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Robotics in Social Care

Using robotics has been suggested as one way to help improve the quality of UK social care and manage increasing pressures on services. This POSTnote describes robotic technology and outlines the main ways it has been developed for use in social care. It reviews evidence on the impact of robotics on the costs and quality of social care and its workforce, and explores the main ethical, social, and regulatory challenges to its use in social care.

Overview

- Technology is expected to be a theme in the Government's upcoming policy paper on adult social care in England.
- A wide range of robotic technologies can be used in social care from automated vacuum cleaners to robots resembling humans or animals. Few are used currently in social care and further research is needed to assess their impact in practice.
- Robotics can provide physical, social, and cognitive assistance and a small number of studies report positive impacts on users' mobility, mental health, and cognitive skills.
- Using more robotics may save up to £6 billion through automating some tasks, but there are concerns about affordability, and effects on the quality of care and staffing.
- Ethical, legal, and regulatory issues include impacts on users' autonomy and privacy and questions over the use and ownership of data.

Background

Social care is part of a complex system of public and private services to provide support for people who require assistance with daily living. It covers a range of activities from child protection to end-of-life care,[1] and can include assistance with washing, taking medicine, and protecting children or adults with physical or learning disabilities from harm.[2] A range of organisations and people can provide social care and it may be paid for by local authorities or privately by individuals themselves.[2] Families and communities also provide unpaid care (see POSTnote 582).

The demand for, and cost of, social care is expected to rise as the number of users increases and their needs become more complex.[3] At the same time, social care is facing challenges in recruiting and retaining staff and from reduced funding.[4,5] For example, in England government funding to local authorities reduced in real terms by 49% since 2010.[6] The charity, Skills for Care, estimates that the number of staff leaving jobs in adult social care in England (both local authority and independent) increased by 8% between 2012/13 and 2017/18.[7] The quality of care is also an issue, with the Care Quality Commission (CQC - the provider quality regulator in England) stating that too many people are getting care that is not good enough.[3,8]

There is growing interest among care providers, charities, and academics in using robotics to improve the quality of care and ease pressure on the social care system.[9-14] New technology to support social care is expected to be a theme in the upcoming Green Paper on adult social care in England,[15] and its potential has also been highlighted by the Scottish Government,[16] the Welsh Government,[17] and in Northern Ireland.[18]

Robotic Technology

Robotics is a broad field that encompasses different aspects of the creation and use of programmable machines (robots) to perform independent or semi-independent actions.[19-21] While there is no universally accepted definition of a robot,[21] they typically comprise three main components:[22]

- Sensors gather information about the robot's environment, such as monitoring temperature.
- Actuators provide physical motion to the robot in response to input from the sensors and controllers, such as hoists.

- Controllers respond to data from the sensors and allow parts of one or more robots to operate together.

While robots are typically thought to comprise all three components, sensors and actuators can be employed on their own and can be used in social care, like sensors that detect falls and actuators in the form of stair lifts. With the use of appropriate sensors (such as cameras or microphones) and smart control software, robots can operate with varying levels of autonomy.[23,24] Autonomous robots often include artificial intelligence (AI)–technologies with the ability to perform tasks that would otherwise require human intelligence, such as visual perception[25]–and they sometimes have the capacity to learn or adapt to new experiences using machine learning.[26] Robots can (and for the most part do) operate without any AI however.[27] Some robots can also share information through remote access to shared computing resources (cloud computing).[12] A 'smart home', for example, can sense its occupants and then manage multiple systems within the house such as heating, air-conditioning, and alarms based on knowledge of the occupants' needs and activity.[12]

Many of the robots and robotic devices developed for social care appear to still be at the conceptual or design phase.[28] A key question is whether robots and robotic technology can integrate into existing social care environments, and with current technology, or replace them altogether.[12] Currently, there are technical limitations to the tasks that they can undertake. For example, most struggle with certain tasks like operating in unstructured environments, and robots cannot yet match human ability to pick up and store items.[29-31] The 2017 Amazon Robotics Challenge event, which brought together robotic engineers to compete on a gripping robot challenge, revealed that even the most advanced machines continue to have difficulty handling items that are wrapped in plastic, obscured, or which bend and change shape when moved.[32]

