RoboCare
Healthcare in the robot age
Abridged version of the TA-SWISS study «Robotik in Betreuung und Gesundheitsversorgung»

In der vorliegenden Studie werden die Geräte nach ihrer Funktion in drei Gruppen einteilt: (1) Trainingsgeräte und Hilfsmittel dienen der Rehabilitation von Patientinnen und Patienten und fördern deren Mobilität und Selbständigkeit. (2) Assistenz- und Telepräsenzroboter entlasten den Menschen oder ersetzen seine physische Anwesenheit. (3) Sozialinteraktive Roboter können den Menschen begleiten und mit ihm interagieren.

Die Studie ermittelt Chancen und Risiken im Hinblick auf einen technisch machbaren, wirtschaftlich realisierbaren und ethisch wünschenswerten Einsatz solcher Geräte und formuliert auf dieser Grundlage Empfehlungen.
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Very briefly: Robots in healthcare and support care

In industry, repetitive, difficult and dangerous tasks were long ago handed over to robots, which work with remarkable precision. Developments in artificial intelligence and in the production of contact-friendly materials hold out the promise of machines doing things which require even greater sensitivity. In view of the shortage of staff in the healthcare sector, there is growing potential for using robots and autonomous devices in support care and healthcare.

Their opportunities...

Robots could take over physically demanding work and routine activities from healthcare staff. This would leave them more time for patients. Robot assistants could help these people to achieve greater independence: smart wheelchairs or walking aids would reduce their dependency on human attendants. Service robots could also take over as important helping hands in the home, making it possible for people needing support and assistance to live independently for longer.

...and their risks...

If robots reduced the level of direct contact between healthcare staff and patients, relations and cooperation between them might suffer as a result. There would be a greater risk of wrong decisions being made, leading to impaired quality of healthcare. The isolation of sick people would increase. For many people, the loss of interpersonal contacts would reduce the attractiveness of the health profession. Without adequate data protection, information collected by care robots and robot assistants could be misused for the surveillance of sick people and for commercial purposes. Ultimately, robots might actually contribute to a rise in healthcare costs, rather than bringing them down.

...and the key recommendations

Lawyers, researchers, consultants and representatives of the Federal Office of Public Health should check whether the existing legislation covers issues of liability for robots in healthcare. If necessary they will propose amendments.

The conditions have to be created to enable the introduction of the electronic patient file combined with a regulation on data protection, because robots are reliant on digital data.

Telepresence robots, robot assistants and service robots also frequently gather data from the surroundings of their users. Data protection must also be clarified for data that are unrelated to health. If need be, additional regulations must be issued.

In its medical-ethical guidelines the Swiss Academy of Medical Sciences SAMS should take into account the effects that the use of robots might have, especially on people who are unable to make decisions for themselves. It is the duty of organisations with responsibility for care homes – cantons, local authorities or foundations – to ensure that the guidelines are implemented.

In the case of research projects professional and non-professional users should be included at an early stage, so that the development of robots and support systems does not lose sight of their needs.

An interdisciplinary team

The study «Robotics in support care and healthcare» was conducted by an interdisciplinary team led by Heidrun Becker, Professor at the Zurich University of Applied Sciences, as well as experts from the Department of Health, employees from the Institute of Mechatronic Systems and the Winterthur Institute of Health Economics. The study looks at a development horizon up to the year 2025.
He is in fact a slim box made of stainless steel with the sort that are so familiar from science fiction films. Günther bears absolutely no similarity to humanoid robots of name plate on his metallic surface, because Günther is in fact a robot – or, as the explanation on YouTube specifies, a «driverless transport system» (www.youtube.com/watch?v=p-37v345DyY). There is a gentle irony in the fact that someone has stuck a big pair of small lamps flashing on its front end. He is designed to travel with the load to be carried, picking it up and taking it to its destination.

The nursing crisis calls for solutions

In their annual reports, many of the people responsible for Swiss hospitals regularly reflect on how difficult it is for them to attract people who want to train for a career in nursing. In fact, in the last five years the number of healthcare trainees has fallen. Furthermore, many nurses are women, who are rather more interested in working part time or abandoning their career for a few years if their children are still small. Physical wear and tear plays its part in forcing many nurses to give up work prematurely. But the more tasks are spread over few shoulders the greater is the risk of burnout among the remaining nurses. A vicious circle which many clinics try to deal with by hiring staff from abroad.

