



Acceptance of service and care robots from the nursing perspective

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Abstract:

To counteract the nursing shortage in Germany, approaches other than more nursing and junior staff are needed. One possibility is the use of service and care robots. These can be used, among other things, to assist with physically difficult work, to reduce walking distances, to carry out logistical tasks and to care for patients. The use of these robots requires the willingness of both the patients and the nursing staff. This contribution addresses the extent to which nursing and service robots are accepted and desired from the point of view of nursing staff. Therefore, 34 nursing staff members of a rehabilitation clinic provided information about their current willingness to accept five presented service and nursing robots. The results showed that the service robots, which take over walking and logistical tasks, find almost unrestricted acceptance. However, in the case of social care robots, with direct, immediate contact with and to the patient, there are definitely moral and ethical concerns. Nevertheless, the use of these robots is also advocated by most nursing staff, as the potential for use is very high. Education, training and practical measures increase acceptance and can also ideally dispel ethical and moral concerns. For the future, a broader use of nursing and service robots could contribute to reducing physical strain and routine tasks and thus make the nursing profession as a whole more attractive.

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1 Introduction

In Germany, demographic change is leading to an increasing proportion of older people in the population with a rising average life expectancy. The age structure is continuously changing and leads to an increasing surplus of older cohorts. This development results in higher health care expenditures and an increased need for nursing staff (AOK 2022a). The future care situation is becoming an ever-greater challenge. In 2019, approximately 4.13 million people were in need of long-term care as defined by the Long-Term Care Insurance Act. By comparison, 10 years earlier, 2.34 million were considered to be in need of care (Statistisches Bundesamt 2022). The security and quality of care for elderly individuals, those in need of care and assistance, is increasingly becoming the focus of social attention (Hülsken-Giesler and Daxberger 2018).

This problem is exacerbated by the clearly noticeable shortage of skilled workers in health care facilities. Germany is not sufficiently prepared for demographic changes in the field of care. Often, nursing staff suffer from high workloads, both psychological and physical, which result in a very high level of illness in this sector. In addition, nursing staff complain about musculoskeletal disorders, which can mostly occur as a result of frequent mobilisation and transfer activities. These difficulties are only some of the reasons for the problematic recruitment of new nurses. It is estimated that there will be a shortage of approximately 450,000 professional nurses in 2050 (Boll-Westermann et al. 2019). One strategy to support carers in their work is the use of new technologies.

This contribution is primarily dedicated to autonomous systems - or colloquially, care robots, which are becoming increasingly important in the field of care (Hülsken-Giesler and Daxberger 2018). These can, for example, hand over objects close to hand, transfer or lift patients, offer infotainment or take over household, transport or cleaning tasks (Bendel 2020). So far, robots have only been used in research projects or on an experimental basis for limited periods of time (Carros 2019). In this contribution, we investigate the acceptance of care workers with regard to the use of care robots. We also examine the extent to which the new technologies of service and care robots truly provide support for nursing staff and how well known the topic is.

2 Background

Care robots assist human caregivers in dealing with those in need of care and help reduce walking distances. This includes bringing medication, handing drinks and food, assisting with lying down and sitting up the person in need of care, or alerting the emergency services. Subordinate to the term "service robot" are the "cleaning and transport robots" responsible for cleaning and transport tasks and "social robots" for activities of a social nature (Bendel 2020)

Mobile robot systems are becoming increasingly necessary to relieve the workload of specialist staff in healthcare facilities and to constantly improve their working conditions (Graf 2019). For use in dynamic environments, these systems increasingly offer the required flexibility. It is not only important that the robots have a high level of reliability and safety, their reaction to changes in the environment must also be adapted to human-like behaviour (Gruhler 2016). Via suitable algorithms, these autonomous systems can thus convert machine perception into machine action. This process enables the execution of tasks without direct human control (Hülsken-Giesler and Daxberger 2018).

Basically, robotics in healthcare is continuously expanding. There are various application areas within medical robotics. A broad distinction is made between surgical assistance, modular (therapeutic exoskeleton robots), service, social, mobile and autonomous robots (Intel 2021).

In this chapter, however, only service, social and care robots are considered and presented, in accordance with their predominant use in the care sector. These primarily support the nursing staff by performing everyday routine tasks or interacting with the patients. Logistical routine tasks are generally performed by service robots. These include cleaning tasks, replenishing medical supplies and transporting materials and laundry. The time that healthcare staff can save as a result could then be used for other important tasks with the patients (Honekamp et al. 2019).

Social robots, on the other hand, are in direct contact with patients. The tasks here lie primarily in the social interaction and monitoring of patients. By communicating with these robots, patients can also be kept alert and in a positive mood during their stay in a hospital or a nursing home. The workload of caregivers can be reduced, and the emotional well-being of patients can be strengthened (Intel 2021).

Physically demanding tasks, such as moving beds or lifting patients, can be performed by mobile robots and reduce the physical strain on healthcare workers. The five robots used within the study are explained in the next subsections. Among the nursing robots presented, 3 help the nursing staff with physical and organisational tasks, while 2 act as assistants directly with the patients and thus support the nursing staff in providing services.

Transport robot CASERO

The driverless transport vehicle "CASERO" was developed in the research project "WiMi-Care" in cooperation with the University of Duisburg-Essen, the Fraunhofer Institute IPA, the company MLR System GmbH and the company User Interface Design GmbH. "CASERO" is an autonomous robot that can independently transport

laundry, beverage crates or other materials. The order can be given by a caregiver via a touch screen on the robot (Luz et al. 2011).



Figure 1: The transport robot CASERO (Graf 2019)

Care robot RIBA-II

Scientists from the Japanese company RIKEN and TRI (Tokai Rubber Industries) developed a robot that can carry patients weighing up to 80 kg from bed to bed or lift them from bed to wheelchair and back. The product name of the care robot is RIBA-II (Robot for Interactive Body Assistance) (Guo 2011).



