patient (Luxton, 2014, p.8). Also, if robots are perceived as servants or slaves by robot users, then it might lead to people to having a desensitisation for caregivers and towards other fellow human beings. This has the potential to cause people to act callously and disrespectfully towards one another (Petersen, 2012, p.249).

There is sometimes a misperception that caregiving is simply a burden on the carer, that they would much prefer to not have to do it, and the personal and societal value of providing care becomes lost in some discussions. Instead, as Vallor has highlighted, the use of robots could diminish the benefits the carer gets from caring (Vallor, 2011, p.255). In another study, carers were worried that the robots were being implemented at first as helpers but might increasingly compete for the carers' jobs (van der Plas, et al., 2010, p.310). Caregivers should not be disrespected by being considered replaceable by robots. Instead they should be there to provide robots with assistance and ensure the quality of care. Robots are "tools" to help them carry out their jobs (Decker, 2008, p.324).

In one study, some caregivers were found to be very reluctant to give robots commands or even allow robots in the workplace. They stated that the use of robots was disrespectful to their work and expressed the fear that they would be replaced. There were also cultural differences, insofar as Germans were more reluctant while the Spanish professionals were more open to robot use (Mast, et al., 2010, p.5).

A related concern is that caregivers may get demoted in the hierarchy of care because the robot has comprehensive information that they may not have access to. The dignity and place within the team might then be undermined by lessening their care role and putting the robot in a more privileged position (Jenkins & Draper, 2014, p.183).

Even for non-professional carers similar concerns may arise. Women have been looking after family members as their carers for free or at minimal income. The use of robots may potentially threaten societal valuation of their status and their importance in that role (Parks, 2010).

Accordingly, decision-makers need to distinguish between using robots to foster the physical or psychological well-being of the elderly, using them to lighten the caregivers' workload or to cut costs. Society has a duty to ensure that the elderly receive high-quality care and that no elderly person is left in the exclusive company of machines (Sharkey & Sharkey, 2012b, p.287).

SUMMARY: Ethical evaluation for care robots in terms of new roles and positions of caregivers	
Effect on humans	***Results***
Care robots could be used to carry out menial, boring, and disrespectful jobs instead of caregivers and free them up for more meaningful and satisfying aspects of care.	*Improve caregivers' well-being and self-respect*
If caregivers are used to perform menial tasks related to facilitating functioning of the robot (e.g. clean up after robots), while the robot performs parts of care that they enjoyed or would enjoy, they might perceive their role as shifting towards being secondary in importance to robots.	*Devalued caregivers' role, decrease self-respect and dignity*
For informal carers, the use of robots may potentially threaten the societal valuation of their status and the acknowledgement and appreciation they receive in that role.	*Devalued caregivers' role, decrease self-respect and dignity*

4.3.4. Responsibility for robot actions

There is also the problem that there is less direct accountability and responsibility when a robot makes a mistake (van Wynsberghe, 2013a). The manufacturer is only responsible for fabrication, construction, and instruction of the robots (Decker, 2012, p.184). If a robot fails or something goes wrong, the robot can be understood as accountable. However, we cannot punish or make them responsible for their actions. Because they are autonomous or semi-autonomous, it is difficult to allocate blame when something goes wrong (van Wynsberghe, 2013b, p.438). Legally, the situation regarding accountability of such care robots also requires further clarification.

4.4. Robots and ethical issues in the quality of care

After integrating into the care environment, care robots will also affect the care context and the quality of care. Healthcare quality is defined as the degree to which health services for individuals and populations increase the likelihood of desired health outcomes (Institute of Medicine, 2001). In this report, six dimensions (target improvements) of quality are emphasised: safety, effectiveness, patient-centeredness, timeliness, equity and efficiency. In different countries, a range of additional dimensions of care that are assessed such as acceptability, accessibility, care environment and amenities, competence or capability, continuity, expenditure or cost, efficiency, governance, equity, and sustainability (Kelley & Hurst, 2006). Health professionals, health care organizations, patients and governments have ethical responsibilities to cooperate in maintaining and improving the quality of health care. The government also has ethical responsibilities with respect to the quality of care (Baily, et al., 2006).

The context of care robots is the social and health care environments. We can compare the effects of human carers and care robots on the quality of care. Because the design process and features affect the implementation, both will be evaluated in terms of target improvements and conflicting ethical values.

4.4.1. Efficiency

In a care setting, efficiency comprises the determination of the optimal level between obtained results and consumed resources to produce maximum benefits (Kelley & Hurst, 2006). The cost of looking after elderly patients into old-age is a problem that is a worry for many countries around the globe (van Wynsberghe, 2013b). The creation of robots in care settings was designed to address future resource shortages and the fact that there will be fewer carers for an ageing population (van Wynsberghe, 2013a, p.408). The use of robots may provide a benefit to the healthcare industry, by providing caring organisations and their care staff with the tools to adapt to this emerging demographic crisis (Wada, et al., 2008; Ljungblad, et al., 2011).

For the health and social care context, a robot can provide multiple different functions that would require many different healthcare professionals and carers to fulfil. With current capabilities of care robots, a single robot would usually be assigned to each patient, instead of being responsible for many different patients like carers often are, and accordingly patients are not left waiting while staff are too busy elsewhere (Sorell & Draper, 2014; Feil-Seifer, et al., 2007).

The use of robots can help human carers to: carry out their tasks, decrease required care time, relieve physical strain, reduce the number of caregivers needed and may help carers to provide better quality care (Feil-Seifer, et al., 2007 p.432; Mordock, et al., 2013 p.19; Decker, 2008 p.322; Sorell & Draper, 2014 p.188; van Wynsberghe, 2013b; Moon, et al., 2012). Also, the use of robots may also cause caregivers to behave more honestly in their jobs because of fear of being monitored or replaced by the robot (Prescott, 2013).

Robots also may free up resources for carers by alleviating some of the communication needs of patients (Dautenhahn, et al., 2015). Some particularly communicative patients may use up a lot of a carer's time and resources, so having a robot to partially accommodate the patient may allow the carer to provide better quality of care to more patients, lead to less strain on their resources, and provide constant social interaction for patients in need of such communication . It may also prove beneficial to the patient to be able to communicate with the robot whenever needed and also to have a digital interface with their healthcare professional through the care robot. It could allow them to interact digitally with specialist healthcare staff thereby optimising the use of health care resources, employing their time more efficient for more patients, saving on costs of travel, and generally lower the cost spent on health care professional resources within the system (Luxton, 2014).

In a study, there was evidence that robot experts were aware of general resource shortages in care settings such as long hours, less staff, increasing aged population, however they were comparatively less aware of the specific needs of nurses and other primary care staff (van der Plas, et al., 2010, p.307). During the design of the robots, there is a need to take into account the needs of carers and the resources required to meet them (van Wynsberghe, 2013a p.419).

The use of robots in the home will allow elderly patients to choose to stay in their homes which may give care homes greater resources to concentrate towards those that want to go into care (Sparrow & Sparrow, 2006 p.147), potentially improving overall satisfaction with residential care.

Robots may also provide significant help to family carers looking after patients with dementia (Mordock, et al., 2013 p.19). The family may be less burdened with worry and responsibility to take care of family members as a result of robotic assistance (Sharkey, 2014, p.70). Caregivers can give instructions to robots to alleviate some strain on themselves. Women are typically caregivers, so robots could make their job less burdensome by alleviating some of the mental and physical strain involved in performing these care tasks (Borenstein & Pearson, 2010 pp.283-284).

In a study, the estimated cost of health care for a patient with dementia has been identified as $33,000 a year, with a life expectancy of eight years (Wada et al., 2008 p.59). For now, replacing human carers with robots is not more cost effective, as human carers are comparatively cheap and versatile whereas robots are still extremely expensive and more limited in their functions (Sparrow & Sparrow, 2006 p.150).

Some robots will require additional personnel to operate them, thus causing greater costs in the use of the robot. Because robots are expensive, they are mostly confined to healthcare facilities rather than being used in home settings, although theoretically their most beneficial use would be in the home setting (Yakub, et al., 2014, p.9, 10).

Very often robots will break down, malfunction, and will also require the training of human carers on how to use them. This will require resources and effort to ensure their optimal running. As we know from our current machines and computers, we often need to hire technicians or experts to show us how to work them properly. The same will happen for healthcare staff who need to be trained-in on how to use the assistive robots (Yakub, et al., 2014).

Whether robots are cost effective depends on a number of different considerations. Patients currently seem to expect them to be overall cost-effective. In some studies on the issues, some patients stated that they would expect it to be more economical to have a robot than hire someone (Wu, et al., 2014 p.9), and they also compared the cost of a robot to the cost of maintaining a living pet (Sorell & Draper, 2014). Cost-effectiveness might also be related to telepresence and the improved access to healthcare that it might allow, insofar as they might be able to communicate their issues via the robot as opposed to having to travel in person to see to a consultant (Luxton, 2014, p.8).

Potential users may not see robots as being worth the large cost while others may see them as worthwhile to save themselves the burden of doing annoying household chores (Decker, 2008, p. 316). It is important for users to analyse carefully whether or not their use of robots is as cost-effective as they first think; it might still be more cost-effective to hire a carer to achieve the same care goals (Dahl & Boulos, 2013, p.12). For example, smaller companion robots are often cheaper and easier to maintain than larger assistive robots, so it is important to identify which type of robot is required by the patient - whether it is solely for companionship/communication or if they require other assistance (Sharkey, 2014).

The current technological developments in robotics do not yet allow for robots to be used widely at present (Martin, et al., 2013, p.194). The efforts for designing robots to be as minimal as possible in order to reduce expenses for the patient ($2000, with an aim for $1000), if successful, might make them more affordable and allow for wider accessibility and distribution (Lowet & van Heesch, 2012, p.21).

However, just because robots can do particular tasks, it does not mean that they should be employed to do so. Efficiency should not come before ethical care, therefore the design and functionalities of any proposed care robot need to be assessed carefully not just from a cost effectiveness perspective but also from an ethical viewpoint as well (Borenstein & Pearson, 2010, p.284).

SUMMARY: Ethical evaluation for care robots in terms of efficiency	
Positive Sides	**Negative Sides**
Care robots were designed to address future resource shortages and provide tools to adapt to the emerging demographic crisis	*Extremely expensive and comparatively limited in their functions*
A single robot would usually be assigned to each patient and patients are not left waiting while staff are too busy	*Require additional personnel to operate causing greater costs. (applies only to some robots)*
Robots help carers to provide better quality care via carrying out routine tasks, decreasing required care time, and relieving physical strain	*Lack of reliability of current robots, can break down and malfunction*
Use of robots can reduce the number of caregivers needed, particularly relevant given demographic trends	*Robots require training of human carers on how to use them.*
Caregivers might behave more honestly in their jobs because of fear of being monitored or replaced by the robot	*Require technicians or experts for maintenance and education*
Robots may decreases the communication needs of patients with carers by providing immediate access technologies.	
Directly interact digitally with specialist healthcare (through telepresence); saving on costs of travel, and decreasing the cost spent on professional resources.	
Allowing elderly patients to choose to stay in their homes; improving overall satisfaction with residential care, freeing greater resources for care settings.	
Reducing care burden and mental and physical strain for family members	
Efficiency should not come before ethical care, therefore the design and functionalities of any proposed care robot need to be assessed carefully not just from a cost effectiveness perspective but from an ethical viewpoint as well.	

4.4.2. Effectiveness

Effectiveness is the degree to which expected high outcomes are reached when appropriate evidence-based health care services are given to beneficiaries (Kelley & Hurst, 2006).

It has been argued that the use of robots would allow patients to stay independent for longer and some users welcomed the prospect of such assistance (van der Plas, et al., 2010, p.310). Robots allow specifically for the protection of autonomy because they enable patients to remain in their homes longer, feed themselves, and retain control over their own actions (Kemna & Does, 2006; Nylander, et al., 2012; Salvini, 2015). Robots may also allow patients greater control over their lives by giving them knowledge and confidence in their actions (Shibata, 2012).

Giving robots instructions may reduce physical pain, distress, and embarrassment about not being able to perform daily activities like bathing, toileting, and feeding. Certain robots will allow individuals to be more mobile and provide them with greater ability and freedom of movement (Sharkey, 2014; Feil-Seifer, et al., 2007; Coeckelbergh, 2012b). Patients may become less violent, hostile, and demanding on caregivers while using care robots (Shibata, 2012). The benefits to patients could include increased well-being, reduced stress (Shibata, 2012; Coeckelbergh, 2012a), immune response improvement (Broekens, et al., 2009) and reduction of loneliness (Sorell & Draper, 2014). Also, the use of robots may also provide more reliable and convenient access to medication, instead of relying on forgetful busy carers (Borenstein & Pearson, 2010).

Often elderly patients will not admit their need for support but they will use it when it is provided for them. Carers need to be aware of this fact when receiving feedback from users (Wu, et al., 2014, p.12).

If the patient establishes a good helper-help receiver balance with the robot, it will increase the patient's self-respect and ability that they can retain the ability to carry out functions (Lammer, et al., 2011 p.3; Sharkey, 2014 p.70).

At present, there is a high level of neglect and physical, mental and financial abuse of patients by carers (Sharkey & Sharkey, 2012a; Prescott, 2013, p.3; Borenstein & Pearson, 2010, p.286). The use of robots may amend some of these issues by allowing carers more time and less stress in their workplace to concentrate on the quality of care when robots are taking over many menial, repetitive and boring jobs (Sharkey, 2014, p.72; Vallor, 2011, p.255; Prescott, 2013, p.3; Borenstein & Pearson, 2010, p.286). This might also give caregivers greater self-respect and allow them focus more on the more important tasks (Feil-Seifer, et al., 2007; Salvini, 2015).

The robot's presence in the home acts as a multi-functioning (companion, helper and enabler) humanoid appearance that establishes a co-presence with the user. The robot is more interactive than other technologies, like a television, and can potentially enhance the patient's social skills. The robot can also provide comfort to the user by simply being there (Sorell & Draper, 2014 pp.188-190).

However, some of the negative effects of robots on human well-being may include the fear that the robot might attack or harm individuals (Kidd, et al., 2006); fear that if they malfunctioned they would harm patients (Mast, et al., 2010); emotional distress if they break or are taken away (Riek & Howard, 2014); or their effect on potentially malignant social psychology (Metzler & Barnes, 2014).

Also, patients may not get the same psychological benefit of giving instructions to robots as they would to human beings (Sparrow & Sparrow, 2006). The social interaction between carer and patient would be lost if the robot intervenes to perform these tasks instead (Sparrow & Sparrow, 2006, p.151). This could have a negative effect on both the physical and psychological wellbeing of the patient (Bogue, 2013, p.523). It is difficult to guess what will be the effect of using robots in the future on social interactions and relationships (Decker, et al., 2011, p.39). There is the problem that by replacing humans with robots, there will be a loss of the interpersonal experiences of emotional warmth, friendliness, or helpfulness from carers (Decker, 2008, p.316). When patients give instructions to robots, they lose out on the love and care received from human caregivers (Moon, et al., 2012, p.10).

There is still a requirement for human carers to intervene and persuade patients to do certain things. While motivational interactions have been successful in rehabilitation robots, robots generally lack the capability to persuade more adaptively, like a human being (Draper, et al., 2014, p.140). If caregivers are replaced by robots, it will also diminish their capacity to empathise with the cared-for, through having less interactive opportunities, and this might affect the dignity afforded to both. As Vallor cautions, the capability of prudential reason seems to require for full realization of its deep acquaintance with caring relations, not only from the standpoint of the cared-for but also from the standpoint of the caregiver (Vallor, 2011, p.264). Robots may also be expected to have the same capacities as human carers and be able to notify care staff when there is a need for help. However, the robot may not in fact have these differentiated capabilities, potentially resulting in the patient's need for help going unheard (Feil-Seifer & Mataric, 2011a, p.28).

The effectiveness of care robots will depend on their improved functionalities such as physical, psychological and social assistance. There needs to be more clinical trials done to test the efficacy of robots (Mordock, et al., 2013, p.19). When designing a robot and their actions, it is important to evaluate whether or not they are bringing any benefit to the patient's life through quality-of-life measurements (Feil-Seifer, et al., 2007, p.433). Also, before marketing a robot, it is important to identify what could possibly go wrong, whether or not the robot’s actions will benefit patients, and what changes could occur because of their actions (Stahl, et al., 2014, p.77).

SUMMARY: Ethical evaluation for care robots in terms of effectiveness	
Positive Sides	***Negative Sides***
Allow patients to stay independent for longer	*Patients might fear being harmed by the robot*
Improving autonomy because they enable patients to remain in their home longer, feed themselves, and retain control over their activities of daily life	*Risk of harm if robot malfunctions*
Allow patients greater control over their lives by giving them support and assistance and greater confidence in their actions.	*Potential emotional distress if robots break or are taken away*
Reduce pain, distress, and embarrassment about daily activities.	*Potentially malignant social psychology*
Allow patients more mobility and provide greater freedom of movement.	*Patients may not get the same psychological benefit from interacting with robots as they would to human beings*
Patients may become less violent, hostile, or demanding of robot can provide timely care and assistance when needed.	*There will be a loss of the interpersonal experience of emotional warmth, friendliness, or helpfulness from carers.*
Increased well-being, reduced stress improved immune response, decreased loneliness of patients.	*Patients lose out on the love and care received from human caregivers.*

SUMMARY: Ethical evaluation for care robots in terms of effectiveness (… continued)	
Positive Sides	**Negative Sides**
Provide more reliable and convenient provision of medication	*If caregivers are replaced by robots, it will diminish their capacity to empathise with thepatient. (might affect the dignity of patients)*
Increased self-respect and ability to carry out functions (if the a good balance between support and the patient's own activities is achieved)	*Robots cannot interpret human needs and communications reliably in their context of meaning potentially resulting in the patient's need for help going unheard.*
Contribute to the prevention of negligence and abuse of patients by carers by potentially allowing more time for care and a less stressful work profile for carers.	
May give caregivers greater self-respect if more satisfying activities of care become predominant and allow them to focus more on the more important tasks of care.	
Establishes a continuous co-presence with the user, also potentially providing comfort to the user by simply being there.	
More interactive than other technologies and could potentially enhance the patient's social skills through active engagement of patient in interactions.	

4.4.3. Patient centeredness

Patient-centeredness means providing care that is respectful of and responsive to individual patient preferences, needs, and values, and ensuring that patient values guide all care decisions (Institute of Medicine, 2001). Acceptability is conformity to the wishes, desires, and expectations of care users and their families and is often presented as a part of or a substitute for patient-centeredness (Kelley & Hurst, 2006). In our context, we slightly extend the scope of the patient as the recipient of care more generally.

To evaluate the acceptability and patient-centeredness dimensions of care robots, the capability approach may be a useful framework for the evaluation of the use of technology in the care of older people (Misselhorn, et al., 2013). This approach give us an opportunity to handle the expression of the ethical implications in terms of robot design and implementation and users' characteristics such as age, gender, race, ethnicity, personality and cultural differences (Ljungblad, et al., 2011).

Age is an important factor to evaluate the effects of care robots as an indirect indicator of possible age-dependent medical and psychological conditions. An ethical evaluation of the use of new technologies must take into account age-specific physical, psychological and social characteristics (Misselhorn, et al., 2013). In childhood, physical and psychological development is easily affected by functional and aesthetic components of robots (Pearson & Borenstein, 2014). In the age of old and the oldest-old similar effects result, due to increasing physical, social and cognitive frailty in this population.

In a recent study, contrary to the common misunderstanding of the carers and the stereotype that "elderly people are resistant to technology and change", elderly patients did not mind robots being in their home (Draper, et al., 2014, p.138). In another study, older people reacted very similarly to middle-aged people with regard to the robot, despite having far fewer computer skills or abilities (Decker, 2012, p.193). In yet another study, patients claimed that they would not need robots nor desired to have them in the future. They put the need for robots onto others, those that were sicker, older, or lonelier (Wu, et al., 2014, p.8).

A person's personality type might give some indication of how that individual will respond to a robot. For example, introverted persons prefer more mechanical-looking robots, whereas extroverts prefer a more human-looking robot (Pearson & Borenstein, 2014).

Patients' perspective on robots are reliant on different cultural and religious attitudes, and not solely focused on what is most economical or efficient (Stahl, et al., 2014, p.82). Some authors proposed that, in Japan, because of Shintoistic animism, there is a "robophilia", while there is a "robophobia" in Christian Europe (Mushiaki, 2013; Cornet, 2013). Japanese culture embraces robots more than many other cultures (Veruggio & Operto, 2008, p.1512) and there are prominent attempts in Japan to try to create robots that appear as human-like as possible (Mordock, et al., 2013; Parks, 2010). Patients may feel more comfortable around robots than around carers with different cultures to themselves (Salvini, 2015). In Japan in particular, there is a culturally grounded unease with hiring immigrants in the care professions (Šabanović, 2014, p.358), and robots are perceived to be a more suitable solution to the problem of care provision. It has been argued that in Japan, robots are not just perceived as mere artefacts that we are controllers of or that might threaten deeply held values like autonomy or the dignity of users (Šabanović, 2014, p.323). In contrast, North American culture sees robots with scepticism, in a more cautious and uncertain light, often preferring animal-assisted therapy instead of robot-assisted therapy (Mordock, et al., 2013, p.15).

Physical and mental issues are the key points that must be considered to determine possible ethical issues (Sharkey & Sharkey, 2012a). Patients view robots differently depending on what kind of condition or impairment they are suffering from (Feil-Seifer & Mataric, 2011a). Some patients like the presence of robots (for example in postpartum units, or among Alzheimer's patients) and some do not (for example cancer patients) (Feil-Seifer & Mataric, 2011a, p.26; van Wynsberghe, 2013a p.421).

Designers should be respectful of the different types of users, different environments, and different situations for the robots to function in (Salvini, 2015, p.434). Because of these differences, there should be a close collaboration between planners and users in the design stage, the integration of those affected, and tools to provide training and education (Decker, 2012, p.183). Robot experts sometimes overlook the needs of the patient in their enthusiasm to develop robots with new functionalities (Broadbent, et al., 2012, p.115). It is important to incorporate the users' feedback in the development loop (van der Plas, et al., 2010, p.303) and address the potential psychological, physical, and emotional impacts of the robots (Roger, et al., 2012, p.92) as well as users' and more generally societal ethical concerns, as realised in the value sensitive design methodology. Products should be easily adaptable to changing needs and usable by all, and standardized interfaces should be developed to be capable of being accessed by specialized users (Decker, 2012, p.186). Also, the design team needs to have a clear idea of who exactly the potential users might be and the characteristics of people who might be interested in acquiring or using a robot (Parlitz, et al., 2008, p.6).

While using care robots, some activities of patients may be restricted (Sharkey & Sharkey, 2012c). Sometimes, there may be a conflict between the instructions of the carer and the decisions of the patient. Robots may be used in a paternalistic way to curb a patient's autonomous decision-making (Draper et al. 2014; Jenkins and Draper 2014). Designers should place the users' concerns first when designing robots, not the caregivers', relatives', or another stakeholder's. There should also be adequate safeguards put in place to protect humans from the robots (Borenstein & Pearson, 2012, pp.251, 259).

Patient-centred care proposes to allow a patient to make an informed decision, taking into account his/her preferences and knowing the harms and benefits of a particular activity. Monitoring with robots may create a particular problem because the patient may not have been made aware of information about the robot's functioning and capabilities (Nylander, et al., 2012; Feil-Seifer & Mataric, 2011a). At this point, proper informed consent has a great value, and even if in the case of dementia cognitive capacity raises challenges for the realisation of informed consent. The balance between the respect of individual freedom including privacy, dignity and security can be achieved if an adequate informed consent process is realised that involves the beneficiaries or, if not possible, their representative (Cornet, 2013). Assisted decision-making for persons with cognitive impairments requires much sensitivity and adjustment to the patient's needs and capacities.

SUMMARY: Ethical evaluation for care robots in terms of patient centeredness	
Positive Sides	***Negative Sides***
There is a "robophilia" in Japan culture and Japan patients may feel more comfortable around robots than around carers.	*There is a "robophobia" in Western and North American cultures.*
In postpartum units, or Alzheimer's units patients like the presence of robots.	*Cancer patients don't like the presence of robots.*
	Physical and psychological development is easily affected by robots during specific developmental stages like childhood, age of old and the oldest-old.
	Robot experts sometimes overlook the needs of the patients.
	While using care robots, some activities of patients may be restricted
Patients' perspectives on robots are reliant on different cultural and religious attitudes, and not solely focused on what is most economical or efficient. *Informed consent about care robots provides the balance between the respect of individual freedom, including privacy and dignity, on the one hand and security and health on the other hand.*	

4.4.4. Safety

Safety is the degree to which care systems protect adverse and unexpected damaging outcomes or injuries that originated from within itself (Kelley & Hurst, 2006). Also, safety is an ethical value already addressed in the work of roboticists to conform to existing International Organization for Standardization (ISO) standards and regulations (van Wynsberghe, 2013b).

In some cases carers can use specific remote controls to give instructions to a robot for carrying out specific tasks and functions (Martin, et al., 2013; Mast, et al., 2015; Goodrich, et al., 2013; Moon, et al., 2012). The use of robots to perform actions such as lifting, moving, carrying, and assisting may help carers to perform physically-demanding care jobs where they would have previously sustained injuries, pain, and discomfort from doing them alone (Parks, 2010; Mast, et al., 2010; Goodrich, et al., 2013). This promotes both the safety of the carer but it also protects the patient - i.e. the carer dropping the patient (van Wynsberghe, 2013b). Caregivers can monitor the patient through the robot instead of just leaving them with it, so as to ensure their safety. Robots may also stop a person from going out of their home to prevent potentially harmful wandering.However, such intervention for the sake of safety might instead be perceived as inappropriate infringement on liberty, a de facto imprisonment within their home that infringes on their autonomy (Sharkey & Sharkey, 2012b pp.2-3).

Recording robots can also identify specific past patterns of visits, for example what is the best time to visit a patient, and to keep records of who is visiting and when for safety reasons (Garzo, et al., 2012).

In some studies, patients did not want care robots in case they malfunctioned and caused them harm (Mast, et al., 2010, p.2). Therefore, robots need to be designed to be durable, light and have a user-friendly interface (Bogue, 2013). Socially assistive robots are generally considered to be safer than their physically assistive counterparts because there is less physical involvement between patient and the robot (Feil-Seifer, et al., 2007, p.427).

Some robots may be in danger of getting broken during therapy, so robot designers need to be aware of this and to design them adequately for their purposes (Wada, et al., 2008, p.59). Many carers do not want robots to take over their specialised roles in certain tasks such as catheterisations, helping with eating, and injections. They believe there is a high risk of harm to the patient unless these are performed by experienced human carers (Kemna & Does, 2006, p.13).

Roboticists should make sure that they follow precautionary procedures and ensure robots are traceable and identifiable, for the safety of patients (Veruggio & Operto, 2008, p.1512). There needs to be an awareness that elderly users may not be able to follow the instructions as well as a younger person or have efficient use of the system and thereby might be in greater danger of harm if safety depends on the correct use of the robot (Decker, et al., 2011, p.35).

This raises the general concern of how the robots will be designed to interact with humans outside of more predictable laboratory situations, whether or not they will be able to perform as well in often chaotic real-life situations as those regulated by the scientist and technician (Feil-Seifer, et al., 2007, p.427).

SUMMARY: Ethical evaluation for care robots in terms of safety	
Positive Sides	***Negative Sides***
Provide increased safety for caregivers and patients during physical activities.	*Intervention for the sake of safety might instead be perceived as inappropriate infringement on liberty and autonomy.*
Prevent potentially harmful wandering and/or help to locate patients more easily.	*Malfunctioning robots may cause harms*
Provide safety via monitoring external environments and recording.	*There may be a risk of harm to the patient during specialised medical interventions.*
	If robots depend on correct use, older people with dementia might be in greater danger of harm
	For chaotic real-life situations, the general concern whether the robots will be designed to cope.