The nursing crisis will continue to intensify, because the proportion of older people among the Swiss population is steadily rising. The Federal Statistical Office estimates that in 2060 over 28 per cent of people will be of retirement age; today the figure is just below 17 per cent. As the proportion of senior citizens grows, so too does the number of people who are dependent on medical care and assistance. As a result there could be a shift in the disease spectrum currently predominant in Switzerland: chronic complaints and polymorbidity will increase.

In industrial manufacturing, robots began decades ago to take over stereotypical work stages or dangerous jobs. The obvious question is whether the devices that now perform tasks in a versatile and precise way could also be used in healthcare and support care.

The study by TA-SWISS explores the technical bases for this and considers the social, economic, legal and ethical aspects of using such devices.

In the shop window: training devices, telepresence and autonomous robots

The Günther transport system never comes into contact with patients; it is used solely to convey laundry baskets or trolleys carrying meals between the kitchen and the wards. Günther should therefore relieve nursing staff from doing simple routine jobs. He only communicates – if one wishes to call it that – with his human work colleagues from the nursing team.

The study by TA-SWISS classifies the devices into three different types. The group of training devices and mobility aids includes arm and leg trainers in rehabilitation, «smart» gripping and walking aids fitted with electronic sensors or semi-automatic wheelchairs. But there are also telepresence robots and assistant robots which replace the personal attendance of a nurse, therapist or physician. A characteristic of this type of device is that they relay a video conversation with a physician, for example. The third category comprises socially interacting robots which support patients as companions and partners. The focus here is on the direct relationship between robot and human being.

Training with ARMin and walking with SmartCane

Robots which are not socially interactive come in different shapes and sizes and can perform a variety of tasks.

In Switzerland several universities and companies are working on the development of rehabilitation devices.
ARMin, a training robot built by the Federal Institute of Technology and the University of Zurich, looks a bit like a piece of apparatus in a gym. Its producers describe it as an exoskeleton – an external skeleton. ARMin consists of an upper and lower arm which leads to a support surface for the human hand; seven pivots enable the steel arm to bend and perform rotation movements. The arm of the seated patient is strapped to ARMin and the device aids coordination and movement of the weakened part of the body. The machine can also set exercises which the patient has to perform; the instructions are given on a screen – for instance the task of throwing a coin into a vending machine simulated on the monitor. Patients can also see straight away on the screen whether they have successfully completed the exercise. Training robots also exist for the legs, for example the ‘Lokomat’ developed by the Swiss company Hocoma. This walking robot is used by patients who are paraplegic or have suffered a stroke.

But there are also smaller machines that are intended for training at home or which assist patients with their daily chores. A glove fitted with sensors which can be used as a video game controller practises gripping movements with stroke patients. Gripping and manipulation tools help with teeth cleaning, eating and housework. Mobility aids such as SmartCane, a stick with additional functions, can recognise obstacles and enable users to find their way around them by means of a navigation system. There are already about fifty ‘smart’ wheelchairs, and the ReWalk exoskeleton should soon be on the market, with the aim of helping even paraplegic patients to walk again: it is attached to the side of the hip, knee and foot joints and can be controlled remotely to make the wearer place one foot in front of the other. Intelligent prostheses fitted with electronics also belong to the category of mobility aids. These are of interest not least because they assist residual neuromuscular functions or are even able to take over movement completely.

The on-screen therapist

A roughly shoulder-high slim chassis, with an eye-level screen: that’s what TeleStroke, HOSPI-Rimo and Ava look like, three telepresence robots from different manufacturers. Equipped with camera, microphone and loudspeakers and normally controllable remotely via the Internet, they transfer video and audio signals between the therapist at the practice and the patient at home or in the clinic. Patients can talk to their physician, receive training suggestions and advice while depending on the device the physician can retrieve information on bodily functions such as heartbeat, blood pressure and insulin level. Supporters of telepresence robots have great hopes that they will improve healthcare provision in remote locations. And because telepresence robots enable physicians to make routine «visits» remotely, it leaves them more time for more expensive consultations which can only be conducted on site.

