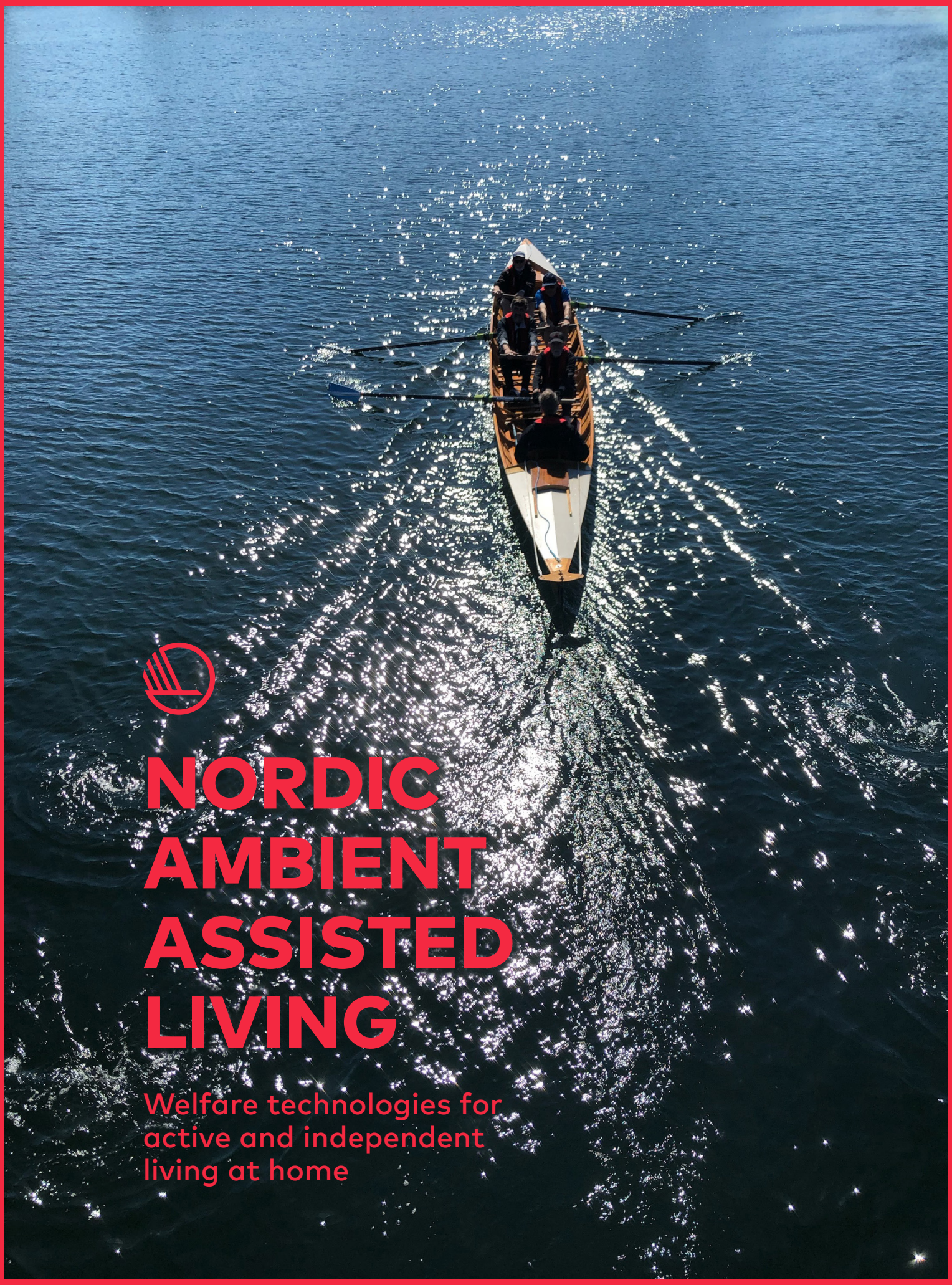


NORDIC AMBIENT ASSISTED LIVING

Welfare technologies for active and independent living at home

Colophon

Nordic Ambient Assisted Living – a stronghold of the Nordic health and care sector

Nordic Welfare Solutions is one of six flagship projects under the Nordic Prime Ministers' joint initiative, Nordic Solutions to Global Challenges, coordinated by the Nordic Council of Ministers. Nordic Welfare Solutions is managed by Nordic Innovation and has the goal of increasing exports through Nordic cooperation, branding and storytelling. The aim is to create a critical mass, strengthen Nordic networks and improve market access for Nordic companies.

This white paper introduces a selection of Nordic solutions for Ambient Assisted Living. These are technologies and welfare services developed in the Nordic Region, which enable the elderly to lead an independent life in their own home for a longer duration. It is one of three white papers derived from an analysis of the Strongholds of the Nordic Health Tech Ecosystem, published by Nordic Innovation in 2018. This white paper is based on input from more than 70 interviewees working within health and care provision, research and technology development in the Nordic Region.

Editors: Mona Truelsen, Nordic Innovation, Bengt Andersson, Nordic Welfare Centre.
Contributors: Finnsson & Co, Páll Tómas Finnsson
Photo credits: Finnsson & Co, Nectarine Health (p. 17), byACRE (p. 21), Assistep (p. 23), Evondos (p. 35)

Nordic Export Task Force: Representatives from HealthCare Denmark (DK), Welfare Tech (DK), Danish Trade Council (DK), Scion DTU (DK), Innovation Norway (NO), Oslo Medtech (NO), Norwegian Smart Care Cluster (NO), FinPro (FI), Healthtech Finland (FI), Upgraded (FI), Business Sweden (SE) Swedish Medtech (SE), Swecare (SE), Federation of Icelandic Industries (IS) and Promote Iceland (IS).

Nordic Innovation and Nordic Welfare Centre
Version 1, June 2019

NORDIC AMBIENT ASSISTED LIVING

Welfare technologies for active and independent living at home

Executive Summary

Technologies to enhance care and quality of life of elderly persons living at home

The population in the Nordic Region, as well as in other developed countries, is getting older. People live longer, more people are living with chronic diseases, and the ratio of elderly to the working age population is increasing.

This calls for new ways to provide health and care services.

Welfare technology is destined to play a key role in enabling the elderly to lead a secure, independent and active life in their own homes for longer.

This white paper on Nordic Ambient Assisted Living introduces Nordic welfare technologies that improve care and enhance the quality of life of elderly living in their own homes.

This area of technology is highlighted as a key stronghold in *Strongholds and Qualities of the Nordic Health Tech Ecosystem*, an analysis carried out for Nordic Innovation, which laid the foundation for the Nordic Welfare Solutions project. This report is part of a larger effort to showcase and export outstanding Nordic health and welfare solutions.

This report focuses on five key issues connected with assisted living solutions:

- *Safety of Elderly Living at Home*
- *Assistive Technologies and Devices*
- *Rehabilitation and Disease Management*
- *Robots and Automation*
- *Digital Solutions and Platforms*

In addition, we address some of the factors necessary for successful implementation, such as education and training, organisational change, privacy issues and infrastructure.