Figure 2: The care robot RIBA-II (Guo 2011)

The intelligent care trolley

Service robot solutions have been developed by the Fraunhofer Institute for Manufacturing Engineering and Automation to give staff more time and to relieve them physically. The researchers at this institute and other institutions have set the goal of providing nursing staff with support from a robot that automatically provides nursing utensils and document materials that have been removed. With the help of the MLR company, the "intelligent care trolley" could be realised. To distinguish the intelligent care trolley from driverless transport vehicles, the materials are brought to the front of the rooms, i.e., to the "point of care". In this way, unnecessary walking distances can be avoided or reduced (Schiller et al. 2019).



Figure 3: The intelligent care trolley (FraunhoferIPA 2018b)

Robotic service assistant

The robotic service assistant is also a project of the Fraunhofer Institute IPA with the aim of making people in need of care more independent and relieving nursing staff. While nursing staff are working on the wards, the robotic service assistant can offer patients drinks and snacks in common or dining rooms. This not only promotes patients' independence and regular hydration but also gives them a certain entertainment factor (Graf 2018).



Figure 4: The robotic service assistant (FraunhoferIPA 2018b)

Pepper

The French company Aldebaran Robotics SAS and the Japanese telecommunications and media group were significantly involved in the development of the humanoid robot "Pepper". This robot has many applications, including being used for entertainment, therapy or knowledge provision (Reis 2018). With a height of 1.2 metres, Pepper was modelled on the appearance of a child. Even the first impression, gestures, facial expressions and body posture can trigger empathy in the child as nonverbal communication (AOK 2022b).

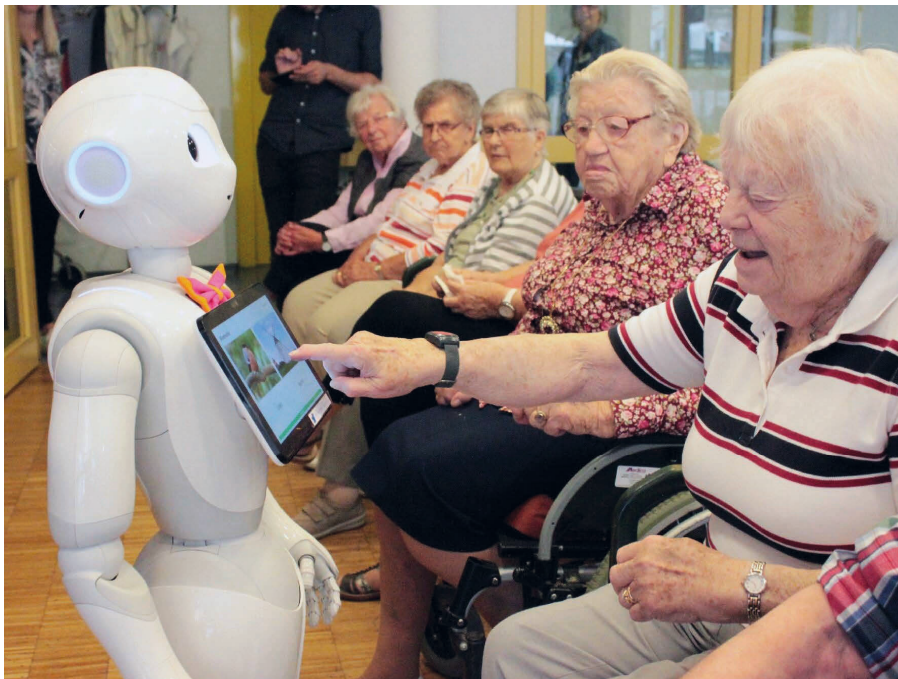


Figure 5: Pepper (AltenheimVideos 2019)

3 Methods

To narrow down the definitions of acceptance, the present study examines the acceptance of new technologies by nursing staff in a rehabilitation clinic. Technologies are understood here as the use of robots, especially care and service robots. In business acceptance research, acceptance can be divided into the following phases: preuse behaviour (attitude acceptance), the process of adoption decision (action acceptance), and actual medium- or long-term use (usage acceptance) (Dockweiler 2016).

This quantitative study uses five robots to investigate the attitudes of caregivers towards potential use. The presented care robots were described in detail in pictures and text and are also largely self-explanatory due to their direct reference to everyday work processes. It remains unclear to what extent the result moves the respondents to action. The measurement is done on the level of attitude and action, not on the level of acceptance of use. This is because by measuring acceptance, the influencing factors that lead to rejection or reinforce positive adoption of the innovation can be identified at the attitude and behavioural level. In this work, technology acceptance is understood as the positive attitude of the potential user towards the new technologies in care (Olbrecht 2010). In developing the questionnaire, we were guided by the Service User Technology Acceptability Questionnaire (SUTAQ) (Torbjørnsen et al. 2018). The Likert scale was chosen as the measurement instrument, and the questionnaire was designed and created using the survey tool Survio.

The questionnaire starts with an introductory text and gives a general overview of the topic. To obtain a more detailed overview of the extent to which care workers accept support from technology to relieve their daily work, five service and care robots were presented in separate question sections. For this purpose, the respective question section was preceded by a descriptive and illustrated summary of the robot in question. For a better illustration of the mode of operation of the robot in question, there was also the option to start a video via a link in each case. The arrangement of the questions was taken from the "Technology Acceptance Questionnaire". This is derived from the Technology Acceptance Model (TAM), which is widely used in the field of business informatics. It is one of the best known and most studied models for predicting the intention to use a technology (Gunnesch-Luca 2019). Here, questions are classified into three superordinate dimensions: the individual context, the technical context and the organisational context. In this work, the first dimension includes the individual context with general information about the person, the positive or negative perceptions about new technologies and the unbiased attitudes of the respondents towards service and care robots. In the second dimension, perceived benefit and user-friendliness meet the variable habits (Egger 2018). The question here is to what extent the user can integrate the robot presented in each case within their routine tasks. The

questions about the robots are adapted in the same way. The following aspects are examined: Accepting help, trust, emotional state, benefit, change in the work environment and relief. The following five answer options were given: "do not apply at all", "rather do not apply", "rather apply", "largely apply" and "completely apply".

The questions within the last dimension are indirectly related to the place of work. Here, if the organisational and technical conditions are present, the subjective wishes and possibilities for the use of robots are questioned. The evaluation of these questions can reveal a behavioural intention and determine whether, in addition to normative and practice-oriented factors, motivating convictions also favour the use of care robots. In the last question, a multiple choice can be made to determine the robot that has the most meaningful benefit for one's own needs. However, the compulsory question could also be answered with "none of the presented robots". For each robot, 8 identical questions were provided. A total of 51 questions were to be answered.