This may change with increasing investment in robotics and several trials are being undertaken in the social care sector.[28] According to the National Audit Office, the UK Government will invest over £300 million in robotics and autonomous systems (RAS) research between 2012–2020.[33,34] The European Commission (EC) is also investing €700 million between 2014–2020 in its joint partnership with the robotics industry and academia (SPARC), which is expected to yield a total investment of €2.8 billion.[35] Using patents as a measure of innovation,[36] in 2013 the Intellectual Property Office found a 24% increase in published patent applications in RAS from 2011–2012 compared to a 13% increase in patent publications for all technologies. This was in excess of the overall growth in each year except 2009–2010.[37] According to the market-forecast advisory firm ABI Research, global investment in the robotics industry in 2017 amounted to US$2.7 billion.[38]

Uses of Robotics in Social Care

Robotics in social care can take many forms, for example: automated vacuum cleaners, wearable devices to assist with walking, and machines that physically resemble humans or animals (Box 1). While much has been written about the potential uses of such technology, the development and use of robotics in social care is still relatively new and, as yet, there is limited evidence of robotic technology being used in social care outside of some small-scale trials.[28,39,40] Use may increase as existing smart technologies such as home hubs and smartphones are used in care delivery.[28] The underpinning evidence base on robotics in social care currently suffers from a number of limitations:

- **Limited focus**. Most of the focus has been on how technology can aid social care for older people, and fewer studies have looked at care for children or those with lifelong learning disabilities.[28]
- **Methodological limitations**. Many studies have small sample sizes and the findings are not generalizable to other contexts.[41]
- **Context specific**. Many studies have been conducted in Japan,[42,43] which has a different social care system and different cultural values around care. These factors may shape the acceptance and effectiveness of the technology in the UK.[44]
- **Limited availability of technology**. Some robots are commercially available (such as robot vacuum cleaners). However, much robotic technology is being trialled and is not widely used within the social care sector.[28]
- **Knowledge gaps**. Few studies have explored the effects on the social care workforce or the cost-effectiveness of using robotics in social care.[45]

It has been suggested that robotics can provide three types of assistance: physical, social, and cognitive (Box 1).[12,15,46]

Physical Assistance

Robots providing physical assistance have been developed to perform tasks such as lifting and carrying.[28] Robots have also been developed to assist with tasks like feeding,[47] washing,[48] and walking, and are being developed to support physiotherapy.[49-52] Prototypes of robotic toilets have also been developed that can raise, tilt, recognise the user, and adjust its settings.[53] A 2018 review identified few studies that reported on the effectiveness of physically assistive robots in social care.[41] One study looking at the results of an EC funded pilot project found that physically assistive robots (such as semi-autonomous wheelchairs) helped to promote mobility and assisted with users' personal care.[54]

Social Assistance

Socially assistive robots include robots that aid daily living activities, such as those that remind users when to take their medicine and those that detect and prevent falls.[28,55,56] It can also include robots designed to provide companionship and assist with loneliness and social engagement,[57] monitor and improve wellbeing, and can also help educate preschool children.[58,59] A pilot conducted by Hampshire County Council found that while the Amazon Echo did not reduce the costs of care, it did result in a reduction in users' self-reported feelings of isolation and loneliness.[60] Trials of other socially assistive robots have found positive evidence

of impacts on users and caregivers, although evidence of their use in the social care sector in the UK is limited.[28,61-63]

Several reviews have reported positive impacts from socially assistive robots on users' mental health, like reducing users' self-reported levels of depression, agitation, and increasing in self-reported quality of life. Studies have also suggested that robots can encourage social interaction between users such as care-home residents.[41,64-67] Two studies have suggested robots can promote social behaviour in children with autism, although the research overall was noted to lack substantial quantitative data.[68,69] However, one review reports that results were mixed as to the effectiveness of these robots when compared with soft toys and to the robot when it was switched off (a placebo robot).[41]

Box 1: Examples of Robots in Social Care Practice

Robotics can support caregivers or those receiving care. Most robots provide a range of types of assistance. In particular, many robots offering cognitive assistance do so alongside other support, such as social or physical assistance.