The technologies featured in the publication have been selected based on interviews and input from leading Nordic health tech developers, welfare technology researchers and care providers in the Nordic Region.[1]

[1] See the full list of contributors on page 43

Safety of Elderly Living at Home
The most widespread Nordic welfare technologies are safety technologies, such as monitoring solutions, GPS-based location services, fall detection devices, sensor technology and Artificial Intelligence (AI) solutions that register and analyse behavioural patterns. These technologies release an alarm or send messages to relatives or healthcare staff in case of emergencies or deviations in behaviour. These monitoring and detection solutions reduce the need for home care visits while still providing comfort and safety for the elderly and their families.

Assistive Technologies and Devices
In the field of assistive technologies, the Nordic market offers a variety of technologies and devices that enable the elderly to move around freely inside and outside their home, maintain their personal hygiene and carry out basic tasks of everyday life. The range of solutions includes various low-tech appliances, such as sock aids and reachers, as well as more advanced technologies, including loft lifts and stair assist devices, toilet and shower solutions and adjustable beds, tables and sinks. Walkers, wheelchairs and other mobility aids also belong to this category.

Rehabilitation and Disease Management
Rehabilitation is an area in which welfare technology offers great potential, reducing and delaying the need for care. Nordic technology providers have developed solutions that allow the elderly to participate in rehabilitation activities from home via one-on-one video consultation, web-based group training, or by using apps and devices offering standard exercises or tailored training programmes. Furthermore, Nordic technology has been applied to self-manage chronic disease, permitting users to take a more active part in their own care.

Robots and Automation
Using a wide definition of robot technology, the fourth category describes robot and automation solutions developed in the Nordic Region, such as automatic medicine dispensers, assistive eating devices, cleaning robots, communication robots and technology for rehabilitation and training.

Digital Solutions and Platforms
In the fifth category, digital solutions and platforms, we present Nordic communication- and planning solutions that facilitate coordination and communication between care personnel, the elderly and their relatives. We also address the need for a robust infrastructure and safe electronic sharing of health information, as well as common platforms on which different technologies and applications can be combined to create more complete care solutions.

Table of Contents

Preface

Welfare technology founded on the Nordic model

The Nordic model has been central to the economic and social vitality of the Region, ensuring high living standards and excellent health and care services for its residents. The Nordic countries offer free, high-quality education, universal healthcare and comprehensive social safety nets, with life expectancy among the highest in the world. All five Nordic countries have invested in developing competitive research and innovation environments and strong technological infrastructure.

Like most developed countries, the Nordic countries are faced with extraordinary challenges when it comes to providing the effective health and social care services to serve a rapidly growing elderly population. The goal is to enable the elderly to enjoy active, independent and dignified lives in their own homes for as long as possible.

The welfare technologies presented in this white paper are aimed at accomplishing this goal. They are the product of close cooperation between the Nordic research and innovation environments and health technology companies that have introduced new ways of delivering care to the elderly. Technological progress is encouraged by the public sector's willingness to test new technologies in real care environments, generating valuable input into their further development.

Successful integration of welfare technology addresses the health, independence and happiness of each citizen and frees up resources for better, more personalised care.

Nordic welfare technology has vast market potential all around the world. The global market for ambient assisted living amounted to €900 million in 2017 and is expected to grow six-fold, to more than €5 billion, by 2021. This rapidly growing market represents tremendous opportunities for Nordic businesses.

This publication is part of a series of white papers introducing innovative solutions in the health and care sector under the Nordic Welfare Solutions project, managed by Nordic Innovation. It is one of six lighthouse projects under Nordic Solutions to Global Challenges, a joint initiative launched by the Nordic Prime Ministers, addressing grand challenges such as climate change, sustainable development and healthcare provision in a changing world.

Nordic health technology companies have developed a wealth of expertise and new technologies to empower elderly to lead active, healthy and independent lives. These technologies will play a key role in the transition towards bringing health and care services closer to the home and adjusting them to the needs of each individual.

Svein Berg, Managing Director, Nordic Innovation
Eva Franzén, Director, Nordic Welfare Centre

Introduction

Global transition in elderly care – driven by technology

Population ageing is a global demographic challenge, and countries all around the world are facing a staggering increase in the cost of caring for their elderly citizens. People are growing older, and the proportion of elderly in the population is increasing, resulting in fewer taxpayers supporting aged care services. The longer lifespan also leads to an increase in the proportion of people living with chronic disease for longer periods. These demographic changes place greater demands on healthcare services for the elderly.

The principles of the welfare state are core values in the Nordic countries. The healthy take care of the sick, and the entire system strives to ensure good health, high quality of life and general happiness of the population.

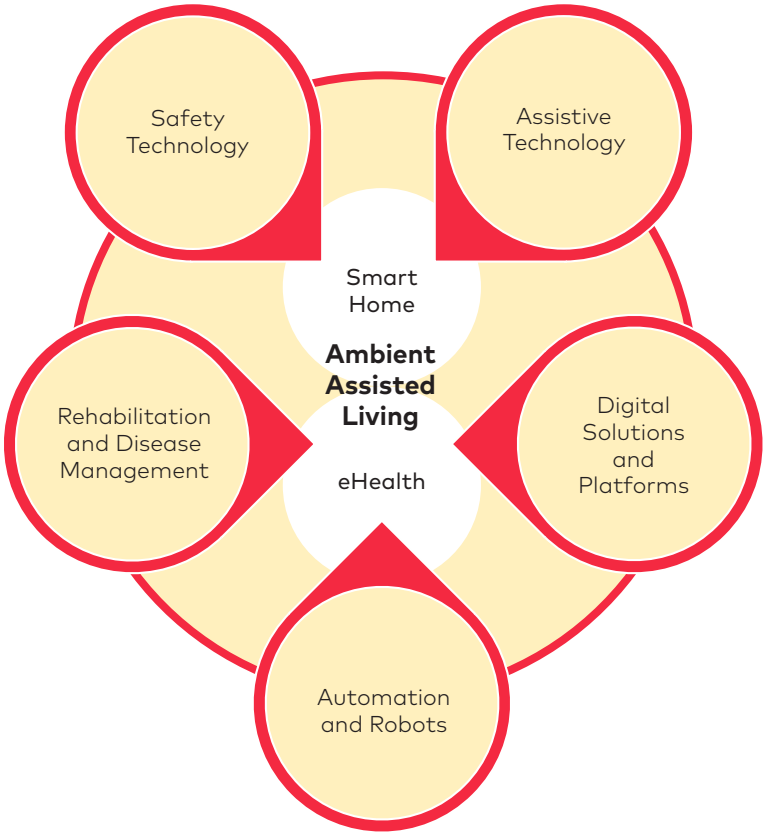
Increased integration of welfare technology in health and care will be vital in order to maintain the same high level of services in the future at similar or less cost.