But staff in hospitals and care homes could also rely on the assistance of robots. They would primarily take over routine tasks such as cleaning floors or carrying meals, drugs, laboratory or administrative material and laundry. There are also robots on the market that serve drinks and supply consumables. In Japan carrier robots are already in use lifting patients out of bed into a wheelchair or into the bath. Another product from Japan is a robot that can transform itself from a bed into a wheelchair. These mechanical «colleagues» should relieve nurses of some of their workload – at least of physical exertions; if as a result they remain free of the symptoms of wear that are typical of their
profession, they could also stay in the profession for longer. And last but not least, some hospital managers are hopeful that with robot assistants they can make do with fewer staff without the quality of care suffering as a result.

Although experts in hospitals and nursing homes recognise the huge potential of using robot assistants, there are only a few systems on the market in Europe. That is because they still face a range of hurdles: high acquisition and maintenance costs, a lack of liability regulations, lack of acceptance among staff, as well as technical problems such as energy consumption and batteries failing at inopportune times, are all fueling scepticism about mechanical helpers.

**Vehicles of metal and plastic**

The two droids R2-D2 and C-3PO so well known to lovers of science fiction who steal the show from the leading human actors in «Star Wars», or the permanently depressed little white plastic man called Marvin, travelling with the «Hitchhiker’s Guide to the Galaxy», correspond very well to the archetypal social robot: they can express and perceive feelings, are personalities in their own right with their strengths and weaknesses, recognise their counterpart and learn from him or her and enter into social relationships. Up to now, social robots have been developed mainly as toys. A forerunner was the robot dog Aibo, which Sony launched onto the market in 1999, but which by 2006 had been put back to sleep when production ceased. The robot dinosaur Pleo, a product from the USA which recognises its owner’s voice and behaves more and more animatedly the more its master or mistress looks after it, is still available. Another well-known example is the cuddly white robotic seal Paro, which responds to stroking by purring and fluttering its eyelashes.

While robotic pets are relatively simple machines, the development of socially interactive robots is regarded as a supreme discipline in the industry. The instrumental models are designed to perform certain services, such as in selling, as personal companions in museums or for serving meals. The affective types, however are designed to form an emotional bond with their users. According to experts, demand for their use in nursing, therapy and support care will be mainly for mixed forms which combine instrumental uses with affective functions. Nevertheless, the widespread use of such devices could well still be a long way off. Globally, there are a hundred or so ongoing research projects on android robots; but in the near future autonomous, socially interactive systems may not yet be realised, and it is currently difficult to predict whether such devices would actually be useful and affordable.
2 Stress test for robots

Healthcare is a sector of activity that is full of pitfalls: there is friction between the numerous interest groups, and developments in different areas often result in conflicting aims that are difficult to reconcile with each other. The study by TA-SWISS explores the issues in robotics that are important politically, economically, socially, technologically, ecologically and legally for nursing and support care.

When politicians talk about the healthcare system, there is inevitably a call for cost-effective management and savings. The steady rise in sickness insurance premiums guarantees repeated headlines every year, and numerous health policy measures such as the introduction of flat rate payments (diagnosis related groups, DRG) or savings on medications and laboratory diagnoses should help to prevent costs from getting completely out of hand. The new hospital funding with DRG could lead to healthcare provision being increasingly switched from hospital to outpatient care at home. As a result, telepresence robots and robot assistants could take on greater significance. In this case, the State has the opportunity to promote certain fields of research and control the type of devices being developed.

Steadily rising costs and staff shortages shape the healthcare market

Healthcare is a rapidly growing market; at all events costs are currently increasing by between 2.7 and 3.4 per cent, more sharply than GDP, which rose by 1.9 per cent in 2011.

But at the same time hospitals and nursing homes do not have the capacity to satisfy the foreseeable demand: the Swiss Health Observatory OBSAN forecasts that by the year 2020 there will be a need for about 17 500 extra nurses to look after the residents of old people’s homes and nursing homes. A further 5000 additional staff will be required for outpatient care. Moreover, some 60 000 healthcare specialists will go into retirement during this period; they too will have to be replaced.