This survey could only be realised through cooperation with the Greifswald BDH Clinic. The BDH is a large German social association and sponsor of specialist clinics for neurological rehabilitation. Greifswald is the only BDH clinic that also has a centre for paraplegics. The clinic also specialises in intensive and acute medicine to be able to intervene as early as possible in the treatment and rehabilitation process (BDH Clinic Greifswald 2021). There are approximately 400 employees at the BDH Clinic Greifswald. Approximately 200 full-time and part-time nursing staff are employed here. At present, the clinic has 60 acute beds and 70 beds for rehabilitation. These are divided into 5 wards and the day clinic. A further subdivision is made between the intensive care ward, the neurological ward and the paraplegic ward.

The online survey was conducted from 02.05.2022 to 17.06.2022 and could be accessed via the in-house intranet of the BDH clinic. Out of approx. 200 employees in the nursing area, 34 (17%), completed the questionnaire. All questionnaires were answered completely and could therefore be included in the survey. Thus, a net response rate of only 17% and a completion rate of 100% can be assumed. The data were collected and visualised via the survey tool Survio. The survey was conducted anonymously so that no personal data and the related answers could be determined.

The sample was largely made up of 30- to 50-year-olds (N=19), who made up more than half of the total sample (55.9%). With 20.6% each and 7 absolute statements each, the age groups "20 to 30" and "over 50" are of equal size. Only one person stated that they were under 20. More female (N=19) than male participants (N=13) took part in the survey. Two of the respondents did not identify with either the male or female gender and indicated diverse as their gender.

When asked in which department the respondents worked, 33 responses were counted. Therefore, 23 of the persons stated that they worked in the neurology department, while 15 participants chose the cross-sectional department as their area of

work. Five persons work in both neurology and the cross-sectional ward, which is why they chose both specialties when answering. Most of the participants in the study stated that they suffered from physical complaints as a result of their job as a nurse, occasionally (44.1%), frequently (35.2%) or always (14.7%).

4 Results

The nurses answered some questions about "general attitude towards new technologies" at the beginning of the survey to see if this had an influence on their answers to the subsequent questions about robots.

The following two questions examined attitudes towards technical devices and aids. In response to the statement that technical devices and aids would be helpful in the workplace, 14 persons (41.1%) answered "strongly agree", and 7 persons (20.6%) said "strongly agree". This majority corresponds to a share of 61.7%. In addition, almost 30% of the respondents (N=10) felt that the statement was rather true. Only three people felt that technical devices and aids were rather not helpful or not helpful at all at the workplace. (8.8%)

A similarly significant opinion is formed with the question of whether technical aids make the work more complicated. Here, 22 nurses vote for "rather not true" and 6 vote for "not true at all", representing the majority of the sample with 82.3%. For the remaining 6 persons, technical devices tend to make the work more complicated: "rather agree" (N=3), "strongly agree" (N=2) and "strongly agree".

In the following overview, the diagrams for three questions were combined. First, it was asked whether the topic of care and service robots is known. Then, it was investigated which basic attitude the care workers have towards care and service robots and whether they could imagine working with them.

Six people (17.6%) stated that they had never heard of care and service robots. The largest proportion answered with "rather not applicable" (N=13, 38.2%). Seven nurses each stated that they had already dealt with this topic or had become aware of it. Only one person feels completely familiar with this topic. Despite the rather low level of awareness of care and service robots, a majority is positive about their use in the workplace. Thus, (N=12) nursing staff stated that they were substantially positive about an introduction and (N=4) were completely behind it. (47%) Almost 30% of the respondents answered "rather agree" and thus tend to be in favour of the use of care and service robots in their company. Six people (17.6%) were not positive about the introduction, and two of the nursing staff decided against the introduction of nursing and service robots (5.8%).

Although the majority has not yet become aware of care and service robots, 6 people (17.6%) can certainly imagine a future cooperation. Furthermore, 11 nursing professionals strongly agreed (32.4%), and 8 persons answered "rather agree" (23.5%) that they would work with nursing and service robots in the future. This contrasts with 7 care workers who cannot truly imagine working together and two people who reject this intention. (26.5%)

RIBA-II

With regard to the RIBA-II nursing robot, the first three questions refer to the emotional view of the nursing staff. The use of the RIBA-II in the mobilisation and movement of patients was completely trusted by 2 caregivers and substantially trusted by an additional 8 caregivers (29.4% in total). A further 9 people (26.5%) tended to have positive confidence. However, an equal number of nurses (26.5%) said the RIBA-II would make them feel uncomfortable, and an additional 17.6% would answer the confidence question in the negative.

Furthermore, the care robot triggered complete discomfort for four people (11.7%). Six caregivers each stated that the RIBA-II does not release any unpleasant feelings at all, while the others answered "rather true" (N=12, 35.3%). The remaining 10 respondents (29.4%) stated that the statement was not true. The extent to which the nursing robot positively influences the working environment of the nursing staff is shown in Figure 12 on the right. The two extremes are equal, i.e., 3 people each stated that the presence and use of RIBA-II positively or not at all positively influences their working environment. (N=6, 17.6%) While in 9 people (26.4%), essentially a good feeling is triggered should the robot be used, 12 people (35.3%) agree that the robot will not have a positive influence on the working environment. The remaining 7 care professionals answered "rather agree".

With regard to the increasing physical strain on a nurse, the following questions can be used to determine whether the RIBA-II can help here. A large part of the respondents would rather reject the help of the robot in mobilising patients. (Total=13) In contrast, there are 13 persons who would accept the help immediately (20.5%) or are essentially not averse to its use in the workplace (17.6%). The decision of the nurses whether RIBA-II can be a good addition to their regular work routine is very balanced with a slight overhang of the positive view. Five nurses (14.7%) clearly viewed the RIBA-II as an addition to their regular work routine. Another 16 people (47%) could more or less imagine the care robot as a good addition to their daily work routine, while a total of 13 care workers (38.2%) did not see the RIBA-II as a good addition.