The population of the entire Nordic Region, currently 27 million persons, is projected to increase to 30 million by 2030. Life expectancy is 83.8 years for women and 79.8 for men, among the highest in the world.[2] By 2070, one fourth of the Swedish population, to take one example, will be aged 65 or more, compared to one fifth today.[3]

This trend is even more evident in Europe as a whole, where more than one-third of the population will be aged 65 or more by 2060. The old age dependency ratio[4] in Europe is projected to rise from 53.9% in 2017 to 79.7% in 2080,[5] which means that whereas in 2017, there were 1.86 people of working age for each individual aged 65 or more, this figure will drop to 1.25 in 2080. Studies also show that the elderly are becoming more accepting of the use of welfare technology in care services. In a recent Danish study, 71% of 60-69 year olds were positive toward using welfare technology if needed.[6]

Welfare technology will therefore play an increasingly important role in empowering people to live longer in their own homes, increasing their personal freedom and allowing them to lead happy, active and enjoyable lives in their older years.

The market for welfare technology is expected to grow exponentially in the coming years. The global market size in 2017 was €900 million. This market is projected to grow to €5,272 million by 2021, a compound annual growth rate of more than 50 per cent. The EU market is expected to reach €1,384 million in 2021, around 26 per cent of the global market, while Asia is the fastest growing market, increasing ten-fold from €111 million in 2017 to €1,174 million in 2021. The US remains the largest single market, accounting for an expected 40% of the global market in 2021. The largest markets in Europe are forecasted to be Germany, UK, France and Italy.[7]



Integrating more welfare technology into health and care services is a key priority for all the Nordic countries, each of which has launched initiatives to further innovation and technology development. Here, we put the spotlight on those Nordic technologies that enable the elderly to lead an independent, active and meaningful life in their own homes. We focus on five categories of welfare technologies: Safety of Elderly Living at Home, Assistive Technologies and Devices, Rehabilitation and Management of Own Disease, Robots and Automation, and Digital Solutions and Platforms.

[2] Nordic Statistics 2017
[3] Sveriges framtida befolkning 2018-2070 – The future population of Sweden 2018-2070
[4] The age dependency ratio is the ratio of people ages 65 and older to the working age population, ages 15-64
[5] Eurostat – Population structure and ageing

The list of Nordic technologies presented here is far from comprehensive. The featured technologies have been selected based on their proven track record; all of them have been successfully implemented in elderly care. The technologies have been developed, tested and applied in cooperation with some of the best healthcare systems in the world, which are willing to test new solutions and provide input into their further development. The result is a range of first-rate, cutting edge technologies that greatly enhance the efficiency and quality of care for elderly living at home.

[6] Danish Chamber of Business – De kommende ældres velfærd – The welfare of the future elderly
[7] Danish Chamber of Business – De kommende ældres velfærd – The welfare of the future elderly

Safety of Elderly Living at Home

Ensuring the safety of elderly living at home

A vital part of enabling the elderly to lead active and independent lives in their own homes is to ensure their physical safety and security, both by providing preventive measures and by ensuring a rapid reaction in case of an emergency or other situations in which assistance is needed. The solutions in this category include alarms and smart home solutions, advanced monitoring and tracking technologies.

Starting from the widely used personal alarm button, Nordic safety solutions for the elderly now combine a range of highly advanced technologies to monitor people's well-being and safety, such as camera monitoring, sensors, location tracking and AI technology. In this field of technology, Nordic health technology providers have created supremely efficient safety solutions that can be adapted to the specific needs of each user, providing the ideal balance between the extent of monitoring while safeguarding individual privacy. Addressing privacy concerns and ensuring informed consent from the user is an absolute necessity in implementing any technology that monitors the movements and activities of an elderly person.

Nordic solutions to ensure the safety of the elderly include a broad range of technologies to track a person's movements inside and outside the home, prevent or detect falls, and monitor activity levels, daily routines and consumption of, for example, water and electricity. The technologies are designed to detect changes and events in behaviour that might indicate that something is amiss. In case of deviations in monitoring data, the devices are programmed to alert the user and then relatives, caregivers or a central alarm unit, which can then react according to the situation.

The key principle is to provide the right care at the right time, and only when care is needed.

In this chapter, we introduce some of the most widely implemented Nordic safety solutions for the elderly. Three kinds of safety solutions are described: (1) monitoring services, (2) location tracking, and (3) intelligent sensors. The monitoring services range from non-invasive monitoring using motion sensors to visual monitoring that generates either anonymised or recognisable images of the user. Type (2), location-tracking technologies, are solutions designed to support an independent and active lifestyle. Finally, type (3), the intelligent sensors, are used for passive monitoring in the home.

Safety technology for the elderly is one of the areas in which welfare technology delivers the greatest value,[8] and they are also among the most widely accepted welfare technologies.[9] The solutions described here have been used with great success to improve the quality of life of the elderly, provide their families with a sense of security, and reduce the cost of care for society.

[8] See for example Andre gevinstrealiseringsrapport med anbefalinger, a report on the benefits of welfare technology implementation produced by the Norwegian National Welfare Technology Programme
[9] Danish Chamber of Business – De kommende ældres velfærd – The welfare of the future elderly

Safety of Elderly Living at Home

Nordic monitoring solutions catering to every need

Nordic health tech providers have developed a wide array of monitoring solutions for the elderly who reside in their own homes. These solutions offer varying degrees of surveillance while meeting the needs to safeguard user privacy. A key question is whether the monitoring is based on visual data, and, in that case, whether the images are anonymised.

Using motion sensor technology, *Alerto Care* provides an alarm system that monitors activity levels in the home without producing any visuals. If no movement is registered during a certain period of time, the system sends out an alarm to pre-selected contacts. The system is equipped with an alarm button and a smoke detector that sends an alarm to a designated alarm monitoring unit.

Another popular solution is *RoomMate*, a 3D-technology based on infrared depth sensors capable of locating a person and registering if they are sitting in a chair, lying in bed or if they have fallen to the floor. *CareEye* by DoNet provides a fall-prevention service using thermal sensors and artificial intelligence, which is individually programmed to register the user's position, movement and activity. These solutions provide anonymised visual monitoring, showing only the contour and movements of the person, combined with alarm services if a critical situation arises.

As an alternative to anonymised monitoring, the City of Gothenburg has developed a monitoring service called *Trygghetskamera*, offering regular video monitoring at agreed times during day and night. The camera is activated for 30 seconds and then switched off. The camera only stores the basic logging information from each session. If the elderly person is not visible during a monitoring session, the camera is switched on shortly afterwards, and if still not visible, a central care unit checks up on the person and sends assistance if necessary.

The Nordic market also offers a variety of digital supervision solutions combining sensors and camera monitoring, including *Digitalt Tilsyn* from Sensio. These types of services range from momentary camera monitoring, either at agreed times or activated by an alarm from the user, to continuous monitoring using audio and video.