4.4.5. Competence (capability)

Competence or capability describes the level of education and ability of health care personnel to communicate effectively with patients and consumers in their professional efforts (Kelley & Hurst, 2006).

Often there is a lack of trained personnel, which may make it harder to adopt robot technology (Dahl & Boulos, 2013, p.12). In the robotic care context, caregivers need to be provided with more training in order to understand how to use and implement robots in care practices more effectively (Rabbitt, et al., 2015, p.25), (Roger, et al., 2012, p.92). It has been argued that once staff were adequately trained to use robots, then their attitudes about robots would change (Broadbent, et al., 2012, p.119).

However, carers should not have to fear that their jobs are at risk or that they will soon be replaceable by the robots they are giving instructions to. When robots are introduced into care contexts, it is important that efforts are made to communicate with carers that the robots are tools to allow them carry out their jobs more effectively, rather than being competitors for their jobs (Decker, 2008).

SUMMARY: Ethical evaluation for care robots in terms of competence	
Positive Sides	***Negative Sides***
	There is a lack of trained personnel in care settings, and it makes harder to adopt robot technology.
	In the robotic care context, caregivers need to be provided with high quality training in order to upskill.
	Carers can feel their jobs are at risk or they will soon be replaceable by the robots.

4.4.6. Equity, accessibility and sustainability

Equitable care means to ensure that the quality of care does not vary because of characteristics such as gender, ethnicity, socioeconomic status, or geographic location (Institute of Medicine, 2001). Accessibility is the ease with which health services are reached. Accessibility can be expressed as physical, financial, or psychological capabilities required to reach given care services (Kelley & Hurst, 2006). Sustainability is the capacity to provide personnel and material infrastructure to produce innovative solutions in response to new needs (Kelley & Hurst, 2006).

There are not enough robotic technological developments to allow for robots to be used widely at present (Martin, et al., 2013, p.194). Efforts to design robots to reduce expenses for the patient will make it more affordable and allow for greater access to more people (Lowet & van Heesch, 2012, p.21). However, instead of becoming more widely available, robots may end up as personal luxury items in the future and, as with other novel health technologies, a further division between rich and poor, developed and developing countries, may result (Coeckelbergh, 2012b, p.80). It needs to be considered who receives robot care and in what contexts, and whether those with the greatest need actually have access to them.

Today, because robots are expensive, they mostly are confined to healthcare facilities rather than being used in home settings (Yakub, et al., 2014, p.9-10). Users can become quite attached to robots (Rabbitt, et al., 2015, p.28). For example, soldiers might be sad at the loss of their robot (Borenstein & Pearson, 2010, p.283) or patients might become distressed when they are taken away for repair (Feil-Seifer & Mataric, 2011a, p.27).

The expectation of quality and sustainability of robotic care is an important issue (Coeckelbergh, 2010; Sparrow & Sparrow, 2006). Also, patients need to be told that robots may need to be taken away to be repaired or replaced, so they are not unprepared if robots will only be available to them for a limited time (Feil-Seifer & Mataric, 2011a, p.28).

SUMMARY: Ethical evaluation for care robots in terms of equity	
Positive Sides	***Negative Sides***
The efforts for designing robots to reduce expenses for the patient will make them more affordable and allow for greater access to more people.	*There are not enough robotic technological developments to allow for robots to be used widely at present.*
	Instead of becoming more widely available, robots may end up as personal luxury items in the future and further increase the divide between rich and poor.
	Users can become quite attached to robots and might become distressed when they are taken away for repair or finishing of the research.

4.5. Robotic functionalities for care improvement

Care robots' functions that are intended to improve human capabilities may affect three aspects of human integrity, understood according to the biopsychosocial model, i.e. physical, psychological and social. Design and implementation decisions must be made in ways to promote their health in relation to those three dimensions (Pearson & Borenstein, 2014; Riek & Howard, 2014).

4.5.1. Physical and environmental assistance

The ***physical aspect*** of human beings is the biological and external (environmental) aspect of their being. Care robots can monitor, remind and support users against environmental harms. Specifically, in the health care context, robots can be effective and efficient for monitoring health parameters, reminding users to take medications, or making interventions and assessments.

Affecting the physical dimension may have a significant impact on patients, insofar as this may directly restrict or harm their capabilities and skills. Therefore, it is an obligation to balance the potential physical health benefits with other ethical values and concerns.

4.5.1.1. Ambient awareness and monitoring

Some effective monitoring methods include LED displays to notify users, sensors to identify falls or emergencies, and monitoring pill-taking and falls and notifying someone when required (Jenkins & Draper, 2014).

Monitoring with robots has the potential to enhance or infringe upon a patient's autonomous choices and actions. They may allow patients to age in their homes instead of being forced to go into nursing homes (Salvini, 2015). Robots that monitor patients allow for greater freedom of choice than outside monitoring or constant internal monitoring. There may also be a differentiation in cultures and how they view monitoring robots, i.e. in Japan they may be seen as more dignity-preserving (Parks, 2010), while in Western cultures robots may be seen as potentially disrespectful to older people (Sparrow & Sparrow, 2006).

Monitoring with robots can help elderly people feel more protected and safe because they can alert others when they are in danger (Sharkey, 2014, p.70). For example, robots can record patterns in door opening times and hours (Sorell & Draper, 2014, p.186). In some studies, participants wanted to implement sensors to monitor when there may be an emergency such as a fire (Garzo, et al., 2012, p.73), or the use of LED display panels to identify potentially hazardous situations for the user (Koay, et al., 2014, p.472). But, there is the possibility patients will take greater risks if they are being monitored because of the comfort that someone will come to their rescue if they are in need or are harmed (Caine, et al., 2012).

Depending on the seriousness and immediacy of threats, certain robot interventions may not constitute infringements of autonomy. For example, it is not an abuse of autonomy if the robot intervenes to cut off the water supply if it is connected to flood support, and to wait until the user tells it what to do next (Sorell & Draper, 2014, p.192).

Monitoring with robots can be used to both protect/ensure and harm a patient's dignity (Cornet 2013, p.5). They can monitor a patient in case they fall or hurt themselves and call for outside help when appropriate, rather than leaving the patient suffer needlessly and embarrassingly on their own. However, a patient's dignity must be ensured by allowing adequate control over what is deemed to be within the scope of the user’s decision-making ability and/or considered an acceptable risk, i.e. a minor fall where users are not hurt and can manage it themselves.

Monitoring robots also can implement respectfulness towards patients by ensuring that they have a sufficient level of privacy. This should be dictated by the user and settings adjusted to individual needs. Also, robots should not constantly follow patients around while monitoring them and should have functions to demonstrate when they are monitoring and when they are not.

Robots can be programmed with certain rules and functions but it is difficult to program them so that they are able to tell the difference between a real potential threat of harm to the patient and when they are prohibiting the patient from doing something that may be of no harm to them or constitute a worthwhile activity, despite containing some degree of risk (Sharkey & Sharkey, 2012c, p.272).

Monitoring with robots may infringe on the privacy of the patient by monitoring them when they think they are in private (Sharkey & Sharkey, 2012a; Sharkey & Sharkey, 2012b). It may also lead patients to feel that they must conceal and hide things even when they are not being monitored, thus making them potentially paranoid and fearful. However, some claim that there will always be trade-offs between privacy and the protection of the patient, and it is simply a matter of finding an ethically acceptable level (Sorell & Draper, 2014; Coeckelbergh, 2010; Salvini, 2015).

Also, a monitoring robot does not infringe on privacy any more than a nurse giving a patient a bath, AAL monitoring or CCTV. In fact, many claim that a moving monitoring robot is far less invasive than unwittingly being video-recorded through CCTV or AAL (Broadbent, et al., 2012, p.117; Sparrow & Sparrow, 2006, p.147; Lowet & van Heesch, 2012, p.24; Caine, et al., 2012).

Robotic functions may support and empower people to accomplish their daily life functions. At the same time, these additional capabilities may cause new and unforeseen risky situations. For example, when we support users’ mobility by the use of robots, we also need to take measures to protect them from the potentially dangerous situations that they might encounter as a result (Sharkey & Sharkey, 2012a).

SUMMARY: Ethical evaluation for care robots in terms of ambient awareness and monitoring	
Effect on humans	***Results***
Warning against threats and possibility of calling for help when required allow patients to stay longer independently in their own homes	*Protect/ensure patient's well-being,* *Enhance patient's autonomous choices and actions*
Patients may take greater risks because they feel more protected and safe	*Safety risks*
Contacting health care staff of family members when critical events occur against the wishes of patient or preventing the patient from doing something that may be of no great harm to them	*Infringe patient's autonomous choices and actions*
Allow for greater freedom compared with constant human monitoring.	*Improve autonomy and potentially privacy*
Allowing control to patients regarding they everyday actions and decisions may increase feeling of control	*Improve dignity*
Monitoring patients when they think they are in private or constantly following.	*Infringe privacy*
There is a trade-off between privacy and the protection of the patient and an ethically acceptable level needs to be found. Safety need not always be the overriding value.	

4.5.1.2. Medical monitoring and assessment

Monitoring with robots may be beneficial for patients that want to remain in their home longer. The use of monitoring robots and telecare will allow those who want to remain at home to do so. They will also allow online communications between carers, doctors, and patients, which will reduce travel costs and time lost between travelling (Sorell & Draper, 2014).

For family members as well as physicians, care robots could be a way to have immediate access, via the robot cameras, to what a person is doing (care-receiver or caregiver). Monitoring their relatives, patients and the people looking after them, as well as having a means to directly interact with the person in need (via audio and video implemented in a mobile base) can also contribute to family members' peace of mind (Salvini, 2015).

Robots can monitor vital functions, asthma levels, heart and lung functioning and diabetes and report incidences when they occur. This can help elderly people feel, and be, safer in their environments and also alert carers to the need for early intervention when required (Sorell & Draper, 2014, p.186; Borenstein & Pearson, 2010; Decker, 2008, p.322). The use of monitoring robots can allow patients to remain in their homes longer than would otherwise be possible (Roy, et al., 2000, p.2).

Monitoring can reduce the "burden" of care by reducing anxiety, the number of visits required, and the amount of ongoing care required. Also the use of robotics may force carers to treat patients with better care because they are being monitored (Jenkins & Draper, 2014, p.182; Sharkey, 2014 p.70). Robots can monitor the number of visits users have and can predict the number of visits that they are expected to have in the future, and they can also monitor their mood during these times to assess when it may be an appropriate time to visit and when they are likely not to appreciate visits (Garzo, et al., 2012, p.73). More generally, robots can monitor the emotional state of patients and become aware of when they are happy or sad (Broadbent, et al., 2012, p.117). This may allow for better allocation of health resources (Stahl, et al., 2014, p.77).

Constantly monitoring is one of the main burdens of caring for family members, so if a robot could alleviate some of this burden it would be very beneficial to family carers (Mast, et al., 2010, p.4). But if a person is severely impaired then it may not be ethical to leave them solely in the monitoring care of a robot; instead they would require higher levels of monitoring and intervention by human carers (Borenstein & Pearson, 2010, p.285). Also, there is a trade-off between privacy and effective care responses from allowing monitoring systems in the home (Sorell & Draper, 2014); privacy enhancing modifications of monitoring usually decrease the overall accuracy of the monitoring.

Monitoring robots can help prevent patients from falling, not being able to get up, or spending too long in the bathroom and can alert the attention of others for help (Nylander, et al., 2012, p.2; Roy, et al., 2000, p.2). Sometimes, the user wants to practice their autonomy by not alerting their carer when they fall, which may be a reason of conflict (Draper, et al., 2014, p.136).

Robots can record and monitor the use of medications. It can help improve the well-being of the patient by obtaining accurate information about them (Roy, et al., 2000, p.2; Sorell & Draper, 2014, p.184). While a robot can give medication, a doctor should monitor it doing so for the benefit of the patient (Feil-Seifer, et al., 2007, p.428).

Robots should not be left to monitor patients with dementia if it means that their overall social interaction will decline (Vlachos & Schärfe, 2014, p.282). In those cases, the benefits of robot monitoring would be offset by a resulting increase in social isolation.

Robots may also be able to avoid the human pitfalls of having a personal bias in a consultation. The consultant may access this more objective information from the robot later on, leading to better care for the patient (Luxton, 2014, p.7). Sometimes patients are also hesitant to tell the nurses or doctors what is wrong with them, while they may actually converse openly with care robots. Therefore, the use of robots might lead to improved accuracy of diagnosis, based on information that would otherwise not have been available (Shibata, 2012, p.2533).

SUMMARY: Ethical evaluation for care robots in terms of medical monitoring and assessment	
Effect on humans	***Results***
Allow patients to remain in their homes longer than would otherwise be possible through providing online communications between health care staff and patient.	*Protect/ensure patient's well-being,* *Enhance patient's autonomous choices and actions*
Patients feel, and and will be, safer in their environments.	*Improve patient's well-being*
Alert carers to the need for early intervention when required.	*Improve patient's well-being*
Reduce the burden of care by reducing the number of healthcare visits required, and the amount of ongoing care required.	*Better allocation of health resources*
Force carers to treat patients with better care because they are being monitored	*Improve patient's well-being*
Monitor the mood and cognitive state of patients and assess the best time for visits and interventions	*Better allocation of health resources*
Reduce the burden of care by reducing the concerns and efforts by family members	*Beneficial to the family carers*

SUMMARY: Ethical evaluation for care robots in terms of medical monitoring and assessment (… continued)	
Positive Sides	**Negative Sides**
Recording and monitoring the use of medications provides accurate information on adherence	*Improve patient's well-being*
If severely impaired person monitored only by care robot it may not meet their needs and potentially lead to harm.	*Risk for patient's well-being*
Medical monitoring by robot may reduce the overall social interaction and increase social isolation.	*Increase social isolation*
Consultant may access this more reliable and objective information.	*Improve patient's well-being*
Patients may converse more openly with care robots while hesitating to tell professionals	*Improve accuracy of diagnosis and patient's well-being*
Privacy enhancing modifications decrease the overall accuracy of the monitoring and there is a trade-off between privacy and effective care which requires careful assessment.	

4.5.1.3. External assistance

Different types of robots empower elderly and disabled people and caregivers in their daily activities e.g. lifting, carrying, feeding, clothing, cleaning, walking. Chin joypads, speech recognition, hand joysticks, and eye movement tracking are used (Sorell & Draper, 2014, p.188; Bogue, 2013, pp.520,522; Veruggio & Operto, 2008, p.1513; Martin, et al., 2013, p.199; Sharkey, 2014, p.72).

When the robot asks for help, users may feel empowered and entertained (Lammer, et al., 2011, p.7). But, if caregivers used robots to move patients in a way that results in them feeling like they are 'objects', this would affect the patient's dignity (Sharkey, 2014, p.70).

In home care settings a patient may prefer autonomous assistance robots instead of a human carer in order to promote their personal dignity by improving access and mobility, allowing greater freedom and independence, increasing autonomy, and ensuring better privacy (van Wynsberghe, 2013a, p.428; Sharkey, 2014, p.70; Sharkey & Sharkey, 2012a; Moon, et al., 2012, p.8, Kemna & Does, 2006, p.9; Nylander, et al., 2012, p.4).

In a study, carers said that they would not want robots to be used to wash patients as it would infringe upon patients' dignity (Kemna & Does, 2006, p.13). Despite the fact that being washed is often seen as an intimate moment where many would see their privacy being infringed upon, a lot of elderly actually enjoy the activity because they get to interact with their carers. This source of positive experience may be lost if robots replace this activity (Nylander, et al., 2012, p.2; Mast, et al., 2010, p.4)

The use of robots for daily activity may reduce physical pain and emotional stress in a patient (Sharkey, 2014, p.65). Carrying patients or lifting them is a heavy physical burden on caregivers, so the use of robots may help them dramatically with these actions (Mast, et al., 2010, p.4; Parks, 2010, p.109).

There is a relationship of trust between the carer, the care-receiver, and the robot, to provide safety and care to the patient (van Wynsberghe, 2013a, p.428). Robots that can lift people must be big, bulky, and heavy. But because of this there is the risk that if they fall over they may seriously harm or even kill the person they are trying to assist. Such robots also need to be made more durable and long-lasting because if one breaks down then it could seriously affect a person's well-being by not providing vital services or calling for assistance when required (Sparrow & Sparrow, 2006, p.145).

There is a need for caregivers to operate robots during lifting due to safety concerns. Delivering objects also requires teleoperation because of robot design, for example the lack of reliable object recognition (Goodrich, et al., 2013, p.202). Teleoperators can access the robot when the user is unable to or having difficulty using it themselves, so that they can remotely control it from a different location (Mast, et al., 2015, p.24).

Some patients may prefer robots assisting them as they feel a discomfort giving orders to a human carer (Feil-Seifer, et al., 2007, p.434). At the same time, getting a robot to respond to our request does not have the same social meaning and does not provide the same satisfaction and social recognition as if a human being was carrying out these tasks (Sparrow & Sparrow, 2006, p.152).

A greater control should be given to the patient over what is deemed an emergency or when others need to be contacted. User involvement to adjust robot functioning to their individual needs and values gives greater dignity to the patient, as there are times where they do not want/need outside help, for example over minor falls (Sorell & Draper, 2014, p.187). But, if the user has too much control over what functions the robot will perform, there may be other risks as a result. In addition to fall prevention, one rather remote risk that has been highlighted in this context is the risk that the robot may carry out problematic actions at the behest of the patient, for example support a patient in performing assisted suicide (Stahl, et al., 2014, p.81).

There is a lot of controversy in the literature about the effects on autonomy in robots that intervene and prevent the patient from acting in a certain way. While robots may have the potential to prevent individuals from getting into harmful situations (Sharkey & Sharkey, 2012a), to patients this may feel like they have even less control over their lives than before (Bogue, 2013). It is, however, unclear what trade-offs between freedom and well-being are permissible or desirable (Sharkey, 2014) and whether or not allowing robots to stop patients will lead to a slippery slope of robot-enforced imprisonment (Sharkey & Sharkey, 2012b; Sharkey & Sharkey, 2012c).

There are some additional issues regarding what is ethical and unethical intervention by a robot, especially with regard to what is considered overly paternalistic or just for the benefit of the patient. Specifically, for patients with dementia, robots that can intervene when they are about to walk into traffic (Sharkey, 2014); wander off by themselves (Sharkey & Sharkey, 2012b); or about to accidentally hurt themselves with a knife (Sharkey & Sharkey, 2012c); will be greatly beneficial to ensure their well-being when nobody else is around to help. They can also help by providing assistance with walking (Sorell & Draper, 2014); identifying obstacles and assisting them around them (Simonov, et al., 2012); or by doing housework/other chores (Veruggio & Operto, 2008).

A robot may not be programmed to understand the difference between when a patient understands a risk and consciously wants to accept it as opposed to when a patient is unaware and endangering themself needlessly. Using a robot to scold, chastise, or ignore patients when they are behaving poorly or being disrespectful can be seen as an abuse of the individual's autonomy and as treating them in a paternalistic, coercive, and patronising way (Draper & Sorell, 2014).

Robots must be designed so as not to physically harm the user when intervening. For example, if the robot falls on the patient, or breaks down in an inconvenient or dangerous position or location, this may actually present a greater harm to the patient's health than if they never used the robot at all (Sparrow & Sparrow, 2006).

SUMMARY: Ethical evaluation for care robots in terms of external assistance	
Effect on humans	**Results**
Autonomous assistive robots can improve mobility	*promote personal dignity and independence, increasing autonomy and privacy*
Robotic functions may support and empower people to accomplish their daily life functions when nobody else is around to help.	*Improve patient's well-being and dignity*
Intimate care activities by human carers sometimes embarassing to patients. Robot care can relieve this problem.	*Improve dignity*
Carrying patients or lifting them with robot support can reduce physical and emotional burden on caregivers	*Improve dignity, provide better service*
When patients are moved by robot they may feel they are treated like 'objects'	*Affect dignity, objectification*
A lot of elderly enjoy the interactions with their human carers. Robotic care may reduce this activity.	*Negatively affect patient's well-being, reduce social interaction*
If robot falls over it may harm the patient	*Negatively affect a person's well-being*
Some patients may feel more comfortable giving orders to care robot instead of a human carer	*Improve experience and effectiveness of care*
Robotic assistance does not provide the same satisfaction and social recognition comparing with a human carer.	*Negatively affect patient's well-being*
When robot intervenes to prevent the patient from an action, they may feel that they have less control over their lives.	*Decreased autonomy and freedom*
User involvement to adjust robot functioning may increase safety risks, especially given cognitive impairments of patients with dementia.	*Safety issues*
When user is involved in adjusting robot's functioning, they may feel they have control.	*Improve patient's dignity and self-control*
Robot may carry out problematic actions at the behest of the patient, for example being used for performing assisted suicide.	*Safety issues; raises autonomy issues*
Care robots may cause new and unforeseen risky situations	*Safety issues*

4.5.2. Cognitive and emotional assistance

The psychological perspective is another important aspect of human beings. Care robots can support the mental processes, feelings, thoughts and behaviours of people with various capabilities such as cognitively supportive games and applications, reminders, guidance, etc.

Caregiver robots can benefit people's lives and well-being, and allow them to enjoy their relationships with other people. Patients can communicate with robots to keep up their cognitive functioning to allow them to prevent a decline in brain functioning (Borenstein & Pearson, 2010, p.280). Communication with robots can have a therapeutic effect on the patient (Sorell & Draper, 2014), increase their well-being (Wada & Shibata, 2006), decrease their wandering at night (Shibata, 2012), maintain their cognitive functioning (Borenstein & Pearson, 2010), and improve their mood (Tapus, et al., 2007). They can reduce stress and anxiety while providing companionship and happiness to the patient (Sharkey, 2014; Martin, et al., 2013; Feil-Seifer, et al., 2007; Tapus, et al., 2009; Lammer, et al., 2014).

4.5.2.1. Psychological and cognitive support

The use of robots to play games with elderly patients and to keep them entertained, cognitively active, and happy are all likely to improve the well-being of the patient (Tapus, et al., 2009, p.6).

The robot may increase a patient's sense of dignity and identity by recording the visitors' and family members' name and information. If the patient has indeed received visitors, the patient may feel 'remembered' when they have access to such information despite experiencing memory problems. The stored information can be used to customize information to relevant situations and personal needs and requirements. However the reverse could also occur, where the patient feels a loss of dignity when information provided to the robot is not remembered or acknowledged. Another problem in this context may be that the robot does not use their title or name appropriately, or does not deal with them in a personal manner (Sharkey, 2014, p.66).

Support also does not need to mean that the robot does all the work for the user. For example, in a study, when patients gave the robot instructions, the robot was designed to come back to tell the patient where the keys were or that flowers looked thirsty, in order for the patient to do the tasks themselves. This activating approach kept the person active and aimed to ensure that the person was still feeling useful and able to engage effectively with some everyday tasks (Lammer, et al., 2011, p.8).

SUMMARY: Ethical evaluation for care robots in terms of psychological and cognitive support	
Effect on humans	**Results**
Robot facilitates patients to increase social contacts with family and friends	*Improve patient's well-being*
Care robots may help to keep up patients cognitive functioning, reduce stress and anxiety	*Improve patient's well-being*
Playing games provides entertainment to patients, and keeps them cognitively active and happy	*Improve patient's well-being*
Recording and reminding patient of names of social contacts and providing further information on them supports social integration	*Improved dignity and identity*
When robot does not use the recorded and stored names appropriately patient may feel disappointment.	*Decreased dignity*
Reminding patient of a schedule of enjoyable activities keeps the person active and patients may feel more able to engage effectively with everyday life.	*Improve well-being and social integration*

4.5.2.2. Robots as the medical reminder

Care robots can be built as a medical monitor and reminder for taking medications (Broadbent, et al., 2012, p.117; Sorell & Draper, 2014, p.184; Lowet & van Heesch, 2012, p.22). Giving instructions to robots may allow patients better access to their medication and reminders of when to take them (Borenstein & Pearson, 2010, p.282). But, while patients like to have reminders for medication, some of them may not like when the robot gives them reminders or instructions regarding other types of medical recommendations (like moving their leg to avoid ulcers) (Draper, et al., 2014).

SUMMARY: Ethical evaluation for care robots as medical reminders	
Effect on humans	**Results**
Medical reminder for taking medication provides patients with better and more consistent access to their medication.	*Improves effectivenss of care and improves patient's well-being*
Sometimes, patients does not like medical reminders.	*Feeling loss of freedom, lack of autonomy*

4.5.2.3. Navigation support

For advanced usability in care environments, robots need to be designed to navigate around particular environments and unintended obstacles, to move slowly, all for the safety of the user (Yakub, et al., 2014, p.9; Dahl & Boulos, 2013, p.14; Šabanović, 2014, p.351; Goodrich, et al., 2013, p.192; Kemna & Does, 2006, p.9). The robot should not always follow the user as this would likely be experienced as annoying (Garzo, et al., 2012, p.74).

The robots could be designed to interpret obstacles and things in the person's walking path and guide them through spatial recognition to their desired location. It could also alert caregivers or emergency personnel when there is a danger to the user (Simonov, et al., 2012, p.96) and may prevent persons with dementia from walking out into traffic or hurting themselves (Sharkey, 2014, p.71; Sharkey & Sharkey, 2012a). One potential danger in this context is that users might become too reliant on the robot and as an effect may show reduced attention to managing everyday challenges independently.

SUMMARY: Ethical evaluation for care robots in terms of navigation support	
Effect on humans	**Results**
If robot always follows user, user may feel annoyed	*Loss of control and freedom*
Continuous use of navigation support may reduce the patient's attention to manage everyday challenges independently	*Loss of capacity for independent action*

4.5.3. Social support and companionship

Human beings are also ***social* beings**. Many critics have highlighted that extensive interaction between humans and robots could have an effect on interpersonal social contact available to patients.

Current robots are only able to provide a poor form of communication and social interaction for the patient. They are not able to show compassion or empathy with our current levels of technology (Sharkey, 2014, p.65). The use of robots is therefore not to take over the communication between patients and carers but that they can help patients feel less lonely and isolated when there is a shortage of care staff/time to talk to patients (Dautenhahn, et al., 2015).

People would like to see their robots perform the following roles for them: friend, servant, pet, colleague, or tool. How these roles were perceived by individuals depended on their previous experience of ICT. People who primarily used computers for gaming wanted the robot as a friend or colleague (effectively, they seemed to consider the robot as potentially their equal). In contrast, those that used computers mostly for work wanted the robot to be clearly controlled, so they considered it primarily as a servant or tool. Those that used computers for social media and communication opted for the robot to be used as a kind of pet (Koay, et al., 2014, pp.473,474). A trial with a serious and a playful robot observed that patients communicated and listened more carefully to guidelines presented by the serious robot and felt it was caring about their health. In contrast, the playful robot was graded higher on realising certain personality traits (Kemna & Does, 2006, p.3).

Human interaction has proven to help alleviate depression and early death amongst elderly patients. Also, sometimes the only adequate response to a person's suffering is from another human understanding their frailty and human emotions (Sparrow & Sparrow, 2006, p.151). Because of the deeper meaning and significance of genuine and heartfelt human interaction, robots should not reduce levels of human contact (Draper, et al., 2014).

The effects of robots on social interaction of users can be conceptualised in terms of two main categories: the experience of companionship with the robot (that is, all types of socially interactive, assistive and companion robots, robotic pet and dolls) and the practical effects of care robots on social interaction (that is, the direct and supportive effects of robotic functions).

4.5.3.1. Companion/social robots

If robots are designed to be more socially active, then patients will feel less uncomfortable talking to them or giving commands them than if they are designed to be less socially interactive (Kemna & Does, 2006, p.7).

In the literature there are many different terms to describe the social capabilities of the robots, e.g. social robot, socially interactive robot, socially intelligent robot, socially assistive robot, and companionship robot (Moral, et al., 2009).