It should be further examined whether the nursing staff would use the technology and whether it would relieve them in their work. Regarding the results of this survey, it is clear that the RIBA-II nursing robot would not necessarily be used in every situation that comes into question. More than half (N=19, 55.9%) would not use the robot to

mobilise patients. However, 12 nurses (35.3%) could more or less imagine using the RIBA-II. Three of the respondents would use the technology in any situation to avoid physical exertion. The last question brings together very different opinions. On the one hand, 41.2% of the caregivers (N=14) vote against a possible relief by the care robot; on the other hand, 47% can essentially imagine support with the help of the robot. The remaining part decided to "rather agree" (11.8%).

CASERO

Here, too, the same aspects are examined and evaluated. The trust in CASERO with regard to carrying out transport tasks for laundry or beverage crates is rated very high. Significantly more agreed that they could rely on CASERO for their activities (73.5 %). "Fairly true" was stated by 6 people (17.6%). The remaining three respondents (8.9%) had no confidence in the transport robot.

The majority of the nursing staff (N=30, 88.2%) did not experience any unpleasant feelings when they thought about the use of CASERO. The answers showed that the presence and use of this robot would essentially have a positive influence on the working environment for 21 people (61.7%). Only 4 respondents (11.7%) of the survey would experience unpleasant emotions, and 6 of the respondents (17.6%) stated that their working environment would not change positively if the transport robot was used. The remaining 20.5% (N=7) of caregivers answered "strongly agree" to the possible positive impact on the work environment.

Regarding the robot's tasks, 76.4% of the participating nursing staff (N=26) would accept the help. Three of the respondents would reject it, and 5 persons stated "rather agree" (23.5%). For 64.7% of the caregivers (N=22), CASERO would be a good addition to their regular routine at work. Exclusively, 6 people (17.6%) did not find the robot helpful, while another 6 people (17.6%) did not exclude the statement. Regarding the use of the transport robot, 21 care professionals (61.7%) answered that they would largely use CASERO in eligible situations. On the other hand, five persons stated that they would rather not use the robot, and one person would not want to use it at all (17.6%). The answers showed that the use of the transport robot would relieve 14 people considerably and 8 people completely (64.7%). A few (N=4) are absolutely against it, and the remaining four claim that the use of the robot would not reduce the workload (23.5%).

Intelligent care trolley

The majority of respondents (N=31) said that they would trust the intelligent care trolley to transport care items. (91.1%) However, three people decided against it. They could not rely on the machine (8.8%).

The majority of the participating caregivers (N=27, 79.4%) shared that the service robot does not trigger any unpleasant feelings in them. Nevertheless, the remaining respondents (N=7, 20.5%) would already feel rather negative emotions when thinking about the use of the intelligent service trolley. The results of the following statement also form a majority in the positive sense in favour of the robot. In detail, 17 caregivers (50%) essentially voted that the service robot would positively influence their personal work environment. Another 14.7% would completely agree with this statement (N=5). However, five people also stated that the intelligent care trolley would have no influence at all on their working environment.

The survey showed that 61.7% of the participants would accept help from the intelligent care trolley (N=23). Seven people can imagine that they would allow assistance from the service robot. Only 4 care professionals refused the services of the service cart (11.7%). A similar number of survey participants (N=7, 20.5%) thought that the robot would rather not be a good addition to their work routine. However, a larger portion (N=22, 64.7%) of the respondents could imagine the nursing trolley as a competent addition to their daily work routine. The robot promises to save time and travel for the nursing staff, which is why the evaluation on the topic of "relief" shows a corresponding result. A total of 91.1% (N=31) stated that this service robot could reduce their workload. The following frequencies were evaluated: "totally agree" (N=10), "strongly agree" (N=15) and "rather agree" (N=6). In addition, however, the question about the benefit is somewhat contradictory. Here, 19 people stated that they would want to use the trolley in every situation that came into question. However, 9 people said that the service trolley did not relieve their daily workload.

Robotic service assistant

Trust in the robotic service assistant is fairly balanced. In each case, 35.3% (N=12) either said they could not trust the robot or they could. A solid midfield is formed by those who chose "rather agree" (N=10).

For the respondents (N=15), the machine beverage delivery service does not trigger any unpleasant feelings (44.1%). Seven participants stated that the use of the service robot could cause bad feelings for them. In addition, the caregivers (N=14) thought that the presence and use of the robotic service assistant had no positive effect on their personal work environment. In contrast, 8 people assume that this robot would be positive for their work environment. Most votes were cast for "rather agree" (N=12).

No clear result emerges from the survey data here. On the one hand, twelve people would accept help from the service robot, while the other twelve would tend to disagree. The remaining 10 participants stated "rather agree" and would accept this help. Approximately half of the caregivers surveyed (N=16, 47%) would not consider the

service robot a good addition to the work routine. Ten people could imagine the talking machine as a support in the distribution of drinks. However, only 8 people (23.5%) would use it in every situation considered. A total of 32.3% of the respondents were in the midfield with a willingness to use the service assistant. The remaining 44.1% would decide to use the service assistant rarely or not at all. Finally, 19 people stated that the robot would not relieve them at work (55.8%). Only 7 nursing professionals who participated in the survey answered that the robotic service assistant can provide support at work.

Pepper

From the results of the question of whether caregivers trust Pepper when dealing with patients, it can be seen that 82.3% would rely sufficiently or completely on the social robot. Only 6 people stated that they did not find Pepper trustworthy.

The survey results show a clear majority (N=25) who are positive about their emotional response to the interactive entertainment robot. For two of the respondents, the robot causes complete discomfort, four people feel essentially the same and three people answered "rather agree". (26.5%) Pepper causes half of the participating caregivers (N=17) to feel that the working environment is improved by it. However, 9 people (26.5%) would not consider that this robot positively affects the working environment.

A total of 64.7% of the respondents intended to accept and embrace help from a social robot, such as Pepper. For 9 of the participants, assistance from Pepper is conceivable, and the remaining 3 would reject the assistance. Some caregivers (N=8) assumed that the social robot would not be easy to integrate into their ongoing routine. The much larger group, however, can definitely imagine using Pepper in their daily work. Whether the interactive entertainment robot can actually be used is a very diverse question. Ten people would rather not use Pepper, 10 caregivers would use it frequently and 6 others in every situation that comes into question. When asked whether Pepper is a relief at work, slightly more caregivers answered affirmatively (N=17). Six are not sure but would still vote in favour of robot use, and the remaining survey participants stated that the social robot does not provide any support.