Safety of Elderly Living at Home

Location tracking for safety and comfort

The task of ensuring the safety of elderly persons living in their own homes is not bound to the home itself. The use of safety technology, notably location-based tracking services, is an important aspect of empowering the elderly to lead an active and healthy lifestyle.

Location-based technologies for the elderly serve three main purposes. First, they provide a precise location in case something happens, such as a fall or a seizure, whether inside or outside the home. Second, geofencing can be used to define areas in which an individual usually moves and then activate an alarm if they leave these designated areas, which is particularly useful for elderly dementia patients. Third, GPS technologies can deliver a detailed overview of a person's activities and movements.

Nordic technology providers in this category include Safemate, which offers a range of portable alarm buttons and location-tracking devices that simultaneously alert up to four contacts if a critical situation arises. The first person to respond is put in contact with the user. A message with the user's position and information about who responded to the alarm is then sent to all contacts.

Swedish Doro manufactures user-friendly mobile phones and safety technologies, including IP-based care phones. Another Doro device, the *Doro Secure 480* GPS tracker watch, features an SOS-button, fall detector, two-way communication, geofencing and time slot alerts. The watch has seven-day battery life and can be charged from empty to full in 90 minutes. The *Contact* health watch, made by the Norwegian firm ContinYou, is another example of cutting-edge monitoring equipment. The Contact is equipped with GPS tracking, fall detection, geofencing, two-way communication and a manual alarm button.

As part of their GPS tracking product range, Posifon offers the *GPS SmartSole*, a discreet tracking device that is inserted into a person's shoe. Activated when the shoe is put on, the device sends out an alert if the person leaves a predefined area. The SmartSole is just one of many examples of new technology options that can provide both enhanced safety and increased personal freedom for the elderly.


Overblik updates
Dagtimer mandag til fredag

Safety of Elderly Living at Home

Intelligent sensors offer new possibilities

Sensors are becoming an increasingly integrated part of safety solutions for elderly living in their own homes. Perfectly symbolised by the smoke detector, intelligent sensors enable passive monitoring, where data is continually collected and analysed, while the technology reacts only in case of any irregularities or critical events. Combined with AI technology, sensor-generated data provides valuable information about people's daily routines and activities, enabling a timely reaction to any changes in behavioural patterns.

The sensor category includes monitoring systems based on motion sensors and infrared technology, automatic lighting systems and other environmental control systems, and solutions combining motion sensors, pressure sensitive beds and floors and exit sensors on doors. Technology to monitor ambient conditions, such as temperature and humidity, is also becoming more widely available, as well as sensors to monitor water consumption and the use of electrical appliances.

Examples of Nordic technologies in this category are Swedish *Safebase*, a discreet bed sensor that collects and analyses movement data, such as if a person leaves the bed for a long time or too frequently. *Emfit QS+Care* sleep and health monitors, developed in Finland, detect movement in and out of bed, and also measure breathing, heart rate and sleep quality. Both solutions use AI to provide a detailed overview of the individual's sleep and movement patterns over time.

Other sensor-based Nordic technologies include *eLea Activity Sensing*, a wireless system that monitors movement and transmits an alarm in case of a fall; *Nectarine*, which gathers data through a discreet wristband and uses machine learning to automatically identify abnormal behavioural trends, sending out alerts in case of an emergency; and *Sensio Digitalt Tilsyn*, a solution that combines a range of sensors and video monitoring to ensure safety in the home. Lastly, Icelandic Alvican has introduced *Home Heartbeat*, a solution that monitors electricity and water consumption and reacts to any anomalies that may indicate that the user is in need of assistance.

Assistive Technologies and Devices

Assistive technologies for an independent everyday life

Leading an independent life in their own home requires the elderly to maintain their competence to manage various activities of daily living, such as personal care and hygiene, shopping, preparing meals, eating and house cleaning, either by themselves or with support from family, friends or caregivers.

The Nordic health tech ecosystem has focused intensely on developing technology that could empower elderly to move around freely and carry out these essential tasks themselves for as long as possible in their own home. When well integrated into people's homes and everyday lives, assistive technology can support the independence of elderly and prolong the period in which they can remain at home. To illustrate developments in this area, this chapter introduces a selection of innovative Nordic technologies designed to assist the elderly in their daily lives and enhance their functional mobility.

The capacity to move around freely, whether inside or outside the home, is vital in ensuring the self-reliance of elderly.

The Nordic countries are home to world leaders in developing ergonomic mobility technology, such as walkers, wheelchairs and scooters, which remain a popular option for elderly all around the world. Many of these technologies have now been embedded with digital features, and their design adapted to the increasingly active lifestyles of modern-day elderly.

Functional mobility can also be enhanced by modifying the built environment and installing accessibility features such as access ramps, loft lifts and track systems, or by addressing barriers in the home, for example by using stair assist devices that enable people to move safely between floors.

Nordic health tech companies have achieved a strong position in the market for technology to support and enhance the mobility of the elderly, getting safely in and out of bed, sitting down and getting up from a chair or a sofa, taking a shower or going to the bathroom. In addition, there is a growing availability of Nordic interior solutions that can be adjusted to the needs of the user, including height-adjustable kitchen and bathroom interiors, flexible toilet solutions and rotating sinks.

Nordic health technology providers have also led the way in utilizing digital technology to compensate for sensory changes, notably reduced vision or hearing, which could otherwise lead to reduced functional ability or social isolation. The most prominent example of such technologies is the advanced digital hearing aid, an area in which Nordic companies have set the global standard for innovation and technological development.

Digital technology, moreover, has become an integrated feature of many of the traditional assistive technologies developed in the Nordic Region, providing useful enhancements to the use of the technology, improvements in the health and wellbeing of the user and potential improvements in care services.