Interaction with **social robots** may improve the ability to communicate and the mood of the patient, decreasing loneliness, stress and anxiety and thereby increasing the user’s immune response (Tapus, et al., 2007, p.36; Broekens, et al., 2009 p.98). Also, the use of social robots may allow patients to communicate better with friends, family, and carers (Shibata, 2012, p.2530).

Companion robots can allow patients greater emotional engagement, communication and social interaction with the robot, as opposed to task-oriented care robots. They have the ability to activate reclusive and isolated patients and work as social facilitators, increasing interactions between patients, especially on the topic of the companion robots (Sharkey, 2014, p.71; Feil-Seifer, et al., 2007, p.423). They are usually comparatively more affordable and smaller, making them more accessible for patients than larger and more costly robots (Sharkey, 2014, p.71).

The companion robots could potentially reduce the amount of outside social interaction because users’ social needs might already be met with the robot (Sharkey, 2014, p.72; Sharkey & Sharkey, 2012a; Metzler & Barnes, 2014, p.12; Parks, 2010, p.108). While the loss of outside interaction is potentially problematic, it may nevertheless provide company for patients that is experienced by them as valuable and enjoyable and thereby reduce the feeling of social isolation and loneliness (Borenstein & Pearson, 2010, p.282).

There is the possibility that a patient's dignity is being affected if robots encourage them to respond in child-like ways or if they carry them like a baby, or sometimes dress and groom them. For some companion robots, family members may see their elderly family communicating to the robots as a loss of dignity (Sharkey, 2014, pp.67,72). However, this perception needs to be put in context with the effects that such robots have on the actual well-being of the users.

Robotic dolls and pets

Robotic dolls may relax people who feel anxious or distressed (Kidd, et al., 2006). Patients may communicate and use the robot dolls as cathartic entities to discuss their feelings, viewing the robots as their wife or daughter. This may allow for the psychological benefit of releasing pent up emotions. However, it could also lead to unnecessary distress on the patient (Turkle, 2006). Also, when using robotic dolls the patients' dignity may be negatively affected because it appears that they are infantilised (Sharkey & Sharkey, 2012b, p.8). In a study, carers were worried that patients were being deceived by the robotic dolls insofar as patients were viewing them as real and were trying to look after them as such (i.e. they were finding oatmeal in the doll's mouth) (Kidd, et al., 2006).

Art therapy and animal therapy can greatly benefit patients' well-being. But animals are often not allowed in care settings because of their unpredictable nature, diseases, risks of biting, etc. (Tamura, et al., 2004, p.85). Robotic animals may help caregivers to provide better care to patients without the downsides of real animals, such asrequiring new skills or the care real animals need (Wada, et al., 2008, p.58; Roger, et al., 2012, p.90; Sorell & Draper, 2014). Robotic animals provide a therapeutic benefit to patients providing companionship and affection (Sorell & Draper, 2014, p.184). Interaction with robotic animals has been shown to increase patients' communication and interaction with other patients, and they may become topics of conversations, allowing patients to interact more (Kemna & Does, 2006, p.7).

Patients clearly form emotional bonds with robotic animals like Sony's Aibo robot dog and Paro baby robotic seal (Kemna & Does, 2006, pp.7,8). Whether such bonds should be assessed as positive or negative depends on the actual overall effects that this relationship has on the user, but also the overall ethical framework that is being employed in assessing the issue.

Robot pets could allow elderly people, especially those with the cognitive limitations associated with later stages of dementia and Alzheimer's, increased access to certain capabilities that previously appeared to be lost or fragmented. In particular, the provision of robot pets for the elderly could facilitate increased access for them to the central capabilities of 'Emotion' and 'Affiliation', as well as that of 'Bodily Health', as identified in Sen's and Nussbaum's Capabilities Approach. The capability of 'Emotion' here refers to having the opportunity to 'have attachments to things and people outside ourselves', and 'Affiliation' includes being able to 'engage in various forms of social interaction' (Sharkey & Sharkey, 2012a).

The use of robotic pets and dolls is implicitly associated with treating their users like children, and therefore with potentially less respect than they deserve. Accordingly, it might be problematic if socially assistive robots are designed to trick or fool elderly patients. Designing them as too life-like may cause embarrassment when they realise the robot is not a real human or animal (Sharkey, 2014).

However, there is a need here for an evidence-based approach, in which empirical evidence is collected off the extent to which the expected benefits and risks of robot pets are in fact being obtained (Sharkey, 2013).

Paro experiences

Interaction with Paro (a small robot seal) provides companionship to elderly patients, reduces stress, loneliness, anxiety, and can calm down those with dementia especially in its advanced stages (p 433) (Feil-Seifer, et al., 2007, p.433; Sharkey, 2014, p.71; Shibata, 2012, p. 2529; Sorell & Draper, 2014, p. 190). Patients viewed Paro empathetically, which may also be beneficial for patients with autism (Martin, et al., 2013, p. 198). Interaction with Paro was beneficial for psychological and physiological well-being of users (Wada & Shibata, 2006, p. 3967).

If patients have a shared experience of the robot, then it can potentially lead to greater social interaction amongst individuals. Shared experience is also desirable because it may be too overwhelming for individuals to feel that they have been given sole responsibility for the care of the robot (Kidd, et al., 2006). When patients were given Paro they became more sociable (Feil-Seifer, et al., 2007, p. 433), (Wada & Shibata, 2006, p. 3967) and increased their communication with fellow nursing home residents (Kidd, et al., 2006). Users' families noticed an increase in their happiness and social interaction after prolonged use and interaction with Paro. It also allowed them to enter into a dialogue with their family members for example by use of reminiscence as a result of the robot, using Paro as a point of conversation, or providing a form of emotional release (Roger, et al., 2012, pp.91,92).

Caregivers were also more social with their colleagues and patients when the Paro robot was introduced. They also appear happy to see and use the Paro robot. There is evidence that it reduces stress levels and increases their happiness levels and makes them laugh too (Roger, et al., 2012, p.89; Shibata, 2012, p. 2532).

Robot toys also have the possibility of causing patients to lose touch with reality; to become dependent on the robot; and to experience further confusion between the real, imaginary, natural and artificial (Veruggio & Operto, 2008, p.1518). In a study, one patient treated Paro like it was her grandchild. Other patients said they communicated with Paro like he was alive (Wada, et al., 2008, p.57). In another study, one patient who communicated with Paro was able to speak Danish again, but otherwise had forgotten the language entirely. She had no ability to speak this language except when she communicated with Paro (Shibata, 2012, p.2536).

4.5.3.2. Effects of care robots on social interaction

It is difficult to predict how robots will affect social interactions between human beings (Decker, et al., 2011). Some claim that robots will damage the social interaction between carers and patients (Sparrow & Sparrow, 2006) and lead to a loss of socialisation of the patient (Bogue, 2013). Others claim that the social interaction between carer and patient during processes such as lifting is not as important as their relationship as a whole, which may even be enhanced by the use of the robot, so the use of robots can be justified in certain activities (van Wynsberghe, 2013b).

The general consensus in the literature is that robot carers should not be seen as replacements for the social interaction of human carers. While human carers are not officially employed for their companionship, it is an essential by-product of their interaction with patients, so robots need to be explicitly programmed to have this function (Sharkey & Sharkey, 2012c, p.276). How far they can achieve similar levels and quality of interaction is a matter of debate, however.

Negative effects

It is generally agreed that current robots are unable to meet the complex social and emotional needs of elderly patients. It is considered unethical to replace human contact with robotic interaction. Although, some social interaction with robots may alleviate social isolation, robots are incapable of real friendships, love or concern (Sparrow & Sparrow, 2006, pp.141,147,154), and therefore, reducing possibilities of such deeper social interaction by using robots is ethically problematic. Itis potentially depriving users of deeply meaningful interaction.

If robots substitute carers then there is no chance for the virtue of reciprocity to take place in these settings. The social interaction of reciprocating care and recognition to another is a fundamental benefit of care settings and to relinquish this would negatively impact both the person cared for and the carer. Also, caregivers would not be able to practice empathy towards the patient, leading to a potentially much shallower role as caregiver and diminishing the deeper value that they can gain from performing their professional activities (Vallor, 2011, pp.258,259).

When robots are the only form of social interaction of the patient this is problematic, because they cannot provide emotion, empathy, friendship, or a close bond, and if human-robot interaction becomes pervasive in care contexts this may eventually lead to a change of what we mean by these values (Sparrow & Sparrow, 2006; Coeckelbergh, 2009). It is generally agreed that robots should not replace communication with other human beings, but may be used to support it (Dautenhahn, et al., 2015; Rabbitt, et al., 2015).

Also, there is the risk that patients with dementia may worsen due to the experience of “malignant social psychology” as a result of the robot being their new companion (Metzler & Barnes, 2014, p.10).

The difference and similarities between robots and humans makes it difficult for users to identify how to understand their relationship. Patients may view them as simply slaves to their human masters whenever they break down or need repair. On the other hand, if a patient views the robot as being similar to themselves because of mimicked traits, but the robot's capabilities do not match the perception, then this relationship may be ethically problematic because it raises the issue of deception and lack of informed consent by the patient (Feil-Seifer, et al., 2007, pp.426-429).

Caregivers also are worried that the robots would replace their social interaction with the patients (p 310) (van der Plas, et al., 2010).

Robots also have the potential to make patients become more socially isolated, when the robot becomes their sole means of communication (Sorell & Draper, 2014; Sharkey, 2014; Parks, 2010; Sharkey & Sharkey, 2012c; Coeckelbergh, 2012a). For example, if the carer uses the lifting robot, their social interaction with the patient (through touch and eye contact) will be affected. The carer might be paying attention to the remote control rather than the patient. There is also a level of trust between the patient and carer that the robot will work, that it is suitable for the task, and there is a level of trust in the institution for allowing the robot to fulfil tasks in the care facility in the first place (van Wynsberghe, 2013a, p.425). The use of robots to perform such tasks as lifting could also be seen as having a potentially distancing effect between carer and patient, removing bodily touch and close interaction, which many patients seem to prefer to the social interaction that is shaped by the use of a lifting care robot (Parks, 2010, p.109).

Positive effects

Some researchers claim that the suggestion that robots will cause social isolation for elderly users is inaccurate, partly because we are a long way from being able to leave robots with patients without supervision (Prescott, 2013, p.2).

While much of the ethical discussion in the field refers to ethically successful caring, social interaction between the caregiver and patient is not always at the top of their priority list. More important things are the physical welfare of the patients and balancing their workload so as to provide sufficient basic physical care. Also, interaction with patients may frequently not be pleasurable because patients with dementia can be quite difficult to deal with (Dautenhahn, et al., 2015). Optimists predict that social interaction between the patient and carer will increase in the future because robots will take over many of the mundane and boring jobs that the carer has to do, freeing up their time to spend more productively caring for the emotional and psychological well-being of the patient (Prescott, 2013, p.2). It is generally considered essential for robots not to take over the patient's social interaction with other humans (Rabbitt, et al., 2015, p.28).

There is also the possibility that our perception of robots may lead to better social interaction with other human beings, forming stronger community bonds of sharing and partnerships, for example, looking after the robots in care homes (Kidd, et al., 2006); different cultures may interact with robots in a more caring way (e.g. Japanese culture) (Šabanović, 2014). However, not all positive experiences of robots would be automatically ethically desirable; as Sharkey & Sharkey point out, it is possible that elderly persons may only view robots positively because their other opportunities for social interaction are so minimal (Sharkey & Sharkey, 2012b).

Robots have already been shown to improve aspects of the social interaction of patients with their family, carers, and other patients (Roger, et al., 2012; Borenstein & Pearson, 2010; Feil-Seifer, et al., 2007; Kidd, et al., 2006; Wada, et al., 2008; Shibata, 2012; Wada & Shibata, 2006). They may do this by activating socially isolated people, improving the communication skills of the patient, reminiscing about their past, or by being used as the topic of communication between the patients and others (Sharkey, 2014; Kemna & Does, 2006; Roger, et al., 2012). Robots may also be used by carers to free up their time so that they can spend more time socially interacting with patients (Ljungblad, et al., 2011, p.2).

In some cases patients may be unwilling to talk about their problems or issues with nursing staff or doctors but may more freely talk about them to their robotic carer or pet because they feel more comfortable and less worried about how their disclosures are perceived by the robot (Shibata, 2012).

Assistive robots may also allow patients to become more mobile and allow them to become more sociable as a result - i.e. greater mobility to go places and meet people (Sharkey, 2014).

Sometimes a social connection is not always required, and a person may want to exclude busybodies, and people annoying them, from communication. In that case, as Sorrel & Draper highlight, they may use the robot deliberately to apply "chosen", selective connectedness (Sorell & Draper, 2014, p.192).

How we perceive and act towards robots may drastically affect how we socially interact with other human beings. Robots are much more socially interactive than other machines in the home (Sorell & Draper, 2014) and their replacing of humans in care may lead to a change in what exactly we mean by care, companionship, and helpfulness (Metzler & Barnes, 2014; Decker, 2008).

SUMMARY: Ethical evaluation for care robots in terms of social interaction	
Effect on humans	***Results***
The presence of the robot can help patients feel less lonely and isolated when there is a shortage of care staff/time to talk to patients	*Improves well-being*
Social interaction between the patient and carer may increase in the future because robots may take over more of the mundane and boring jobs and the human carer may be better able to focus on the emotional and psychological well-being of the patient	*Improve patient's well-being*
Assistive robots may improve mobilliy and sociability - i.e. greater mobility to go places and meet people	*Increase independence and social integration*
Care robots have the potential to make patients become more socially isolated	*Decrease social integration*

SUMMARY: Ethical evaluation for care robots in terms of social interaction (… continued)	
If the carer uses the assistive robot, caregivers' social interaction with the patient (through touch and eye contact) will be affected.	*Decrease quality of social interaction*
The social interaction of reciprocating care and recognition to another is negatively impacted regarding both carer and patient	*Decrease quality of social interaction*
Caregivers would not be able to practice empathy towards the patient	*Decrease quality of social interaction, decrease patient's dignity*
Caregiver may lose the deeper value that they can gain from performing their professional activities.	*Decreased dignity (of caregiver)*
Caregivers may be worried that the robots would replace their social interaction with the patients	*Decreased dignity (of caregiver), increased distress of caregivers*
Risk of "malignant social psychology"	*Decreased well-being and social integration*
If a patient views the robot as being similar to themselves, but the robot's capabilities do not match the perception, it will be deceptive.	*Deception*
There is also the possibility that our perception of robots may lead to better social interaction with other human beings, forming stronger community bonds of sharing and partnerships, for example in looking after the robots in care homes	*Increased social integration*
For elderly persons, robots may affect their well-being positively because their other opportunities for social interaction are so minimal	*Increased well-being, sustaining social skills*
Care robots give an opportunity for selective connectedness	*Increased social connectedness*

4.5.3.3. Telepresence and telecare

Patients that give robots instructions may actually be able to improve their social interaction and communication with others through the use of online forums, sites, skyping, and telepresence (Draper, et al., 2014; Prescott, 2013). But patients may feel more comfortable with using Skype on an iPad rather than a robot, partly out of privacy-related fears related to the general monitoring functions of the robot and specifically the fear as to what pictures and videos that they are using might get recorded and potentially distributed to others outside their home (Dahl & Boulos, 2013, p.14).

The use of robots allows doctors to have a potentially complex and time-sensitive telepresence in the home. This is a cheaper, easier, and more flexible way to keep track of the patient's health and reduce the amount of money and resources required for their health care (p 2) (Roy, et al., 2000, p.2; Sorell & Draper, 2014, p.187). Television and webcam equipment can facilitate appropriate intervention when required (Sorell & Draper, 2014, p.185).

Telecare allows older people to make a choice to stay in their homes rather than being forced to go into nursing homes (Sorell & Draper, 2014, p.186). But, it is uncertain whether telecare will cause social isolation for the patient because of the reduction of human carer contact in the home (Sorell & Draper, 2014, p.187). Also, it is uncertain whether or not robots should be designed to coerce patients to act in a certain way in emergency situations, even if it is for their benefit, as such functions would infringe upon their liberty and autonomy (Sorell & Draper, 2014, p.193).

SUMMARY: Ethical evaluation for care robots in terms of telepresence and telecare	
Effect on humans	**Resultss**
Care robots may improve the social interaction and communication with others through the use of online forums, sites, skyping, and telepresence	*Increased social integration*
Due to monitoring, recording and sharing functions, patients may feel privacy-related fears and prefer to use Skype on an iPad rather than a robot,	*Loss of control and freedom*
Telepresence gives an opportunity for care professionals to keep track of the patient's health and reduce the required healthcare resources	*Improve patient's well-being* *Better allocation of health resources*
Telecare allows older people to make a choice to stay in their homes rather than being forced to go into nursing homes	*Improve patient's well-being* *Better allocation of health resources*
Telepresence may cause social isolation for the patient because of the reduction of the human carer contact in the home	*Decreased social integration*
Care robots may be designed to coerce patients to act in a certain way in emergency situations.	*Infringement upon patient's liberty and autonomy*

4.6. Design and capabilities of the care robots

4.6.1. Aesthetic characteristics

Because design choices generate expectations about the abilities that a robot possesses, they must be compatible with how a robot will be used. To minimize confusion, disappointment, or other negative emotional responses, users should be provided with a clear explanation of the robot's role, abilities, and limitations (Pearson & Borenstein, 2014).

A robot's capabilities may not match what it appears it can do, which presents a barrier to true informed consent; particular care needs to be taken to give enough information in a manner appropriate to the user's abilities (Feil-Seifer & Mataric, 2011a, p.30).

Even though some affective bonding will be inevitable regardless of the morphology of most care robotic platforms (Riek & Howard, 2014), it is clear that the humanoid or animal inspired aesthetic features of many robots facilitate the formation of emotional attachment between the human and the robot (Soegaard, 2014).

The field of human–robot interaction investigates in depth specific visual, linguistic and other cues that support engaging interactions; this knowledge is essential for the design of an effective but also ethically appropriate care robot.

4.6.1.1. Core (objective) features of appearance

In the 1930s and 40s, Gestalt psychology was applied to visual perception to investigate the global and holistic processes involved in perceiving structure in the environment. These investigations crystallised into "the Gestalt laws of perceptual organization." Some of these laws, which are often cited in the HCI and interaction design community are the law of proximity, the law of similarity, the law of “Praegnanz” (figure-ground contrast), the law of symmetry and the law of closure (Soegaard, 2014).

Aesthetic judgment is affected by ‘‘objective’’ or ‘‘core’’ features (e.g., the quantity of information, figure-ground contrast, and clarity) as well as a perceiver’s prior experience with certain kinds of stimuli. Symmetry is integrally connected to whether a living being is deemed to be attractive. ‘‘Clarity’’ refers to the readability of facial expressions. How stimuli are processed is not solely a function of the features of the object perceived but also of the present psychological state and the previous experiences of the perceiver and the perceiver’s general psychological make-up (Mason, 1986).

The law of proximity posits that when we perceive a collection of objects, we will see objects close to each other as forming a group. The law of similarity captures the idea that elements will be grouped perceptually if they are similar to each other. The figure-ground phenomenon captures the idea that in perceiving a visual field, some objects take a prominent role (the figures) while others recede into the background (the ground). The law of symmetry captures the idea that when we perceive objects we tend to perceive them as symmetrical shapes that form around their centre. The law of closure posits that we perceptually close up, or complete, objects that are not, in fact, complete (Soegaard, 2014).

In addition to the core features mentioned above, aesthetic judgments and corresponding affective responses are also partially a function of experiential fluency with regard to typical objects and aesthetic conventions within a culture. This fluency develops over time. Accordingly, designers of robots need to keep in mind the comparative importance of core features when designing robots for children; they should incorporate certain of the aforementioned ‘‘core’’ aesthetic features into a robot’s design to promote its acceptance for this user group. ‘‘Clarity’’ (readability of facial expressions) would be one important example of such a core feature (Pearson & Borenstein, 2014).

Practical considerations also play a significant role in decisions about morphology, For example, autonomous care robots for the elderly should not be small because they may appear in unexpected places and residents may trip over them. To optimise usability, care robots robots should also have large buttons, be visible, have clear voices, and be and hygienic. It would also be advantageous if they are able to support a user leaning on them, to ensure the user’s safety, (Broadbent, et al., 2012, p.117).

4.6.1.2. Humanoid morphology and “uncanny valley”

A major design consideration is whether and to what degree robots should be humanlike.

Many robot experts claim that it problematic to build robots which are too similar in appearance to humans, partly because it would become difficult to differentiate humans and robots (van der Plas, et al., 2010, p.308). Humanoid morphology and general appearance automatically induces expectations, attitudes and modes of interaction that would be appropriate for encountering human beings; accordingly, as long as a robot does not have human capacities or is not considered to be socially and ethically equivalent to a human being, inducing such attitudes would be inappropriate and potentially deceptive. Humanoid morphology in particular may be an ethical issue in the context of eldercare, where robot users are frequently relatively starved of human companionship, so that an even greater willingness exists to engage with robots as if they are human beings (Allen, 2010). Accordingly, a fine balance needs to be found between the inclusion of humanoid features that might increase acceptability and usability on the one hand, and making sure that the robot is not unduly anthropomorphised and induces inappropriate attitudes, interactions and attachments in its users.

It is particularly problematic to create a robot to act and behave like a human because people will become inappropriately attached to them; to deliberately choose such a design could therefore be considered deceptive. But often it is advantageous for robots to be designed like humans to achieve better usability and acceptance (Feil-Seifer & Mataric, 2011a, p.27). Human beings have a strong tendency to attribute "life" or "intention" to particular objects with "trigger features" in shape and movement. There may be some cultural differences in detail, but the strong tendency to anthropomorphize objects with certain trigger features appears universal (Mushiaki, 2013). For this reason, humanoid morphology and functionality should be carefully considered during design and is permitted only to the extent necessary for the achievement of reasonable design objectives; advantages or problems of such design need to be carefully balanced against each other, rather than giving overriding importance to ease of use (Riek & Howard, 2014).

Different humanoid features have been found to have differing importance for human attitudes towards robots, but there are contrasting assessments of their significance. In one study, patients preferred the appearance of a humanoid robot with arms and head, but no preference was given to the sex of the robot (Decker, 2012, p.193). Sometimes, the patients preferred robots in their homes to be somewhat humanoid (Kemna & Does, 2006, p.5). However, in another study it was argued that a non-human appearance would be preferable, specifically with no face (Decker, 2012, p.195). Sometimes it is better to have the robot in a non-familiar shape because it does not give off false impressions or associations to patients (Shibata, 2012, p. 2530). If a robot looks too human-like, the patient will have false expectations of the robot beyond what they are capable of (Tapus, et al., 2007, p.39). In many countries people's attitudes reflect these concerns; the majority of Western countries dislike robots with human characteristics/appearance.However, in Japan it seems to be more culturally accepted to create robots to be as lifelike as possible (Parks, 2010, p.104).

In relation to these concerns the Japanese roboticist, Masahiro Mori, proposed the hypothesis of the "uncanny valley": the ''valley'' of great discomfort when we interact with a robot or other entity that looks human but lacks key attributes that we would normally expect to accompany a human appearance (Mushiaki, 2013; Pearson & Borenstein, 2014) (see Figure 3.4).

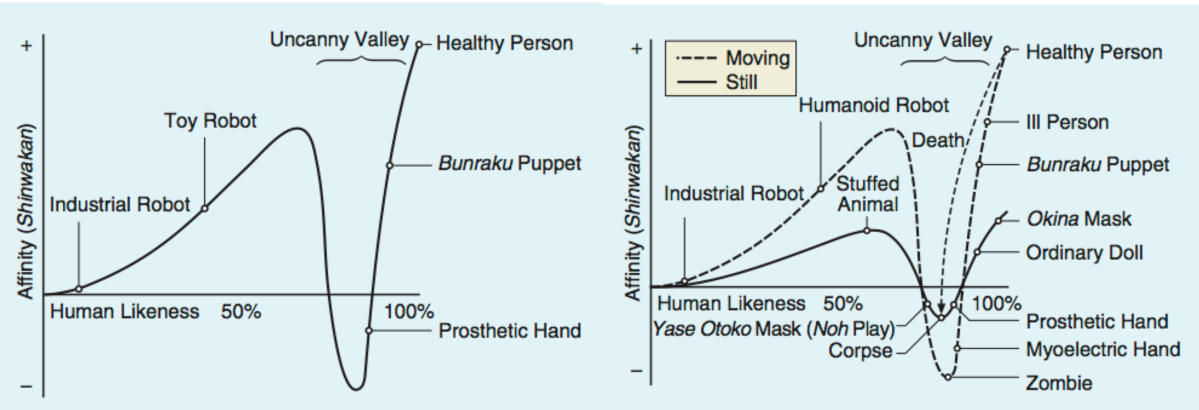

Figure 3.4. *A: The graph depicts the uncanny valley, the relation between the human likeness of an entity and the perceiver's affinity for it. B: The presence of movement, typical for robots, steepens the slopes of the uncanny valley. The arrow's path in the figure represents the sudden death of a healthy person (Mori, 2012).*

Children's attitudes toward humanlike robots, at least up to a certain point, are more positive than toward machinelike or animal-like robots. However, when the robots approached the uncanny valley and started to seem too humanlike, the children tended to attribute negative character traits to the robots (e.g., bossy, aggressive, angry). Older people are more willing to overlook defects in a robot when rating whether it looks humanlike (Pearson & Borenstein, 2014).

One way to overcome the deceptiveness of the uncanny valley is to design robots in a zoomorphic manner, i.e. animal-like rather than human-like (Kemna & Does, 2006, p.6). However, there is the problem that sometimes robots are designed to be life-like or animate, yet similarly to the humanoid case, they do not have the skills and abilities that the user thinks they should have, and as a result their expectations and attitudes towards the robot may not match what would be appropriate (Rabbitt, et al., 2015, p.27).

In research on Paro, the therapeutic robot seal that is used frequently with patients with advanced dementia, some people viewed Paro as real and were afraid that it would harm them, for example they were afraid that it would bite them. Others viewed Paro as a real animal and were confused why it was given to them. Some even wanted to put it in water because seals belong in water. They viewed it as a pet and communicated with it accordingly. Some even said that they loved him (Kidd, et al., 2006). Others, frequently males, disliked Paro, because it was not a real animal, or because they thought playing with Paro was stupid, girlish, or childish (Wada, et al., 2008, p.58).

Additional substantial empirical evidence is needed to answer questions regarding what precisely might be called for in terms of a robot's appearance both to achieve user acceptability and meet ethical requirements (Pearson & Borenstein, 2014).

4.6.1.3. Gender, race and stereotypes

Ethical questions about the selection of robot morphology and behaviours also arise regarding manifestations of gender, race, and ethnicity. The vast majority of humanoid robots are presented as Asian or Caucasian, and most of them tend to have a Euro-centric design with regards to their appearance, behaviour, and voice. Many robots could be considered to conform to Hollywood-driven stereotypes; grey, boxy, masculine (Riek & Howard, 2014). Stereotypes are not necessarily problematic and can serve a positive function; however, robots giving rise to negative stereotypes would not only be ethically objectionable but might also have deleterious consequences (Pearson & Borenstein, 2014).

A gendered robot caregiver or playmate might be seen to influence beliefs about gender roles in a way comparable to human caregivers and peers. It is expected that a person's response to gender differences in robots will resemble that person's response to human gender differences. The female gender is associated with positive robot traits such as happiness, friendliness and caring. Gender aspects might be particularly significant in relation to children, because care or therapeutic robots are often presented as toys to them. Very young children are already sorting people and objects into gender categories. Even if a robot has a gender-neutral appearance, users may assign a particular gender to it based on the specific tasks of the robot.

It has been suggested that the robot should be designed with neutral gender attributes so that patients do not falsely associate the robot with a specific gender (Parlitz, et al., 2008, p.2). However, whether such neutral appearance is advantageous would need to be further investigated. Whether it is feasible also depends on the overall morphology and functions of the robot. For example, if robots have voice output, it will be nearly impossible to avoid gendering the robot.