Robots providing physical assistance

- Wearable devices, like the currently available 'REX' and 'ReWalk', can assist with rehabilitation for walking and personal use.[70]
- Exoskeletons and cobots (robots designed to operate alongside people or with human input[71]) can support caregivers with lifting tasks.[72,73] For example, 'Robear' is a robotic device being developed to help with lifting patients.[74]
- The commercially available 'Roomba' vacuum-cleaner or robotic lawnmowers can aid with domestic chores and may free up more time for caregivers, parents, and carers.[75,76]

Robots providing social assistance

- Robots such as 'Paro', a robot in the form of a baby seal, 'Pepper', a humanoid robot, and MiRo, a robot resembling a rabbit or small dog, have been trialled with people with dementia, children with disabilities, and in care-homes.[77,78,79,80]
- Robots like Pearl, CareBot™, Hector and uBot5 have been developed to monitor patients in case of falls. Hector is integrated with emergency calls or remote monitoring services,[28] and CareBot™ can sense vital signs, such as blood pressure.[81]
- Robots such as GiraffPlus provide remote health monitoring ('telehealth'–see POSTnote 456) and connect users with family and friends.[82]

Robots providing cognitive assistance

- Hector (see above) also offers cognitive stimulation/games.
- Nodding Kabochan, a robot in the form of a child-like teddy, is designed to communicate and play exercise and singing games with users. A 2012 trial in Japan suggested that it improved users' cognitive function.[83]
- Lego® Mindstorms® TriBot, Zora and virtual robots (that perform play activities in a simulated environment on a computer screen) can assess the cognitive skills of children with disabilities.[84,85]

Cognitive Assistance

Robots have been developed to support people to perform cognitive tasks, such as improving users' memory and supporting people with dementia.[86-88] They have also been proposed as an alternative method for assessing cognitive skills of children with disabilities.[89] However, studies use a range of different measures to demonstrate cognitive improvement, making comparison difficult (for example, cognitive tests, such as Mini-Mental State Examination which is used to measure cognitive impairment).[90-92]

Impacts of Robotics in Social Care

The use of robotics in social care has implications for: the cost of social care, its quality, and the social care workforce.

Cost of Social Care

Using robotics could reduce social care costs by: enabling older people to stay in their homes for longer rather than going into residential care; preventing hospitalisation through falls, illnesses, and keeping people healthier for longer; and reducing staffing costs by automating a greater number of tasks.[93] In 2018, the think tank, the Institute for Public Policy Research estimated that the use of robotic and other technology could improve productivity in the adult social care sector through increased automation of mainly administrative tasks up to the value of £6 billion a year.[94] A 2014 review found that assisted living technologies (such as sensors that can monitor the health and safety of users remotely - see POSTnote 456) reduces costs. However, it noted the limited data available, much of which was deemed to be of poor quality.[95] Potential savings are weighed against the costs of introducing robotics technology.[96,97] Robots can be expensive, which may present a barrier to their wider use in social care.[98-103] Other types of interventions that support people to live more active and healthy lifestyles may also result in savings by reducing incidences of disability and chronic health conditions amongst older people, thereby promoting independence and autonomy in later life (POSTnote 539).

Quality of Care

In July 2018, the CQC rated over 80% of adult social care services in England as 'good' or 'outstanding', and 18% as 'requiring improvement' or 'inadequate'. It also noted geographical variation.[8] The consensus is that robots should not completely replace human care, particularly the pastoral aspects.[104,105] Robotics may free up time for caregivers enabling them to focus on delivering a better service for care recipients.[106,107] However, there are concerns that social care quality may diminish with the use of robots, because robots are incapable of fulfilling the social or emotional needs of older care recipients and may increase loneliness and isolation amongst this group.[28,108-113]

Social Care Workforce

Increasing the use of robotics in social care will require training for current staff to be able to work alongside the technology.[114] It may also increase jobs in other sectors, such as for those with skills in robotics including data analysts, and programmers.[115] However, this may have knock-on effects if the social care sector is required to buy-in such skills given potential salary differentials, raising the question about whether this outweighs any efficiencies created by the use of robotics.