Concluding questions

The majority (59%) assume that robots of any kind can relieve nursing staff in their work. Nevertheless, some (20%) would deny this statement, and others (21%) do not know where they stand on this.

Almost half (44.1%) of the respondents expressed no ethical or moral concerns when thinking about the use of care and service robots. However, six people (17.6%) questioned the introduction of care robots. Another part (N=13) answered with "rather

agree". The results of the survey showed that 58.8% of the participating nurses would undertake training, which would positively change their attitude towards robots. Furthermore, seven more nurses also tended to agree that a training session on the topic would have an impact on their attitude (20.5%).

The attitude of the rest (N=7) would not be positively influenced. A clear majority (N=25) stated that they can expect more advantages than disadvantages from the use of service and care robots (73.5%). Nine of the participants answered these statements negatively (73.5%).

The final question was to answer which of the robots mentioned would most likely be used by the nursing staff. Here, multiple selections could be made. Most of the persons (N=24, 70.59%) found the use of the intelligent nursing trolley on their ward to be good. CASERO would come in second place with 61.7% and would be a help at the workplace (N=21). For 3rd place, half of all participants stated that they could imagine using Pepper on their ward (N=17). In 4th place, with 13 votes each, RIBA-II and the robotic service assistant are less well received (38.2% each). That none of the nursing or service robots presented would come into question was the case for only 3 people (8.8%).

5 Discussion

The lifting robot RIBA-II had the worst result on the question of whether caregivers would trust the robot. Lifting robots are most closely related to humanoid robots, and one might expect that this would build a basis of trust. Nevertheless, the majority of respondents said that the RIBA-II would make them feel uncomfortable. This may be due to the size and heaviness, which allows movement only on wheels instead of legs (Bouwhuis 2016). The survey also showed that the robot would have a positive impact on the working environment for 55.9% of the participants. Here, a connection could be derived from the fact that 94% of the respondents experience physical discomfort from their work because one of the occupation-specific causes of back pain is transferring patients, for example, from bed to wheelchair or to the toilet (Frey et al. 2018). This assumption results in a rather high willingness to use the robot for mobilising patients. Only 15 people stated that they always use the robot. Presumably, the majority is against it because of the presumably time-consuming procedure of fetching the robot from another room, placing it in front of the patient's bed and only then being able to help him with lifting or transferring. This assumption is reflected in the results of the following statement. A total of 41.1% of the participants (N=14) stated that the RIBA-II would not be a relief for them in their work. The remaining 20 persons, possibly caregivers with frequent physical complaints, would see the use as a relief.

Confidence in the CASERO transport robot is rated very high by the respondents in this study. Thus, 31 of the 34 participants could rely on the robot for transporting

laundry, beverage crates, etc. Apparently, CASERO's machine-like appearance and the activity it takes over can cause less mistrust and concern because the service robot would only trigger unpleasant emotions in 8 people. Most of the respondents stated that the presence and use of CASERO could even improve their personal working environment. As the nursing profession is accompanied by an ever-growing shortage of skilled workers, considerable time pressure and increased workloads are no longer uncommon (Hanefeld, Hoppe and Matulenski 2018). The transport robot can possibly save time by taking over walking routes. Therefore, 91.1% would probably accept the help. Apparently, CASERO fulfils the desired and needed purpose because the majority of respondents would use it in any situation that comes into question. The usage effect is very high, which is why the transport robot is considered a good addition to the regular routine and a noticeable relief for most.

The nursing trolley as such is known to every nursing professional, which is why trust in the intelligent nursing trolley is considered to be very high. The majority do not experience any unpleasant feelings at the thought of the service robot. Since presence and use are also seen by most as having a positive influence on the working environment, it can be assumed that the provision of required care utensils directly on site is an enrichment. An increasingly burdensome task is the large number of documentation and administrative duties that steadily increase a caregiver's time pressure (Hanefeld, Hoppe, and Matulenski 2018). Most likely because of this, many would accept the help of the intelligent nursing trolley, as the robot can provide relief and take over some of the work through automated documentation and automated replenishment of necessary utensils (Graf et al. 2018). For 91.1% of the respondents, the service robot would represent a noticeable relief. The general acceptance is higher for this robot than for the other care and service robots presented. Only 9 people would not be able to use it at all times, presumably due to certain emergency situations in which a quick response is required and calling in the intelligent care trolley could take too much time.

The robotic service assistant is not evaluated as trustworthy by 35.2%, and the majority receive bad emotions from the robot. In addition, a significant proportion think that the service robot would not have a positive impact on the work environment. Perhaps this assumption stems from the fact that the robotic service assistant acts by voice function or because it is in direct contact with patients. There seems to be mistrust here. Nevertheless, some indicated that a positive impact on the work environment may be the result of the activities taken over, such as handing drinks to patients in common or dining rooms. Twenty-two people can imagine accepting and embracing the help of the service robot. The main focus here is on keeping patients hydrated, which is why the nursing staff would presumably be grateful for any help. Just over half of the respondents see the robot as an addition to their daily routine and would

also use it very often. In terms of potential relief, however, the majority of survey participants vote against the robotic service assistant. Possibly, the placement of the robot or the assistance to be provided during the ordering process is a reason for this (FraunhoferIPA 2018b).

From the results of the survey, 28 participants consider Pepper trustworthy, and it triggers unpleasant feelings in only one-third. Although the image of a robot is often distorted by the media, the majority of caregivers choose to trust the humanoid entertainment robot (Carros 2019). According to Carros, dehumanisation of care is one of the many fears of patients and caregivers regarding the introduction of humanoid robots. Nevertheless, Pepper can positively influence the work environment according to most of the participants interviewed here. One reason for the predominantly good criticism of the interactive robot could be that an example of the Pepper robot is being used by therapists at the BDH clinic as part of a research project. It is possible that the nursing staff already came into contact with the talking robot, which alleviated their scepticism. A total of 91.1% of the nursing staff surveyed recognised and accepted the help of the humanoid robot. For regular use, 70.5% would claim it. According to Bouwhuis, acceptance depends on perceived usefulness but also on preference for less human-like looks (Bouwhuis 2016). This assumption could not be proven with this sample because Pepper represents quite accepted support after the intelligent care cart and CASERO. The interactive entertainment robot is even seen as a relief by 67.6% of the respondents.