Gender attributions by users of otherwise gender-neutral robots might indicate that particular emotional attachments have been formed. Sometimes patients name robots and assign gender to them as a sign of having developed close personal connections. However, such attachment to robots might also have constructive functions. For example, the choice of humanoid robots may help patients keep up their social skills with regard to the norms of human interaction, which might be especially valuable when they are socially isolated and have less opportunities of interacting with other persons (Sorell & Draper, 2014, p.185).

4.6.1.4. Conformance of movement, appearance and voice

Many designers focus predominantly on the different types of facial features and expressions needed for a robot while ignoring robot movement and body shape. However, behaviour is an equally important variable impacting on human-robot interaction. Feelings of eeriness might result not solely due to atypical appearances or behaviour patterns, but also due to unusual movements that do not conform to standard human or animal movements. A mismatch between various sense modalities is another potential factor that can give rise to feelings of eeriness. Care should be taken that there is a match between the degree of human likeness of the voice and other visual elements (Pearson & Borenstein, 2014).

The communication of the robot, their voice, robotic or recorded, male or female, are all important parameters that need to be taken into account, and they need to be designed to provide a coherent and consistent overall experience for the user (Feil-Seifer & Mataric, 2011a, p.27).

4.6.1.5. Individual perception

As already indicated above, the processing of visual stimuli depends partly on the previous experiences and the psychological make-up of the perceiver. A person's personality type might give some indication of how that individual will respond to a robot. For example, it has been claimed that introverted humans may prefer more mechanical-looking robots, whereas extroverts prefer a more human-looking robot. Additionally, the manner in which individuals are socialized is another important variable. However, in time, people tend to adapt to a robot whose appearance initially repels them if they fulfil their functions (Pearson & Borenstein, 2014).

Because design choices generate expectations about the abilities that a robot possesses, the selection of design features must be compatible with how a robot will be used (Pearson & Borenstein, 2014). It needs to be considered whether certain design choices might impact disproportionately on the acceptability and usability of certain individuals (for example favouring persons of a certain gender, personality type, social or cultural background etc.). In that case, care needs to be taken that this will not negatively affect the quality of health care services that they will receive.

SUMMARY: Ethical evaluation for care robots in terms of aesthetic characteristics	
Effect on human	***Result***
A robot's capabilities may not match what it appears it can do.	*Deception*
Morphology and general appearance induces expectations and attitudes about the abilities that a robot possesses	*Deception*
Humanoid or animal inspired aesthetic features of robots facilitate the formation of emotional attachment, leading potentially to more effective use of robot.	*Affective bonding / emotional attachment;*
Humanoid robots may help patients keep up their social skills with regard to the norms of human interaction.	*Improving social interaction*

4.6.2. Intelligent skills

4.6.2.1. Communication skills

Care robots need to be designed to possess communication skills appropriate to their tasks. For example, a care robot that will be used in private homes of the elderly should be designed to understand calls for help (Cornet, 2013), communicate with users (Borenstein & Pearson, 2012), and also should have a serious communication design when being used in interaction with healthcare professionals (Kemna & Does, 2006).

Ensuring effective and socially appropriate communication with the elderly user is probably the most important consideration in this context. The robot must be respectful to the patient by listening, communicating, and interacting with the patient in accordance with current social and cultural norms. Head and facial movements, hand gestures, and change in vocal tone to indicate understanding would contribute to the representation of respect towards the elderly (Dahl & Boulos, 2013). Through monitoring the patient, the robot should be able to adapt to an individual's needs and preferences in order to ensure a respectful interaction with the user (Tapus, et al., 2007, p.39). Robots should not talk to elderly patients like they are babies or infantilise them and their experiences (Sharkey & Sharkey, 2012b). For example, encouraging or motivating interactions should use appropriate words of encouragement and not be experienced as patronising.

The robot's functions may also include the fostering of social skills. To achieve that purpose the robot can be designed to react to patients by a tablet interface showing a diagrammatic ‘‘empathic mask’’ that emits pleasure or displeasure at their interaction with the user to increase the patient's sociability skills (Sorell & Draper, 2014, p.189).

If the robot is programmed to ignore the rude and hostile voice and behaviour of the user, it might be difficult for the robot to differentiate these from shouts for help or assistance. In a study, most of the participants said that it was permissible to use the robot in this manner to modify a user's rude behaviour, as it would have beneficial outcomes for everyone, both the user and those persons interacting with them. Yet, others claimed that she should be allowed to talk to the robot in this manner because the robot is not human and does not have rights or feelings. Some people claimed that if the robot is not responding to the user, then it is an infringement of the user's autonomy because it is not giving the user the choice to behave how she wants to, especially given that no ethically problematic issues are taking place when they are being rude to a robot. There is a conflict between supporting a patient's autonomy to act how they want and the goals of their rehabilitative care team, which might include the goal of acting reasonably and sociably around others (Draper & Sorell, 2014, pp.129,130,133).

Social engagement and communication between the patient and robot can be achieved through designing the robot to maintain eye contact, or to maintain a certain distance between the user, and also may include non-verbal communication signals (Tapus, et al., 2007, p.39). For example, when a patient communicates with a robot, the robot can turn towards the person and move its arms to greet the person (Dahl & Boulos, 2013, p.10).

Robot behavior might be interpreted as disrespectful; for example, if the robot misunderstands what the user is saying, or is unable to understand their voice or accent. Robot communicative functions should be programmed to the best of our current technological ability in order to achieve successful communication and manage problems in understanding effectively (Dahl & Boulos, 2013).

Human-robot proxemics focuses on the question of how close a robot can approach a person in the fulfilment of their functions without them experiencing this as unpleasant. The robots should be designed to be able to adapt to the wishes of the patient about the optimal physical proximity to the robot (Koay, et al., 2014, p.470). When a robot intervenes with a patient, they must ensure that they are being respectful to personal space (Tapus, et al., 2007, p.40). In studies, people preferred the robot to be 0.5 m away from them and to approach from the front. People that are more extroverted tend to be less concerned with physical closeness than those who are more introverted (Koay, et al., 2014, pp.469,471). Generally, the robot should not be closer than 50 cm away from the patient unless physical interaction is required (Garzo, et al., 2012, p.74).

When patients communicate with robots there is the possibility that they will be deceived by thinking that the robot actually cares for them (Sharkey & Sharkey, 2012a); understands them (Sharkey, 2014); has emotional capacity or empathy (Sparrow & Sparrow, 2006; Luxton, 2014; Metzler & Barnes, 2014; Borenstein & Pearson, 2012); or that it can talk back on the basis of meaningful understanding of what they said (Kemna & Does, 2006). Vulnerable people may be tricked into believing that the robot has the same capacities as a real human being (Sharkey & Sharkey, 2012b; Turkle, 2006); a real animal (Sharkey & Sharkey, 2012b; Kidd, et al., 2006); or that they can enter into a close mutual interpersonal relationship with them (Sharkey, 2014). It is also difficult to know if the robot is illegitimately manipulating the patient when they are asking them to do certain things (Sullins, 2015, p.5).

4.6.2.2. Self-learning robots

Robots may be designed with an active learning and communication process built-in to improve communication skills. The "Ask&Learn" function of robots refers to a mutual learning process between robot and user where the robot asks questions in order to learn from the user, while at other times the user has to actively ask the robot to learn relevant information from the robot (Lammer, et al., 2011).

However, if the robot learns new things that have not been programmed into it, this raises the problem whether the robot designers can be held responsible for a robot's actions, or whether the owner assumes responsibility, because the owner’s actions and behaviours towards the robot may change the robot. The owner of the robot must be made aware that the robot is a learning robot and that the owner assumes greater responsibility and presumably also has a greater liability than if the robot was a non-learning robot whose behaviour is fully determined by the way the robot has been programmed (Decker, 2008, pp. 325-326).

4.6.2.3. Autonomy of users vs robots

When care robots are designed to show a certain degree of autonomous action vis-à-vis their users, problems arise with regard to the impact they have on each other’s their scope of action. While some robots require additional personnel to operate them, thus limiting the ability of the user to operate them independently (Yakub, et al., 2014, p.10), most robots are operating autonomously with significant possibilities of control by the user. However, in some cases, especially in the case of care robots, a robot might interfere with the actions of their users. For example, a robot may infringe a patient's autonomy and freedom of choice in order to ensure their physical safety or health. Sometimes, a robot will prevent a person from doing certain things based on reasons of their wellbeing. This may also affect their ability to choose their actions autonomously (Sharkey, 2014, p.71,73).

It is a problem to define when a robot should be allowed to intervene in a person's decisions (Decker, et al., 2011, p.40). In a study, patients stated that they preferred robots that took commands and obeyed instructions, rather than ones that worked autonomously (Mast, et al., 2010, p.2). Some researchers propose that a certain degree of autonomy and independence vis-à-vis user commands is desirable, insofar as a robot should not abide by a patient's requests if it would cause them grave injury or death. This is justified even with regard to user autonomy because such actions would undermine the person's autonomy (Sorell & Draper et al., 2014, p.189). More generally, despite considering certain limitations of autonomy legitimate, these researchers propose that the autonomy of the individual should be placed first in the list of priorities when designing a care robot's values, at times even overriding safety and social connectedness (Sorell & Draper, 2014, p.184). In another study, patients generally accepted that robots could be programmed against a patient's wishes for their own good (Draper, et al., 2014, p.142). But with regard to details there was a split between old people, informal caregivers and formal caregivers. Old people and informal caregivers tended to state that patients should have control over their actions while formal caregivers saw a greater need for paternalism to be used through the robot to protect the patient (Jenkins & Draper, 2014, p.180). Some robot experts propose ensuring that the robot is controllable by the patient to promote their autonomy (van der Plas, et al., 2010, p.308). Following primarily formal caregivers' preferences in deciding on the extent to which user behaviour should be controlled by robots would likely lead to an overreliance on paternalistic reasoning, in keeping with their professional care imperatives. In contrast, including users and family members' preferences in the design process could provide a counterbalance to the paternalist assumption. Users should also be made aware of these paternalistic functions in a comprehensive informed consent process prior to agreeing to use of the robot. Users must be aware of the robot's sphere of decision-making and must have given their approval to the use of such functions (Decker, 2012, p.184).

If the robot is programmed to include paternalistic interventions, the robot should not be too pushy towards the patient. Some suggest that robots should merely provide relevant information and ensure that it has been acknowledged by the patient, but that the user should still decide their actions and should be free to go against the robot's advice if they so desire (Garzo, et al., 2012, p.74).

4.6.2.4. Artificial emotions and empathy

Affective computing acknowledges the importance of emotions for effective human computer interaction. It consists of three areas with regard to interaction with the user: to recognise human emotions, express emotions in ways understandable to human beings, and to model human emotions more generally (Stahl, et al., 2014, p.75). It is important for establishing effective therapeutic interactions with robots in the healthcare sector that they are designed to engage their users emotionally and show emotions in interaction with users (Gunkel, 2015, p.156). It is known that patients who receive empathy and hold their therapists in high regard tend to recover more quickly. If robots were designed with an effective empathy function, it might prove beneficial for patients' well-being and improve their therapeutic effectiveness (Tapus, et al., 2007, p.38).

Even when an individual is aware that displayed emotions are not deeply felt by the robot, they still react automatically to such displays on an emotional level (Luxton, 2014, p.4). The concern is that when patients communicate with emotionally expressive robots, they are being deceived that the robots are empathetic and reflective towards them and their concerns (showing "artificial empathy"). In reality, robots detect basic human social gestures and respond with human-like social clues (Metzler & Barnes, 2014, p.6; Sparrow & Sparrow, 2006, 149, 156; Luxton, 2014, p.4; Turkle, 2006; Sharkey & Sharkey, 2012a; Taggart, et al., 2005). At this point, patients might feel deceived by artificial intelligent technology designed to appear like biological life but de facto do not have any of these displayed capacities in a "deeper" sense (Coeckelbergh, 2010, p.187; Borenstein & Pearson, 2012, p.253).

Creating a robot that displays emotions to improve the therapeutic effectiveness may also have unintended negative consequences. For example, if a patient views the robot as understanding and pre-empting their thoughts and emotions, then they may not reveal and disclose important information to the robot and be just as hesitant to disclose with the robot as they would be with a human carer (Luxton, 2014, p.8).

SUMMARY: Ethical evaluation for care robots in terms of intelligent skills	
Effect on human	**Result**
A robot's capabilities may not match what it appears it can do.	*Deception*
Appropriate non-verbal signals like head and facial movements, hand gestures, or vocal tone can contribute to the representation of respect towards the elderly.	*Improved dignity*
Robots may communicate with elderly patients in a manner inappropriate to their age and status, e.g. giving them instructions in a tone of voice or with word choice as if they were children.	*Infantilisation*
Empathic responses may increase the patient's sociability skills.	*Improved sociability*
If the robot is programmed to ignore louder expressions of the user as potentially hostile, it might be difficult to differentiate them from shouts for help.	*Safety issues*
Extensive social engagement and communication between the patient and robot could be achieved through designing the robot with a focus on sociability.	*Improved sociability*
If the robot misunderstands or is unable to understand the user's voice or accent, it might be interepreted as disrespectful.	*Decreased dignity*
The robots should be designed to be able to adapt to the wishes of the patient about the optimal physical proximity to the robot.	*Improved dignity*
When patients communicate with robots, they might be deceived into thinking that the robot actually cares for them and understands them in a deeper, meaningful way.	*Deception*
Vulnerable people may be tricked into believing that the robot has the same capacities as a real human being.	*Deception*
If the robot learns new things that have not been programmed into it, this raises the issue of responsibility and liability for the robot's behaviour.	*Responsibility and liability*
The owner of a learning robot must be aware that the owner might assume greater responsibility and liability for robot behaviour.	*Responsibility and liability*
The robot may prevent a person from doing certain things based on reasons of their wellbeing.	*Infringement of patient's autonomy and freedom of choice (paternalism)*
If robots were designed with an effective empathy function, it might improve the therapeutic effectiveness	*Improved well-being*
When patients communicate with emotionally expressive robots, they could be deceived into understanding them as having an interior life and/or full human or animal interactive capabilities.	*Deception*
If patients perceive that the robot understands their thoughts and emotions, then they may feel that it is safer not to disclose important information.	*Privacy infiringement*

4.6.3. Data collection, storage, process and sharing

Like ordinary computers, care robots can collect, store, process, retrieve, and share complex data. The data recorded by the robot may be sensitive personal data e.g. identity information, individual behaviours and attitudes, images, medical data, addresses, and communication information.

The robot has many potential possibilities regarding the sharing of information, including the ability to record messages and send them to distant family members or friends so that they can keep in contact with them (Coeckelbergh, 2010). Also, the robot may use stored photographic or semantic information to help users with dementia to identify their interlocutors, thereby facilitating better social interaction and increasing their dignity. Also, a robot could help users manage challenging situations by using stored information and giving suggestions or instructions on their basis (Sharkey, 2014, p.66). However, if these functions are implemented insufficiently, the reverse could also occur, where users might feel a loss of dignity when the robot does not use their name or does not deal with them in a personally sensitive manner (Sharkey, 2014, p.66).

Like every computer system, robots need to conform to principles of information and computer ethics such as authorization, prevention of piracy, information accuracy, intellectual property rights, information privacy, and confidentiality. There is a particular need to implement privacy, security and legal regulation for stored robotic data (Decker, 2012, p.196). Data can be stored and transferred by a robot, and accordingly there is the possibility that privacy will be affected through the distribution of information about a robot user. Information that was originally collected by the robot may be passed on to outside sources, for example governments, corporations, or even future employers (Luxton, 2014, p.5). If there is a need for third-parties to have access to this information, information accessed via the internet should be concerned with safety risks (Luxton, 2014, p.6).

Often patients will not be made aware of who can access information that is recorded about them and where it is distributed to. In keeping with ethical norms of confidentiality and data protection guidelines, patients should have awareness and control over who can access their personal information in order to protect their privacy (Garzo, et al., 2012, p.73). Breaches of confidentiality and access to a patient's information without their consent can lead to a lack of trust in the robot or the care professionals using the robot (Feil-Seifer & Mataric, 2011a, p.30; Sharkey & Sharkey, 2012a; Luxton, 2014, p.5). Adequate information should be given to the patient prior to beginning use of the robot about how their information will be accessed and used (Broadbent, et al., 2012, p.29).

A patient may feel that they are not in the position to refuse being recorded, even though they would prefer not to be in order to protect their privacy. For example, they may be pressured into being recorded by family members that cannot provide the care themselves or cannot afford to pay for professional carers. Users may feel like they have no choice but to agree to being recorded and monitored, because they may fear that the only alternative is being put into a nursing home. On the other hand, some possible autonomy-promoting outcomes of a recording robot may be that it might provide safeguards against abuses and inappropriate interpersonal pressures because all stakeholders know that there will be a record of their interactions. Accordingly, even though the agreement to monitoring might have been influenced by non-autonomous considerations, the result might be that there is less likelihood of being forced into decisions that they do not want (Sharkey & Sharkey, 2012c).

In this context, it also needs to be considered how long recorded information should be stored for (Sharkey & Sharkey, 2012a). Information that is transferred directly into the medical record should be immediately deleted after transfer. For other information which might be useful for identifying health trends, storage length needs to be carefully considered, and principles of data protection and careful consideration of the value of this information need to underpin any decision on this issue. In general, recording robots might lead to avoidance behaviour by users and other persons within the scope of recording. Patients may feel uncomfortable that a robot is recording them so they may prefer to use other means that they are more used to such as Skype or phone calls, rather than rely on the functionalities of the robot (Dahl & Boulos, 2013). The possibility that recording robots can infringe upon a patient's privacy may also cause patients to be fearful when the robot is around to avoid its collection of information. The recording function of robots may also make visitors uncomfortable because of the feeling of unease at being monitored and recorded (Coeckelbergh, 2010). Even if users and other stakeholders do not seem to mind being recorded, robot designers have a duty of care towards stakeholders. Therefore, privacy and data protection principles need to be considered carefully with regard to the use of each function and should be deeply embedded in the design of the robot.

Attitudes to privacy, with regard to care robots, patients did not mind formal caregivers having access to their information but had concerns about informal caregivers (family) having access to their information. Users felt uncomfortable that their actions in private might be available to family members; they felt such functions would leave themselve open to a “big brother” scenario where all their actions could potentially receive scrutiny. Caregivers were also worried about their privacy if the robot monitored them during visits (Draper, et al., 2014, p.139). One particular concern was that the robot may not be able to differentiate between private information that is “nobody’s business” and information that should be saved for the purpose of enabling its health functions. Unselective recording of all activities would be a violation of privacy. The robot may not reliably know the difference between who should have access to a patient's information and who should not, which has the potential to lead to problematic data breaches (Feil-Seifer & Mataric, 2011a, p.29). This could be particularly challenging in a formal care context where a large number of changing care staff need to be authorised to access the robot. However, having accessibility to open may significantly increase the danger of data breaches.

Eventually, while privacy concerns should be included in the design process of the robot, it needs to be balanced against other, potentially more important, capabilities such as the benefit of increasing social interaction with family and friends (Coeckelbergh, 2010, p.186). Certain privacy risks might be appropriate to incur, if reasonable safeguards are put in place, to address issues that are crucial to improving the well-being and the quality-of-life of users. However, those decisions need to be made on the basis of careful ethical considerations and not left to individual technical designers during the design process.

SUMMARY: Ethical evaluation for care robots in terms of data collection, storage, process and sharing	
Effect on human	***Result***
Data can be stored and transferred by a robot.	*Privacy and confidentiality*
Information collected by the robot may be transferred to outside sources (e.g. governments, corporations etc.)	*Privacy and confidentiality*
Information accessed via the internet should be concerned with safety risks.	*Security, Privacy and confidentiality*
Access to a patient's information without their consent can lead to a lack of trust in the robot or the care professions using the robot.	*Privacy and confidentiality, ownership*
Information about how it will be accessed and used should be given to the patient prior to beginning use of the robot.	*Informed consent, Privacy and confidentiality, ownership*
It also needs to be considered how long recorded information should be stored.	*Privacy and confidentiality*

SUMMARY: Ethical evaluation for care robots in terms of data collection, storage, process and sharing (… continued)	
Information that is transferred directly into the medical record should be immediately deleted from the robot after transfer.	*Privacy and confidentiality*
Patients may feel uncomfortable that a robot is recording them.	*Privacy and confidentiality; Monitoring and loss of control*
The recording function of robots may also be uncomfortable for visitors and caregivers.	*Privacy and confidentiality; Monitoring and loss of control*
Potential unselective recording of all activities for general monitoring or data mining purposes raises serious informed consent and data protection concerns.	*Informed consent, Privacy and confidentiality*

4.7. Summary of concerns

The following is a summary table that provides an overview of core ethical considerations discussed in this chapter.

Table 4.1. Some ethical concerns about the care robots
(It is assumed that achieving the patient's **health** and **well-being** is the core value underlying all proposed interventions)

ROBOT	NEGATIVE EFFECTS ON HUMAN	VALUE (CONCERN)
Mobilization of people	**Physical:** Potential creation of new and unforeseen dangerous situations	(loss of) **physical functioning**; (loss of) **safety**; (restriction of) **autonomy** and independence
Prediction of dangerous situations and **warning/restricting** patients and carers	**Physical:** Control and restriction of patients' activities	(loss of) **Well-being** and **health**; (loss of) **safety**; (restriction of) **personal liberty/freedom**
Performing intimate care tasks such as bathing and sanitation	**Physical:** Direct physical contact such as lifting patients, interacting with naked body	**Privacy** (infringement); (loss of) **dignity**
Performing intimate care tasks such as bathing and sanitation	**Psychological:** Observation of patients and carers when performing intimate bodily functions	**Privacy** (infringement); (loss of) **dignity**
Lifting or moving patients	**Psychological:** if moving without consulting them potential feeling as an "object."	(loss of) **control**, (objectification)
Everyday care tasks with **implicit interpersonal component**	**Social:** Reduction of human social contact	(Reduced) **social contact,** (lack of occasions of) **interpersonal respect,** (lack of occasions for) **reciprocity**
Aesthetic: Humanoid morphology	**Psychological:** The tendency for humans to form attachments to and anthropomorphize robots	Relationality (Human frailty due to inappropriate psychological bonding)
Aesthetic: Anthropomorphize objects by projecting human-like characteristics	**Psychological:** Feeling of infantilisation or deception	Truthfulness (Deception and infantilisation)

4.8. Disease-specific ethical concerns

In addition to focusing primarily on the robot, it is also important to be aware of the particular characteristics of the disease of dementia. Neglecting any of the ethical principles or conflicts related to care of persons with a certain condition in particular care contexts may lead to the emergence of disease-specific ethical issues (DSEIs) (Knüppel, et al., 2013). Various care context specific ethical issues are published in the scientific literature on dementia care (Appendix B) (Strecth, et al., 2013).

Related to the robotic functionalities as embedded in the dementia care context, various ethical concerns can be extracted from an analysis of dementia specific ethical concerns.

The inadequate assessment of their condition may constitute a specific ethical problem for dementia patients (Strecth, et al., 2013). Various opportunities for gathering cognitive function data outside of the clinic or laboratory have been explored, which may be relevant for the use of care robots. Since the start of the millennium, groups have conducted cognitive tests via a variety of remote platforms: via the telephone using interactive voice response technology, via cell phones, and via the internet. Furthermore, many neuropsychological tests have been computerized. Other developments have included virtual reality testing in Alzheimer patients and cognitive testing embedded in games (Wesnes, 2014). With the automated evaluation of cognitive skills, robots may be able to avoid the human pitfalls of having a personal bias in a consultation. The consultant may access this potentially more objective information later on, which, if successful, would have the potential to lead to better care for the patient. Also, given the evidence that patients sometimes speak more openly about sensitive issues to robots rather than human caregivers, a more reliable assessment might be possible with the use of care robots. However, with the current state of technological development, the performance of comprehensive geriatric assessment and specifically the assessment of dementia still require significant human interaction and computers are not yet able to interpret relevant information reliably.

Also in the evaluation process, the patient will **need to feel himself/herself respected**, in the sense of not feeling that they are treated like an object (Strecth, et al., 2013). A dementia diagnosis is often linked to the fear not just of the loss of self, but also of the reduction of respect and status by others in social contexts. Automatic evaluation may augment this potential negativity of the evaluation, as it may appear to the patients, that in a care context where assessment is conducted by robots rather than human beings, they perhaps are not even considered worthy of human personal attention. To relieve this potential issue, automatic assessment should be complemented or put into context by a personal, professional evaluation and introduced appropriately, including an explanation of the particular value of the inclusion of robotic assessment. If at all possible in a particular care context, as long as robots are not a generally accepted part of health care delivery, patients should have the choice to refuse assessment by robot. The disease-specific aspect of confusion and impairments in information processing might further compound these concerns, as finding oneself interacting with a robot rather than a reassuring human doctor or nurse might lead to further confusion of already vulnerable patients.

Due to their disease specific impairments, dementia patients may also have problems with regard to understanding, decision-making and specifically the issue of informed consent. In terms of employing the robot at all, and also in relation to the use of specific robot features and functionalities, this issue must be carefully considered and managed sensitively, especially if assisted decision-making procedures are required.

Information and consent related issues are another potential ethical problem for dementia patients (Strecth, et al., 2013). Incorporating a care robot into a care context is a new and unexpected situation for both patients and their family members. To minimize confusion, disappointment, or other negative emotional responses, users should be informed about the robot's role, abilities, and limitations (Pearson & Borenstein, 2014) and asked their permission for using the robot for assessment. While patients will often be accompanied at their initial assessment and special attention is given to informing them, the continued use of care robots throughout the process of care might lead to additional considerations regarding the use of care robots. A person with dementia is likely to forget what they have been told about the robot and so might not be aware that the robot was monitoring them. Accordingly, they will not be able to adapt their behaviour to the realisation that they are being monitored and could perform acts or say things thinking that they are not being monitored. Persons with dementia (and their legal custodians) would have to consent initially to the use of the robot on the basis of comprehensive information, and should also be allowed the opportunity to reconsider their consent at later stages, once they are more familiar with the impact of the presence of the robot on their daily life and care. Their children or family or other important persons in their lives should be included in the consent process (Sharkey & Sharkey, 2012a). The robot should be designed in a manner so that it is possible to adapt and potentially disable certain functionalities of the robot, depending on the patient's experience. This would mean for example that the collection of information in certain contexts might need to be able to be selectively disabled if consent for this function is withdrawn. In the context of dementia care, the use of additional GPS based (global positioning system) devices, medical reminders or medical monitoring tools also needs to be considered (Strecth, et al., 2013), which raise similar information and consent concerns. There are various ethical debates regarding the usage of this type of control system and ethical issues with regard to their use in specific care contexts need to be taken into account before implementing them.

In dementia patients, **retaining and improving the patient's decision-making competence** is a critical goal. Care robots may provide the opportunity to support decision-making capacity and empower dementia patients to retain abilities despite their cognitive impairments. If successful, these might improve significantly the autonomy, self-respect and freedom of patients; however, whether this is indeed the case needs to be assessed through carefully designed studies. Patients must also be adequately involved in decision-making processes. On the one hand, care robots can help to improve cognitive skill and decision-making capabilities. On the other hand, particular care must be taken that the care robot is designed so as to facilitate constructive involvement in decision-making and not be too cognitively demanding or overwhelming in the presentation and timing of choices and consent options. Especially the design of a dementia-friendly interface deserves particular attention, and user-trials need to carefully target this area of concern. In addition to the interface, attention would also need to be paid to the incorporation of ethical principles of assisted decision-making where appropriate, including the active facilitation of human assistance should the user so desire. The robot should not replace human involvement, but should be designed as a tool that will be carefully incorporated and integrated into a human care context.

