Routledge
Taylor & Francis Group

Journal of Technology in Human Services

ISSN: (Print) (Online) Journal homepage: https://www.tandfonline.com/loi/wths20

Caregivers' use of robots and their effect on work environment – a scoping review

Marcus Persson, David Redmalm & Clara Iversen

To cite this article: Marcus Persson, David Redmalm & Clara Iversen (2021): Caregivers' use of robots and their effect on work environment – a scoping review, Journal of Technology in Human Services, DOI: 10.1080/15228835.2021.2000554

To link to this article: https://doi.org/10.1080/15228835.2021.2000554

Published online: 11 Nov 2021.

JOURNAL OF TECHNOLOGY IN HUMAN SERVICES
https://doi.org/10.1080/15228835.2021.2000554

Caregivers' use of robots and their effect on work environment – a scoping review

Marcus Persson[a], David Redmalm[b] and Clara Iversen[c]

[a]Department of Behavioral Sciences and Learning, Division of Education and Sociology, Linköping University, Linköping, Sweden; [b]School of Health, Care, and Social Welfare, Division of Sociology, Mälardalen University, Västerås, Sweden; [c]Department of Sociology, Centre for Social Work, Uppsala University, Uppsala, Sweden

ABSTRACT

Despite the lively discussion on the pros and cons of using robots in health care, little is still known about how caregivers are affected when robots are introduced in their work environment. The present scoping review fills this research gap by mapping previous studies about the relation between robots in care and caregivers' working life. The paper is based on searches in four databases for peer-reviewed articles about robots in care settings, published 2000 to 2020. The 27 included papers were examined with the questions of 1) how robots are used by caregivers, and 2) how robots affect caregivers' work environment. The analysis shows that the use of robots can affect both the physical and the psychosocial work environment, in positive as well as in negative ways. Robots are used in care settings to reduce physical and mental demands of the caregivers, but they can, in fact, increase caregivers' workload. Thus, the review indicates that robots can improve the quality of work, but that they seldom work as a shortcut to increased efficiency or time effectiveness.

ARTICLE HISTORY
Received 29 January 2021
Accepted 27 October 2021

KEYWORDS
Robots; caregivers; working life; work environment; scoping review

Introduction

Research on robots in care settings has been criticized for being either technophobic or technophilic (Gleason, 2014; Nørskov, 2014): overly optimistic concerning the possibility of new technology, or pessimistic about the risk that robotization of care will entail adehumanization of patients (Lee, 2015). While some researchers (Sharkey, 2014; Vandemeulebroucke, Dierckx de Casterlé, & Gastmans, 2018) raise ethical questions regarding the risk that the introduction of robots in care settings may increase older people's social isolation, others (Lorenz, Freddolino, Comas-Herrera, Knapp, & Damant, 2019; Moyle et al., 2017; Petersen, Houston, Qin, Tague, & Studley, 2016) argue that robots can play social, assistive, or therapeutic

CONTACT Marcus Persson Marcus.persson@liu.se Department of Behavioral Sciences and Learning, Division of Education and Sociology, Linköping University, Linköping, Sweden.

roles by interacting with individuals who face difficulties in maintaining social relationships. The sole focus on the patient-robot relation contributes to this binary view on robots by excluding a key part of the relation: the caregiver. By reviewing the current knowledge state about the implications of robots for *caregivers'* working life we offer knowledge about an understudied area and provide a fuller picture of robots in care situations. The aim of this study is therefore to compile knowledge in previous research on how robots in care settings a) are used by caregivers, and b) affect caregivers' work environment.

Several reviews of the literature on robots in care settings have been published during the last decade, focused on patients' use of robots in connection to health and well-being (Bernabei et al., 2013; Kachouie, Sedighadeli, Khosla, & Chu, 2014; Mordoch, Osterreicher, Guse, Roger, & Thompson, 2013), patients' physical activity (McArthur, 2019), and caregivers' attitudes toward technology and robotic devices (Krägeloh, Bharatharaj, Sasthan Kutty, Nirmala, & Huang, 2019; Savela, Turja, & Oksanen, 2018). Some reviews have a broad take on the use of technology in elderly care (Frennert & Östlund, 2018), while others have a niched take on a specific type of robot, such as socially assistive humanoid or animal-like robots in care settings (Papadopoulos, Koulouglioti, & Ali, 2018). The study most relevant to our focus (Kangasniemi, Karki, Colley, & Voutilainen, 2019) provides a systematic review about nurses' use of robots and automated devices. However, the review focuses on findings that promote good work routines and health outcomes for the patients. By contrast, the current review offers a more nuanced understanding of the implication of robots for caregivers' work environment. The purpose of the article is to contribute with knowledge that can promote a healthy work environment and a sustainable working life. The qualitative scoping method enables us to categorize findings from previous studies, thereby offering a sound conceptual ground for research with an interest in the influence of robots in working life.