In the final question, which robot would be most likely to be imaginable for use on the nursing staff's ward, the majority opted for the intelligent nursing trolley (N=24). Possible backgrounds could be the reduction of manual documentation as well as the saving of various walking distances. Presumably, the function of locking and thus the safekeeping of particularly important utensils is another advantage that speaks in favour of the service cart (FraunhoferIPA 2018a). Proportionally not far away, the CASERO transport robot is placed with 21 votes. The time factor is becoming increasingly valuable in the nursing profession, and activities such as the transport of laundry, beverage crates or other things can be noticeably taken over by the support of this robot. The simple operation via the touchpad probably reinforces the choice of the nursing staff surveyed. However, it is also possible that the decision is based on the assumption that neither robot takes on tasks that directly affect the patient. Since the service and care robots "robotic service assistant", "Pepper" and "RIBA-II" are in direct contact with the care recipients and received a poorer rating, it can be assumed that robots that act socially are always met with reservations. For the other two service robots presented, trust was almost unrestricted. What is striking in this study, however, is that the entertainment robot Pepper still convinced half (N=17) to such an extent that they could imagine using it in their ward. Most likely, this is also related to the research project currently taking place at the BDH clinic (Sommer 2022).

Nurses in this sample are less receptive to robots for social and emotional support compared to robots for physical support and documentation. It is possible that nurses are sceptical of the use of social robots because the machines are in direct contact with the patient and trust is not highly valued. In part, nursing staff in a workshop in Hamburg commented that they were afraid robots would take over and monitor their work. Humanoid robots in particular were presented and discussed here (Carros 2019). The assumption that caregivers are hostile to social robots could not be confirmed. The majority would accept the help in any case, possibly because the critical situation in inpatient care is also one of the reasons for this.

All age groups tend to have a positive attitude and can for the most part imagine working together in the future. There were no significant differences between the younger and older age groups. Presumably, solutions to the problematic care situation are sought in the most urgent form by all age groups to curb the associated negative consequences of demographic change (Weber 2018). The majority of respondents would accept the offered support from robots. Most likely, coping with the current situation as well as the future challenge in a society of long life is reason enough to accept any help (Hülsken-Giesler and Wiemann 2015).

Attitudes towards new technologies

A large proportion of respondents have already dealt with the issue of care and service robots and are in favour of their use in the workplace. Within this group, approximately 1/3 of them tend to be in the positive midfield. This part of the group is more inclined towards the new technologies and not rejecting them. This tendency can be strengthened by additional education and training units. The vast majority of participants stated that such measures would positively influence their attitude towards care and service robots.

The vast majority of participants felt well trained in the use of new digital technology in everyday life. Nevertheless, 14 people only answered with a tendential agreement ("rather agree"). Given the average age (30-50 years) in this sample, this is an expected result. It can be assumed that this target group also uses modern, technical devices in their private lives. In the survey, the majority votes that technical devices are a help at work and do not make work more complicated. One reason for this could be that handling and dealing with new technologies is natural for this generation.

Caregivers who have no connection to the topic chosen here would also tend to reject its use in the workplace. It is possible that the term "robot" is a deterrent because many people imagine it to be an autonomous machine from the world of science fiction. This leads to fears such as total surveillance, a future domination of the machines or even the violation of human life (Habscheid et al. 2018).

There is a possibility that nurses from the cross-sectional department would prefer a lifting robot, while nurses from neurology would rather favour the social robot for patient entertainment and therapy. However, this assumption could be disproved. On the individual wards, both the intelligent nursing trolley and CASERO were rated as the most useful robots. The only difference between the two specialties is that the majority of nurses in the cross-sectional ward could also very well imagine using Pepper (66.6%) and RIBA-II (53.3%). In this specialty, technical solutions to reduce mental or physical stress are more likely to be advocated.

Ethical aspects

Robots in nursing are described as nonhuman systems that take over human activities by technical means. Due to the shortage of skilled workers, almost all nursing tasks are considered (Manzeschke 2019). In the future, a robot could take over the tasks of reminding a person to take their medication and to drink fluids, of helping a person in need of care to stand up, or of playing community games. Inevitably, ethical and moral questions also come to the fore as a result of interacting with humans (Kreis 2018). The handling of personal data, the human design of care relationships and the patient's self-determination are at the top of the list (Bendel 2018).

Under the structural conditions brought about by demographic change, caregivers move in a web of different perspectives and constant innovations that are not infrequently perceived as burdensome. In the course of the changing nursing profession, nurses have to fulfil new roles. This involves bridging the "gap" between advanced technology on the one hand and humanely designed care and treatment environments on the other (Remmers 2019). To make collaboration possible, caregivers must always be able to trust the machines on the one hand and not feel uncomfortable using them on the other hand. In this survey, it turns out that the lifting robot RIBA-II and the robotic service assistant cause the most discomfort among the nursing staff. According to Manzeschke, ethical and moral evaluations of robot types are less about their technical skills and more about their specific areas of application. A surgical robot to assist in the operating theatre is much more likely to be accepted than a nursing robot in hospital rooms or common areas. Furthermore, Manzeschke questions whether technical support by robots displaces human care. Since both low-rating service robots (RIBA-II, robotic service assistant) are in direct contact with the patient and use the catchment area of the nursing staff, there is a connection between Manzeschke's statement and the ratings of the surveyed nursing staff (Manzeschke 2019).

In general, 73.5% state that the presence and use of service and care robots bring them more advantages than disadvantages. This positive response is unexpected, as all the presented care robots have different functionalities and thus different architecture, so that none of the robots can perform all necessary or desired care activities (Bouwhuis

2016). Nevertheless, 73.5% of the respondents were able to derive more benefits from it for themselves, and this although just over half of the respondents even expressed ethical or moral concerns. Perhaps the hope for appropriate help and support for the workplace prevails.