In the dementia context, **disregarding the need for continuous relationships** with the patient is also a common and highly problematic ethical risk in traditional care settings (Strecth, et al., 2013). Today, it has been well established that social contact has a healing and supporting effect for elderly people, including dementia patients, and that social isolation is a particular risk factor for acceleration of cognitive decline and general deterioration of health. A robot carer can take over and accomplish many one-to-one responsibilities of human carers, and in some sense might be able to provide more continuity of care than is possible in many residential settings where larger numbers of staff may be involved in each resident's care and high staff turnover is common. However, the fear is that in the context of institutionalized care, the use of robotic devices might minimize human contact (Misselhorn, et al., 2013). The existence of a care robot should not decrease the amount and quality of social contact between patients and human carers. Additionally, dementia patients must be given the opportunity to choose human carers instead of robot carers for as wide a range of activities as possible; accordingly care robots would need to be customised flexibly in this respect. Social assistance functions of the care robots and relevant ethical issues should be considered. A prominently presented goal of many care robots for the elderly is the increase of social connectedness. Whether these functions are indeed successfully implemented is something that needs to be evaluated carefully in light of the importance of social connectedness for patients' health and especially the ethical concerns regarding the danger of increasing social isolation through the use of care robots.

In dementia patients, there is also a risk of **weakening decision-making competence by infantilisation** (Strecth, et al., 2013). For many functions, robots will have pre-set functions or their settings will be decided by carers that determine how robots will behave and what decision-making options are open to the user. However, these may not match the patient's subjectively perceived needs and preferences. Particularly for rules that restrict users' behaviour, automated orders by care robots may increase the feeling of infantilisation and increase a sense of lack of autonomy. If the interaction and communication capabilities of care robots cannot be structured in a manner sensitive to the interaction needs of the user, they might give rise to a feeling of infantilisation. To decrease these effects, rules must be set in a process of informed consent involving the patients, family and carers. The robot's conversation style (audial and aesthetic features) must also be selected carefully. Also, patients must be allowed to decide which functions will be taken over by robots or human carers, making sure that human carers will remain involved in care according to the wishes of patients.

Patients may also develop an **affective bond** with the care robot. This appears to be frequently the case with the use of simple companion robots like Paro or robotic dolls, especially in advanced dementia. With increasing communicative abilities and advances in affective computing the potential for such bonding to occur is likely to increase further. Patients with dementia might be particularly vulnerable in this context because frequently they are already comparatively socially isolated at the point where care robots would be introduced to them. Accordingly, they may be particularly prone to bond with these robots, which raise the issue of inappropriate deception and infantilisation. Having bonded with a care robot also raises the issue of potential negative emotional effects if the robot becomes unavailable. This is an issue especially for user trials where robots are only available for certain time periods or for situations where robots might need to be shared between different users. Removing a robot after a bond has been formed may give rise to distress; similarly periods of repair or maintenance might be problematic. It would have to be carefully assessed whether the creation of such bonds has significant positive effects on users that would counterbalance potential ethical concerns in given contexts and practices of use.

Robotic care is a new development and it is open to many unintended and unpredictable potential benefits and harms. If robots were placed under the full control of elderly people with dementia, this raises the issue of **responsibility if things were to go wrong** (Sharkey & Sharkey, 2012a), especially given that persons with dementia may be decisionally impaired. The issue of potential impairments of users needs to be taken into account when designing the robot, without however removing important decision-making scope for the users in the name of safety. Professional carers must continuously follow the changing care context and a policy of a continuous feedback process must be written and used to effectively address emerging issues and implement safe and beneficial procedures. Also, in the design phase, the robot's **decision paths must be reconstructible** for the purposes of litigation and dispute resolution (Riek & Howard, 2014) and all stakeholders need to be informed of potential challenges and benefits if a certain decision-making scope is left up to the users despite their impairments. The importance of retaining and fostering autonomy while minimising safety threats needs to be acknowledged by all.

Care robots may also change the roles of carers and the balances of decision-making in the care context. Care robots are not a replacement for caregivers, and should be designed to be tools of care. They should be designed to decrease their burden and provide elements of care that would not be feasible to deliver by human carers under normal circumstances rather than be designed to replace human carers. Involvement of the care robots may be stressful for the carers in respect to various aspects. Care of the dementia patient can be troublesome both physically and emotionally, and robot carers might remove some of the burden, to free up time and emotional resources for other care elements. However, the risk of further depriving the elderly care sector of care staff is real, and robot strategy and robot development need to be underpinned by a societal commitment to do justice to all human needs of care. **Continuing education and capacity building of the carers** for dementia care should be provided to carers so that they can integrate the robot effectively in their care planning. Such training should involve training about the potential functions of the robotic carer, potential problems arising in their use and recommendations for solutions.

5. Ethical Evaluation of MARIO Use Cases

The focus of this chapter is the application of the ethical considerations from Chapter 4 to the MARIO project. Because the Ethics Framework has been developed during the earliest stage of the project the discussion could not be based on the actual implementation in the project robot. Instead it is based on proposed use cases that have informed preliminary decisions within the project on the desired functionalities of the care robot Mario. Some of these might not be implemented in the final robot prototype that will be used in the field trials.

This chapter discusses ethical considerations with regard to different aspects of the robot design. It will not mirror the themes from Chapter 4 one-by-one, but rather focus on those themes that are particularly relevant for the design process and use of a robot with the characteristics and intended functionalities of Mario. We extract possible ethical concerns and provide initial recommendations.

5.1. Robot morphology

The Kompai Robot has been designed specifically to assist elderly and dependent persons at home. It has humanoid features, including a shape that vaguely associates a sitting person resting on the mobile base, albeit without limbs. At its top it features a stationary head with painted-on eyes. It communicates with the users through a tablet interface, with a default visual interface that lists a number of icons. The tablet is roughly at eye level for a sitting person and can be removed by the user. The Kompai robot appears non-threatening and perhaps vaguely friendly despite the absence of facial features beyond the eyes.

The physical features of the robot come across as solid and sturdy, and it is too heavy to be accidentally pushed over. This might invite a sense of trust in users. Through the absence of limbs or an emotive visual interface it does not employ natural movements or non-verbal emotive cues in communication with the users. On the one hand this might be seen as making its appearance more honest and less deceptive: it does not hide that it is a machine and does not induce the users through its morphology and physical behaviour to engage with it as if it was a human or animate being. On the other hand, the absence of such cues might make acceptance of the robot and emotional engagement with it more difficult. This might be problematic with regard to the realisation of its companionship and motivational functions. Given the limitations of speech recognition and production in current robots the lack of non-verbal cues to complement verbal interactions could have a negative impact on the overall quality of interaction.

The robot moves on wheels and while its dimensions are comparatively small, its manoeuvrability around typical home environments might be an issue. While it is clearly suitable for institutional settings like nursing homes and hospitals, many older houses in the two trial sites of the UK and Ireland have comparatively small rooms, with layouts that are not always straightforward and can often be cluttered. Also, when elderly persons live in houses with stairs the movement on wheels provides a challenge, insofar as the potential range of the robot will be restricted. This might affect the extent to which reliable and consistent support can be provided to the user with regard to the desired functionalities. Accordingly, such potential limitations need to inform inclusion and exclusion criteria in the recruitment of potential users, will have to be communicated to the user as part of the consent process before robots are introduced, and need to be taken into account when assessing the potential future reach of these and similar care robots in community settings.

5.2 Robot functionalities for care improvement

Mario's functionalities can be categorised into three larger categories: (I) physical and environmental assistance and monitoring (ambient awareness and monitoring, medical monitoring and assessment) (II) cognitive, and emotional assistance (psychological and cognitive support and medical reminder), and (III) leisure activites and socialconnectedness, (see Table 5.1).

Table 5.1 Functionalities which are defined in MARIO use case scenarios.

I. PHYSICAL AND ENVIRONMENTAL ASSISTANCE AND MONITORING **Medical monitoring and assessment** • Geriatric assessment • Mental/emotional state • Blood pressure • Body temperature, pulse and respiration rate • Drug usage • Fluid intake • Physical activity • Fall prediction **Ambient awareness and monitoring** • Locate important personal items • Monitor content of the fridge, identify food needs and provide shopping lists and food intake suggestions • Monitor and regulate house temperature	**III. LEISURE ACTIVITIES AND SOCIAL CONNECTEDNESS** • Facilitate communication via Skype • Play favourite music • Provide "sing-along" Karaoke system for favourite music • Facilitate taking of photographs • Follow favourite teams or other leisure activities based on social media feeds • Watch matches or cultural events • Engage with entertainment offers on YouTube • Provide access to electronic or audio books • Provide electronic or audio news • Play radio programmes • Play movies or TV programmes • Offer card games
II. COGNITIVE AND EMOTIONAL ASSISTANCE **Medical reminders** • Provide reminders for medication intake • Provide reminders for fluid intake • Provide reminders for food intake • Remind user to engage in physical activity **Psychological and cognitive support** • Provide instructions for getting dressed, • Inform user about weather with link to recommendations for appropriate clothing • Support usage of household tools and devices, • Provide reminders of date, time and daily schedule • Guide user to their destination • Offer cognitive stimulation exercises and brain training • Recognise family members and friends and remind user of their names and relationship to them • Remind user of recent activities, family visits and social contacts • Engage user in reminiscence activities based on stored memories and photos • Decrease agitation through music, distraction or reminiscence activities,	

Some possible ethical concerns about these functionalities are listed in Table 5.2., based on the biopsychosocial model which takes into account the physical, psychological and social aspects of human life. Subsequently, concerns relating to the different groups of functionalities will be discussed.

Table 5.2. Some possible ethical concerns in the MARIO use cases

FUNCTION	**EFFECT**	**VALUE (CONCERN)**
Some reminder functions • Instructions for getting dressed, • Support tool usage, • Reminder of date, time and daily schedule • Reminder and guide for walking route • Reminder for fluid intake • Reminder for medication • Reminder for physical activity	**Physical:** Control and restriction of the user's activities.	(restriction of) personal liberty/freedom
		Privacy infringement/ loss of privacy
	Psychological: Control and restriction of the user's activities.	Feeling of infantilisation
	Physical: Potential conflicts between patient preferences and robot decisions.	Concerns about autonomy and independence
	Psychological: Continuous interaction and support by the robot.	Bonding and human frailty
Intensive use for all functions instead of human carers • Health-related assessments • Brain training tools • Cognitive stimulation exercises • Games	**Psychological:** Feeling as an "object". **Social**: Lack of genuine social interaction around these activities	(loss of) control (objectification) (loss of) reciprocity
Communication via Skype	**Social:** Technologisation of human interaction / Remote social connectedness instead of face to face communication.	Reduction of human social contact (for patient) or Increase of social connectedness

5.2.1. Physical and environmental assistance and monitoring

5.2.1.1. Medical monitoring and assessment

Inadequate assessment of their condition is a specific ethical problem for dementia patients (Strecth, et al., 2013). It can include inadequate standard clinical care, partly due to cognitive impairments of the patients, but potentially also through discrimination. Providing routine testing through robots of vital signs that give indication of current care needs may have the advantage of allowing more continuous monitoring of patients which could provide better awareness of early warning signs without having significant negative implications for available healthcare resources. Many more complex neuropsychological tests have also been computerized; similarly, virtual reality testing in Alzheimer patients and cognitive testing embedded in games has also been attempted (Wesnes, 2014). At this point, it is important to use existing and accredited automated assessment tools, otherwise it might be hard to evaluate the degree of capabilities and the level of the condition and, the robot might not be able to reliably perform this function. Robots may be able to administer such standardised tests more consistently, thus allowing for greater reliability, and on a more regular basis than might be possible with human testers. This could potentially enable better monitoring of the development of their condition. The MARIO project aims to provide at least some aspects of comprehensive geriatric assessment (CGA) administered through the Mario robot. However, given the current limitations of speech recognition and semantic analysis, during the development of Mario robot the automated provision of testing is likely only to supplement the assessment by qualified clinicians. Even if the technology improves significantly, such testing will always have to be embedded in personal relationship with members of the treatment team, due to the very prominent and significant ethical concern that robots might replace the role of human carer, rather than merely supplement it.

5.2.1.2. Ambient awareness and monitoring

The connection of the robot to a range of environmental signals allows for further possibilities of support of the person with dementia in their activities of daily life. For many patients with dementia it is a significant challenge to keep track of important objects; location of such items is planned through the use of RFID chips in the MARIO project. A potential integration with the internet of things (IoT) as part of an overall ambient assisted living (AAL) strategy is also envisaged, for example the connection with the user’s fridge in their home. The fridge contents can be monitored and prompts and shopping lists can be generated on that basis and potentially be used for online purchases. Ambient temperature regulation is also planned with this technology.

While these AAL technologies have significant potential in facilitating persons with dementia to manage their daily lives successfully and stay in their own homes for longer, they also raise a number of concerns. First of all, there are safety concerns: the service provided through these technologies needs to be reliable and at all times safe for the patient. At the same time, they need to be sensitive to the patient’s preferences within the scope of safe limits and not be overly paternalistic. For example, safe heating temperatures need to be kept, but the user needs to be able to adjust to their comfort level. Similarly, basic health considerations in relation to food choices might influence the shopping list if there are known significant problems with the person’s diet, but they should not lead to the paternalistic imposition of a diet that does not meet user’s food habits and preferences.

In addition, significant privacy concerns arise in this context. It has been shown that the security features of IoT devices tend to be of comparatively low quality, so that they can provide easy entry into the home network. Security breaches of this kind might endanger the security of the sensitive information stored on the robot.

Another concern is the general issue of potential “big brother” style total surveillance of the person in an AAL setting (and potentially even beyond through RFID tagging or GPS tracking of the person), especially if combined with a care robot that additionally captures many further details of their activities and social interaction. The potential increase in autonomy and well-being achieved through these supports needs to be carefully balanced against the data security and privacy risks through use of those technologies.

These privacy concerns are further compounded by the potential capacity impairments of the user. This raises concerns if information from data breaches or even from the mere identification of the connecting device as a care robot is used to target the user inappropriately, for example exploiting their vulnerability with regard to the unnecessary purchase of goods or services. Accordingly, in the design of the MARIO robot particular care must be taken at the design stage that the principles of “Privacy by Design” are realised consistently and at all levels to minimise the potential of unintended data leakages. Care should also be taken to install appropriate privacy settings to minimise data gathering through legitimately accessed websites like Facebook or YouTube.

5.2.2. Cognitive and emotional assistance

5.2.2.1. Medical and health reminders

The use of medical and health related reminders is generally presented as a particularly beneficial aspect of the use of care robots. Especially in home settings, if no one-on-one human carer is available at all times, it can be difficult for the patient to know whether medication has already been taken, especially if they are not oriented with regard to the date or day of the week. Insufficient fluid intake is a significant risk factor for adverse health events; malnutrition arising from insufficient or imbalanced food intake is also not uncommon. Lack of physical activity is similarly is significant risk factor for accelerated cognitive and physical decline. Accordingly, effective reminders and continuous monitoring by a robot on these issues might enable the patient to avoid health crises and generally maintain a stable health state.

However, while regular reminders can be provided easily according to a schedule, the current technical capabilities regarding monitoring at this stage are not yet reliable enough to ensure the successful realisation of demand-sensitive reminders. (For example, recognition of actual fluid intake can be difficult if no normed drinking containers are being used.) Accordingly, it will be important that carers are aware of these limitations when Mario is being introduced and do not delegate their own monitoring completely to the robot.

In relation to the presentation of reminders to the users, another consideration will be the design of its communicative features. One important issue is how frequent and intense the reminders will be if the user is not complying with the reminders. It will need to be discussed whether the robot interaction should be designed with a view to motivational engagement of the user, or whether simple reminders will instead be chosen. The effectiveness and acceptability of the chosen reminder/motivation feature will need to be investigated carefully in light of other empirical evidence, in order to make an evidence-based decision on the most effective approach. At the same time, it will also need to be considered what level of paternalism is appropriate; the health imperative should not be automatically considered overriding, and the danger of inappropriate objectification or infantilisation of users through such functions needs to be kept in mind.

If reminders are linked to monitoring of actual engagement in the respective activity, privacy issues similar to those discussed in the previous section arise. If video footage of the person's activities throughout the day is being taken by the robot in order to extract relevant monitoring information, it needs to be carefully assessed how much of this information is being stored, who (if anybody) has access to it and for how long it is kept. The principles of Privacy by Design need to be kept in mind and collection of data and storage of data need to be limited to the amount necessary for the performance of this function, and also the privacy risks need to be proportionate to the likely benefit in comparison to less intrusive methods.

5.2.2.2. Psychological and cognitive support

Similar to the medical and health reminders, the provision of psychological and cognitive support through the care robot has clear potential benefit insofar as they could support users in successfully managing the demands of daily life despite their impairments. This not only supports their physical safety and psychological well-being but might also help preserve users' dignity and avoid the occurrence of situations that may be experienced as shameful, like being inappropriately dressed (for example with clothes put on in the wrong order).

The Mario robot is intended to provide assistance with various activities of daily life, for example instructions for getting dressed, including weather related recommendations for appropriate clothing, and provide instructions for the use of household tools and devices, for example cutlery, coffee machine etc. It is also meant to guide the user to locations related to their daily routines and leisure activities. Such activities will allow users to manage demands of everyday life and avoid confusion related distress, with little apparent downsides if the users are by themselves.

However, it needs to be kept in mind that intimate activities by patients (like getting dressed, washing, toileting) should not be recorded by the Mario robot; maximally privacy preserving settings need to be selected, because observation and recording of the sensitive situations can be perceived as privacy infringement by patients. The design needs to take into account what information is essential for the fulfilment of this function, but needs to be respectful of the user's dignity.

Another concern could be if other persons are able to overhear or notice these instructions. Witnessing those instructions may be experienced as undignified by the user who will be frequently aware that requiring instructions for such everyday activities is indicative of their cognitive impairment. Accordingly, care must be taken in the design process that the robot adjusts its instructions, depending on whether users are alone or in social contexts, with less intrusive modes of instructions given in social contexts.

Reminders are also planned regarding the recognition of family and friends, on the basis of face recognition software using stored personal photographic information. For these reminders, the aspect of shame also needs to be taken into account, and appropriate ways of presenting the names and information to the user will need to be identified, with the goal of minimising embarrassment of being seen to need reminders (for example visual display of the names might be preferable to an audio reminder).

Mario robot will also offer a range of cognitive stimulation activities and reminiscence activities, based on stored material that includes extensive information on family, friends and personal life experiences. Such activities have been shown to be beneficial for the cognitive and emotional well-being of persons with dementia, and their provision by robots might allow them to be performed more frequently and when it suits the person with dementia, rather than when it suits their carers. On the other hand, the previous significant consideration of potentially replacing the involvement of interpersonal engagement and the involvement of human carers needs to be taken into consideration.

And finally, such personalised information can also be used to calm down users when they experience agitation. For example, a user's favourite music can be played, or they can be distracted by engaging them in pleasurable activities. This will minimise the experience of negative affect and social disruption and therefore is likely beneficial for the person's well-being, however with the possible downside that in difficult situations the robot will be left to care for the person, rather than human carers, raising again the spectre of replacement of interpersonal human care by robots. Accordingly, training of care staff with regard to the use of the Mario robot needs to address this as problematic issue. Procedures could be implemented in the robot that require substantial involvement of human carers at some point for any episode in which the robot is being used to manage an emotional crisis, to ensure that no substantial replacement of human care by robot care is taking place. The Mario robot should be assigned tasks for which it is particularly suited, especially in relation to challenging and conflicting situations, or tasks where a constant presence on stand-by is required but not practically feasible with human carers (e.g. visit to the toilet at night time). If used properly, the Mario robot can help to perform some duties, and free up human carers' time, so that better and higher quality social contact between elderly people and carers could be facilitated.

5.2.3. Leisure activities and social connectedness

A significant group of functionalities of the Mario robot aims to address the common social withdrawal and isolation of dementia sufferers and the resulting frequent lack of cognitive stimulation. Providing opportunities of social connectedness and a wide range of leisure activities could counteract these problems. Facilitating easy social connectedness with family and friends through providing Skype connections is one of the core functions in this context. Facilitating ease of access includes the considerations of date, time, and other information potentially impacting on likely availability of respondents, such as differences in time zones (this is a significant concern particularly for many elderly persons in Irish communities where emigration is extremely common).

The aim of the MARIO project is to provide a customised set of activities that are enjoyable for the user and match their life experiences and interests, for example favourite card games, music, movies, books, or online versions of favourite sports games, as well as news and social media connections to their favourite teams or other leisure activities. Many of these activities might have a reminiscence element insofar as they may be based on material from their youth and early adulthood. Outside of intellectual property considerations, there is little reason to doubt the likelihood of predominantly beneficial effects from such offerings.

Some of these activities may also have a social component and can provide opportunities for social interaction, either with family members in home settings or with other residents in residential settings. Music can be listened to and enjoyed with others, for example in a sing-along of popular songs, or movies or matches could be watched jointly. Many games can also have a social component, and could be set up to provide the option of playing with the computer or with another person. Engaging with news and other types of leisure information may also provide opportunities for communication and give rise to instances of communication and sharing.

However, it would need to be considered how any offerings should be integrated in residential settings. Instead of a source of positive interactions, the robot might be perceived as a nuisance, or it might also be a source of envy and conflict. Group settings more generally raise the issue of how the robot relates to others who are not the specific person cared for. At the moment in the MARIO project the assumption is that one robot will be assigned to one individual, to be able to be customised to the needs of the individual within existing technical constraints. But even more generally, having to relate to more than one person, especially in the case of conflicting demands, might give rise to problems of designing appropriate interaction patterns of the robot in such situations. Especially in light of the predominance of residential settings in the trial sites of the MARIO project, the design of the robot's interaction in social contexts will need to be carefully thought out. Given the likely limitations of the robot capabilities in explicitly engaging with other residents, care will need to be taken to design it such that in social settings it is likely to be perceived as polite and socially inclusive rather than rude or disruptive. This aspect would also need to be addressed in training of care staff in those settings and procedures would need to be set with regard to this issue.

5.3. ICT capabilities

Different robot designs and functionalities pose different ethical implications and design challenges. Any design plan will involve particular values that may relate to ethical concerns, and are a result of specific design choices (Ljungblad, et al., 2011). Likewise, for different robotic functions, there might be more than one possible ICT solution and in different solutions we might encounter various possible ethical violations or ethical strengths. In the following Table 5.3., we will outline a number of potential ethical issues related to the currently envisaged ICT capabilities of Mario.

Table 5.3. Some basic ICT components and capabilities of Mario robot.

Data collection approaches/technologies	Sensor systems (to determine location, activity, physiological state, ambient sensors), microphone, camera, screen (touchscreen/keyboard)
Outputs to human	Screen (for visual outputs), speaker (for audial outputs).
Outputs to other systems	Websites/services (TV, movie, radio, Skype web sites/services), data sharing with other information systems (e.g. nursing information system), data sharing with intelligent home systems (e.g. heat system, fridge)
Capabilities	Data recording, storage, speech recognition, face recognition, image sentiment analysis, location determination system, falling prediction, taking photograph, gamification (cognitive stimulation exercises, brain training tools etc.), games, skype, karaoke system, reminders and recommendation systems (drug, daily activity), mobilisation, movie player, music player, e-book/newspaper reader, tv/radio/YouTube applications)

In terms of the proposed use cases, the Mario care robot will:

- Collect and store various kinds of personal and sensitive data (such as photos, addresses and identity information of people, and data about personal preferences),
- Connect with other systems and devices (sensors, nursing information system, various internet websites/web services, home automation system etc.),
- Share various types of data with these external systems, much of it sensitive personal data,
- Interpret the input data based on pre-identified rules and produce inferred outputs,
- Analyse input data using intelligent techniques (speech and face recognition, fall prediction, and sentiment analysis),
- Contact people using audio-visual capabilities,
- Provide various services via applications, many of which in turn are reliant on the web.

The Mario robot will provide a Skype connection and connection with other information systems and sensors. Due to the need of an internet connection, **digital vandalism** and **hacking** will be possible threats. Some functions, for example ambient monitoring (heating), health state tracking, guidance for outer environment activities will be particularly critical for patients' safety and wellbeing, and the robot will need a **reliable connection** to facilitate reliable performance of such functions.

To accomplish some of the selected functions, the Mario robot needs access to a wealth of personal data such as photos, contact details, identity information of people, and data about individual preferences and joint past experiences. Some of this information will be patient's personal data, but much of the reminiscence-related material is about family members, friends and other people. To collect and process such information, ideally **informed consent** should be provided from people once potentially sensitive (and criminally interesting) **personally identifying information** are processed in a way **that may become available to others beyond the person with dementia**. However, it would be unfair to allow most persons in everyday life to collate information on friends and family in their diaries or on Facebook and engage with their families and friends around this information, but discriminate against persons with dementia who use a robot by requiring unusually high standards of consent. In particular, the requirement for informed consent for all information may also strongly highlight the extent of the person's cognitive limitations to those included in the database which may be shameful for the person and increase exclusion or set the person apart from others. But with potentially lower requirements of informed consent, **data security and strong requirements for confidentiality settings** become essential. It should not be possible to access this information from outside the robot itself, and in addition to the user themselves only clearly identified carers or close family members should be authorised by the robot to access such information, and only in joint interactions with the person with dementia (as opposed to being allowed to browse through such information by themselves).

Manual data recording and rule identification are another problem. Particular care needs to be taken in defining data and rules which will determine the performance of functions and underlie inference processes. A faulty definition or mistakes in the entry of relevant data could be a reason for faulty inferences and unintended and/or potentially harmful robot behaviour. Similarly, there is a need to continuously monitor the adequacy and quality of robot outputs and behaviour in particular, to be able to catch any such problems as early as possible.

Intellectual property rights are also a critical area. Regarding the use case scenarios, the functionality of the Mario robot will include the use of a range of entertaining material from websites (radio, movies, matches etc.) and/or external materials (uploading from CD, DVD etc.). How exactly access and storage of this material is carried out should be considered carefully and with qualified legal advice to prevent possible infringement of copyright, intellectual property and legal requirements. It will also need to be considered how such requirements relate to the robot's existing functionalities and whether they might have an impact on quality of functioning. For example, should it be required that access to movies needs to be through a DVD drive, which would need to be part of the robot hardware, or should streaming from a website be required rather than from downloaded material, which would have implications for the robot's functioning if the existing internet connection is not always consistent and reliable.

5.4. Consent

Patients' involvement in the MARIO user trials will be based on an informed consent process that meets the ethical principles enshrined in the Declaration of Helsinki and any national research ethics requirements and guidance documents applying in each trial site. The safety and well-being of participants will be a crucial consideration and any risk will be minimised so as not to exceed minimal risk standards. Persons with dementia will all participate completely voluntarily and can withdraw from the project at any time. The consent approach will be based on the model of assisted decision-making, All staff involved in the delivery of the user trials will be instructed in the rights of research participants and no pressure will be exerted for participants to continue participation if they do not want to participate. However, patients will be asked (but not requested) whether they would like to explain why they are continuing participation in order to inform the project team of potential emerging concerns. Distress and critical incident protocols will be in placed before the user trials begin and all staff will be familiar with their requirements.

Consent raises particular problems for the case of dementia, given the cognitive impairments characteristic of the condition. However, given current human rights standards for persons with disability, the person with dementia needs to be involved in a consent process with careful consideration of their impairment and an "assisted decision-making" process should be initiated in which the opportunity to express relevant preferences and provide a decision is given. If necessary, additional persons, for example close family members can be brought in to support the process.

In relation to Mario robot, a range of settings for the same functionalities is envisaged, to adapt to needs and preferences of users. For example, the health state and level of physical and mental frailty will have an impact on the level of safety and risk that will be considered justifiable for a particular user. Accordingly, the scope of decision-making that the user has in a particular case might be more circumscribed if they have a higher frailty and risk-level as opposed those with lower levels. For example, a person with a low risk of falls might be allowed to switch off monitoring, whereas it could be argued that a person with dementia with a high fall risk should not be allowed to choose to switch off the monitoring function. Decisions on general settings need to be set by the developers, but require substantial input of health care professionals and users or potential users.