From today’s point of view it seems questionable whether this will succeed. With its restrictive admission to medical studies, Switzerland itself is training far too few doctors to meet its needs. It is also foreseeable that the migration of physicians and nurses from abroad will soon fall sharply, because surrounding countries – Germany in particular – are also experiencing a shortage of healthcare professionals. The Swiss Federal Council therefore feels that there is no guarantee that the present standard of care will be maintained in the future. The shortage of specialists on the one hand and the increase in people requiring nursing care on the other are opening up the potential for the increased use of technical support systems.

A culture shaped by devices and gadgets

The proportion of older people has been steadily rising in Switzerland since 1980. At the same time there has been a change in the predominant perception of old age held by society, and the understanding of healthcare is also changing. Today, being healthy means staying fit, attractive and able-bodied until the evening of one’s life, and beyond that to be well settled within a circle of friends.

Senior citizens are therefore also increasingly resorting to electronic media – firstly to keep themselves up to date, and secondly to maintain contact with their friends; a study carried out in the USA in 2012 found that «silver surfers» over 50 years of age are currently the fastest growing group on Facebook, and many networks such as www.espaces50pluslaval.com and www.bestage24.de which are aimed specifically at more mature users have been set up. The technical infrastructure for Web-based activities is available in Switzerland: more than three-quarters of households in this country have an Internet connection.

Furthermore, more and more user-friendly small devices are available for everyday tasks. In-car navigation systems are already standard for mid-range saloon cars, and the first robots are being used in private households for cleaning work and grass mowing. The baby boomer generation, which is used to many different technical aids, is hardly likely to balk at using technical assistance systems in nursing as well. In fact, it is precisely the «elderly of the future» who might appreciate the advantages that robots offer to be able to live for longer independently in their own homes and to enjoy a social life despite any possible handicaps – thanks either to a smart wheelchair or a telepresence assistant with virtual links to maintain contact with therapists and friends.

Energy shortages as barriers to robots

Higher electricity costs could slow down the deployment of robots. The federal government’s new energy strategy is in any case increasingly looking to regenerative forms of energy, which could lead to rising prices.

Ammunition for skirmishes by the lawyers of the future

The jurisdiction has so far hardly been confronted by the deployment of semi-automatic or independent robots in healthcare. The industry is nevertheless aware that automats can be implicated in serious accidents that have fatal consequences for human beings.
From a legal viewpoint, questions of liability, data protection and other patients’ rights could therefore certainly be subjects for discussion. The RobotRecht Research Centre at the University of Würzburg is already investigating the need for new regulations. Consideration is being given there to granting highly developed and independently operating robots legal entity status. Manufacturers, programmers and users would pay into an account as a provision for losses or damage caused by robots.

**The PESTEL Analysis**

As part of the study by TA-SWISS, robots used in the healthcare sector were subjected to a PESTEL analysis. The acronym PESTEL is the name given to an investigation whose aim it to help companies or organisations to orient themselves strategically in their environment; other synonyms used are the terms «eco-analysis» or «macro-trends analysis». This involves looking at key trends in politics, economics, society, technology, environment and law. The PESTEL analysis is also a good foundation for exploring the opportunities and risks for organisations.

**Structure of the study**

- **Current state analysis**
  Analysis of the literature: current developments, prototypes, use in practice

- **Eco analysis**
  PESTEL analysis: investigation of macro-trends

- **Analysis of requirements**
  Survey of actors using focus groups

- **Evaluation**
  Survey of experts: feasibility (technology), viability (economy), desirability and justifiability (ethics, law, socio-culture)

- **Scenario creation**

- **Recommendations**
3 High expectations, sceptical estimations

The use of robots touches different circles of users. Hospital managers, lawyers, physicians, nurses and, not least, patients all have different perspectives on mechanical service and care aids. Their reactions to the devices are correspondingly contradictory.

Staff shortages in the healthcare sector is a strong argument for using robots. There is nevertheless some dispute: while experts in economics and technology think that in view of the nursing crisis resorting to mechanical support is unavoidable, legal experts, social scientists and patients’ representatives are advocating other solutions, because they are unwilling to sacrifice interpersonal contact to machines. Nurses also fear that pressure on costs could incite hospital managers to deploy robots as a rationalisation measure to save staff.