The need for support in the nursing profession, as this work also shows, is enormous. The motivation of nursing staff to hand over part of their work to service and care robots is extraordinarily high. To make use of this potential, training courses, training units and research projects directly on site are a way to achieve ever greater acceptance. Here, the handling of robots can be learned, tried out and practised. In this way, the benefits, the savings effect or the relief for the nursing staff become increasingly noticeable. In the best case, ethical and moral concerns can also be dispelled through this own experience and thus built-up trust.

For the future, a broad use of robots could also increasingly lead to caregivers finding further areas and niches in which special technology is required or desirable. The use of robots also requires, among other things, a safeguarding of control mechanisms, legal regulations for the handling of patients and the clarification of questions of guilt in the case of errors. These aspects also have a high influence on psychological and moral concerns as well as on the acceptance of robots. In this work, however, the ethical aspect was only discussed in the immediate and interactive context between robot and nurse. However, this did not include a full ethical and moral discussion of the many facets of the relationship between humans and technology.

Limitations

The results of the present study are subject to some limitations. An online survey was launched on the intranet as a data collection method. Only a small collective (N=34) of participating nurses within the BDH clinic could be obtained. It is possible that some nurses did not start the survey due to lack of interest, time or motivation. Involving other institutions could have increased the participation rate, but convincing decision-makers is very time-consuming. Neither equipment nor financial means were available for an on-site presentation of the service and care robots.

6 Conclusions

It is already known that the care sector needs much more help to provide high-quality care in Germany. In addition to more care workers and more junior care workers, there is a need for extensive support from technical devices to make the profession more attractive and less physically and mentally demanding. The aim of this chapter was to investigate the extent to which nursing staff accept and approve of the use of service and nursing robots. In addition to the actual benefits, ethical and moral considerations were also important.

The results of the online survey showed that the purpose and place of use play an important role in the acceptance by the nursing staff. Thus, service robots that predominantly fulfil transport, logistics and provision services are perceived as useful and ethically and morally largely rated as unobjectionable. However, with regard to social robots with direct contact with the patient, there were considerably more emotional doubts. The assumption of interpersonal activities by robots, such as moving patients or handing them drinks, has a much higher acceptance threshold.

In the future, more research projects should be conducted on the topic of service and care robots to make future support more approachable and accessible to small institutions. In view of the results of the moral and ethical view as well as the general awareness of service and care robots, information and advertising campaigns, brochures or workshops could also play a part in raising awareness. It is very likely that after sufficient education and training sessions and direct exposure to service and care robots, understanding and acceptance would be much higher.

7 References

- AltenheimVideos (2019): Sieht so die Zukunft der Pflege aus? Ein Roboter im Pflegeheim. <https://www.youtube.com/watch?v=1WOL212IOMM> (June 1, 2022).
- AOK (2022a): Demografischer Wandel. https://aok-bv.de/lexikon/d/index_00282.html (June 1, 2022).
- AOK (2022b): Patientenkommunikation: Grundregeln, Smalltalk und Beschwerden. <https://www.aok.de/gp/praxispersonal/patientenkommunikation> (June 1, 2022).
- BDH-Klinik Greifswald (2021): BDH-Klinik Greifswald. https://de.wikipedia.org/wiki/BDH-Klinik_Greifswald (May 29, 2022).
- Bendel, O. (2018): Roboter im Gesundheitsbereich. In: *Pflegeroboter*. Springer Fachmedien Wiesbaden, pp. 195–212. https://doi.org/10.1007/978-3-658-22698-5_11 (June 1, 2022).
- Bendel, O. (2020): *Pflegeroboter*. Wirtschaftslexikon. <https://wirtschaftslexikon.gabler.de/definition/pflegeroboter-54138/version-378290> (June 1, 2022).
- Boll-Westermann, S. et al. (2019): Pflege und digitale Technik. ZQP-Report, pp. 10–14. <https://www.zqp.de/wp-content/uploads/ZQP-Report-Technik-Pflege.pdf>.
- Bouwhuis, D. G. (2016): Current use and possibilities of robots in care. *Gerontechnology*, 15(4), pp. 198–208. <https://doi.org/10.4017/gt.2016.15.4.003.00> (May 29, 2022).
- Carros, F. (2019): Roboter in der Pflege, ein Schreckgespenst? <https://dl.gi.de/bitstream/handle/20.500.12116/25218/588.pdf?sequence=1&isAllowed=y> (May 29, 2022).
- Dockweiler, C. (2016): Akzeptanz der Telemedizin. In: *eHealth in Deutschland*. https://doi.org/10.1007/978-3-662-49504-9_13 (June 1, 2022).