It is also acknowledged that users might change their mind once they have experience of the robot. They may be annoyed by certain functions, or find others less disruptive or irritating than they might have initially thought, or may care less or more about certain issues once they have experience of the reality of the human-robot interaction. The project is committed to the principle of dynamic consent, acknowledging that changes in preferences can occur over time and that the project staff and/or robot designers have a responsibility to facilitate decision-making on changed preferences. The particular challenge in this context is that any consent process needs to minimise confusion and be a simple and straightforward as possible. It will need to be carefully considered how to design feasible reconsiderations of consent that will not be too demanding for the target group but allow them meaningful choice.

5.5. Conclusion

An important aim of the MARIO project is to do justice to the principles of value-sensitive design and to integrate the consideration of ethical needs and challenges into the design process at all stages. We hope that the present ethics framework provides a first step and perhaps a foundation for the realisation of this goal. However, its considerations will most likely need to be adapted in response to emerging challenges and cannot replace careful multi-disciplinary ethical reflection and decision-making within the project with regard to such challenges.

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APPENDICES

Appendix A: Ethical perspectives of selected robot and ambient assisted living projects

In this document, 24 European projects were reviewed. Of these, 15 had a physical robot:

ACCOMPANY
Companionable
MOBISERV
GiraffPlus
ALIAS
KSERA
Florence
ExCITE
Hobbit
ROBO MD
SRS
DOMEO (2 robots – robuWALKER and robuMATE)
Project Romeo
Robot-Era (3 robots - Outdoor robot, domestic robot and condominium robot)
SERA

The remainder of the projects either had a robot prototype in development but not fully finished, or were purely software- or ethics-based.

Some of the projects listed above used the same robots:

- ACCOMPANY and SRS used the Care-O-Bot 3
- KSERA and ROBO MD used the Nao robot
- The robuMATE robot used in the DOMEO project was based on the Kompai robot used in the MOBISERV project

Morphology and functions

The general functions of the robots are listed in Table A.1.

Table A.1. Main functions of each robot

	Fetching & carrying objects	Monitoring for falls/ emergencies*	Telepresence	Reminders (e.g. to take medicine)	Entertainment, games & Internet services
ACCOMPANY	✓	✓	✓	✓	
Companionable		✓	✓	✓	
MOBISERV		✓	✓	✓	✓
GiraffPlus		✓	✓	✓	
ALIAS		✓	✓		✓
KSERA		✓	✓	✓	
Florence		✓	✓	✓	✓
ExCITE			✓		
Hobbit	✓	✓			✓
ROBO MD		✓	✓		
SRS	✓	✓	✓		
DOMEO – robuWALKER robuMATE		 ✓ ✓	 ✓	 ✓	 ✓
Robot Era - Outdoor Domestic Condominium	 ✓ ✓ ✓	✓	✓	✓	✓
Project Romeo	✓	✓		✓	
SERA					✓

*includes monitoring the environment by linking with smart home sensors

The most common functions were monitoring for emergency situations and telepresence. The least common function was fetching and carrying objects – this was not possible for the many robots who did not have hands and arms. However, the Robot Era robots were able to transfer objects among themselves and thus were able to effect efficient transport of objects even though “2” of the “3” did not have arms.

The number of robots with entertainment/Internet services was less than the number of robots with a tablet interface; this functionality would be easily implemented in such robots or possibly already is and was just not explicitly stated on the websites as a function.

These robots will be looked at individually in the table comparing functions as the main functions may differ from project to project, but will be grouped together in the table comparing morphology (see Table A.2.).

Table A.2. Morphology of each robot

	Has hands & arms	**Has emotive face**	**Has tray table**	**Able to speak**	**Has tablet interface**
Care-O-Bot 3 (ACCOMPANY & SRS)	✓	✓	✓	✓	✓
Companionable		✓		✓	✓
Kompai robot (MOBISERV & DOMEO - robuWALKER)				✓	✓
GiraffPlus robot (GiraffPlus & ExCITE)					✓
ALIAS		✓		✓	✓
Nao robot (KSERA & ROBO MD)	✓	✓		✓	
Florence					✓
Hobbit	✓	✓			
DOMEO – robuWALKER					
Robot Era – Outdoor Domestic Condominium	✓	✓ ✓ ✓	✓ ✓		✓ ✓
Project Romeo	✓	✓		✓	
SERA				✓	

The most common morphological features were the emotive face and the tablet interface.

User involvement

13 of the 15 projects above had evidence of user involvement during the process of robot development.

In the **ACCOMPANY project**, there was a work package of several deliverables related to eliciting the user requirements. These requirements were taken in account (within reason, allowing for the technical capabilities of the robot) when choosing which functions to carry out in the scenario-based tests.

In the **Companionable project**, no deliverables related to user involvement were available from the website, but a conference paper mentions user involvement to determine the use requirements and states that "the Companionable framework architecture takes these needs into account".

There was a work package of several deliverables dedicated to user acceptability in the **MOBISERV** project. The final deliverable recommends changes that could be made to the robot to improve acceptability.

In the **GiraffPlus** project, there was a deliverable dedicated to defining the main functionalities of the robot based on the user requirements, and a separate work package (of 1 deliverable) dedicated to ensuring a user-centered design approach throughout the development cycle. Quantitative means were used to list the functions in order of priority. Users' preferences for the robot's physical appearance were also examined in the workshops.

In the **ALIAS** project, there was a work package of several deliverables dedicated to user requirements. A list of required functions was drawn up and fed back to the technical development team so that the robot could be developed to be able to carry out those functions. The functions were later included in scenario-based tests. Users were also consulted to ensure that the robot's manual was accessibly written.

For **KSERA** project, no deliverables were dedicated to user involvement were evident, but a paper identified 6 user needs based on user involvement. It is stated that the smart home/robot combination in its current form can address the 6 needs.

Florence project include two deliverables related to the in-lab and in-home tests of the robot; one related to a questionnaire and wizard-of-Oz test and included user feedback on the physical appearance of the robot. However, the tests seem to mostly involve examining users' ability to control the movement and orientation of the robot; the robots' function were already designated.

In the **ExCITE** project, no deliverables were available from website, however there were several publications regarding user involvement. One publication mentioned cyclic development of the robot whereby a prototype would be tested by users, their feedback would be analysed and use to design the next iteration which would then be tested by users, and so on. It was evident from the papers that the researchers were seeking to improve some of the technical capabilities of the robot that users had experienced difficulty with in the long-term trials.

For **Hobbit** project, no deliverables were publically available on the website, however there were several publications relating to user involvement. One of the publications drew the conclusion that the prototype generally met the needs of users, but listed some small changes that could be made. These included functionality but also aspects such as size, voice and price of the robot.

In the **SRS** project two deliverables related to user involvement. Information was gathered on user requirements which were divided into high, medium and low priority. Scenarios for testing at a later stage in the project were defined based on the user requirements (within reason, allowing for the technical capabilities of the robot).

In the **Domeo** project one work package (3 deliverables) relating to initial interviews of users and another work package (2 deliverables) relating to the in-home trials. User interviews were analysed to determine users' opinions on acceptability and privacy, pertinence of services, costs, possible obstacles, motivation level to use the proposed services, organisational issues, appearance of robot. The deliverable stated that many of the users' recommendations could be taken into consideration during development, but some were not realistic at present.

Robot Era project contain one work package related to user-centered design, but deliverables were not available from the website. However, there were other publications relating to user involvement. Information was obtained about scenarios, user requirements, usability, acceptability, demand for the services and cost of the robot. The information allowed the refinement of scenarios to be tested and was also fed back to the technical development team.

No deliverables were available from website of the **SERA** project, however a paper mentioned user involvement. In the case of this project that robot was a simple toy that was a finished design, therefore a list of user needs was not collected and used to influence the robot design.

The following tables reflect:

- The number of users, informal carers and formal carers involved in testing the robot (see Table A.3),
- The methods of testing used and the stages of development at which user involvement occurred (see Table A.4),
- The length of time over which the user involvement occurred (see Table A.5).

Table A.3. Number of participants

	Elderly people involved	Informal carers involved*	Formal carers involved*	Age range of elderly people, if given	Average age of elderly people, if given
ACCOMPANY	32	32	32	60-95	78.4 (median)
Companionable	17	13	31		
MOBISERV	42	44		60-93	
GiraffPlus	39	76		71-94	81 (mean)
ALIAS	20	✓	✓	54-83	72 (mean)
KSERA	38 + unspecified no. more in focus groups			Lab trials 61-74 Field trials 71-90	66.8 (mean) 77 (mean)
Florence	10	15		60-80	
ExCITE	11		26		
Hobbit	113 – questionnaire 38 - interview 49 – scenario-based tests	35		70-88	
SRS	22 – focus groups 64 - interview	17	28	65+	
DOMEO	40-questionnaire 10 –focus group	40-questionnaire 13-focus group	40-questionnaire 7-focus group	77-85	
Robot Era	149 – focus groups 67 – lab tests		17	65-83	
SERA	2			55-65	

*Numbers given where possible, if numbers were not mentioned then ✓ used to denote that members of this group took part.

It was difficult to count the number of participants as sometimes the same test subjects participated in more than one set of tests and it was not stated which participants were new to the project and which had already participated previously. The numbers in the table are the number of people who participated in each stage added together.

In many cases, medical professionals such as doctors, physiotherapists and dieticians participated in the studies. Rather than creating a separate category for medical professionals they were counted under “formal carers”. Formal and informal carers were involved in almost all of the projects.

Table A.4. Methods of user involvement used at each stage of project

	Initial Research	Development of prototype	Testing of prototype	Development of next iteration of robot	Finished robot
ACCOMPANY	Focus groups			Focus groups, in-home trials	
Companionable	Questionnaire, interviews				In-home trials
MOBISERV		Focus groups	Scenario-based tests		Scenario-based tests
GiraffPlus	Focus groups		Scenario-based tests		
ALIAS	Questionnaires, focus groups		Scenario-based tests		
KSERA	Focus groups, semi-structured interviews				Scenario-based tests in lab & in nursing home
Florence	Questionnaire, wizard of Oz tests				Scenario-based tests
ExCITE				Focus groups & questionnaires for formal carers Interviews & in-home trials for elderly people	
Hobbit	Focus groups, questionnaires, interviews		Scenario-based tests		
SRS	Focus groups, questionnaire-based interviews, (scenario-based tests*)				In-home trials
DOMEO		Focus groups	Lab tests (robuWALKER)		In-home trials (Kompai)
Robot Era	Focus groups, group interviews				Scenario-based tests in lab
SERA					In-home trials, interviews

*Tests involved a human standing in place of the robot and were to determine what functions the elderly people found most useful

Almost all projects included user involvement during the initial research stage and incorporated end-users' needs into the functionalities of the robot. However, in some cases, it was also difficult to categorise the exact stage of development during which the user involvement occurred.

The general pattern appeared to be that focus groups/questionnaires/interviews were conducted in earlier stages of development, and scenario-based tests/in-home trials were conducted in later stages of development.

Focus groups that occurred at an early stage of development (e.g. during initial research) tended to involve discussions about very broad concepts of what the participants would like to see in a robot, which the researchers would then use to define User Requirements. Focus groups that occurred at a later stage in development tended to be about more specific issues/scenarios that had arisen during the development of the robot. The later-stage focus groups were more likely to include a video demonstration of the robot or a working prototype of the robot to stimulate discussion.

Regarding the earlier stages of development, there was variability among projects in which focus groups, interviews and questionnaires were used as to which method was used first. In some cases the same participants completed all of these methods on the same day; in other cases focus groups were conducted first and interview questions were designed based on those results; in other cases preliminary questionnaire were used to choose the topics of discussion for the focus groups.

The size of focus groups were always ~10 individuals or less. When there were more participants available than this, they were split into multiple groups.

In most instances, in-home trials and scenario-based tests in lab involved questionnaires/ interviews before and/or after the trials which I did not specifically mention above to save space in the table.

Table A.5. Specifics of in-home trials

	Length of time of trial	**Number of test subjects**	**Location**
ACCOMPANY*	2-3 weeks	2	Own home
Companionable	2 days	11 total – 5 couples and 1 single person, so 6 trial sessions overall	Test home (smart home)
Florence	1 week (total time for all participants) 2 days	5 elderly + ~10 carers 5 elderly (+5 relatives to communicate with via telepresence)	Living lab Own home
ExCITE	3-12 months (not specified)	1	Own home
SRS**	1.5 days	2 elderly people living in 1 apartment	Own home
DOMEO	10-12 weeks	12	Own home
SERA	10 days	2	Own home

*In-home trials involved mock-ups of the robot rather than fully functioning ones and were designed to see how elderly people would respond to having a robot in their home long-term.

** Trial was mainly to investigate technical elements such as moving the robot through narrow halls.

The sample sizes and length of time of in-home trials were very limited in most cases.

Ethical considerations

In the **ACCOMPANY project**, there was a series of dedicated ethics deliverables in which an ethical framework was proposed, focus groups of elderly people, informal carers and formal carers discussed hypothetical scenarios relating to the different ethical values, and the framework was revisited based on this feedback. In addition, there were several papers published exploring the feedback from the focus groups in greater detail.

In the **Companionable project**, there was a dedicated ethics deliverable which examined the general ethical issues that were relevant to the project and the national ethical guidelines of several different European countries. There was a particular focus on informed consent as trial participants in this project had mild cognitive impairments.

The **MOBISERV project** had no ethics deliverables available.

In the **GiraffPlus project**, ethical guidelines formed part of a deliverable on user-centered design. Ethical standards in different European countries are examined. Informed consent is discussed and the leaflet of information and consent form that potential participants were given are included in the deliverable.

The **ALIAS project** had no ethics deliverables available.

The **KSERA project** had no ethics deliverables or publications available, however an online press release mentions privacy of personal data as a concern.

The **Florence project** included a dedicated ethics deliverable which examined the national ethical regulations of several European countries. Informed consent is discussed and the leaflet of information and consent form that potential participants were given are included in the deliverable.

In the **ExCITE project**, there were no ethics deliverables available from the website. Other publications mention the use of informed consent procedures for trial participants. Safety and privacy concerns are also raised due to the ability of the robot to be remotely operated. One criteria for participation in user trials is that the person must be free of dementia or any cognitive impairments, so that they do not become alarmed or confused when the robot is remotely operated.

The **Hobbit project** had no ethics deliverables available from the website. A paper raises deception of the user and autonomy as ethical issues, arguing that unconscious social mechanisms will lead the user to view the robot as a person, resulting in the user being less likely to decide against the robot and thus compromising their autonomy.

The **SRS project** includes a dedicated chapter of a deliverable about ethics and ethics are also mentioned in a deliverable about user requirements. Privacy, safety, autonomy and human welfare are discussed and explanations are provided of how concerns relating to these are addressed.

The **Domeo project** had no dedicated ethics deliverable available, but a deliverable about user trials included the information leaflets and informed consent forms given to potential participants.

The **Robot Era project** had no ethics deliverables available from the website, however a presentation briefly mentioned informed consent for user trials.

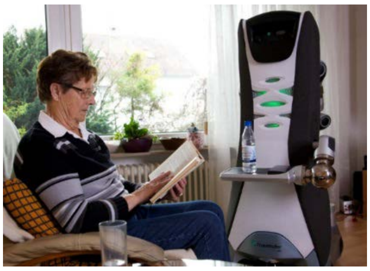
The **SERA project** had no ethics deliverables available.

A summary of the ethical considerations of each project is provided in Table A.6:

Table A.6 Ethical considerations

	Ethics deliverable(s)	Informed consent mentioned/process described	National regulations of countries in which project took place	Values discussed
ACCOMPANY	✓			Ethical framework developed. Values mentioned: autonomy, independence, privacy, enablement, safety, social connectedness.
Companionable	✓	✓ (particular focus –MCI)	✓	
MOBISERV				
GiraffPlus	✓	✓	✓	
ALIAS				
KSERA				Mention of privacy as concern
Florence	✓	✓	✓	
ExCITE		✓		Mention of safety and privacy as concerns
Hobbit				Mention of deception and autonomy as concerns
SRS	✓			Privacy, safety, autonomy, human welfare
Domeo		✓		
Robot Era		✓		
SERA				

Detailed project definitions

Project name and website	**ACCOMPANY (Acceptable robotiCs COMPanions for AgeiNg Years)** http://accompanyproject.eu	
Brief explanation	The proposed ACCOMPANY system will consist of a robotic companion as part of an intelligent environment, providing services to elderly users in a motivating and socially acceptable manner to facilitate independent living at home. The ACCOMPANY system will provide physical, cognitive and social assistance in everyday home tasks, and will contribute to the re-ablement of the user, i.e. assist the user in being able to carry out certain tasks on his/her own.	
Funding dates	2011-2014	
Consortium partners	The University of Hertfordshire (UH), United Kingdom Hogeschool Zuyd (HZ), The Netherlands Fraunhofer (Fraunhofer), Germany University of Amsterdam (UVA),The Netherlands University of Siena (UNISI), Italy Maintien en Autonomie à Domicile des Personnes Agées (MADOPA), France University of Birmingham (UB), United Kingdom University of Warwick (UW), United Kingdom (See University of Birmingham) University of Twente (UT), The Netherlands (See University of Amsterdam)	
Core functions of the robot	*Care-O-Bot 3* Monitoring, fetching and carrying objects, opening doors, telepresence via tablet, obtaining help in the case of a fall/emergency, reminders to take medication/drink water etc.	
Ethics	"A series of ethical principles such as **autonomy, independence, enablement, safety, privacy and social connectedness** were identified, using theoretical analysis. The project has developed a framework that allows us to identify the tension between some of these principles and to highlight these tensions in knowledge transfer activities. Our planned future user studies allow for prioritising these principles. *(http://rehabilitationrobotics.net/cms2/sites/default/files/accompany_leaflet2.pdf)* *(Ethics deliverables available from http://accompanyproject.eu)*	
Ethics publications	Robots and the Division of Healthcare Responsibilities in the Homes of Older People Using Robots to Modify Demanding or Impolite Behaviour of Older People Ethical Dimensions of Human-Robot Interactions in the Care of Older People: Insights from 21 Focus Groups Convened in the UK, France and the Netherlands What asking potential users about ethical values adds to our understanding of an ethical framework for social robots for older people Robot carers, ethics, and older people *(available from http://rehabilitationrobotics.net/cms2/publications)*	
Involvement of users and carers	In total 96 persons participated in the study: • Thirty-two elderly persons (7 male, 25 female) with a mean age of 78.4 years (from 60 to 95 years) participated in focus group meetings in the Netherlands (7) and France (25). All elderly persons were still living at home and received some form of care assistance (e.g. home care, telecare). • Thirty-two professional caregivers (1 male, 31 female) participated in focus group meetings in the Netherlands (6), UK (4) and France (22). Caregivers' professions varied from care workers, nurses, psychologists to managers. All professional caregivers worked closely with elderly. • Thirty-two informal caregivers (2 male and 30 female) participated in focus group meetings in the Netherlands (7), UK (5) and France (20). Informal caregivers took	

	care of (one of) their parents, their spouse, neighbour, or their aunt. In two cases the elderly person taken care of was recently institutionalised and in one case the elderly person had recently passed away. (*http://rehabilitationrobotics.net/cms2/sites/default/files/ACCOMPANY%20D1.2%20V1%202%20pm%20final.pdf*)

Project name and website	**CompanionAble (Integrated Cognitive Assistive & Domotic Companion Robotic Systems for Ability & Security)** http://www.companionable.net
Brief explanation	The distinguishing advantages of the CompanionAble Framework Architecture arise from the objective of graceful, scalable and cost-effective integration. Thus CompanionAble addresses the issues of social inclusion and homecare of persons suffering from chronic cognitive disabilities prevalent among the increasing European older population. A participative and inclusive co-design and scenario validation approach will drive the RTD efforts in CompanionAble; involving care recipients and their close carers as well as the wider stakeholders. 
Funding dates	2008-2012
Consortium partners	University of Reading (Project co-ordinator) Technische Universitaet Ilmenau (UIL) Assistance Publique Hopitaux de Paris (APHP) Groupe des Ecoles des Telecommunications (GET-INT) Fundacion Robotiker (TECNALIA-RBTK) AIT Austrian Institute of Technology GmbH (AIT) Legrand France SA (LEG) AKG Acoustics GmbH (AKG) Chambre de Commerce et d'Industrie de Paris CCIP (ESIEE) AG ESIGETEL (ESIG) Universite d'Evry-Val d'Essonne (IBISC) Metralabs GmbH Neue Technologien und Systeme (MLAB) Stichting Smart Homes (SmH) Center for Usability Research and Engineering (CURE) Universidad da Coruna (UDC) Innovation Centre in Housing for Adapted Movement (In-HAM) Fundacion Instituto Gerontologico Matia - Ingema (ING) Verklizan B.V. *(http://www.companionable.net/index.php?option=com_content&view=section&id=3&Itemid=4)*
Core functions of the robot	*Companion Robot Hector* Telepresence, comes when name is called, can mind user's wallet and glasses, reminds user to take medication and carry out tasks, contacts remote control centre if user falls
Ethics	The paradigm of ethics is to assess the consequences of an action before the action is performed in order to avoid any risk of harm (physical, psychological, social or economic) that could not be balanced by a relevant and sustainable advantage for the persons exposed to the action, with respect to the social and ethics rules of the community… One important concern is the search for balance in the relationship between the demand for a better quality of life and respective researches, and rights of the research participants. On the level of the EU, the basic regulations are provided in the Charter of Fundamental Rights of the European Union … 1. Everyone has the right to the protection of personal data concerning him or her. 2. Such data must be processed fairly for specified purposes and on the basis of the consent of the person concerned or some other legitimate basis laid down by law. Everyone has the right of access to data which has been collected concerning him or her, and the right to have it rectified… Article 25 recognises the rights of the elderly and designates the aging population as a special stratum deserving special attention" (F*rom Deliverable 2.2)*

Ethics publications	Deliverable 2.2 also discusses the importance of patients giving informed consent in order to participate in the project, as to participate patients must have diagnosed Mild Cognitive Impairment (MCI) or Alzheimer's Deliverable 2.2 also looks at ethics guidelines from several different EU countries – Spain, France, the UK, Belgium, the Netherlands, Germany, and Austria.
Involvement of users and carers	Users from testbeds in Spain, France, Netherlands and Austria were engaged in the requirements elicitation process that was facilitated by cultural probes, and multi-media visualisation of potential usage-contexts, so as to deepen understanding of user groups' needs and explicate the users' individual needs and priorities. Overall some 17 CRs, and 13 care-givers as well as 31 professionals were involved in the initial questionnaire survey and the subsequent interviews. *(from Badii, A., et al. "CompanionAble: Graceful integration of mobile robot companion with a smart home environment." Gerontechnology 8.3 (2009): 181)*
Other Publications	Schroeter, Ch, et al. Realization and user evaluation of a companion robot for people with mild cognitive impairments. *Robotics and Automation (ICRA), 2013 IEEE International Conference on*. IEEE, 2013. Cornet, Gérard. Robot companions and ethics: A pragmatic approach of ethical design. *Journal International de Bioéthique* 24.4 (2013): 49-58.

Project name and website	**MOBISERV (An Integrated Intelligent Home Environment for the Provision of Health, Nutrition and Well-Being Services to Older Adults)** http://www.mobiserv.info
Brief explanation	Mobiserv has developed a personal intelligent platform consisting of various devices, middleware, and services. The Mobiserv platform consists of the following: A social **companion robot** – an autonomous robot, containing processing power, data storage capability, various sensors, machine learning/experience gathering/adaptation, a touch screen, speech synthesis, and speech recognition; Wearable **smart clothes** – implementing various functionalities such as monitoring of vital signs or sleeping patterns, and detection of falls; A **smart home** environment – including smart sensors, optical recognition units, and home automation elements, to detect among others eating and drinking patterns, activity patterns, and dangerous situations. 
Funding dates	December 2009-September 2013
Consortium partners	Ananz wonen-welzijn-zorg in the Netherlands University of the West of England in the UK Aristotle University of Thessaloniki in Greece Lappeenranta University of Technology in Finland Smart Homes in the Netherlands Centre Suisse d'Electronique et de Microtechnique in Switzerland Robosoft in France Smartex in Italy
Core functions of the robot	*Mobiserv robot "Kompai"* Monitoring, telepresence, reminding user to exercise/eat/drink/take medication, seeing who is at the door, plays game with user, has customisable tone of voice & behaviour.
Ethics	
Ethics publications	Deliverable 2.7 User Acceptance Criteria
Involvement of users and carers	Six user groups of older people, three in the UK and three in the Netherlands, took part in the research. There were embodiment workshops, in which users discussed what was meant by "an ideal robot", "a nightmare robot", and had discussions based on a documentary about robot development, and scenario-based workshops, in which the participant were provided with scenarios related to hydration, nutrition support, exercise, front door control and voice/video calling. The participants were separated into groups based on gender; the researchers believed that single-gender groups would lead to the participants being less inhibited in expressing their opinions. *(from Deliverable 2.7)*
Other Publications	Heuvel, H., et al. Mobiserv: A service robot and intelligent home environment for the Provision of health, nutrition and safety services to older adults. *Gerontechnology* 11.2 (2012): 373. C. Huijnen, A. Badii, H. van den Heuvel, P. Caleb-Solly, D. Thiemert. Maybe It Becomes a Buddy, But Do Not Call It a Robot. Seamless Cooperation between Companion Robotics and Smart Homes (2011) M. Nani, P. Caleb-Solly, S. Dogramadzi, T. Fear, H. van den Heuvel. MOBISERV: An integrated intelligent home environment for the provision of health, nutrition and mobility services to the elderly (2010) *Not about ethics but could be relevant to VSD as it mention the 7 personas used by the design team to imagine the perspectives of users of the system.

Project name and website	**GiraffPlus** http://www.giraffplus.eu
Brief explanation	GiraffPlus is a complex system which can monitor activities in the home using a network of sensors, both in and around the home as well as on the body. The sensors can measure e.g. blood pressure or detect e.g. whether somebody falls down. Different services, depending on the individual's needs, can be pre-selected and tailored to the requirements of both the older adults and health care professionals. At the heart of the system is a unique telepresence robot, Giraff, which lends its name to the project. The robot uses a Skype-like interface to allow e.g. relatives or caregivers to virtually visit an elderly person in the home. Special emphasis in the project is given to evaluations and input from the users so that the system can have an empathetic user interaction and address the actual needs and capabilities of the users. 
Funding dates	Jan 2012 - December 2014
Consortium partners	Örebro University Lund University University of Malaga Giraff Technologies AB Consiglio Nazionale delle Ricerche - ISTC Consiglio Nazionale delle Ricerche - ISTI Intellicare - Intelligent Sensing Healthcare LDA Tunstall Healthcare Limited Mälardalen University Örebro City Council XLAB Razvoj Programske Opreme in Svetovanje D.O.O Azienda Unita Sanitaria Locale Roma/A ASL RM/A I Servicio Andaluz de Salud
Core functions of the robot	*Giraff robot* Telepresence, maintaining social connectedness There are also smart home sensors (separate from the robot) that carry out monitoring and reminding functions.
Ethics	
Ethics publications	Deliverable 1.1 User Requirements and Design Principles Report Deliverable 6.1 Preliminary Evaluation Report
Involvement of users and carers	At the beginning of the project, there were focus groups of elderly people and formal carers in Sweden, Italy and Spain. 98 people participated in total. "Each focus group was a one and a half hour long discussion about health deterioration due to aging, elderly persons' expectations and need of support, how this support should be delivered, what should be monitored, and what constitutes an alarm." –Deliverable 1.1 A questionnaire was given to 200 participants, primary users (elderly people) and secondary users (informal and formal carers). The questionnaire asked people to rate services that could potentially be offered by the GiraffPlus system on a scale of 1-5 for usefulness, and on a scale of 1-5 for acceptability. Based on the responses, services were designated as "key", "desirable" or "optional". At a later stage in the project, 11 elderly people in Sweden were shown a prototype of the Giraff robot. They completed a pre-questionnaire where they were asked about their expectations of the robot, then carried out several scenarios designed to test the usability of the robot, then completed a post-questionnaire where they were asked about how they perceived the GiraffPlus system, usability and their views and thoughts regarding being monitored. – Deliverable 6.1 A scenario-based workshop with 6 formal carers was also carried out in Italy.
Other	S. Frennert, B. Östlund *Review: Seven Matters of Concern of Social Robots and*

Publications	*Older People* In International Journal of Social Robotics Volume 6(2):299-310, 2014, DOI:10.1007/s12369-013-0225-8 S. Frennert *Older People and the Adoption of Innovations - A study of the expectations on the use of social assistive robots and telehealthcare systems* Licenciate thesis, Lund university, 2013, ISBN: 978-91-980817-3-2 S. Coradeschi, A. Cesta, G. Cortellessa, L. Coraci, J. Gonzalez, L. Karlsson, F. Furfari, A. Loutfi, A. Orlandini, F. Palumbo, F. Pecora, S. von Rump, A. Štimec, J. Ullberg and B. Östlund. *GiraffPlus: Combining Social Interaction and Long Term Monitoring for Promoting Independent Living.*In Proceedings of the 6th International Conference on Human System Interaction (HSI 2013), pp. 578-585, Gdansk, Poland, June 2013. DOI 10.1109/HSI.2013.6577883 IEEE. 2013 *All of the above available from* *http://www.giraffplus.eu/index.php?option=com_content&view=article&id=86&Itemid=87&lang=en7* Frennert, Susanne Anna, Anette Forsberg, and Britt Östlund. Elderly People's Perceptions of a Telehealthcare System: Relative Advantage, Compatibility, Complexity and Observability. *Journal of technology in human services* 31.3 (2013): 218-237. Frennert, Susanne, Britt Östlund, and Håkan Eftring. Would granny let an assistive robot into her home? *Social Robotics*. Springer Berlin Heidelberg, 2012. 128-137.