Working life and robotic care

Research about people's working life is a broad and interdisciplinary area, involving sociology, psychology, medical science, economics, and engineering. The common denominator is the interest in changes in work conditions and how these changes affect people and organizations, e.g., regarding qualifications, health, occupation, innovation, identity, social orientation, and culture (Håkansta, 2014; Karasek & Theorell, 1990). In this review, we focus on changes in the employees' work routines due to implementation of robotic devices, and potential consequences for the employees'

work environment – both in relation to physical and psychosocial work environment.

Nurses and care workers (including personal assistants and health care assistants[1]) are the most affected groups of healthcare professionals in regard to health, comfort and safety (Ribeiro, Serranheira, & Loureiro, 2017; Yasobant & Rajkumar, 2014). Because of the specificity of their work tasks and the long duration of tasks in care institutions, they are vulnerable to various occupational risk factors (Sorour, El-Maksoud, & Abd, 2012). Due to the physically demanding work, nurses and care workers are professions with the highest incidence of work-related back injuries (Nelson, Fragala, & Menzel, 2003). Authors report frequent physical injuries, for example neck, shoulder, arm, knee, and back injuries (Cameron, Armstrong-Stassen, Kane, & Moro, 2008; Gabrielle, Jackson, & Mannix, 2008).

Physical work-related risks often go hand in hand with psychosocial risks such as stress, anxiety, depression, and mental disorders (AFA Insurance, 2020; Woo, Ho, Tang, & Tam, 2020). Health care workers are consistently subjected to emotionally draining stressors in the provision of complex care and treatment to patients and are thereby exposed to the risk of occupational burnout (Gómez-Urquiza et al., 2016). Burnout occurs when excessive workloads are compounded by entrenched systemic issues such as working irregular hours, excessive overtime, rotating shifts, and understaffing (Rezaei, Karami Matin, Hajizadeh, Soroush, & Nouri, 2018). Such factors are also involved when nurses decide to leave work (Chan, Tam, Lung, Wong, & Chau, 2013). Furthermore, nurses and care workers encounter workplace violence and abuse at higher rates than any other profession (Honarvar, Ghazanfari, Raeisi Shahraki, Rostami, & Lankarani, 2019), which negatively influences their physical and mental well-being, their experiences of job satisfaction, as well as their professional development (Schuster & Dwyer, 2020; Zhao et al., 2018).

Reducing nurses' and care workers' workload may play an essential role in providing a positive work environment and an effective quality of care. In this regard, robots appear as a potentially promising tool in care work. However, they may also pose new risks if, for example, they replace the empathic relationships with patients that help to make the work meaningful. Against this background, we want to contribute to a better understanding of the working life and work environment of nurses and care workers when using robots.

Review method

The scoping review is a qualitative alternative to the quantitative systematic review when the aim is to identify knowledge gaps, scope a body of

literature, clarify concepts or to investigate research conduct (Munn et al., 2018). Similar to systematic reviews, scoping reviews require comprehensive and structured searches of the literature to maximize the capture of relevant information, provide reproducible results, and decrease potential bias from flawed implementations. However, while systematic reviews usually have quite a specific research question, the research questions in scoping reviews are usually broader (Grant & Booth, 2009). Scoping reviews may also include existing literature and findings from a range of different study designs and methods, which makes the use of formal meta-analytic methods difficult (Sucharew & Macaluso, 2019). We draw on a scoping review method to highlight an overlooked research field and identify new insights and knowledge gaps.

As there are few studies with a working life research perspective on health care robotics, a scoping review is needed to identify studies that in one way or another connect to the working life theme. This means that we ask two broad questions – how robots are used by caregivers and how robots affect caregivers' work environment – to explore insights from various disciplines and approaches. Working life may sometimes be implicit in care robotics research, and a scoping review can highlight this aspect of previous research, thus laying the ground for future working life research within this field.

Search strategy

The literature search was conducted from May to July 2020 using the databases Scopus, Web of Science, PubMed, CINAHL. The first two were chosen for their broad coverage, as our objective was to gather relevant articles from a variety of research fields. PubMed and CINAHL was used to gather articles related to medical and care science. Our search string was robot* AND care* OR nurs* AND work*, and we searched in all fields to capture studies that did not specifically focus on all of our search terms.

Inclusion and exclusion criteria

A robot is normally defined as an actuated, programmable mechanism that is autonomous. This means that a robot can perform tasks on the basis of how it is programmed, without human intervention. There are many types of robots: surgical robots (assisting in surgical operations), pharmaceutical robots (for sorting drugs), service robots (for transporting or mobile issues), care robots (for companionship), socially assistive robots (SARs, for communicating and interacting), and others. Based on the aim of the review – examining the knowledge state on caregivers' use of

robots and their effect on work environment – some robots are more likely to be the object of study than others. The short and all-encompassing term "robots" is used throughout the review in order to refer to all kind of robots that are used by the caregivers to assist them in their work. Furthermore, we have only included articles that focused on the use of robotic devices in care practice with patients and no other technological devices, such as tablets, mobile phones and other telemedical devices. Nor have we included articles dealing with information and communication technology programs, digital platforms, and other kinds of software.