- Egger, J. (2018): Instrumente, Modelle und Theorien zur Erfassung der Akzeptanz von NutzerInnen neuer Technologien. Medizinische Universität Graz. https://online.medunigraz.at/mug_online/wbabs.getDocument?pThesisNr=54694&pAutorNr=79326&pOrgNR=1 (June 1, 2022).
- FraunhoferIPA (2018a): Forschungsprojekt »SeRoDi« präsentiert Abschlussergebnisse. https://www.ipa.fraunhofer.de/de/presse/presseinformationen/servicerobotik_fuer_die_pflege.html (June 23, 2022).
- FraunhoferIPA (2018b): SeRoDi – Servicerobotik zur Unterstützung bei personenbezogenen Dienstleistungen. <https://www.youtube.com/watch?v=d5bQnUu4oy8> (June 1, 2022).
- Frey, D. et al. (2018): Einflussfaktoren auf chronische Rückenschmerzen bei Pflegekräften in der Altenpflege in Rheinland-Pfalz. *Gesundheitswesen*, 80(2). <https://doi.org/10.1055/s-0043-104693> (June 1, 2022).
- Graf, B. et al. (2018): Entwicklung eines intelligenten Pflegewagens zur Unterstützung des Personals stationärer Pflegeeinrichtungen. In: *Digitale Transformation von Dienstleistungen im Gesundheitswesen IV*. https://doi.org/10.1007/978-3-658-13644-4_2 (June 1, 2022).
- Graf, B. (2018): Serviceroboter in stationären Pflegeeinrichtungen. https://www.ipa.fraunhofer.de/content/dam/ipa/de/documents/Kompetenzen/Roboter--und-Assistenzsysteme/Serviceroboter_stationaereEinrichtungen.pdf (June 1, 2022).
- Graf, B. (2019): Neue Servicerobotik-Lösungen für die stationäre Pflege. *Pflegezeitschrift*, 72(1–2). <https://doi.org/10.1007/s41906-018-0002-2> (June 1, 2022).
- Gruhler, M. (2016): *Flexible Navigation autonomer systeme in dynamischen Umgebungen*. Stuttgart. [https://www.ipa.fraunhofer.de/content/dam/ipa/de/documents/Kompetenzen/Roboter--und-Assistenzsysteme/300_303_Flexible Navigation autonomer Systeme in dynamischen Umgebungen.pdf](https://www.ipa.fraunhofer.de/content/dam/ipa/de/documents/Kompetenzen/Roboter--und-Assistenzsysteme/300_303_Flexible%20Navigation%20autonomer%20Systeme%20in%20dynamischen%20Umgebungen.pdf) (June 1, 2022).
- Gunnesch-Luca, G. (2019): Technologieakzeptanzmodell. <https://dorsch.hogrefe.com/stichwort/technologieakzeptanzmodell-technology-acceptance-model> (June 17, 2022).
- Guo, S. (2011): RIBA-II, the next generation care-giving robot. https://www.riken.jp/en/news_pubs/research_news/pr/2011/20110802_2/ (June 1, 2022).
- Habscheid, S. et al. (2018): Robotics and Emotions. *EuropeNow* [Preprint]. <https://www.europenowjournal.org/2018/07/01/robotics-and-emotion/>.
- Hanefeld, S., Hoppe, D. and Matulenski, S. (2018): Employer Branding und Neuorganisation: Wege aus dem Fachkräftemangel in der Pflege. *das Krankenhaus* [Preprint], (01). <https://www.mendeley.com/search/?page=1&query=Zeitmangel+pflege&sortBy=relevance> (June 1, 2022).

- Honekamp, I. et al. (2019): Akzeptanz von Pflegerobotern im Krankenhaus. TATuP - Zeitschrift für Technikfolgenabschätzung in Theorie und Praxis, 28(2), pp. 58–63. <https://doi.org/10.14512/tatup.28.2.s58> (June 1, 2022).
- Hülksen-Giesler, M. and Daxberger, S. (2018): Robotik in der Pflege aus pflegewissenschaftlicher Perspektive. In: Pflegeroboter. Springer Fachmedien Wiesbaden, pp. 125–139. https://doi.org/10.1007/978-3-658-22698-5_7 (June 1, 2022).
- Hülksen-Giesler, M. and Wiemann, B. (2015): Die Zukunft der Pflege – 2053“, TATuP - Zeitschrift für Technikfolgenabschätzung in Theorie und Praxis, 24(2). <https://doi.org/10.14512/tatup.24.2.46> (June 1, 2022).
- Intel (2021): Robotik im Gesundheitswesen: Die Zukunft von Robotern im Medizinbereich. <https://www.intel.de/content/www/de/de/healthcare-it/robotics-in-healthcare.html> (July 1, 2022).
- Kreis, J. (2018): Umsorgen, überwachen, unterhalten – sind Pflegeroboter ethisch vertretbar? In: Pflegeroboter. Wiesbaden: Springer Fachmedien Wiesbaden, pp. 212–216. https://doi.org/10.1007/978-3-658-22698-5_12 (June 1, 2022).
- Luz, J. et al. (2011): CASERO Szenarien für WiMi-Care Technische Herausforderungen. https://www.uni-due.de/imperia/md/content/wimi-care/wb__33_.pdf (June 1, 2022).
- Manzeschke, A. (2019): Roboter in der Pflege von Menschen, Maschinen und anderen hilfreichen Wesen. EthikJournal 1 no. 5, pp. 1–11. https://www.ethikjournal.de/fileadmin/user_upload/ethikjournal/Texte_Ausgabe_2019_1/Manzeschke_1.Nov_FINAL.pdf (June 1, 2022).
- Olbrecht, T. (2010): Akzeptanz von E-Learning - Eine Auseinandersetzung mit dem Technologieakzeptanzmodell zur Analyse individueller und sozialer Einflussfaktoren. Friedrich-Schiller-Universität Jena. <https://core.ac.uk/download/pdf/224757117.pdf> (June 1, 2022).
- Reis, M. (2018): Pepper in der Geschäftswelt? Welche Aufgaben trauen Sie dem humanoiden Roboter zu? <https://it-wegweiser.de/pepper-humanoide-roboter/> (July 10, 2022).
- Remmers, H. (2019): Pflege und Technik. Stand der Diskussion und zentrale ethische Fragen. Ethik in der Medizin 31(4). <https://doi.org/10.1007/s00481-019-00545-2> (June 1, 2022).
- Schiller, C. et al. (2019): Servicerobotik bei Personenbezogenen Dienstleistungen. Stuttgart. https://www.ipa.fraunhofer.de/content/dam/ipa/de/documents/Projekte/Forschungsprojekte/Abschlussbroschüre_Servicerobotik_in_der_Pflege.pdf (June 1, 2022).
- Sommer, R. (2022): Roboter Pepper soll bei Schlaganfall-Therapie helfen“, Nordkurier [Preprint]. <https://www.nordkurier.de/anklam/schlaganfall-therapie-mit-roboter-pepper-0848471506.html> (June 1, 2022).

- Statistisches Bundesamt (2022): Mehr Pflegebedürftige. <https://www.destatis.de/DE/Themen/Querschnitt/Demografischer-Wandel/Hintergruende-Auswirkungen/demografie-pflege.html> (June 3, 2022).
- Torbjørnsen, A. et al. (2018): The service user technology acceptability questionnaire: Psychometric evaluation of the Norwegian version. *JMIR Human Factors* 5(4). <https://doi.org/10.2196/10255> (June 1, 2022).
- Tropf, T. M. and Schenk, A. (2018): Pflege 4.0: Roboterassistenten statt Pflegenotstand? bitkom. <https://www.bitkom.org/Presse/Presseinformation/Pflege-40-Roboterassistenten-statt-Pflegenotstand.html> (June 24, 2022).