Ethical, Social, and Regulatory Challenges

Challenges to the use of robotics in social care include: ethical issues, such as autonomy, privacy, security and bias; public attitudes; and legal and regulatory concerns. Many of these also apply to AI more widely.[116]

Ethical Issues

Ethical issues relating to the use of robots vary depending on the type of user, e.g. child, adult, caregiver; the type of robot in use; and the environment in which the robot operates, e.g. a residential care home, private home.[117-120]

Autonomy, Consent, and Independence

Robotics has been suggested as a way to increase users' autonomy and dignity.[121-123] However, focus groups with older people and caregivers identified concerns about: the degree to which robots could prevent people from engaging in risky behaviours like smoking; the extent that robots could make users do something if they did not wish to, like take scheduled medication; and the potential that users may become dependent on robots, undermining their ability to do things for themselves and reducing independence.[124,125] Concerns about dependence have also been raised about the use of human caregivers.[126] It is also unclear how vulnerable social care users, such as children may be able to give informed consent to the use of robotics.[127]

Privacy

As with other internet-enabled and recording technology, robots that are capable of accessing the internet and recording large amounts of data raise questions over privacy and security.[128,129] Robots capable of processing personal data are subject to regulation under the EU General Data Protection Regulation (GDPR), which requires 'privacy-by-design', whereby data protection safeguards are built into technology early on.[130-132] Robots may be seen as more objective than human caregivers, which may promote users' privacy.[133]

Security

Robots with poor security could be vulnerable to hacking, and could, potentially, be controlled remotely by an attacker.[134] The vulnerabilities of NHS cyber security systems have been previously highlighted.[135] All providers with access to NHS patient information are required, annually, to demonstrate compliance with the data security and information governance requirements set out in the NHS Data Security and Protection Toolkit (DSPT).[136] All NHS Trusts were required to complete a baseline assessment by October 2018. As of November 2018, just over half (53%) of the 24,000 providers in England had registered on the DSPT website, of these, 77% had submitted the assessment, 2% had started but not submitted, and 10% had yet to start it.[137]

Bias, Deception, and Infantilisation

Robotics and AI technology can have in-built biases that may reinforce stereotypes and discriminate unfairly.[138,139] Robots designed to resemble animals or humans may deceive users, particularly vulnerable users who may not be able to distinguish the robot from a real pet or person.[140-143]

Public Attitudes

Attitudes to robotics are shaped by people's previous experience and expectations and may be indicated through their attitudes to computers and related technologies more generally.[144-147] Studies report mixed attitudes towards the use of robots in social care amongst users and caregivers, and it is unclear how such attitudes vary across age groups and between different types, and functions, of robots.[148-150] Research suggests that the design of robots is key to their acceptance and effectiveness.[146,151] A project by the Isle of Wight council suggested that, for social care, cobots (Box 2) were perceived more positively than robots as they were less likely to replace caregivers.[152]

Legal and Regulatory Concerns

Organisations that set regulatory standards for the design of social and care robots include the British Standards Institution (BSI) and the International Organization for Standardization (ISO). A number of standards currently apply (Box 2).[153] The Engineering and Physical Sciences Research Council funded UK-Robotics and Autonomous Systems Network[12] has highlighted the need for international governance and regulation in this area, and a 2017 European Parliament report called for the creation of a European Agency for robotics to supply public authorities with technical, ethical, and regulatory expertise, and a voluntary ethical Code of Conduct.[154]

Legal and regulatory challenges include determining legal personality and legal liability for decisions made by robots.[26,155-158] The aforementioned European Parliament report suggested that autonomous robots could be granted 'electronic personalities' to enable them to be held liable for damages.[154] However, an open letter to the EC signed by 156 AI experts from 14 European countries warned that this would be 'inappropriate' from a legal and ethical perspective.[159] The diverse functions of robots may mean that robots are regulated differently. For example, robots that remind users to take medication may be classified as medical devices and regulated by the Medicines and Healthcare Products Regulatory Agency, while those processing personal data are regulated under GDPR.[27,160] Clarifying ownership of data collected by robotics has been highlighted as an issue of concern.[28,154] Data gathered from robots may be beneficial to roboticists in developing the technology, improving AI, and for machine learning, but in social care this may include personal or sensitive data.[161,162]

Box 2. Existing regulations for robotics in social care

Key regulatory standards for robotics in social care include:

- ISO 8373, which provides an overview of robotics terms and vocabularies, notably defining and distinguishing between types of service robots and industrial robots;[163,164]
- ISO 13482, which focuses on minimising the potential risks posed by robots that come into direct contact with people; [165,166]
- BS 8611, which addresses ethical hazards relating to the use of robots.[167,168]

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