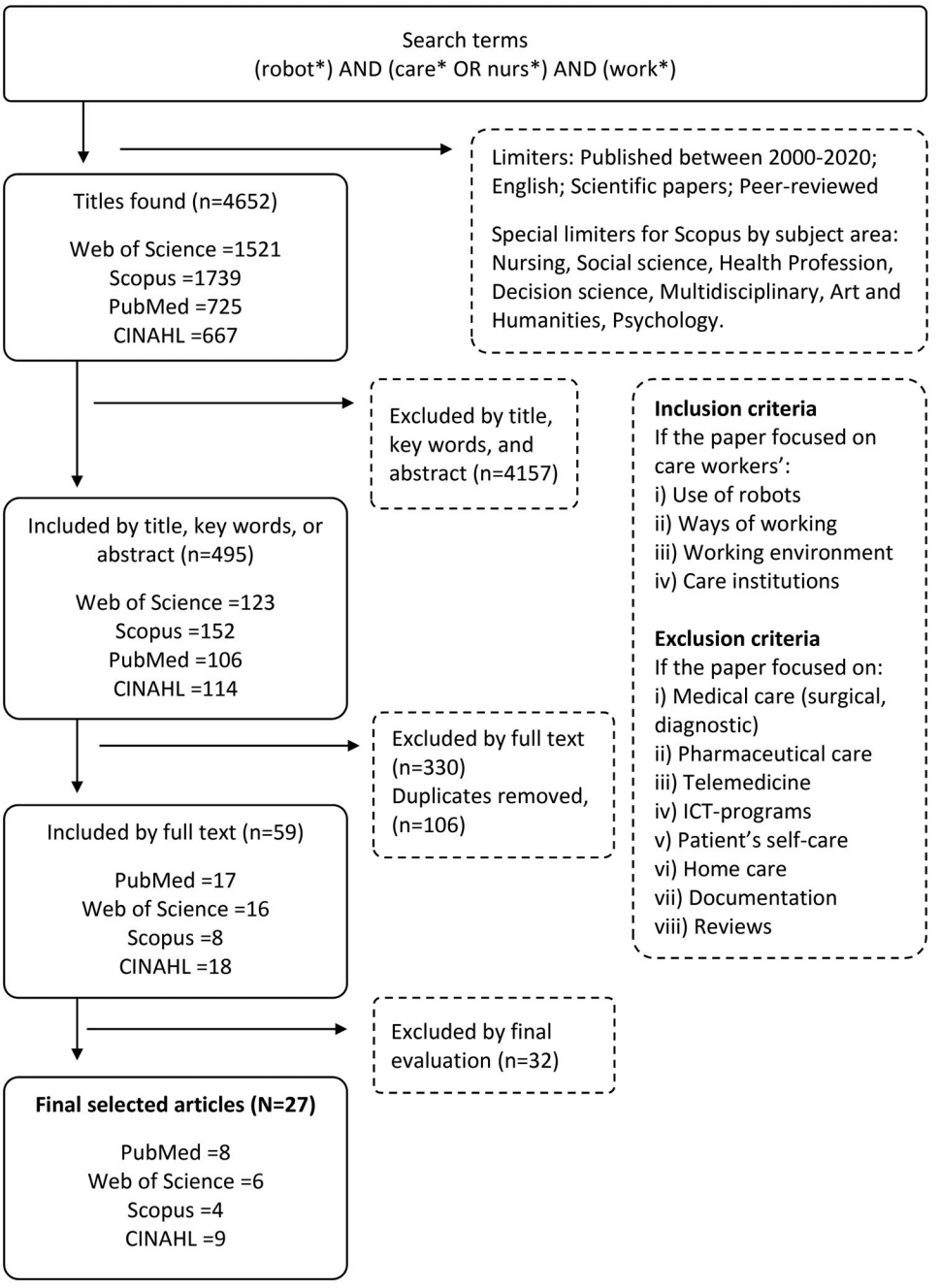
We only include peer-reviewed, scientific papers published in English between 2000 and 2020. We include published literature that had been through a process of peer-review to ensure a degree of permanence. We only select original articles, excluding research reviews as well as papers from sources of subjective quality like summaries or keynotes. No exclusion is made based on academic discipline. During the 1990s society underwent digital transformation and before the year 2000 robots were quite scarce outside laboratory and industry environments. By starting the literature search from 2000, our aim is to provide a comprehensive review regarding the use of robots in care facilities. We include studies that adopts both qualitative and quantitative methods, as well as mixed-methods studies.

In the review we include all caregiving personnel, such as care workers and nurses, but no other occupational groups', or patients', use of robots. Due to the focus on work environment, we only include articles focusing on caregivers working at care institutions, and not in the patients' home. Furthermore, we do not account for articles about attitudes toward robots, or readiness to implement robots, since such studies are based on people's preconceptions and not on actual experiences.