Project name and website	**ALIAS (Adaptable Ambient LIving ASsistant)** http://www.aal-alias.eu
Brief explanation	The objective of the project is the product development of a mobile robot system that interacts with elderly users, monitors and provides cognitive assistance in daily life, and promotes social inclusion by creating connections to people and events in the wider world. The system is designed for people living alone at home or in care facilities such as nursing or elderly care homes. The function of ALIAS is to keep the user linked to the wide society and in this way to improve her/his quality of life by combating loneliness and increasing cognitively stimulating activities. ALIAS is embodied by a mobile robot platform with the capacity to monitor, interact with and access information from on-line services, without manipulation capabilities. ALIAS is not designed to replace human-human contacts, but rather, to enhance and promote these through the proposed wide range of integrated services. By serving as a monitor, a cognitive-prosthetic device and a facilitator of social contacts, the ALIAS system will significantly improve the daily life of elderly people. 
Funding dates	July 2010-July 2013
Consortium partners	Technische Universität München (TUM), Munich, Germany Cognesys, Aachen, Germany EURECOM, Sophia-Antipolis, France Fraunhofer-Gesellschaft zur Förderung der angewandten Forschung e.V. Guger Technologies, Graz, Austria MetraLabs, Ilmenau, Germany PME Familienservice GmbH, Berlin, Germany Technische Universität Ilmenau, Ilmenau, Germany YOUSE GmbH, Berlin, Germany
Core functions of the robot	*ALIAS robot* Communication, health monitoring, calling for help in emergency, entertainment
Ethics	
Ethics publications	The following deliverables relate to the involvement of old people & carers: Deliverable 1.1 Requirements list regarding the needs and preferences of the user groups Deliverable 1.2 List of selected functions Deliverable 1.4 Analysis of pilot's first test-run with qualitative advices on how to improve specific functions/ usability of the robot Deliverable 1.5 Analysis of pilot's second test-run with qualitative advices on how to improve specific functions/ usability of the robot *(All available from http://deliverables.aal-europe.eu/call-2/alias)*
Involvement of users and carers	There did not appear to be any directly ethics related publications or deliverables.
Other Publications	User involvement is mentioned in Rehrl, Tobias, et al. The ambient adaptable living assistant is meeting its users. *AAL Forum 2012*. 2012.

Project name and website	**KSERA (Knowledgeable Service Robots for Aging)** http://www.ksera-project.eu
Brief explanation	KSERA is a research project in the EU's 7th Framework Programme. The main aim is to develop a socially assistive robot that helps elderly people, especially those with Chronic Obstructive Pulmonary Disease (COPD), with their daily activities, care needs and self-management of their disease…The main research question addressed in this project is how to obtain a successful, effective interaction between the human and the mobile robot to guarantee acceptance and adoption of service robotics technology and offer added value of the ubiquitous monitoring services. 
Funding dates	Feb 2010-Jan 2013
Consortium partners	Eindhoven University of Technology (TU/e) Istituto Superiore Mario Boella (ISMB) Maccabi Healthcare Services (Maccabi) CEIT RALTEC gemeinnuetzige GmbH (CEIT RALTEC) Vienna University of Technology (TUW) Consoft sistemi S.p.A. (Consoft) Universität Hamburg (UH)
Core functions of the robot	*KSERA robot "Nao"* Monitoring health & behaviour, communication – video & Internet services, alerting caregivers & emergency personnel in case of emergency, integration with smart home sensors to monitor home environment.
Ethics	"Ethical issues will also be given special attention. The robot must give good advice to patients, but it should not be a policeman, Meesters explains. What to do, for example, when a COPD patient lights a cigarette? And what may the robot system pass on to 'the central operator', and what not? Meesters: "We need to define clear limits, for the robot will continuously measure and see very private data. *http://www.sciencedaily.com/releases/2010/04/100422085218.htm*
Ethics publications	
Involvement of users and carers	
Other Publications	Torta, Elena, et al. Attitudes towards socially assistive robots in intelligent homes: results from laboratory studies and field trials. *Journal of Human-Robot Interaction* 1.2 (2012): 76-99. ***not directly related to ethics but has some user involvement.***

Ethics Deliverables of ICT & Ageing Projects

Project name and website	**ICT & Ageing Projects** http://www.ict-ageing.eu
Deliverables and relevant publications	Deliverable 11: Compilation Report on Ethical Issues McLean, Athena. Ethical frontiers of ICT and older users: cultural, pragmatic and ethical issues. *Ethics and information technology* 13.4 (2011): 313-326.

Project name and website	**MINAmI Project** http://www.ict-ageing.eu/?page_id=1278
Deliverables and relevant publications	D1.4 Ethical guidelines for (mobile-centric) ambient intelligence. Ikonen, V., et al. Ethical guidelines for mobile-centric ambient intelligence. (2008).

Project name and website	**ENABLE project** http://www.ict-ageing.eu/?page_id=1220
Deliverables and relevant publications	Hagen (2007) What is evidence? in Challenges for Assistive Technology (G. Enzmendi et al, eds) IOS Press, pp.222 - 226. *Mentioned on ICT & Ageing website, unable to find link. Orpwood, Roger, et al. The design of smart homes for people with dementia—user-interface aspects. *Universal Access in the information society* 4.2 (2005): 156-164. P. Duff, E. Begley, S. Cahill, P. Topo, K. Saarikalle, T. Holthe, K. Engedal, J. Macijauskiene, K. Jones, J. Gilliard. (2003). European infrastructures for assistive technology: Factors affecting the delivery and uptake of assistive technologies by people with dementia as investigated in the ENABLE project. in Assistive Technology – Shaping the Future. (G. M. Craddock, L.P. McCormack, R.B. Reilly and H.T.P. Knops, eds) IOS Press, pp. 759 – 765. Bjørneby, Sidsel, et al. Ethical considerations in the ENABLE project. *Dementia* 3.3 (2004): 297-312. Hanson, Elizabeth, et al. Working together with persons with early stage dementia and their family members to design a user-friendly technology-based support service. *Dementia* 6.3 (2007): 411-434. Rosenberg, Lena, Anders Kottorp, and Louise Nygård. Readiness for technology use with people with dementia the perspectives of significant others. *Journal of Applied Gerontology* 31.4 (2012): 510-530.

Project name and website	**ASTRID** http://www.ict-ageing.eu/?page_id= 1271
Deliverables and relevant publications	ASTRID: A Guide to Using Technology within Dementia Care. London: Hawker Publications Ltd. 2000 The ASTRID Guide to using technology within dementia care is one of the main outputs of the ASTRID project: A Social and Technological Response to meeting the needs of Individuals with Dementia and their carers. It is the result of a collaborative effort by experts from four countries; the UK, Norway, Netherlands and Ireland. The guide includes a chapter on addressing ethical issues.

Project name and website	**In-home Monitoring of Persons with Dementia** http://www.ict-ageing.eu/?page_id=1285
Deliverables and relevant publications	Mahoney, Diane F., et al. In-home monitoring of persons with dementia: Ethical guidelines for technology research and development. *Alzheimer's & Dementia* 3.3 (2007): 217-226

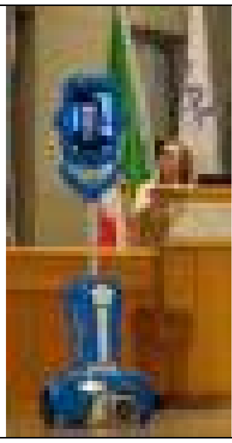
Project name and website	**American Telemedicine Association Guidelines** http://www.ict-ageing.eu/?page_id=1291
Deliverables and relevant publications	Core Operational Guidelines for Telehealth Services Involving Provider-Patient Interactions*Administrative, clinical and technical standards to be met when using telecare.

Project name and website	**Mental welfare Commission of Scotland** http://www.ict-ageing.eu/?page_id=1299
Deliverables and relevant publications	The Mental Welfare Commission for Scotland. (2007). Safer to Wander? Principles and guidance on good practice when considering the use of wandering technologies for people with dementia and related disorders. "Wandering technologies" = Sensor pads (beds, chair, floor), nurse/carer call systems, panic buttons, fall and movement sensors, electronic tagging and tracking systems, CCTV/video surveillance, intruder alerts.

Project name and website	**The Friendly Rest Room Project** http://www.ict-ageing.eu/?page_id=1305
Deliverables and relevant publications	Rauhala, M. & Wagner, I. (2005). Ethical Review – A Continuous Process in an Assistive Technology Project. Ethical Review in the FRR Project – A Continuous Process *(Powerpoint presentation)*

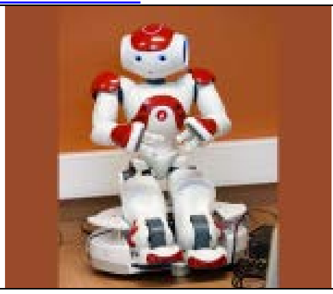
Project name and website	**North Lanarkshire Council's Best Practice Policy** http://www.ict-ageing.eu/?page_id=1310
Deliverables and relevant publications	Accessing Assisted Living Technology: Principles and Good Practice Guidance: Use of Assisted Living Technology.

Project name and website	**Florence (Multi-Purpose Mobile Robot for Ambient Assisted Living)** http://florence-project.eu
Brief explanation	The Florence project aims to improve the well-being of elderly (and that of their loved ones) as well as improve efficiency in care through AAL services supported by a general-purpose robot platform. The Florence system with its multipurpose mobile robot platform will pioneer the use of such robots in delivering new kinds of AAL services to elderly persons and their care recipients. **The main objective is to make this concept acceptable for the users and cost effective for the society and care givers.** Florence will put the robot as the connecting element between several standalone AAL services in a home environment as well as between the AAL services and the elderly person. Via the care and coaching services supported by Florence the elderly will remain much longer independent. 
Funding dates	Feb 2010-Jan 2013
Consortium partners	Philips Electronics B.V. NEC Europe LTD. OFFIS E.V. Stichting Novay Telefonica Investigacion y Desarrollo SA Tecnalia Agencia de Servicios Sociales y Dependencia de Andalucia Wany SA
Core functions of the robot	*Florence robot* Telepresence (including collaborative game playing with family members), assists the user in adopting and maintaining a healthy lifestyle, calls for help if user falls, monitors environment (smart home aspects?), reminds user of schedule.
Ethics	
Ethics publications	Deliverable 6.1: Ethical Guidance Report on the National Regulations (http://www.hitech-projects.com/euprojects/florence/D6_1.pdf)
Involvement of users and carers	The second iteration of the Florence system was tested in 2012 in real-home environments with the elderly in Spain. Details of this user involvement can be found in Deliverables 6.2 and 6.4, which also mention some ethical and safety concerns and describe the process of informed consent used. Deliverable 6.2: Report on the Testing and Evaluation Methodology for the Controlled Home Environment Tests Deliverable 6.4: Report on the Testing Methodology for the Living Lab Testing
Other Publications	

Project name and website	**ExCITE (Enabling SoCial Interaction Through Embodiment)** http://www.oru.se/excite
Brief explanation	The main objective of ExCITE) is to evaluate user requirements of social interaction that enables embodiment through robotic telepresence. This evaluation is performed in situ, on a pan-European scale and with a longitudinal perspective. An existing prototype is deployed to the targeted end users, and is refined by tightly involving the users in the development cycles of the prototype throughout the project. The technology used is a called a **Giraff robot**, produced by Giraff Technologies AB in Västerås. The Giraff is a mobile Telepresence device that allows anyone– professional caregivers, family and friends to virtually visit a home, move about freely and communicate with residents via videoconferencing. 
Funding dates	2010-2013
Consortium partners	Örebro University, Sweden Giraff Technologies AB, Sweden Consiglio Nazionale delle Richerche (ISTC-CNR), Italy Ratio Consulta, Italy University of Malaga, Spain Örebro City Council, Sweden
Core functions of the robot	For details of robot see the GiraffPlus section.
Ethics	
Ethics publications	
Involvement of users and carers	
Other Publications	Cesta, Amedeo, et al. Enabling social interaction through embodiment in ExCITE. *ForItAAL: Second Italian Forum on Ambient Assisted Living*. 2010. *Details the user-centred approach of the ExCITE workplan. R.Bevilacqua, A. Cesta, G. Cortellessa, A. Macchione, A. Orlandini, L. Tiberio Telepresence robot at home: A long-term case study ForItAAL. Proceedings of the Italian AAL Forum, Ancora, Italy, October, 2013 Kristoffersson, Annica, A. M. Loutfi, and Silvia Coradeschi. User-centered evaluation of robotic telepresence for an elderly population. *2nd International Workshop on designing robotic artefacts with user-and experience-centered perspectives*. 2010. Cesta, Amedeo, et al. Addressing the Long-term Evaluation of a Telepresence Robot for the Elderly. *ICAART (1)*. 2012. Cesta, Amedeo, et al. Evaluating telepresence robots in the field. *Agents and Artificial Intelligence*. Springer Berlin Heidelberg, 2013. 433-448.

Project name and website	**Hobbit: The Mutual Care Robot** http://hobbit.acin.tuwien.ac.at
Brief explanation	The focus of HOBBIT is the development of the mutual care concept: building a relationship between the human and the robot in which both take care for each other. Like when a person learns what an animal understands and can do; similar to building a bond with a pet… The purpose of the Mutual Care approach is to increase the acceptance of the home robot. The **goal** of the **HOBBIT** project is to advance towards a robot solution that will enhance wellness and quality of life for seniors, and enhance their ability to live independently for longer at their homes. 
Funding dates	2011-2014
Consortium partners	ACIN, Technische Universität Wien AAT, Technische Univervisät Wien MetraLabs GmbH Neue Technologien und Systeme Hella Automation GmbH Foundation for Research and Technology Hellas Lund University Academy for Aging Research at HB
Core functions of the robot	*Hobbit robot* Pick up objects from the floor, can learn objects and bring objects, easy-to-use entertainment functions, playing games and exercise, detect emergency situations and trigger an appropriate alarm.
Ethics	
Ethics publications	
Involvement of users and carers	The first user trials were carried out in Austria, Greece, and Sweden, with a total of 49 primary users (old people). 35 of the primary users were accompanied by secondary users (carers). The trials consisted of three parts: (A) the introduction phase, including a pre-questionnaire and briefing on how to use Hobbit and what it can do (B) the actual user study with the robot (six trial tasks) and (C) the debriefing phase with questionnaires for the primary and secondary users. Fischinger, David, et al. Hobbit-the mutual care robot. *Workshop on Assistance and Service Robotics in a Human Environment Workshop in conjunction with IEEE/RSJ International Conference on Intelligent Robots and Systems*. Vol. 2013. 2013.
Other Publications	Lammer, Lara, et al. Mutual care: How older adults react when they should help their care robot. *AISB2014: Proceedings of the 3rd International Symposium on New Frontiers in Human–Robot Interaction*. 2014. *Explores the reciprocity (teamwork) of interactions between the user and robot. Vincze, Markus, et al. On the Discrepancy between Present Service Robots and Older Persons' Needs. Körtner, Tobias, et al. Meeting Requirements of Older Users? Robot Prototype Trials in a Home-like Environment. *Universal Access in Human-Computer Interaction. Aging and Assistive Environments*. Springer International Publishing, 2014. 660-671. Weiss, Astrid, et al. Developing an Assistive Robot for Older Adults: Methodological Considerations for Field Trials. Weiss, Astrid, et al. Socially assistive robots for the aging population: are we trapped in stereotypes? *Proceedings of the 2014 ACM/IEEE international*

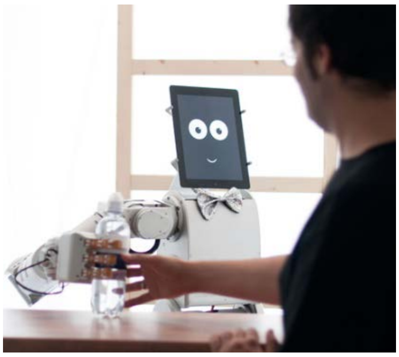
	conference on Human-robot interaction. ACM, 2014. Notes of conference. Huber, Andreas, Lara Lammer, and Markus Vincze. Do Socially Assistive Robots Compromise our Moral Autonomy? *International Conference" Going Beyond the Laboratory-Ethical and Societal Challenges for Robotics", G. Lindemann, G. Fitzi, H. Matsuzaki, and I. Straub, Eds., Hanse Wissenschaftskolleg (HWK)*. 2014. Baumgaertner, Bert, and Astrid Weiss. Do Emotions Matter in the Ethics of Human-Robot Interaction? Artificial Empathy and Companion Robots. Frennert, Susanne, Håkan Eftring, and Britt Östlund. What older people expect of robots: A mixed methods approach. *Social Robotics*. Springer International Publishing, 2013. 19-29. Frennert, Susanne, Håkan Eftring, and Britt Östlund. Older people's involvement in the development of a social assistive robot. *Social Robotics*. Springer International Publishing, 2013. 8-18. Lammer, Lara, et al. Mutual-Care: Users will love their imperfect social assistive robots. *Work-In-Progress Proceedings of the International Conference on Social Robotics*. 2011.

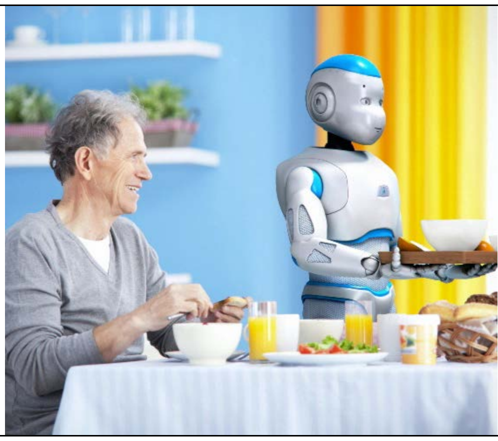
Project name and website	**ROBO M.D.** http://www.innovation4welfare.eu/307/subprojects/robo-m-d.html
Brief explanation	A personal health care system consisting of personal sensors for heart rate, skin temperature and acceleration, possibly environmental sensors, a logging station connected to the sensors by a wireless network, a robot able to reach the person in case of need and establish an oral and/or visual communication. 
Funding dates	
Consortium partners	Johannes Kepler University (Institute for design and control of mechatronical systems) – Austria Institute of Electronic, Information and Communication Technologies (IEIIT) Milano Branch (MI) – Italy Fontys University of Applied Sciences – Netherlands University of South Bohemia CB (Pedagogical faculty, department of Physics) – Czech Republic University of Tartu (Bioinformatics, Algorithmics and Data Mining Group, department of Computer Sciences) – Estonia
Core functions of the robot	*Robo M.D. robot* Monitoring, fall detection, Real time QRS beat detection, interacts with user by asking yes/no questions, telepresence
Ethics	
Ethics publications	
Involvement of users and carers	
Other Publications	van de Ven, Antoine AJ, Anne-mie AG Sponselee, and Ben AM Schouten. Robo MD: a home care robot for monitoring and detection of critical situations. *Proceedings of the 28th Annual European Conference on Cognitive Ergonomics*. ACM, 2010. Found a mention of a deliverable on end-user acceptance, but could not find any deliverables online.

Project name and website	**SRS Multi Role Shadow Robotic System for Independent Living** http://srs-project.eu	
Brief explanation	The project focuses on the development and prototyping of remotely-controlled, semi-autonomous robotic solutions in domestic environments to support elderly people. In particular, the SRS project will demonstrate an innovative, practical and efficient system called "SRS robot" for personalised home care. Most elderly people want to live in the familiar environment of their own residence for as long as possible. However, not many can live with their adult children and therefore, at some stage, often late in life, have to live alone. Studies show that some forms of home care are usually required as they advance in years.	
Funding dates	February 2010-April 2013	
Consortium partners	CU - Cardiff University (United Kingdom) ISER-BAS - Bulgarian Academy of Sciences - Institute of Systems Engineering and Robotics (Bulgaria) FDCGO - Fondazione Don Carlo Gnocchi Onlus (Italy) Fraunhofer IPA - Fraunhofer-Gesellschaft zur Förderung der angewandten Forschung e.V. (Germany) HdM - Stuttgart Media University, Usability Research Lab (Germany) HPIS - HEWLETT-PACKARD ITALIANA SRL (Italy) INGEMA - Fundación Instituto Gerontológico Matia (Spain) PROFACTOR - PROFACTOR GmbH (Austria) ROBOTNIK - Robotnik Automation S.L.L. (Spain) BED - University of Bedfordshire (United Kingdom) IMA - Integrated Microsystems Austria Gmbh(Austria) BUT - Brno University of Technology (Czech Republic)	
Core functions of the robot	*Care-O-Bot Robot used in SRS project* Can be controlled or operate autonomously, can learn from experience, monitors for falls and assist paramedics in gaining access to the elderly persons home by opening the door, fetching & carrying objects, telepresence (allows carers to monitor elderly person's home).	
Ethics		
Ethics publications	Ethics deliverables: DELIVERABLE D1.1: Detailed user requirements, environment definition, general guidelines on ethical concerns and SRS scenario report. DELIVERABLE D6.3 SRS Ethical and Cost-effectiveness	
Involvement of users and carers	The "Project Overview" section of the website mentions different scenarios that they investigated with involvement of the elderly, informal carers and formal carers such as emergency help scenario, situation monitoring scenario, fetch and carry scenario Also related to user involvement was DELIVERABLE 1.4: Requirement specification of future remotely control service robot for home care. All deliverables available from http://srs-project.eu/srs_deliverable	
Other Publications	Dautenhahn, Kerstin, Anne Campbell, and Dag Sverre Syrdal. Does anyone want to talk to me?–Reflections on the use of assistance and companion robots in care homes. Pigini, Lucia, et al. The proof of concept of a shadow robotic system for independent living at home. Springer Berlin Heidelberg, 2012. Onlus, Fondazione Don Carlo Gnocchi. Semi-Autonomous Teleoperated Learning In-Home Service Robots For Elderly Care: A Qualitative Study On Needs And Perceptions Of Elderly People, Family Caregivers, And Professional Caregivers.	

	Pigini, Lucia et al. Service robots in elderly care at home: Users' needs and perceptions as a basis for concept development. Technology and Disability, vol. 24, no. 4, 2012, pp. 303-311.

Project name and website	**DOMEO (Domestic Robot for Elderly Assistance)** http://www.aal-domeo.org
Brief explanation	DOMEO finished on Dec 31st, 2012. It was the first project all over the world to bring assistant robots in real homes with real people, for more than 1 year. This is an AAL Project, which focused on the development of an open robotic platform for the integration and adaptation of personalized homecare services, as well as cognitive and physical assistance. The aim was helping elderly to stay longer and safer at home. The DOMEO platform included: types of robots (cognitive and physical), graphic and tactile interfaces, voice recognition and speech synthesis, cloud services for tele-presence, tools for integration of various sensors and services.
	 *robuWALKER*  *robuMATE*
Funding dates	July 2009-December 2012
Consortium partners	Robosoft ISIR CHUT (Telemedicine Department with formal links to Institut Européen de Télémédecine, and Gerontechnology La Grave Laboratory) NIMR TAS (Thales Alenia Space), industrial R&D group TUW (Vienna University of Technology – Institute of Design & Assessment of Technology, Centre for Applied Assistive Technologies) BME, research University, robotics and biomedical technology specialist Meditech, SME
Core functions of the robot	*ROBOSOFT Kompai robot (see Mobiserv)* **robuWALKER:** physically interacts with users to improve their mobility, and can help them stand up, walk and sit, as well as monitoring their vital signs and transmitting this data to the emergency services, if required. **robuMATE:** links people with the outside world, providing them with entertainment and also cognitive assistance to remind them of appointments, scheduled communications, or the time they need to take their medication. Date and time, weather, agenda, shopping list, entertainment (games, music, Web browser), e-mail, skype, remote control, navigation, emergency signal
Ethics	
Ethics publications	
Involvement of users and carers	D1.1: Interviews methodology report D1.2: Interviews results report D7.2 France deployment report -> some discussion of the ethical issues involved in the field trials All deliverables available from http://www.aal-domeo.org/index.php/dissemination/cat_view/1-domeo-project-public-deliverables
Other Publications	Zsiga, Katalin, et al. Home care robot for socially supporting the elderly: focus group studies in three European countries to screen user attitudes and requirements. *International Journal of Rehabilitation Research* 36.4 (2013): 375-378.

Project name and website	**JAMES (Joint Action for Multimodal Embodied Systems)** http://homepages.inf.ed.ac.uk/rpetrick/projects/james	
Brief explanation	The goal of the JAMES project is to develop an artificial embodied agent that supports socially appropriate, multi-party, multimodal interaction. JAMES focuses on the qualitative aspects of task achievement in social situations, and how such tasks can be improved through multimodal communication, rather than the physical aspects of traditional robotics tasks. In particular, JAMES plans to develop the core cognitive capabilities that enable a robot to interact with humans in a socially-appropriate manner, and demonstrate this behaviour in a bartending scenario.	
Funding dates	2011-2014	
Consortium partners	The University of Edinburgh fortiss GmbH Foundation for Research and Technology-Hellas Heriot Watt University Universität Bielefeld	
Core functions of the robot	*JAMES bartender robot (A NAO robot -see KSERA- and Kinect sensor were used)* interacts with users in a socially appropriate manner – delivers drinks to people in the correct order, acknowledges presence of people, arm and head move in ways that appear natural to humans.	
Ethics		
Ethics publications		
Involvement of users and carers		
Other Publications	*As this robot was not a care bot there did not appear to be any relevant publications.	