Expensive dictate of fashion

Robots and autonomous devices can help to structure workflows more effectively and supplement the human workforce. If they are used to relieve staff from heavy jobs – such as lifting patients – they are also well received by nurses. Those are not, however, the only reasons that can persuade a clinic to acquire a machine. The example of the now established surgical robots (which were not covered by the study by TA-SWISS) shows that possessing a high-tech device is a matter of image for clinics: it is regarded as cool and progressive and suggests to patients that they are benefiting from cutting-edge treatment methods. Possibly in the robots’ favour is the fact that they could lead to the creation of new job profiles in medicine and that more men might take an interest in the nursing profession if it had more technical «gadgets».

As far as the impact of robots on costs is concerned, experts interviewed for the study (see box page 11) are agreed: mechanical support systems will not reduce healthcare costs. On the contrary: they are expensive to buy, the technology is developing rapidly and makes it tempting to replace machines and software prematurely. In the long term, therefore, robots and autonomous devices are more likely to increase healthcare costs.

Independence or reliance on technology?

Greater freedom of action and more independence are the two promises that win points for robots among patients. Patients are also hopeful not least for a stronger position in respect of therapists and nurses, in that as mature customers they will be able to lend more weight to their demand for self-determination. The view of non-professional actors who were interviewed is that the individual and practical benefits of technology are of prime importance. Some non-professional users can get very enthusiastic at the idea of being able to have their hair washed by a machine individually tuned to their preferences, whenever they want to. But this is a point of view that still does not go unchallenged: experts submit that personal hygiene is not just about cleanliness, but also about contact and attention. Many professional users therefore reject an ill-considered use of robots. In individual cases the decision is more about what is important for the person concerned, who must be free to choose.

It is being argued that training devices with playful applications or interactive robotic pets could liven up everyday life for elderly people. And telepresence robots could satisfy the need of senior citizens for entertainment and contact. In the words of one expert, they would thus act as a «digital umbilical cord against
Whether it is possible to ease the burden of nursing staff with robots in order to leave them more time for direct encounters with patients is hotly disputed among experts. They are only unanimous in their call for devices to be used purely as a supplement for human contact and in no way as a substitute.

Experts are worried that in their efforts to achieve greater independence patients might become dangerously dependent on machines. Malfunctions – for instance, in the case of a power failure – might have dramatic consequences if, for example the robot fails to dispense essential medications or gives the wrong dose, or no longer treats a fragile human being with the appropriate degree of care.

There is general agreement that patients and their relatives will inevitably take on more responsibility if nursing robots are used in their home. The gain in independence and freedom of action here is countered by the risk that the sophisticated machines might be too much for their users to cope with. Only if they are sufficiently well trained will they be capable of using the partly autonomous devices correctly. Experiences with the emergency wristband for elderly people show that problems often arise even in everyday use if a design is technically sophisticated, because technology must be appropriate to the needs and capabilities of those using it.

Technology that is made for its users

Many firms which are keen to tap into new markets are working on the development of robots; they are using their technical know-how and expanding it into a new field of activity. The car manufacturer Toyota is therefore developing a sort of wheelchair on two legs, which can also carry people upstairs.

The experts are agreed that researchers who are working on robots for the healthcare sector must keep their eye on the needs of users – and the demands of the various user groups are very different. The view of nursing and support care staff is that there must in particular be a guarantee that robots will not be used as a rationalisation measure, resulting in the loss of jobs. In the design process and in in-use evaluations consideration must also be given to which values a machine used for care is able to achieve (e.g. independence or assistance). And ultimately the decision is made in use whether it meets the needs of the person and is appropriate to the requirements of the situation.

Finally, it is also important to ensure that it is not only those patients who have the appropriate purchasing power who are able to enjoy the advantages of a device. Robots that have proved to be effective and practical would then have to be appropriated for basic care if they offer better care than traditional sources – with the ensuing cost-driving consequences.