Assistive Technologies and Devices

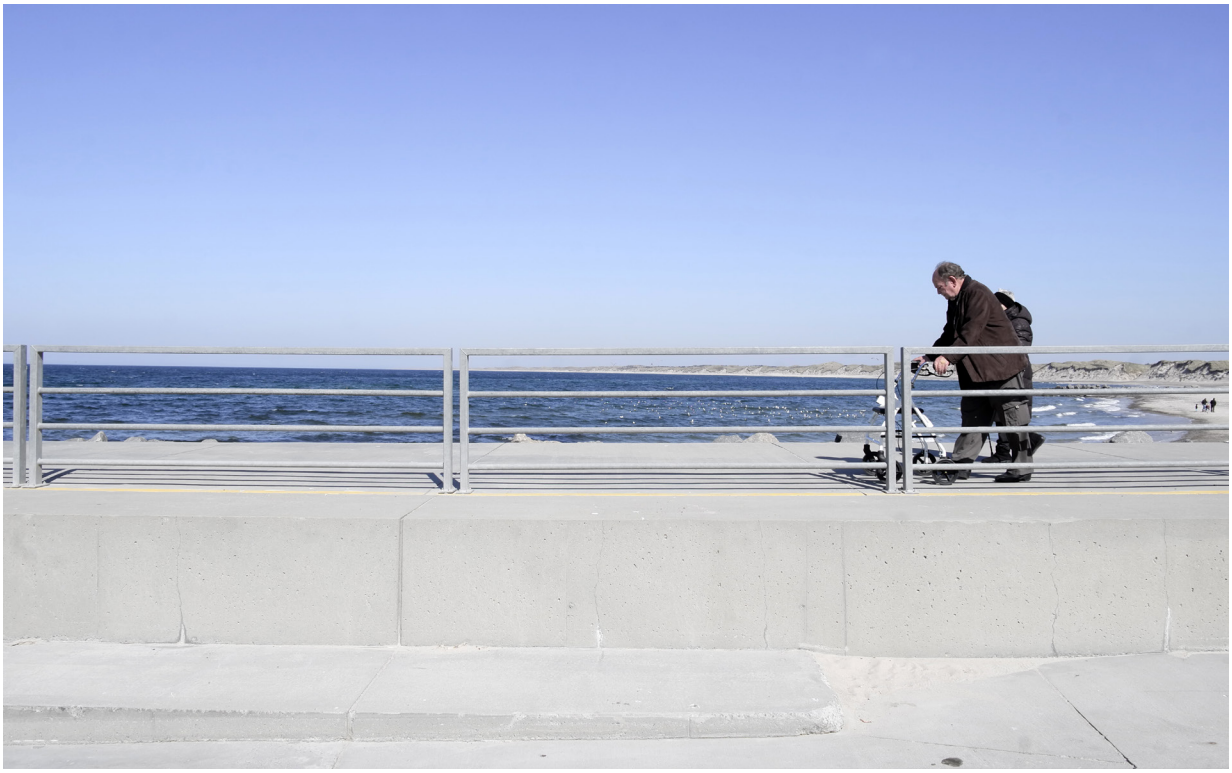
Pioneers of innovative mobility

Nordic mobility solutions span a large variety of products and technologies, and the region has given rise to some of the world's most innovative manufacturers of mobility devices.

One of the leading Nordic assistive technology providers is Swedish *Etac*, which has developed wheelchairs, walkers and other mobility equipment for more than four decades. Etac has introduced the world's first multifunctional cross-folding wheelchair and the first walker equipped with swivel front wheels. Other innovative Nordic wheelchair producers, such as Swedish Panthera and Danish Wolturnus, have developed sophisticated lightweight wheelchairs to accommodate an active lifestyle.

Nordic health tech companies also produce a comprehensive variety of walkers and rollators for those who cannot walk by themselves or who need support to maintain balance and stability. When it comes to this kind of mobility technology for the elderly, Nordic producers are renowned for their focus on aesthetic design, functionality and comfort. As an example, the Danish company byACRE has received design awards for their contemporary rollators for indoor and outdoor use, including the lightest rollator on the market, the *Carbon Ultralight*, weighing less than five kilograms. Designed for easy folding for storage and transport, the rollator supports the user's mobility needs both at home and when travelling.

Moreover, Nordic mobility companies have introduced a wide range of products that are specifically designed to enable the elderly to enjoy outdoor activities, such as the *Let's Fly* rollators from Swedish TrustCare, outdoor rollators from Norwegian Topro, and Trionic's *Walker* outdoor and *Veloped* off-road ranges, which come in several versions for activities such as fitness walking, hiking, hunting and golfing. A recent Nordic innovation is *Crosswalker*, a new type of walker that mobilises the entire body by guiding a natural walking movement using the legs, upper body and arms.




Age is the new black

Assistive Technologies and Devices

Sophisticated design for accessible homes

Based on a proud design tradition, Nordic assistive technologies and interior solutions offer great potential when it comes to creating a safe, comfortable, accessible home environment for elderly persons with mobility impairments.

Some of the best-known accessibility solutions are access ramps and various types of stair and platform lifts. Norwegian stair assist device *Assistep* is an innovative addition to this product range. The solution features a steadying handlebar mounted on wall rails, which can be installed in most types of staircases, providing firm support when walking up and down the stairs. This reduces the risk of falls and contributes to better health, as the user is better able to remain active.

There is also a growing inventory of Nordic interior solutions to ensure that the elderly can move around safely in their own home. These solutions include *EasyRiser*, a lifting chair that helps people sit down and stand up again, and *RotoBed®*, which enables the elderly or infirm person to get safely in and out of bed. The bed is elevated into a seating position and then rotated to facilitate safe and effortless exit. Other innovations to improve accessibility in the home are adjustable kitchen, bathroom and toilet solutions from the firms Pressalit and Ropox, using electric motors from the Danish technology provider LINAK, and *AbleOn*, a customizable shower system that assists elderly users throughout their shower routine.

For the elderly receiving home care, the use of ceiling-mounted hoist systems to lift and move people in the home has been a key focus area of welfare technology implementation in Denmark. This technology helps the user get safely and easily in and out of bed and to the toilet, for instance, and also improves the work environment of home care personnel. Another innovative Nordic solution is *Raizer*, a mobile lifting chair that helps people get up after a fall. Operating the chair requires only one assistant, which allows for swift and efficient support for the person.

Rehabilitation and Disease Management

Rehabilitation transitions from hospital to home

Keeping healthy is a vital part of being able to stay at home longer. Some of the basic preventive measures that the elderly can utilize are to lead a healthy lifestyle, eat nutritious food and exercise to maintain strength, flexibility and balance. Continuing to conduct as many activities of daily life as possible also enhances the ability of the elderly to preserve their functional independence.

For those who have suffered injuries or been hospitalised because of an illness, a planned operation or unanticipated events such as a stroke or a heart attack, effective rehabilitative training is vital. Here, we introduce some of the most widely used Nordic technologies and digital solutions to move rehabilitation from the hospital and into the home.

The use of digital rehabilitation technology correlates well with current trends in patient care, with many hospitals working toward shortening hospital stays.

The digital Nordic rehabilitation technologies described here are intended to remove or reduce patients' dependency on time and place by facilitating efficient communication and remote supervision of the rehabilitation training by specialized personnel. Rather than staying in hospital, these technologies allow people to exercise in the comfort of their own home, while still under guidance from physiotherapists or other trained professionals.

Using the technology, the elderly can participate in a variety of activities, from one-on-one video consultations to virtual group training sessions, supervised by a physiotherapist, networking with others with similar needs. These digital solutions allow for flexible and dynamic training, empower elderly to contribute actively to their own rehabilitation, and allow care personnel to attend to more patients at a lower cost.

The solutions in this category include video communication technology, training apps and other digital solutions that enable healthcare staff to monitor training and ensure that exercises are carried out correctly. Often combined with intelligent sensors, the technologies capture vital health parameters and register movement and training activity, producing a detailed overview of the individual's health status and rehabilitation progress. Finally, digital rehabilitation greatly improves access to suitable training programmes that can be tailored to the needs of each individual.