Search outcomes

The searches resulted in 4652 titles. We scanned the list for relevant studies based on keywords, abstracts, and synonyms in the title, this yielded 495 studies. One of the authors (MP) read the full text of these studies, and with the help of the inclusion and exclusion criteria, as listed in the flowchart (see Table 1), this process resulted in 59 studies. The selection of the final set of articles were based on relevant criteria, such as key results and research focus, in the full text articles. For instance, we excluded articles with findings isolated from working life questions, such as findings limited to technical outcomes. After the final step in the evaluation process, 27 studies, which provided original information and creative ideas, were included in the review. Because we seek to highlight an overlooked

Table 1. The flowchart of the literature searches.



research field and identify new insights and knowledge gaps, no studies were excluded based on methodological quality or a minimum quality threshold, such as minimum number of research participants. Disagreement between the team members were resolved through discussion.

Data analysis

After the final selection of articles was done, we used qualitative content analysis (Graneheim & Lundman, 2004) to analyze the findings. The reason for performing this analysis was to identify both explicit (manifest) and implicit (latent) contents in the articles. Because of the general lack of an interest in working life in the research about robots in health care, the findings in previous research that may be of interest for our review is not always highlighted in the articles as the main findings. In some articles the caregivers' ways of working and work environment are explicitly expressed (manifest) and sometimes implicitly (latently) dealt with. By carefully reading the full texts we have been able to identify (and thereby include) a number of articles that deal with caregivers' work in more implicit ways. Thus, the purpose and strength of using content analysis lies in the possibility of extracting minor, or secondary, findings from the articles.

One of the authors (MP) began the coding process by creating subcategories, which were based on both manifest and latent aspects in the articles. In response to ways of working, the coding of subcategories was conducted based on the identification of specific work tasks that involved the robots, such as distracting or entertaining. In response to the work environment, the coding process was in similar way conducted based on the identification of specific aspects of work environment that was actualized in relation to the caregivers' way of using the robots, such as reducing workload or responding to emotional demands. Thereafter, the subcategories were compared and discussed among the three authors, making sure that each subcategory was well-defined and did not overlap with other subcategories. Through debate and discussion between the team members, the initial set of subcategories were revised, which resulted in a fewer number of subcategories that were mutually exclusive. As one single article could describe several different aspects of robotized care practice, most articles were represented in more than one subcategory. The final stage of the coding process involved collecting subcategories with similar meanings into main categories, e.g., social tasks versus physical tasks, which correspond to the aim of the review.

Results

The following sections present the review findings based on our categorization of previous research, in relation to our questions: How are robots used by caregivers, and how do robots affect caregivers' work environment? The third section consists of a comparative analysis of the findings. An overview of the included studies is displayed in Table 2.

How are robots used by caregivers?

We identify two main categories – social and physical tasks – and eight sub-categories of different ways in which caregivers have been observed to utilize the robots in their practice. The following sections account for the different aspects of these categories.

Social tasks

Included in the social task category are work tasks that are based on reciprocal behavior, which means that the work tasks are based on interactional performances between humans (caregivers and patients) using the robots. This includes both verbal and embodied interaction. Sometimes a robot may also transform a social task into a nonsocial task.

Robots used by caregivers to perform social tasks are often labeled "companion robots" (i.e., pet robots that are design to evoke touching, stroking, and communicative actions) or "social" or "socially assistive robots" (i.e., humanoid, or anthropomorphic robots that are designed to evoke playful and communicative actions). Although the included articles involve different types of robots, they all have one or another technical feature that enable caregivers to use them interactionally.

Distracting. When caregivers use the robots as a distraction, it may both decrease and enhance the caregivers' interaction with the patients. For example, robots are successfully used to distract and divert the patient from challenging behaviors, e.g., restlessness and sadness (Jung, van der Leij, & Kelders, 2017), distress (Moyle, Bramble, Jones, & Murfield, 2018), as well as in stressful and painful situations, such as before and during nursing care, transfer, feeding, and hygiene care (Demange, Pino, Kerhervé, Rigaud, & Cantegreil-Kallen, 2019). Both humanoid and pet robots are in this way used as tools to reduce challenging behavior of patients and to assist and ease the caregivers' work routines (Bemelmans, Gelderblom, Jonker, & de Witte, 2016; Melkas, Hennala, Pekkarinen, & Kyrki, 2020). We also find that robots can be used as a distraction tool in more stimulating and activating ways, e.g., as in therapeutic sessions, and other forms of conversations, between caregivers and elderly patients with dementia (Hebesberger, Koertner, Gisinger, & Pripfl, 2017). Used as a distraction in an activating sense, caregivers may use robots as an interaction tool to increase patients' activity, communication, and mood (Wada, Shibata, Saito, & Tanie, 2004).