Focus groups and experts workshop as a barometer of opinions

The wishes and views of affected groups were conveyed in two stages by the TA-SWISS study. Firstly discussions were held with three focus groups. These were composed of actors involved directly (i.e. physicians, therapists, nursing staff and patients) and indirectly (such as representatives of health insurance funds, engineers involved in robot development and healthcare management employees). The three focus groups each discussed the advantages and disadvantages of one of the three categories of robot «training machines and mobility aids», «telepresence robots and robot assistants» and «socially interactive robots». The members of the three focus groups based their discussions on the requirements that they would have for using nursing robots from their own particular perspective. Secondly, the project group formulated ten theses which referred to the economic, social, legal and ethical aspects of using robots and which were discussed with experts as part of a workshop.
It could be at least 15 years before robots that work largely independently are available on the market; and it is still hard to say whether these prototypes will actually be machines that can be used in healthcare. However, initial evaluations are available for the smart training devices and robot animals that already exist.

Japan is regarded as the country of origin for care robots. The Shinto belief that ascribes a soul to even inanimate objects suggests that a mechanical aid could also be shown sympathy. Moreover, people in the land of the rising sun are extremely tech-friendly, and know many myths which talk favourably of artificial servants. Studies on the effect of care robots have often been conducted in Japan. But a number of states in the USA have also assessed their experiences with telepresence robots and robot assistants. Switzerland has a major presence in the market for the development of training robots.

Training robots cannot replace therapists

Apart from the rehabilitation of patients, training robots such as the Lokomat, which was developed in Switzerland, are also used as a tool for evaluating medical treatments. In fact, one of the advantages of training robots is that they reliably measure and document the progress of treatments.

With regard to training for the arms, several studies show that rehab-robots have a positive effect on the extent of movement, muscle strength and coordination. They are also ideal for increasing training intensity. Nevertheless, analyses show that it requires the support of therapists for patients to be able to transfer to everyday activities the skills they were trained in by robots.

In the case of training devices for the legs, however, evaluations were unable to identify any advantages in comparison with conventional training. Those studies which document the positive effects tested a combination of robotic and conventional training. One negative aspect is the high cost of rehab-robots – not least because the devices have to be regularly serviced. And of course they lack the perception skills of the experienced therapist.

With regard to smaller aids which can be used at home, the evaluation is equally ambivalent. Most of them only exist as prototypes, so that the cost-benefit ratio is difficult to estimate at present. Because the market for them is fairly small, their manufacturing costs and therefore their price could be high. So unless the purchase of smart mobility aids is supported by subsidies, they will only be affordable for a narrow customer segment. Moreover, people with disabilities want devices that are practical but as discreet as possible, so as not to draw too much attention to themselves in everyday situations. At present, smart walking and gripping aids barely fulfil this requirement either.

More efficient consultations thanks to telepresence

Telepresence robots connected to the Internet serve as a means of communication between a person in need of nursing care at home or in a clinic and the therapist at his practice. In the USA the initial experiences with telepresence robots are positive, especially because it is due to them that smaller hospitals are able to alleviate the prevailing shortage of specialists. It is possible for a specialist to be present in several clinics at the same time and give consultations via telepresence. With the TeleStroke robot, for instance,
the neurologist can determine whether a patient has suffered a stroke and immediately initiate emergency procedures. And thanks also to telecare a nurse is able to look after eight times more patients at the same time than is possible with traditional home visits. In both the USA and Europe however, telepresence in nursing care and treatment is still little used because the pay is relatively low, the work is regarded as not very attractive, and the technology has to some extent not been well accepted.

Evaluations of telepresence robots and robot assistants carried out up to now paint a predominantly positive picture of mechanical and digital aids. There is no mention of risks such as misunderstandings in communications between patients and therapists. The carers themselves however are unwilling to simply endorse the approving verdict of the evaluators; they fear that robots could make workflows even more ponderous, create the need for extra training and increase the possibility of error. Important data are lost if there is no direct contact with the patient and the overall situation cannot be perceived fully. Reservations about telepresence or service robots that are remotely controlled are fewer than is the case with machines which act independently and are fitted with artificial intelligence.