Project name and website	**Project Romeo** http://projetromeo.com/en
Brief explanation	Romeo is a humanoid robot from Aldebaran Robotics which is intended to be a genuine personal assistant and companion. This research platform is now being used to validate the possible service uses for a larger robot than Nao and to test new technologies for possible integration in future Aldebaran products… the innovations tested on Romeo include human-robot interaction, moving eyes and the vestibular system, force control, etc. 
Funding dates	First phase – 2009-2012 Second phase – 2012-2016
Consortium partners	ALDEBARAN ROBOTICS ALL4TEC VOXLER SPIROPS CEA LIST ARMINES - ENSTA PARISTECH TELECOM PARISTECH APPROCHE ASSOCIATION INRIA CNRS - LAAS CNRS - LIMSI CNRS - LIRMM COLLÈGE DE FRANCE UMPC ISIR UMPC ISIR STRATE
Core functions of the robot	*ROMEO robot* Reminding user of shopping lists/to take medication, helping with household tasks such as preparing food, monitoring for household dangers and medical emergencies, encouraging user to participate in recreational activities.
Ethics	
Ethics publications	
Involvement of users and carers	
Other Publications	Ozguler, A., T. Loeb, and M. Baer. "Maintaining elderly people at home with a telemedicine platform solution: the QuoVADIS project." *Gerontechnology* 13.2 (2014): 80. Maisonnier, B., R. Gelin, and P. Koudelkova Delimoges. "Humanoid robots for elderly autonomy." *Gerontechnology* 13.2 (2014): 77-78. Cornet, G. "Robots to empower the elderly's well-being, the French perspective." *Gerontechnology* 13.2 (2014): 76. Hewson, D. J., C. Gutierrez Ruiz, and H. Michel. "Development of a multidimensional evaluation method for the use of a robotic companion as a function of care relationships." *Gerontechnology* 13.2 (2014): 79. *All part of the symposium Robots to empower the elderly's well-being: The French perspective.*

Project name and website	**Robot Companions for Citizens (CA-RoboCom)** http://www.robotcompanions.eu
Brief explanation	RoboCom, which stands for Robot Companions for Citizens, proposes an unprecedented S&T Research Programme establishing a bridge between science and sustainable welfare and is designed to capitalize on the synergy resulting from the convergence of science and engineering, as reflected in the structure centred on five Pillars: Matter (Materials), Body (Morphological Computation), Brain (Simplexity), Mind (Sentience) and Society (Society, Ethics and Law).
Funding dates	2011-2012
Consortium partners	See http://www.robotcompanions.eu/consortium
Core functions of the robot	*Pictures of multiple different robotic systems are shown on website*
Ethics	
Ethics publications	Ethical concerns are briefly addressed at the end of this public report: http://www.robotcompanions.eu/drupal-robocom-files/page-files/RCC_PublicReport.pdf
Involvement of users and carers	
Other Publications	Prescott, Tony J., et al. Robot companions for citizens: Road mapping the potential for future robots In empowering older people. (2012).

Project name and website	**RoboLaw (Regulating Emerging Technologies in Europe: Robotics Facing Law and Ethics)** http://www.robolaw.eu
Brief explanation	The main objective of the RoboLaw project is to understand the legal and ethical implications of emerging robotic technologies and to uncover (1) whether existing legal frameworks are adequate and workable in light of the advent and rapid proliferation of robotics technologies, and (2) in which ways developments in the field of robotics affect norms, values and social processes we hold dear.
Funding dates	March 2012-May 2014
Consortium partners	Scuola Superiore Sant'Anna di Studi Universitari e di Perfezionamento di Pisa (SSSA) University of Tilburg, Law School, Tilburg Institute for Law, Technology, and Society (TILT) University of Reading (UoR), England, School of Systems Engineering Humboldt University of Berlin (HUB), Germany, Department of Philosophy Ludwig-Maximilian-University Munich (LMU), Germany, Department of Philosophy
Objectives	Integration of technology into society: Governance patterns Roadmapping Robolaw Elaborating a taxonomy of robotics Philosophical, anthropological, sociological consequences arising from the use of emerging robotic technologies for human enhancement Policy recommendations defining guidelines and suggestions on regulating Robotics
Ethics	
Ethics publications	Deliverable 5.5 **Methodology for identifying and analysing ethical issues in robotics research and applications (no link available)** Deliverable 6.2: Guidelines on regulating robotics (Contains a section on care robots) Salvini, P. On Ethical, Legal and Social Issues of Care Robots. Intelligent Assistive Robots Springer Tracts in Advanced Robotics Volume 106, 2015, pp 431-445.

Project name and website	**Alfred (Personal Interactive Assistant for Independent Living and Active Ageing)** http://alfred.eu
Brief explanation	ALFRED is a project funded by the Seventh Framework Programme of the European Commission under Grant Agreement No. 611218. It will allow older people to live longer at their own homes with the possibility to act independently and to actively participate in society by providing the technological foundation for an ecosystem consisting out of four pillars: **User-Driven Interaction Assistant** to allow older people to "talk" to ALFRED and to ask questions or define commands in order to solve day-to-day problems.  **Personalized Social Inclusion** by suggesting social events to older people, considering his interests and his social environment. A more **Effective & Personalized Care** by allowing medical staff or carer to access vital signs of older people monitored by (wearable) sensors. **Physical & Cognitive Impairments Prevention** by incorporating serious gaming to improve the physical and cognitive condition by offering games and quests to older people.
Funding dates	2013-2016
Consortium partners	IESE Business School Charité – Universitätsmedizin Berlin AITEX Technische Universität Darmstadt Ascora Nationaal Ouderenfonds E-Seniors Atos Worldline TIE Nederland B.V. Talkamatic AB
Core functions of the robot	social inclusion, care, physical exercise and cognitive games, monitoring, alerting carers in emergencies
Ethics	
Ethics publications	
Involvement of users and carers	Tests due to be carried out in 2015 in France, Germany and Netherlands.
Other Publications	D2.3 User stories and Requirements analysis D9.6 Standardization, policy and ethical issues report *Emailed project co-ordinator who said that deliverables would be available on website soon.

Project name and website	**Silver (Supporting Independent LiVing for the Elderly through Robotics)** www.silverpcp.eu
Brief explanation	This is a development project funded by the European Commission under the Seventh Framework Programme for research and technological development (FP7). The SILVER project searches for new technologies to assist elderly people in their everyday lives. By the use of robotics or other related technologies, the elderly can continue independent living at home even if they have physical or cognitive disabilities. The new technologies and solutions are sought by using a Pre-Commercial Procurement (PCP) process.
Funding dates	2012-2016
Consortium partners	see http://www.silverpcp.eu/consortium
Core functions of the robot	The three successful proposals that proceeded to Phase 2 of the Silver project are: HelpingHand, Iron Arm and Lecorob. (http://www.silverpcp.eu/phase2-successful-proposals) (Phase 1: Solution Design, Phase 2: Prototype development, Phase 3: Pre-Commercial small scale product/service development)
Ethics	
Ethics publications	
Involvement of users and carers	The website mentions that end-users were due to test the prototypes in April 2015 (http://www.silverpcp.eu/prototypes-tested-in-odense) but the results of this are not yet published.
Other Publications	No relevant publications were evident from the website or a Google Scholar search as the project is still in the prototyping phase.

Project name and website	**ROBOT-ERA (Implementation and integration of advanced Robotic systems and intelligent Environments in real scenarios for the ageing population)** http://www.robot-era.eu/robotera
Brief explanation	The objective of the project is to develop, implement and demonstrate the general feasibility, scientific/technical effectiveness and social/legal plausibility and acceptability by end-users of a plurality of complete advanced robotic services, integrated in intelligent environments, which will actively work in real conditions and cooperate with real people and between them to favour independent living, improve the quality of life and the efficiency of care for elderly people.
	 *Robot-era robots: Outdoor robot, domestic robot and condominium robot*
Funding dates	Jan 2012-Dec 2015
Consortium partners	Scuola Superiore Sant'Anna (SSSA), Pisa, Italy (Coordinator) Istituto Nazionale di Riposo e Cura per Anziani (INRCA), Ancona, Italy Youse GmbH (YOUSE), Berlin, Germany Orebro University (ORU), Orebro, Sweden Universitaet Hamburg (UHAM), Hamburg, Germany University of Plymouth (UOP) United Kingdom Metralabs GmbH Neue Technologien und Systeme (MLAB), Ilmenau, Germany ST Microelectronics Srl (ST-I), Italy RoboTech srl (RT), Peccioli, Italy TechnoDeal srl (TED), Peccioli, Italy Municipality of Peccioli (MOP), Peccioli, Italy Lansgarden Fastigheter Aktiebolag (LG), Orebro, Sweden
Core functions of the robot	Services mentioned include mediating voice and video calls; escorting around the house during the night; reminding the user of appointments or medications; collecting food that the user has ordered from the shops and bringing it home; carrying laundry to the laundry room and back; bringing out the garbage; warning the user in case of a household emergency; notifying the user of mail delivery. The three robots work co-operatively to complete these services.
Ethics	
Ethics publications	
Involvement of users and carers	WP2 relates to user-centred design of Robot-Era services: Throughout 2012 elderly persons and caregivers from Italy, Germany and Sweden were involved in focus groups and creative workshops to identify which robotic services Robot-Era should develop and which requirements the robots should satisfy. WP8 relates to experimental evaluation of the robots in real scenarios: The robots were tested by more than 50 elderly users in Italy and Sweden July-Dec 2013 Feedback was obtained by questionnaires, interviews and video analysis.
Other Publications	Bevilacqua, R., et al. Robot-Era project (FP7-ICT-2011.5. 4): From the end-users perspective to robotics. preliminary findings. *Proceedings of the AAL—ambient assisted living forum*. 2012. Raffaele Esposito, Filippo Cavallo, Paolo Dario, Fiorella Marcellini, Roberta Bevilacqua, Elisa Felici. Robot-Era Project: Preliminary results of robotic service in smart environments with elderly people. AAL Forum 2014, 9 -12 September, Bucharest, Romania.

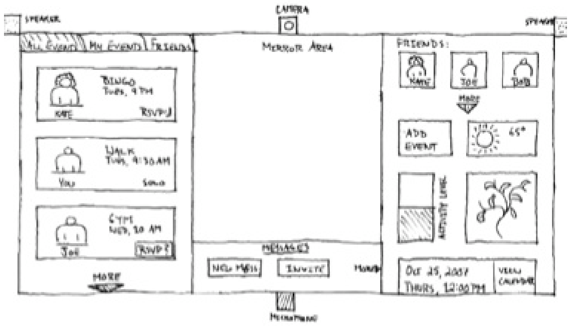
Project name and website	**SERA (Social Engagement with Robots and Agents)** http://cordis.europa.eu/project/rcn/89259_en.html
Brief explanation	The project SERA aims to advance science in the field of social acceptability of verbally interactive robots and agents, with a view to their applications especially in assistive technologies (companions, virtual butlers). To this aim, the project will undertake a field study in three iterations to collect data of real-life, long-term and open-ended relationships of subjects with robotic devices. The three iterations test different conditions (functionalities) of the equipment, which will consist of a room equipped with sensors at the subjects' home, a computer and a simple robotic device (the Nabaztag) as the front-end for interaction.  The project partners will analyse the collected audio and video data in parallel, using different, mainly qualitative, methods. Data analysis will be prepared and accompanied by theoretical and methodological research in order to a) take into account the state of the art and b) ensure quality of the field study. The project will use findings from the field study to specify, build and implement a reference architecture for social engagement, and use it for developing a showcase system of combined speech based service applications with relevance to the target field and audience.
Funding dates	Jan 2009-Dec 2010
Consortium partners	Austrian Research Institute for Artificial Intelligence OFAI University of Sheffield Universteit Twente Universität Duisburg-Essen
Core functions of the robot	*Nabaztag rabbit (Companion robot)* Can connect to the internet and speak out loud so can perform the following functions: weather forecast, stock market report, news headlines, alarm clock, e-mail alerts. Can send and receive MP3s and messages.
Ethics	
Ethics publications	
Involvement of users and carers	
Other Publications	Heylen, Dirk, Betsy van Dijk, and Anton Nijholt. Robotic Rabbit Companions: amusing or a nuisance? *Journal on Multimodal User Interfaces* 5.1-2 (2012): 53-59. Wilks, Yorick, ed. Close engagements with artificial companions: key social, psychological, ethical and design issues. Vol. 8. John Benjamins Publishing, 2010. Cavallaro, Francesca I., et al. Growing Older Together: When a Robot Becomes the Best Ally for Ageing Well. (2012): 834-851.

Project name and website	**RAPP (Robotic Applications) project** http://rapp-project.eu
Brief explanation	RAPP is a 3-year project that will provide an open source software platform to support the creation and delivery of Robotic Applications (RApps), which, in turn, are expected to increase the versatility and utility of robots. The emphasis of this project will be on applications that will enable robots to understand and respond to the intentions and needs of people at risk of exclusion, especially the elderly.
	  *Robots in the RAPP project include the ANG smart walker and NAO*
Funding dates	2013-2016
Consortium partners	Consortium partners: CERTH/ITI – Greece Aristotle University of Thessaloniki – Greece INRIA – France MATIA – Spain ORMYLIA – Greece ORTELIO – UK Sigma Orionis – France Warsaw University of Technology – Poland
Core functions of the robot	***Functions of ANG smart walker:*** intended for patients who have suffered from hip fracture and are in need of rehabilitation. Detection of the correct position of the patient, localization of the patient, interaction of the patient with ANG and detection of potential risky situations; Aims to assist the patient during a walk in terms of mobility aid, monitor him/her, and improve their rehabilitation by motivating it. ***Functions of NAO:*** In house-hazard detection - doors and windows left open and electrical devices switched on and forgotten. Communication and reminder functions assist elderly connecting with family and friends through Skype calls and emails, to follow their medication routine, to be reminded for special events or dates like family birthdays, to create their own memory ball with all those memories they like to treasure like photos, favourite songs etc. and reproduce them at any time they want, as well as to enhance their attention through cognitive games.
Ethics	
Ethics publications	
Involvement of users and carers	
Other Publications	Iturburu, Miren, et al. User Needs and Requirements for the Mobility Assistance and Activity Monitoring Scenario within the RAPP Project. *Progress in Automation, Robotics and Measuring Techniques*. Springer International Publishing, 2015. 105-117. Deliverable 1.5. Report on Ethical Legislations and Guidelines Tsardoulias, Emmanouil G., et al. Merging Robotics and AAL Ontologies: The RAPP Methodology. *Progress in Automation, Robotics and Measuring Techniques*. Springer International Publishing, 2015. 285-297.

Project name and website	**RoboEarth** http://roboearth.org
Brief explanation	Cloud robotics is an emerging field of robotics rooted in cloud computing, cloud storage, and other Internet technologies centred on the benefits of converged infrastructure and shared services. The RoboEarth project was initiated by a multi-disciplinary partnership of robotics researchers from academia and industry. Their goals are to prove that connection to a networked information repository greatly speeds up the learning and adaptation process that allows robotic systems to perform complex tasks, and to show that a system connected to such a repository will be capable of autonomously carrying out useful tasks that were not explicitly planned for at design time.
Funding dates	December 2010-January 2014
Consortium partners	see http://roboearth.org/collaborators
Core functions	*RoboEarth allows robots to:* **Store and Share Information**: Robots can use the common representation provided by the RoboEarth language and the scalable storage provided by the RoboEarth database to store and share information. This has the following key advantages; significantly increases the speed of learning by leveraging the experience of other robots, and allows developers to create general robot task instructions rather than programming individual robots on a case-by-case basis. **Offload Computation**: Robots can use the vast computational infrastructure available on the web for computationally heavy tasks including planning, probabilistic inference, and mapping, among many others. **Collaborate**: Robots can use the cloud as a common medium to collaborate and achieve a common task. The video at https://www.youtube.com/watch?v=mgPQevfTWP8 shows how care robots can work collaboratively in a hospital setting using the RoboEarth system. The robots used are called Ari, Amigo, Pico, Pera.
Ethics	
Ethics publications	There did not appear to be any ethics-related publications or deliverables.
Involvement of users and carers	
Other Publications	

Project name and website	**EURON Roboethics Roadmap** http://www.euron.org/activities/projects/roboethics
Brief explanation	We apply for a Research Atelier on Roboethics - Roboethics Atelier - to develop the concept of an Ethics applied to Robotics. The Atelier will last one working week, possibly in late June 2005. It will be attended by about 30 participants (Senior Scientists and PhD Students) coming from different fields of research, both from Sciences and Humanities. The result will be a Roboethics Roadmap Book…The first aim of the Atelier on Robotics is to produce a Roadmap of Roboethics, and lay the foundation for the creation of the Roboethics Committee inside Beyond Robotics Initiative.
Funding dates	February 2005(?)-June 2006
Consortium partners	Atelier was organised by Scuola di Robotica, Genoa, Italy. It was unclear from the website who the "30 participants (senior scientists and PhD students)" were.
Publications	Veruggio, Gianmarco. The EURON Roboethics Roadmap. *Humanoids*. 2006. (summary of longer document) EURON Roboethics Roadmap (full version) Veruggio, Gianmarco. The birth of roboethics. Institute of Electrical and Electronics Engineers International Conference on Robotics and Automation 2005 Workshop on Roboethics, Barcelona. 2005.

Project name and website	**ETHICBOTS (Emerging Technoethics of Human Interaction with Communication, Bionic and Robotics)** http://ethicbots.na.infn.it
Brief explanation	ETHICBOTS will promote and coordinate a multidisciplinary group of researchers into artificial intelligence, robotics, anthropology, moral philosophy, philosophy of science, psychology, and cognitive science, with the common purpose of identifying and analysing techno-ethical issues concerning the integration of human beings and artificial (software/hardware) entities. Three kinds of integration will be analysed: (a) Human-softbot integration, as achieved by AI research on information and communication technologies; (b) Human-robot, non-invasive integration, as achieved by robotic research on autonomous systems inhabiting human environments; (c) Physical, invasive integration, as achieved by bionic research.
Funding dates	2005-2007
Consortium partners	University "Federico II", Naples, Physical Science Department and Department of Computer and Systems Engineering, Italy (coordinator) Fraunhofer Institute for Autonomous intelligent Systems, Sankt Augustin, Germany Scuola di Robotica, Genova, Italy Institute of Applied Philosophy, Faculty of Theology, Lugano, Switzerland University of Reading, department of Cybernetics, UK Hochschule der Medien University of Applied Sciences, Stuttgart, Germany LAAS-CNRS, Toulouse, France Scuola Superiore Sant'Anna, Pisa, Italy University of Pisa, Department of Philosophy, Italy Middlesex University, Interaction Design Centre, School of Computing, London, UK
Core functions of the robot	
Ethics	
Ethics publications	Deliverable 1 - Analysis of the State of the Art in emerging technologies for the integration of human and artificial entities Deliverable 2 - Methodology for the identification and analysis of techno-ethical issues Deliverable 5 - Techno-Ethical Case-Studies in Robotics, Bionics, and Related AI Agent Technologies (All deliverables available from http://ethicbots.na.infn.it/documents.php) *Capurro, R. "Methodological issues in the ethics of human-robot interaction" (Powerpoint presentation, available from* http://www.slideshare.net/peterbuck/methodological-issues-in-the-ethics-of-humanrobot-interactions*)*
Involvement of users and carers	
Other Publications	

Project name and website	*ETHOS (Ethical Technology in the Homes of Seniors)* http://ethos.soic.indiana.edu
Brief explanation	This project examines the role of information technology in the homes of elders with an emphasis on design and evaluation for privacy. The ETHOS team is creating tools that will help elders make appropriate decisions about home-based computing and guide designers in creating privacy-respecting technologies. Current prototypes being evaluated include those that facilitate social networks, encourage healthy behaviours, decrease isolation and support independence. For example, the Mirror Motive augments a commonly found object in the home, a wall mirror, to provide reminders and encourage social interaction. A second prototype encourages elders to increase their levels of physical activity while staying more tightly connected to a community of their peers. Older adults can seamlessly track the indicators of well-being of community members by looking at the equivalent of a wristwatch (e.g. a networked pedometer). The elder can choose to share his or her information with peers without concern that the data will show up in an Internet search. The ETHOS team is also constructing a “Living Lab” in which elders from the local community will interact with these prototypes and others embedded in the home. These older adults will provide critical feedback about the technology’s usability, appropriateness and privacy implications.
Funding dates	Not explicitly stated; publication dates are 2004-2011.
Consortium partners	Indiana University (for list of faculty & students who worked on the project, see http://ethos.soic.indiana.edu/ethos-team)
Projects carried out by the ETHOS team include	  *Ambient clock* *Mirror Motive* A Staying Safe Online video series (on Youtube) Portal Monitor (monitors front/back door) Using the Intel Mobile Sensing Platform to help seniors become more physically fit. Using the Wii to Promote Cognitive, Physical, and Social Engagement among Seniors Several Android applications
Ethics	
Ethics publications	
Involvement of users and carers	The Living Lab … is equipped to facilitate prototype development, implementation of prototypes into a living space, and research with individuals and groups. The house also has spaces for interviews and focus groups. (http://ethos.soic.indiana.edu/living-lab)
Other Publications	Lorenzen-Huber, Lesa, et al. Privacy, technology, and aging: A proposed framework. *Ageing International* 36.2 (2011): 232-252. Garg, Vaibhav, et al. Privacy concerns in assisted living technologies. *Annals of telecommunications-annales des télécommunications* 69.1-2 (2014): 75-88. Huber, Lesa Lorenzen, et al. How in-home technologies mediate caregiving relationships in later life. *International Journal of Human-Computer Interaction*

	29.7 (2013): 441-455. Shankar, Kalpana, Camp, L. Jean, **Connelly, Kay,** Lorenzen-Huber, Lesa. Aging, Privacy, and Home-Based Computing: Development of a Framework for Design. IEEE Pervasive Computing. December, 2012: 46-54 Caine, Kelly E., et al. DigiSwitch: design and evaluation of a device for older adults to preserve privacy while monitoring health at home. *Proceedings of the 1st ACM International Health Informatics Symposium*. ACM, 2010. Lorenzen-Huber, L., Han, S. Samm, M. What Information, with Whom, and When: In-home Technologies and Privacy. (2010). Presentation Collection: Association for Gerontology in Higher Education Bibliography: Reno, NV. March, 2010 Lorenzen-Huber, L.; Boutain, M.; Camp, L.J.; Shankar, K.; Connelly, K. Privacy, Independence, and Relationships: Older Adults Perceptions of Home-Based Ubiquitous Technologies. Ageing International, (2010). Lorenzen-Huber, L., Boutain, M. & Rogers, W. (2009). Technology, human relationships, and privacy. The Journal of Nutrition, Health, and Aging, 13 (1), p. 621.

Appendix B: Dementia specific ethical concerns

(Strecth, et al., 2013)

This is a comprehensive list of ethical concerns around the provision of care to persons with dementia. While not all of these concerns are strictly relevant for the design of care robots, many of them have implications for the use of care robots, and as a whole they highlight the complexity of ethical challenges encountered in this area of health and social care.

1. Diagnosis and medical indication
   - Adequate consideration of complexity of diagnosing dementia:
     - Risk of making a diagnosis too early or too late because of reasons related to differences in age- or gender-related disease frequencies
     - Risk of making inappropriate diagnoses related to varying definitions of mild cognitive impairment
     - Underestimation of the relatives' experiences and assessments of the person with dementia
   - Adequate point of making a diagnosis:
     - Risk of disavowing signs of illness and disregarding advanced planning
     - Respecting psychological burdens in breaking bad news
     - Underestimation of the relatives' experiences and assessments of the person with dementia
   - Reasonableness of treatment indications:
     - Overestimation of the effects of current pharmaceutical treatment options
     - Considering challenges in balancing benefits and harms (side effects)
     - Not considering information from the patient's relatives
   - Adequate appreciation of the patient:
     - Insufficient consideration of the patient as a person
     - Insufficient consideration of existing preferences of the patient
     - Problems concerning understanding and handling of patient autonomy

2. Assessing patient decision-making competence
   - Ambiguity in understanding competence
   - Problematic aspects in patient decision-making competence:
     - Inadequate assessment
     - Inadequate consideration of setting or decision content
     - Disregarding the complexity of assessing authenticity
     - Underestimation of the relatives' experiences and assessments of the patient

3. Information and disclosure
     - Respecting patient autonomy in the context of disclosure
     - Adequate amount and manner of information
     - Adequate involvement of relatives
     - Consideration of cultural aspects

4. Decision-making and consent
   - Improvement of patient decision-making competence:
     - Risk of inadequate involvement of the patient in the decision-making process
     - Risk of insufficient conditions for fostering decision-making capacity
     - Risk of disregarding the need of continuous relationship building with the patient as a means to foster patient autonomy
     - Risk of setting the time for decision-making processes too short
     - Risk of weakening patient decision-making competence by infantilisation
   - Responsible surrogate decision-making:
     - Adequate handling of 'best interest' and 'substituted judgements' decisions
     - Inadequate communication with relatives
     - Inadequate handling of information stemming from relatives
     - Need of advanced planning
     - Risk of disregarding legal clarifications

- Adequate consideration of living wills/advance directives:
    - Challenges in interpreting the living will/advance directive
    - Challenges in deciding to follow or not to follow the content of the living will/advance directive

5. Social and context-dependent aspects
    - Caring for relatives
    - Caring for clinical personnel and professional carers
    - Assessment of the patient’s potential to do (direct or indirect) harm to others
    - Responsible handling of costs and allocation of limited resources
6. Care process and process evaluation
    - Continuing assessment of potential benefits and harms
    - Adequate patient empowerment:
        - Patient-oriented setting
        - Motivation of patients
    - Self-reflection of carers: Competence (Capability)
        - Attitudes towards patients with dementia
        - Reflection on conflicts of interests and values
        - Continuing education/capacity building of the carers
    - Evaluation of abuse and neglect

7. Special situations for decision-making
    - Ability to drive
    - Sexual relationships
    - Indication for genetic testing
    - Usage of GPS (global positioning system) and other monitoring techniques
    - Prescription of antibiotics
    - Prescription of antipsychotic drugs
    - Indication for brain imaging
    - Covert medication
    - Restraints
    - Tube feeding
    - End of life/palliative care
    - Suicidality

Appendix C: Informed consent

Informed consent is a process by which the investigator informs the person who intends to participate in the study of all aspects relevant to the study so that the participant can make an informed decision. The necessary information should be expressed in plain language, not technical, to enable the subject (or his legal representative) the full understanding and leave time to reflect or deepen any points of the document before deciding whether or not to participate in the study. Guidelines for the process of informed consent are:

1. In obtaining and documenting informed consent, the investigator should comply with applicable regulatory requirements, must adhere to the standards of EU Good Clinical Practice and the ethical principles enshrined in the Declaration of Helsinki.

2. The rights, safety and well-being of the trial subjects are the most important considerations and should prevail over the interests of science and society.

3. Before starting the study, the investigator must obtain written approval from the Ethics Committee on the written informed consent form and any other written information to be provided to subjects.

4. Neither the investigator nor the personnel participating in the study should coerce or unduly influence a subject to induce him to participate or continue to participate in a study.

5. The investigator shall inform the person, with completeness, using non-technical language and in a simple and understandable manner. He/she must ensure that the subject has understood well all relevant aspects of the study, leave the subject as long as necessary for decision and provide the opportunity to learn about the study in which they will participate.

6. The written informed consent form must be signed and dated by the person personally.

7. The consent is given by dating and signing at the bottom of a document where it must be specified:

- an explanation of the scientific and reproducibility of research
- the objectives of the study
- where it is expected this method of study design
- the procedures of the trial
- responsibilities of the subject
- the risks and benefits of a measure
- procedures or alternative treatments available for the subject (and the related risks and expected benefits);
- insurance coverage in case of damage related to the trial
- any reimbursements for expenses incurred by the party for participation in the study.

8. The subject must be expressly informed that his participation in the study is voluntary and you may refuse to participate or withdraw at any time without penalty or loss of benefits to which he is entitled.

9. The subject must be expressly informed that his original medical records will be directly accessible only to employees to monitoring and verification, to the Ethics Committee and to the regulatory authorities. They must also be assured and it must be confirmed that any documentation capable of enabling the participants' identification will be safeguarded.

10. The investigator must inform the person about further circumstances or future acquisitions that could affect, in some way, the will of the subject the same to continue participation in the study.

11. The investigator shall communicate the names of the subject and related contact persons for further information about the study and its rights, foreseeable circumstances for which the subject's participation may be interrupted, the expected duration of the study and number of people who participate.