Entertaining. Findings indicate that caregivers frequently use robots for entertaining purposes in ways that reduce the presence of, or at least the

Table 2. Overview of the articles.

Author(s), Year, Country	Aim of the study	Method(s) and data	Robot	Findings: Robot usage (Q1)	Findings: Work environment (Q2)
Beane & Orlikowski, 2015, USA	Explore caregivers' use of robotic telepresence at night rounds	Observations and interviews with attending physicians (8), nurses (18), patients (8)	RP-7 (mobile tele-presence robot)	Tool to coordinate knowledge work during night rounds, involving attending physicians, nurses, and patients	Intensifies coordination. The demands, work roles, and influence on decision making, changed for the participants
Beedholm et al., 2015, Denmark	Examine implications for caregivers and patients when introducing a robotic bathtub	Interviews with managers (2), caregivers (4), and older patients (2)	Robotic bathtub (washing robot)	Tool for hygiene care of the patients. The bathtub gives a full body wash, with the purpose of replacing the caregivers' labor	No labor savings, or ergonomic benefits. However, the device actualizes professional values and prestige
Beedholm et al., 2016, Denmark	Explore the construction of different types of rationality in relation to assistive technology	Observations and interviews with managers (2), caregivers (4), and patients (2); media coverage	Robotic bathtub (washing robot)	Tool for hygiene care of patients. The bathtub gives a full body wash, with the purpose of replacing the caregivers' labor	The strategic game surrounding the introduction of the robot contribute to the problems it seeks to solve
Bemelmans et al., 2016, The Netherlands	Examine how interventions with a pet robot can be implemented in dementia care	Intervention study. Interviews with caregivers (16), and assessment protocols for patients (23)	Paro (pet robot)	Tool to reduce challenging behavior of patients, and to add value to the caregivers' work	When used in individualized ways, the use of the robot can add value to the quality of caregivers' work
Broadbent et al., 2016, New Zeeland	Examine benefits and problems using multiple health-care robots in elderly care	Non-randomised controlled trial. Observations and questionnaires with patients (53) and caregivers (53)	Guide and Cafero (mobile service robots)	Tool to entertain patients, make skype calls, and take blood pressure	The robots do not affect the caregiver's job significantly. No observed in-/decrease in reported job satisfaction
Chen & Kemp, 2011, USA	Compare a direct physical interface with a gamepad interface when operating a humanoid robot	Controlled laboratory setting. Observations and questionnaires with nurses (18)	Cody (humanoid robot)	The physical interface was more intuitive and similar to guiding patients by hand. Tool for moving patients and objects and janitorial duties	Not tested in care setting
Dag et al., 2017, Sweden	Explore implications for users and caregivers when using a robotic eating aid	Qualitative design. Interviews with users (with intellectual disabilities) (2) and care assistants (4)	Bestic (robotic feeding arm)	Tool for assisting users/ patients and caregivers in meal situations	The robot did not reduce the workload in any significant way, and did not increase the users' independence

(*Continued*)

Table 2. (Continued)

Author(s), Year, Country	Aim of the study	Method(s) and data	Robot	Findings: Robot usage (Q1)	Findings: Work environment (Q2)
Demange et al., 2019, France	Examine the intervention using a pet robot for the management of acute pain in dementia care	Focus group interviews, questionnaires, and feasibility assessment with caregivers (57) and patients (12)	Paro (pet robot)	Tool for distracting stimulus in pain situations, such as before and during nursing care, transfer, feeding, and hygiene care	Overall good results regarding caregivers' and patient's reaction to the intervention. However, caregivers reported feelings of clumsiness and extra workload
Greenhalgh et al., 2019, USA	Compare the usability and task load demand of a robot-assisted transfer device to a clinical standard	Quantitative cross-sectional study. Usability feedback questionnaires with caregivers (21)	Hoyer Advance (mechanic), Strong Arm (lifting robot)	Tool for lifting patients in- and out of the power wheelchair in different dependent transfer situations	Reduced physical demand, fatigue, and discomfort. Less frustration, but also increased mental demands. Caregivers report ethical dilemmas regarding patient safety
Hasse, 2013, Denmark	Examine how a pet robot impact work life and work identities of care workers	Ethnographic fieldwork. Observations and interviews with caregivers	Paro (pet robot)	Tool to create calm and entertain patients	The caregivers start to question their old ways of working, and begins to think about their work identity
Hasse et al., 2018, Denmark	Explore how caregivers use a teleoperated robot in a rehabilitation center	Ethnographic fieldwork. Observations and interviews with caregivers	Telenoid R1 (tele-operated humanoid robot)	Tool for transferring people's presence through the robot presence (similar to a mobile phone with a body)	The caregivers inductively explored the robot's possibilities. Ultimately, the robot was rejected due to lack of purpose
Hebesberger et al., 2017, Austria	Examine how elderly with dementia and caregivers experience a mobile robot in a care facility	Interviews (10) and questionnaires (70) with caregivers	SCITOS (mobile service robot)	Tool for diversion and offers something new within the daily routines. Otherwise not very useful since it did not offer specific tasks	Initially, the robot created a positive work atmosphere. Later, the caregivers got bored of it. Ethical concerns were raised regarding safety of patients
Huisman & Kort, 2019. The Netherlands	Examine how an assistive robot is used in nursing care organizations	Observations, questionnaires, and interviews with caregivers (20), managers (15) and patients (245)	Zora (humanoid robot)	Tool for recreation and entertainment, such as physical exercise and rehabilitation therapy, playing games, music listening	The caregivers reported improved work atmosphere. The caregivers also reported frustration due to technical difficulties