Service robots that are used in private households gather a vast amount of data. They measure the bodily functions of their patients, but at the same time register numerous data from the surroundings with the camera that they need for spatial orientation and with the microphones with which they capture acoustic signals. They even record what the people entering and leaving the house do, whom the patients are visited by and the conversations they have; the mechanical server could therefore very quickly mutate into an omniscient monitoring system. Bioethicists and data protectionists also stress that the continuous recording of data must be kept to a minimum and that users should be given the opportunity to escape from monitoring at least some of the time.

As well as detailing all the criticism, the investigations also hint at which precautions should be set up in order to win both healthcare staff and patients over to mechanical aids. Tasks and responsibilities must therefore be clearly defined between robots and people, and their use must be integrated into the workflow. If the devices manage to exploit their strengths in terms of precision and low error rates, acceptance by hospital staff could increase substantially. From the patients’ point of view it is important that robots are used to supplement rather than replace human attention. For patients to accept telepresence, they must also have got to know the people they relate to personally beforehand. All in all however, studies reveal that the advantages of telepresence robots and robot assistants are still not sufficiently obvious or conclusive to convince potential users of their benefits.

The ethical pitfalls of socially interactive robots

Robots which act independently and are socially interactive are still a long way off as far as everyday use is concerned. They divide the experts: while engineers and researchers of artificial intelligence foresee a great many potential uses for robots which are socially interactive and therefore capable of learning, social scientists tend to reject such devices. Machines that enable communication between people attract not as much harsh criticism than do robots which interact with human beings as «equals». One reason sceptics give to justify their disapproval is that when people encounter others like themselves they sense feelings and therefore a bond with the community. Because of their purely technical nature robots are incapable of stimulating such an exchange.

The first experiences with robotic pets have already been collected from the treatment of autistic children and from the care of elderly people. A study of robotic dolls showed that they animate autistic youngsters to make contact with other people – for instance to draw attention to the mechanical creature. Robotic pets have a calming effect on elderly people; at least a number of studies demonstrate such an effect. Compared to a soft toy cat, however, the robotic cat has proved rather less effective: although they were able to capture the attention of people with dementia whose capabilities had not declined so severely for longer than soft toy cats, the latter encouraged patients to cuddle them: 78 per cent of test subjects picked them up in their arms, while the figure for ro-
botic cats was only 22 per cent. Paro the robotic seal is also a success. According to various studies the purring seal has a calming effect on dementia patients and improves their mood.

Ethicists however regard it as questionable if dementia patients are distracted by soft cuddly animals and robotic pets or dolls. After all, these are ultimately vulnerable people who might only be forming a bond with the robot because they have no other choice and see the machine as a living thing. It may also harm the dignity of elderly people if they behave in a child-like way with soft toys or robotic pets instead of being integrated into a human community.
Even someone who does nothing is taking a stance. If politics restricts itself to a reactive stance, market forces alone will shape the development of robotics in healthcare. A proactive strategy, however, would mean at least setting guidelines to prevent mechanical assistants going astray. The proactive control approach would take steps to ensure that machines are developed which will provide as broad a benefit to society as possible and take the needs of their users into account.

Sometimes it takes just a few seconds to turn a life upside down. At any event, no-one would ever have imagined that an experienced old horse could be panicked by a fluttering plastic bag. Unfortunately this caused his hindquarters to slip on the asphalt, to fall – and to bury Nadine, his rider, under him. It took three years of rehabilitation before she was able to return home in a wheelchair. The fifteen-year-old is paralysed from the neck down, but still has a little selective movement in her right arm. She is therefore able to use her thumb and index finger to activate the small lever which steers the electric wheelchair and the gripping arm mounted on it. With the auxiliary arm – Nadine has named it her «tiny frozen hand» – the teenager manages to clean her teeth and eat her meals. But it also helps her when she uses the PC, to take part in lessons or to chat with her friends. Nadine goes to school by herself, or rather she drives using her smart wheelchair. It is proficient in speech recognition, and finds its way using its navigation system; Nadine simply needs to tell it where she would like to go.

The study by TA-SWISS sets out three scenarios designed to illustrate the future use of robotics. These images of the future differ from each other in the way politics influence the development of robotics in healthcare. One of these scenarios takes up the short story of Nadine recounted above: it depicts the effects that politics taking a proactive control approach would have in the everyday lives of users of care robots and robot assistants.