Nordic health technology companies are also in the forefront when it comes to exploring the potential of virtual reality in rehabilitation. The technology offers the possibility for virtual home visits and training of various activities of daily living in realistic settings, such as a virtual kitchen. Gamification is an integrated part of rehabilitation in virtual reality, aimed at inspiring elderly to exercise and motivating them in the rehabilitation process.

Also in this chapter, we introduce Nordic solutions for self-monitoring of chronic illnesses, such as chronic obstructive pulmonary disease (COPD), diabetes and cardio-vascular diseases. This category comprises a range of telemedicine solutions to monitor and report on patients' vital signs and health, screen dialogue with doctors and healthcare staff, and apps that support the elderly in managing their own chronic condition.

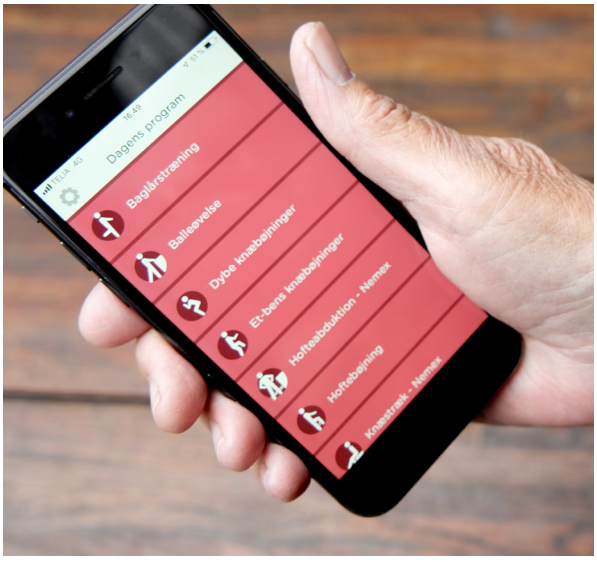
Rehabilitation and Disease Management

Rehabilitation at home increases quality of life

DigiRehab is a digital rehabilitation tool that has been implemented in a large number of Nordic municipalities providing home care. Care personnel can assess a person's strength and functional level, using a series of questions and physical tests. The tool then generates a tailored training programme based on the individual's physical ability and rehabilitation potential. Training is carried out in the home together with caregivers. DigiRehab uses big data and artificial intelligence to provide an overview of the rehabilitation process, the person's motivation, activity levels and progression. This allows for quick and informed adjustments to the training programmes, based on data from a larger group of users. The solution has been shown to increase the independence and quality of life of the elderly, while the reduced need for care delivers considerable savings to healthcare providers.

Another popular option is the *ICURA Trainer*, an app- and sensor-based technology and exercise database that allows people to train by themselves, wherever and whenever they want. All the ICURA Trainer exercises are visualised in an app, and sensors placed on the body register movement, training activity and results. If the exercise is not being carried out correctly, the app can deliver instant feedback to the user. The *ICURA Activity* app registers the user's activity levels, exercise and various activities of daily life, delivering a visual overview of the person's physical activity on the mobile phone.

Norwegian ExorLive is a pioneer in delivering professionally developed exercises and training programmes for rehabilitation specialists. Accessible from all platforms, this web-based service offers more than 7,000 exercises, carefully explained in instructional videos, to inspire elderly and others to remain active. An elderly person living at home can use the *ExorLive Go* app to work out by themselves, or they can get help from a caregiver using the *Exorlive Assistant* app. With the Assistant, the caregiver accesses the user's individualized training programme, guides him or her through the workout, and then sends feedback to the therapist. The service helps elderly to remain physically active and to live an independent life in their own home.


Dagens program
Baglårstrækning
Balleøvelse
Dybe knæbøjninger
Et-bens knæbøjninger
Hofteabduktion - Nemex
Hoftebøjning
Kraftstræk - Nemex

Rehabilitation and Disease Management

Regaining strength in virtual environments

Virtual technology offers possibilities for designing customized training programmes in a wide range of VR environments, mimicking real-life settings and everyday situations in which the elderly can safely exercise, build strength and improve their motor skills. Integrating VR into rehabilitation programmes enables careful monitoring of performance by providing valuable data to patients and care professionals alike.

Virtual reality is rapidly emerging as the rehabilitation tool of the future.

Nordic companies in this field include VR-Rehab, developer of the *ReHub* platform, which provides access to all the software required for efficient and user-friendly training in VR. New users are screened in a range of virtual scenarios to ensure that the training programmes fit their needs and abilities. The platform then allows people to train virtual activities of daily living in realistic environments, such as solving routine tasks in a virtual kitchen or bathroom. In this way, healthcare personnel obtain efficient tools to document and evaluate the training and progression over time.

Finnish *Peili Vision*'s rehabilitation solution uses VR technology, gamification and data processing to empower people to exercise as effectively as possible, whether in hospital or at home. A selection of hundreds of different VR scenarios, exercises and games at various levels of difficulty ensures that the training effort is consistent with the user's physical ability and rehabilitation requirements. Gamification is also a central element in *Gonio VR*, a rehabilitation solution that combines games and physiotherapy expertise that create customized, motivating and entertaining rehabilitation routines. Both these solutions provide a large variety of exercises and detailed data on the user's rehabilitation progress, providing instant feedback to the user and adjustments to the training programmes. The data is transferable to the person's health journals, making it accessible to other healthcare professionals involved in the person's care.


VIVE

Rehabilitation and Disease Management

Self-management of chronic disease

With a growing number of people diagnosed with chronic disease, engaging individuals in self-management of their own chronic condition has become pivotal in elderly care. Equipped with the proper technology, people with diabetes, COPD and cardiovascular diseases are becoming more capable of managing their own conditions from home, reducing the need for hospital visits and re-admissions.

In Denmark, COPD patients have been given the opportunity to manage their own condition using the *COPD Suitcase*, a telemedicine unit combining a spirometer that measures the volume and flow of air, a pulse oximeter that monitors blood oxygen saturation, and a communication unit that transfers data and enables video communication with specialists.

For insulin patients, Medilync provides a solution that combines cloud-computing, big data, computer vision and machine learning. The solution is built around the *Cloudlync* platform that collects, stores, processes and provides real-time access to relevant patient data for all stakeholders; the data include insulin doses, glucose levels, food intake, physical activity and more. The interface of the *Insulync* app, which is used to register and store the data, is designed to encourage the patient to be involved and committed to self-care.

Other examples of Nordic self-care solutions are *Kiwok BodyKom*, a mobile device offering continuous real-time ECG monitoring of heart patients, and *RheumaBuddy*, an app that enables rheumatoid arthritis patients to register daily variations of their symptoms. Using this app provides patients with better knowledge of their condition and improves the collaboration with rheumatologists, thereby contributing to more effective treatment. In addition, the app functions as an online community for people with rheumatoid arthritis.