Jung et al., 2017. The Netherlands.	Explore how caregivers and patients in dementia care use a pet robot	Interviews with two groups of caregivers (one group with and one group without robot experience)	Paro (pet robot)	Tool to distract challenging behaviors. Also, to stimulate social contact and communication	Support caregivers by diverting patients' problematic behavior. Possible tool to reduce the need for supervision of patients
Loi et al., 2018, Autralia	Examine caregivers' acceptability of an assistive robot	Questionnaires including caregivers (24)	Betty (communicative robot)	Tool to entertain and help patients to relax through music, games and weather reports.	Possible signs of less stressful work situation when diverting patients challenging behaviors. Experiences of technical difficulties
Louie & Nejat, 2020. USA.	Examine how caregivers learn a robot recreational activities and facilitate them among patients	Observations and Interview with caregivers (5) who participated in a robot teaching session	Tangy (humanoid robot)	Tool to facilitate recreational group activities, such as bingo	The caregivers found the learning system easy to use, and experienced moderately low physical workload
Melkas et al., 2019, Finland	Examine the impacts of care-robot implementation on caregivers and elderly patients	Multi-sited field study. Observations (27 sessions) of patients (60) and caregivers (50). Focus group interviews with caregivers (35) and patients (5)	Zora (humanoid robot)	Tool to facilitate exercise and entertainment, to divert challenging behavior, and to promote communication	Difficulties regarding technical features. Positive and negative experiences regarding work atmosphere, meaningfulness of work content, professional development. Negative experience of work ethics and impact on workplace community
Moyle et al., 2018, Australia	Examine caregivers' perceptions of a pet robot and a look-alike non-robotic animal	Interviews with caregivers (20)	Paro (pet robot)	Tool to facilitate therapeutic situations with the patients, and to distract patients when distressed	Not accounted for
Nickelsen, 2019. Denmark	Examine implications when caregivers and patients use a robotic eating aid	Multi-sited study. Observations of meal situations, and interviews with caregivers (8)	Bestic (robotic feeding arm)	Tool to reduce the workload at meal situations	Increased workload to mount the device; when mounted the workload is reduced. However, necessary to observe during the whole meal

(*Continued*)

Table 2. (Continued)

Author(s), Year, Country	Aim of the study	Method(s) and data	Robot	Findings: Robot usage (Q1)	Findings: Work environment (Q2)
Obayashi & Masuyama, 2020, Japan	Examine effects of using a robotic system in the care of elderly patients	Observations of patients (2) in nursing homes and caregivers (4)	Sota (communicative robot)	Tool for automatic recording of patients' information, automatic calls to patients to confirm safety, confirmation of drug compliance	Reduce the burden of caregivers by recording vital information about patients. Less stressful night shifts
Pfadenhauer & Dukat, 2015, Germany	Examine the performative deployment of a pet robot in dementia care	Observations (20) and video-documentation (15 h)	Paro (pet robot)	Tool to facilitate communication and interaction among patients in group activities	Effects the caregivers' ways of working (as "participant" or "observer"). Possible impact on caregiving culture, workload, and hierarchies
Read et al., 2020, Canada	Explore implications for physiotherapists' work when introducing a robotic exoskeleton	Interviews with physiotherapist (3)	Eksobionic (robotic) exo-skeleton	Tool for contributing to physiotherapists' work by increasing their work capacity	High level of cognitive workload. Stressful to make it work during a therapy session. Calls for ethical practices of the use in therapy to be developed
Tuisku et al., 2019, Finland	Examine how an assistive robot is perceived by care workers and the public	Interviews with care managers (3), caregivers (30), (nurse) students (6); comments (107) from media	Zora (humanoid robot)	Tool for recreation, e.g., to instruct physical exercise, give dance-shows, and play games	Initially positive attitude among caregivers. No confirmed impact on caregivers' work environment
Turja et al., 2020, Finland	Examine determinants associated with readiness for robotization among caregivers	Questionnaires including caregivers (3800) of which 13% (~500) had experience of working with robots	An industrial robot and a Care-O-bot (service robot)	Tool for physical work tasks, such as moving heavy objects and patients, and sorting and shelving	Possible correlation between job satisfaction and robot readiness among caregivers without robot experience, but not among those with robot experience