**Promote and debate**

The proactive control scenario is not limited to measures aimed at defending against risks which could be linked with robots. It is actually based on a range of further guidelines and controls. Let’s look into the future:

To prevent technical possibilities alone from driving the development of robots, the public sector selectively promotes schemes that are oriented to the needs of society and potential robot users. Interdisciplinary research between engineers, healthcare scientists, humanities scholars and social scientists is selectively promoted, and a National Research Programme ensures that the subject will continue to be debated over the longer term.
Because more and more people live in urban single households, anonymity is increasing. Also, encounters are increasingly transferring to the virtual space of the Internet. Robots and autonomous devices also increase the danger that real contacts will decrease even more and that the impact of telepresence, which is ever more frequently replacing visits to the sick, is going in the same direction. As a counter-reaction, numerous campaigns are therefore being developed to create neighbourhood helps, and guidelines for support care and nursing are also counteracting the isolation of people requiring care and support.

To guarantee the safety of devices, the State has paid particular attention to autonomous robotics for the healthcare sector in licensing procedures and test standards. In principle, these are comparable with those that other medical products have to comply with. In addition, questions of liability law have been clarified and strict data protection regulations issued. Ethical guidelines contain clear statements on freedom of decision, fair access and the protection of people who are unable to give their informed consent. Health Technology Assessment is used to investigate which devices are effective, practical and economical and will be financed.

**Useful, affordable, successful**

The bundle of measures from proactive control politics is leading to the spread of useful and economical devices. Because research is selectively promoted and people affected are included in development projects, machines for small user groups with special needs are also being created.

The well informed public recognises the benefits of mechanical support and is learning to appreciate it.

However, cost increases in the healthcare sector continue apace, because technical progress also means increased demands from patients. To guarantee fair access, devices whose effectiveness has been proved are being covered by basic insurance policies. Ration-alisation effects seldom occur, but there is a substantial improvement in the efficiency of logistics and data management.

**Shaping the future**

Unlike the proactive control scenario, the proactive scenario is limited to adopting standards covering the safety of devices and to using legal and ethical guidelines to prevent the most serious aberrations which could result from the use of robotics in healthcare. The reactive scenario on the other hand follows the prevailing trends: in this case robots compensate for the shortage of staff in the healthcare sector, and it is recognised that devices are occasionally developed that lose sight of the needs of users. There is no guarantee of fair access, so that robots ultimately reinforce the trend to the multi-class society: those who can afford to, buy a smart wheelchair so that they can visit friends, whereas people less well off must resign themselves to waiting for the virtual visit from their therapist on the flat screen. A policy that is not content to minimise risks of nursing and care robots but wants to realise all of their positive potential, will therefore choose a proactive control strategy.

**Scenarios as compressed images of the future**

The aim of the scenario technique is to present possible future developments and from these to identify causative links between determining influences. The scope of «possible futures» is typically defined by means of three scenarios: The basic scenario generally continues the current trends. The other images of the future are action scenarios which outline various possible developments. In the study by TA-SWISS the scenarios (details can be found [here](#)) also serve as a basis for three personalised stories which illustrate how the particular scenario manifests itself in the everyday lives of people who use robotics.
Study «Robotics in support care and healthcare»

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New technology often leads to decisive improvements in the quality of our lives. At the same time, however, it involves new types of risks whose consequences are not always predictable. The Centre for Technology Assessment TA-SWISS examines the potential advantages and risks of new technological developments in the fields of life sciences and medicine, information society, nanotechnologies as well as mobility, energy and climate. The studies carried out by the Centre are aimed at the decision-making bodies in politics and the economy, as well as at the general public. In addition, TA-SWISS promotes the exchange of information and opinions between specialists in science, economics and politics and the public at large through participatory processes, e.g. PubliForums and publifocus. Studies conducted and commissioned by the Centre are aimed at providing objective, independent, and broad-based information on the advantages and risks of new technologies. To this purpose the studies are conducted in collaboration with groups comprised of experts in the relevant fields. The professional expertise of the supervisory groups covers a broad range of aspects of the issue under study.

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