Robots and Automation

Robotics and automation – future game changers

One of the main objectives of integrating welfare technology into elderly care is to reduce the time and effort spent on routine tasks, thereby allowing caregivers to spend more time together with the elderly and attend to their personal needs. The use of robots and automation technology is one means of achieving this goal.

In this category, we describe Nordic automation technologies that have already demonstrated their value in the homes of elderly, in both the Nordic countries and elsewhere. We also provide an overview of some of the robot technologies that are expected to be used in private homes in the coming years.

In our research, we have applied a broad definition of robot technology, encompassing cleaning robots, communications robots, robotic feeding devices and other automation technologies that perform various routine tasks that would otherwise require assistance from home care personnel.

One of the more prominent examples of Nordic automation technology are the widely implemented automatic medication management systems that can enhance the safety and well-being of the elderly, while also delivering considerable savings to healthcare. According to a recent study by the Danish Technological Institute, the savings are approximately €4,000 per year for each elderly person living at home, meaning that the investment is recouped in just six months.[10]

[10] Teknologisk Institut - Evaluering af teknologier til medicinadministration – august 2018

Robots are often identified as potential game changers for the health and care services of the future, as they are projected to be able to take on more and more routine and repetitive tasks in the home. One area offering great promise is the use of personal service robots, capable of executing a range of everyday tasks, such as tidying a room, making the bed, filling and emptying the washing machine or dishwasher, or even getting the user a glass of water or something to eat.

To be safely introduced into private homes, however, these robots must be endowed with the ability to recognize and interact with people and objects, which requires a combination of highly sophisticated mechanics, sensor technologies, computer vision and artificial intelligence. According to Nordic experts, this technology is currently too sensitive to angles, lights and shadows, which is why further development is needed before it becomes a viable option for elderly living at home.

Despite these challenges, there is a tremendous potential of robotics, artificial intelligence and automation in health and care.

Nordic robot technologies for cleaning, logistics, rehabilitation and personal care, already being implemented in hospitals and care institutions, will certainly become more widely available in the future, also in private homes. Introducing such technologies into the homes of elderly receiving home care will enable healthcare providers to increase the efficiency of their care processes, reduce costs and improve client and caregiver satisfaction.

Robots and automation

Automation and robots lift the spirits of elderly

Automated medicine dispensing systems are found in many Nordic homes. One of the market leaders is the *Evondos* medicine-dispensing robot, which reminds the elderly person to take the correct doses of medicine at the right time and guides them through the process. The robot dispenses all pills prescribed to the user and is also equipped with a reminder function for other types of medicine, such as insulin pens. If the prescribed medicine is not taken, a message is sent to the home care services facility or to family members. Other Nordic solutions to ensure safe medication management at home include Dignio's *Pilly* medicine dispenser, *DoseSystem* and *MedimiSmart* by MedicPen.

Addressing the social aspect of elderly life, the Swedish *Giraff* telepresence robot enables people to stay connected with friends and family. The robot is equipped with a screen that shows the face of a remote user and establishes a video connection with the elderly. The robot can be controlled from a distance – by family members, doctors or other caregivers – enabling them to interact with the person and move around in the home. Also developed by Camanio Care, the *Bestic* robotic device assists people with eating difficulties to eat independently and at their own pace.

Developed as a result of the first Norwegian innovation partnership contracts, *Berntsen* is an activity robot for rehabilitation and training. Rehabilitation specialists design an individualized training programme, which the robot communicates to the user via small icons and messages. Training activities can be carried out without the presence of a physiotherapist. The robot motivates and supports the elderly person in maintaining their functional level, thus reducing the risk of hospital readmission.

Nordic health tech companies have also developed a range of robotic solutions to assist with some of the most intimate situations, such as personal hygiene. Examples of this include *Melvin*, a robot that assists people in taking their clothes on and off when going to the toilet, and *Poseidon*, an intelligent shower system, equipped with an advanced ergonomic chair, which helps people get safely into and out of the shower and to shower without assistance from caregivers.


LÄHE
evondos

Digital Solutions and Platforms

Digital solutions for coordination of care

While welfare technologies are a key element in addressing the demographic challenges of an ageing population, the transition toward more home-based elderly care necessitates fundamental adjustments to the current healthcare system. As a growing number of people will be able to lead an independent life in their own home – supported by welfare technology and personalized home care services – health and care provision will become increasingly decentralised.

The transition to decentralised health and care calls for more distributed healthcare delivery models that utilise digital solutions to optimize the quality and efficiency of care.

In this category – digital solutions and platforms – we focus on Nordic solutions designed to coordinate care provision in the homes of the elderly. The category comprises digital access management systems, solutions to coordinate and document care provision, and platforms to manage communication between the elderly, their relatives and those involved in delivering care.

Digitalisation of home care services offers a range of benefits for elderly living at home. The elderly user is provided with a complete overview of all home care services, including the more informal care from relatives and friends, and the technology ensures smooth and effortless communication with all those providing care. The Nordic care platforms often enable video communication with healthcare professionals, preferably with the same personnel who conduct home care visits. This continuity of staff increases the comfort of the person receiving care and enables healthcare staff to build stronger relations to their clients and more intimate knowledge about their needs. Moreover, many of these Nordic solutions are designed to support community-based empowerment – increased involvement from family, friends and neighbours in the elderly person's health and quality of life.

From the perspective of healthcare providers, digital care management systems provide caregivers with a detailed overview of their daily tasks as well as simple and accurate ways to document the services provided. For healthcare management, the data and documentation gathered through the systems therefore supports informed decision-making about workflow optimization and improvements to home care services.

In developing digital care services, Nordic health technology providers benefit from the vast amount of data and statistics available about the healthcare sector in the Nordic welfare societies. An important feature of the new digital care services is the ability to integrate their data with existing health systems and to securely share sensitive patient data across different parts of the healthcare system. In addition, these solutions address the need for increased compatibility and platforms, providing caregivers with a common point of entry to the different digital products and services they use.

Digital Solutions and Platforms

Digitalisation tools for distributed care

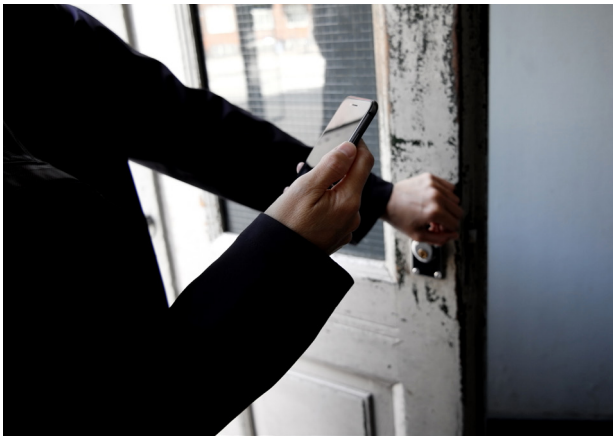
Digital access management systems deliver important benefits in the increasingly distributed care provision environment. One such system is *BEKEY*, a digital key system that allows for efficient access management of all those delivering home care. The home is equipped with digital locks, enabling caregivers to access the home using a smartphone or a tablet. Caregivers can be granted access to multiple homes, either permanently or within a specific time frame. BEKEY performs over five million openings per year.