Wright, 2018, Japan	Examine the caregivers' responses to the introduction of a lifting robot in an elderly care facility	Ethnographic field work. Observations and interviews with caregivers	Hug (lifting robot)	Tool to reduce the physical burden for care workers when lifting and transfer the patients	Caregivers reports deskilling of lifting with care, lack of physical touch and closeness with the patients, and discomfort for the patients
Wright, 2019, Japan	Explore if robots can substitute for migrant human caregivers in aging Japan	Ethnographic field work. Observations and interviews with caregivers at an elderly care home	Pepper (humanoid robot), Hug (lifting robot), and Paro (pet robot)	Pepper as tool to facilitate recreational exercise programs. Hug as tool to lift/transfer patients. Paro as tool for patients to keep them company	Increasing the amount of work tasks for caregivers, deskilling aspects of care labor, recalibrating the distance between the caregivers and care receivers
Wada et al., 2004, Japan	Examine the effects of a pet robot on elderly patients and caregivers	Face scale, questionnaires, and urinary tests including patients (23) and caregivers (6)	Paro (pet robot)	Tool to improve patients' moods, activity, interpersonal communication, and to reduce caregivers' workload	The average burnout score (bodily, emotional and mental aspects) was slightly reduced among the caregivers

attention given by, the caregivers. As tools for entertainment, patients and caregivers use robots to play music, listen to weather reports and the like, as well as to play games. A variety of robots are used to create entertainment and relaxation among the patients: Humanoid robots, such as Zora, are used to give dance shows (Tuisku, Pekkarinen, Hennala, & Melkas, 2019). Pepper is used to play games on its touch screen (Huisman & Kort, 2019). Betty (PaPeRo) is a little robot used as a tool for playing music and weather reports (Loi et al., 2018). Tangy facilitates recreational group activities, such as bingo. The caregivers start by teaching the robot how to play the chosen games, and then the robot takes over and leads whatever games the caregivers have taught it.

Socializing. The findings suggest that caregivers may use robots as tools to stimulate social interaction and communication with the patient, either between the caregiver and the patient or between patients. Depending on which type of interaction (i.e., patient-patient, or patient-caregiver) that is promoted, the caregivers may experience both a lowered and increased workload.

For example, Pfadenhauer and Dukat (2015) discuss preliminary findings from a study of how the robot Paro is used in a nursing home for the elderly and point out that caregivers' may act either as "participant" or "observer" in the interaction with patients when using the robot. In other words, sometimes patients interact with the robot, and sometimes, the robot enables conversations between patient and caregiver (Pfadenhauer & Dukat, 2015). Several studies have found Paro to be used in this way – as a tool to stimulate conversation between patient and caregiver and facilitate therapeutic situations with patients (see e.g., Moyle et al., 2018). As such, the robot may be used to help dementia care patients to remember their life story, human relationships, and previously owned pets. This way of using the robot demands that the caregiver become a participant in interaction by engaging in conversation with the patient. The other way of using robots as social stimuli is for the caregivers to act as observers, i.e., to keep their distance and let patients communicate between themselves with the help of the robot. This is done by introducing the robot to the patients in group situations, such as in common rooms when the patients are engaged in leisure or relaxing activities (Jung et al., 2017; Melkas et al., 2020).

As social stimulus, robots are not only used by caregivers as a physical medium but also a digital medium, i.e., they can facilitate digital communication with not physically present others, e.g., through online video calls (Broadbent et al., 2016). An example of such a robot is the Telenoid R1, a robotic torso that is used to transfer people's presence through

the robot presence (similar to a mobile phone with a body) (Hasse et al., 2018).

Physical tasks

The second main category found in the analyzed articles involves various physical work tasks. Included are work tasks based on physical and bodily activities, such as lifting and moving patients, helping the patients with personal care, or assisting in meal situations. Robots designed to assist caregivers in different physical tasks are often labeled "care or assistive robots" (i.e., a broad category of robots that are used for various tasks in care facilities), "autonomous robots" (i.e., robots that can move and perform certain actions on their own), or "cloud robotics" (i.e., monitoring sensors with integrated digital programs to register patients' health data).

Eating. Caregivers may use robots to assist in meal situations, so called feeding assistive robots. By using robotic devices as tools to assist when eating, the general idea is for the patient to become less dependent on the help of caregivers and instead, with the robots' help, eat for themselves (Dag, Svanelöv, & Gustafsson, 2017; Nickelsen, 2019). The feeding robot Bestic, for example, has an electric spoon that is adapted to the user (the patient) and lifts the food up to the mouth. Dag et al. (2017) show in an interview study with both patients and assistants that the robot helps patients to become more independent in meal situations, and allows for caregivers to take a more passive, observing, role.