Phoniro Care is a cloud platform for welfare technology used by more than 250 private and public care organisations serving over 150,000 clients. The platform offers modules for digital key management, time stamp and attendance, alarms and e-visits. The digital key management allows home care personnel to access the homes of clients using a mobile phone. Not only does this system improve safety, it typically saves 6-8 per cent of total working time through reduction in key administration and transport time. Another module is *E-visits*, where physical visits during the night are replaced by secure e-visits using a web camera, improving sleep quality and delivering savings to care providers.

CareOn is a communication platform that provides elderly, family members, caretakers and management with real-time information about the provision of care. The system facilitates automatic sign-in and documentation of services, thereby producing an overview of the time spent with the person and detailed statistics about the provided care.

Other coordination solutions include *Memaxi*, *Wivra* and the *Jocce* app from FamilyLink, all of which facilitate communication between healthcare staff, home care clients and their relatives, keeping all parties updated on care activities. Norwegian *JodaCare* achieves similar objectives, but it is designed specifically to assist elderly with dementia and others with cognitive impairments.

Among the health tech companies leading the way in combining welfare technologies and services are the Norwegian Telenor, which offers a complete range of connected care technologies and a dedicated IoT platform that enables integration of existing solutions, Visma, which has developed machine-to-machine solutions that bundle different information technologies, and Sensio, providing combinations of alarm technology, digital monitoring, location services, sensors, electronic lock systems and medicinal support.



Epilogue

Nordic welfare technology responds to global demand

Nordic health tech companies and care providers have developed state of the art welfare technology addressing all aspects of empowering elderly to live in their own homes for as long as possible.

The technologies described in this white paper are working to ensure the safety of the elderly, whether inside or outside their home, support them in maintaining their competence to carry out activities of daily life, and create new opportunities for people to take an active part in managing their own health. The key principle behind the use of welfare technology for elderly living at home is to minimize the need for outside care, while still ensuring optimum support when needed.

Successful integration of these Nordic welfare technologies enables the elderly to live self-reliant, active and independent lives – in their own homes and on their own terms.

Nordic welfare technologies are capable of helping the elderly achieve a more active and social lifestyle, enhancing their quality of life and providing a high level of security and comfort to their families and relatives. The technologies also show great promise in improving the working environment of care personnel, enabling them to spend more meaningful time with their clients, attending to more complex personal needs rather than more routine tasks. Finally, the digitalisation of home care services provides large amounts of valuable data that can make healthcare management more efficient and improve the quality of home care services.

Technologies supporting independent living have advanced at a rapid rate in the Nordic Region in recent years, driven by ambitious national strategies and by welfare technology programmes promoted by the local governments responsible for elderly care. The result is a thriving Nordic innovation ecosystem that continues to deliver advanced welfare technologies and user-centred care services, designed to support the kind of independent lifestyles that most elderly desire.

The transformation toward ambient assisted living is underway, and as the acceptance of welfare technology in elderly care continues to grow, more and more Nordic technologies are finding ways to satisfy this emerging market. These welfare-technological solutions will play a key role in responding to the ongoing global challenge of providing quality health and care services for ageing populations.


Sdr. Spilhus

About the Project

Nordic Innovation and Nordic Welfare Centre

Nordic Welfare Solutions is one of six flagship projects under the Nordic Prime Ministers' joint initiative, entitled 'Nordic Solutions to Global Challenges'.

The objective of Nordic Welfare Solutions is to highlight Nordic health and welfare technologies and strongholds as they apply to the future of health and care services. This publication provides examples of Nordic welfare technologies that can enable the elderly to lead an active and meaningful life in their own homes for as long as possible.

The project is being administered by Nordic Innovation, an institution under the Nordic Council of Ministers. Nordic Innovation is a key actor in implementing the Nordic co-operation programme for innovation and business policy. Nordic Innovation is helping to make the Nordic Region a world leader in sustainable growth by increasing entrepreneurship, innovation and competitiveness.

Nordic Welfare Centre is an institution under the Nordic Council of Ministers for Health and Social Policy. The Centre works toward developing the Nordic welfare model through research and knowledge dissemination and by providing recommendations on issues such as welfare policy, disability, labour inclusion, alcohol and drug issues, and welfare technology.

Acknowledgements

Aalborg Municipality, Akureyri Municipality, AllAgeHub, Almega, Capital Region of Denmark, City of Aarhus, City of Copenhagen, City of Gothenburg, City of Helsinki, City of Kuopio, City of Oslo, City of Oulu, City of Reykjavik, Co-Lab, Danish Technological Institute, Danish. Care, DigitalWell, DokkX Aarhus, Erhvervshus Copenhagen, Farsæl öldrun, Frumbjörg Innovation Centre, Gladsaxe Municipality, Gothenburg Region, Health Innovation of Southern Denmark, Healthtech Finland, Icelandic Health Insurance, Kópavogur Municipality, KS Norway, Landspitali, LEB – National Association of Senior Citizens, Local Government Denmark, Norway Health Tech, Norwegian Directorate for eHealth, Norwegian National Advisory Unit on Ageing and Health, Norwegian Smart Care Cluster, Oulu University of Applied Science, Public Intelligence, Region of Southern Denmark, SFV – Association of Companies in Welfare Services, Sintef, SKL – Swedish Association of Local Authorities and Regions, SSH – Association of municipalities in the Capital area, Stockholm Digital Care, Sunnaas Rehabilitation Hospital, Swecare, The Age Institute – Ikäinstituutti, THL National Institute for Health and Welfare, Upgraded, VIVE – The Danish Center for Social Science Research, Welfare Tech

AbleOn Medical, Alerto Care Technologies, Alvican, AssiStep, BEKEY, byACRE, Camanio Care, ContinYou, Curron, DigiRehab, Dignio, DoNet, Doro, DoseSystem, EasyRiser, Emfit, Etac, Evondos, ExorLive, FamilyLink, Gonio VR, HumanWalking, ICURA, Innocom AS, Kiwok, Liftup, LINAK, MariCare, MedicPen, Medilync, Melvin Robotics, Memaxi, Nectarine Health, Panthera, Peili Vision, Phoniro, Posifon, Pressalit, Rheumabuddy, Robotics Care, RoomMate, Ropox, RotoBed, Safebase, Safemate, Sensio, Telenor, Topro, Trionic, TrustCare, Visma, VR-Rehab, Wivra, Wolturnus

Nordic Innovation
www.nordicinnovation.org
+47 4761 4400
info@nordicinnovation.org

Nordic Welfare Centre
www.nordicwelfare.org
+46 545 536 00
info@nordicwelfare.org