Lifting. In contrast to eating robots, lifting robots do not so much replace a human caregiver, as alleviating some of the work. In care facilities, caregivers may use robots to lift patients in and out of beds and wheelchairs, to turn them in their beds, or to support patients when they walk (Chen & Kemp, 2011; Turja, Taipale, Kaakinen, & Oksanen, 2020). Findings indicate that lifting robots reduce the physical burdens of lifting and moving patients in dependent situations many times a day. One example of a lifting robot is Hug, which is a strong robot that can lift patients in different dependent transfer situations (Wright, 2018; 2019). There are other examples of lifting robots, such as Strong Arm, with various features and lifting techniques (Greenhalgh et al., 2019).

Washing. Caregivers may use robots in washing situations to assist or replace a human caregiver in situations involving personal hygiene. One example is the robotic bathtub, an automated bathing machine with sensors that enables a washing adjusted to the patients' body. The bathtub gives a full body wash and is thus designed to replace caregivers' labor regarding

hygiene care of the patients, while increasing the integrity of the user (Beedholm, Frederiksen, Frederiksen, & Lomborg, 2015). In an interview study with managers, caregivers, and users, Beedholm et al. (2015) showed that the bathtub became a complement for caregivers, and as the automated bathtub works a bit like a Jacuzzi, it was experienced as a welcome pleasant additional feature in the care given to patients.

Monitoring. Robots can be used as tools for automatic recording of vital information of patients. In a study of a trial with two elderly persons in nursing homes by Obayashi and Masuyama (2020), a robot automatically recorded information such as the time the participants slept, or the reason for waking up. Based on the collected data, the monitoring system also involved a communicative robot that acted proactively by calling the patients (e.g., to remind them to take their medicine) or by prompting a verbal response if patients woke up at night (e.g., "what are you doing?"). Thus, the robot was used to replace certain activities of human caregivers.

Robots may also be used as communication tools to connect human caregivers to each other. In a study by Beane and Orlikowski (2015), a mobile telepresence robot was used to coordinate distributed knowledge work during night rounds, involving doctors, nurses, care workers, and patients. The robot offered mobile videoconferencing controlled at a distance, allowing individuals to navigate distant locations while interacting with remote workers or problems via two-way video and audio.

Training. Robots for entertainment are also often used to promote physical exercise (Huisman & Kort, 2019; Tuisku et al., 2019). For example, robots can demonstrate physical movements and dance performances to the patients, which they mimic (Wright, 2019). Another type of robot that can be used to promote exercise and rehabilitation training are exoskeletons. These are wearable mobile machines that are powered by a combination of technologies that allow for limb movement with increased strength and endurance. An exoskeleton may help with the rehabilitation from stroke, spinal cord injury or during aging. Such robots may be used by caregivers, or physiotherapists, as a tool for contributing to the rehabilitation training of patients by increasing their work capacity (Read, Woolsey, McGibbon, & O'Connell, 2020).

How do robots affect caregivers' work environment?

We identified two main categories related to work environment – psychosocial and physical aspects – and six sub-categories consisting of ways that robots have been observed to affect the work environment of caregivers.

Each category may include various robots with different technical features.

Psychosocial aspects

The first main category consists of various psychosocial work environmental risks and possibilities. Psychosocial aspects of employees' work environment can be defined in different ways, depending on methodological and theoretical perspectives. However, a definition widely used in international research pertains to interpersonal and social interactions that influence behavior and development in the workplace (Jacobs, Hellman, Markowitz, & Wuest, 2013).

Emotional demands. Emotional demands refer to the process of managing feelings, expressing, and suppressing emotions, to fulfill the emotional requirements of a job. For caregivers, this means that they must express certain positive emotions, and suppress negative emotions, to create a constructive interaction with the patients (Lopez, 2006).

The findings indicate both positive and negative effects on emotional demands when using robots for patients' care. Reported negative aspects involve technical or material tinkering and adjustments with the robotic device, which may cause increased mental demands and frustration (Greenhalgh et al., 2019; Loi et al., 2018; Read et al., 2020). One study reported that caregivers experienced frustration regarding technical difficulties, such as long start up times, low stability, and communication problems (incomprehensible speech; Huisman & Kort, 2019). Similarly, a study about the eating robot showed how it demands repeated tinkering in order to make it work properly, i.e., the robotic device needs (un) mounting, (re)adjusting, and dismantling (Nickelsen, 2019).

Contrary to this sort of tinkering with technology, research also indicates possible signs of less stressful work situations when diverting patients' challenging behaviors (Loi et al., 2018; Wada et al., 2004). Similarly, robots that monitored patients during night could also create less stressful night shifts (Obayashi & Masuyama, 2020). Reduced mental demands have also been observed when caregivers use eating robots in meal situations and thereby reduce their own presence and interaction with the patients (Nickelsen, 2019).

Ethical issues. The experience of ethical issues is connected to the identification of professional values. Professional values are standards for action that are accepted by professional groups and individuals in a certain area of work (Lai & Lim, 2012). Within medicine and care, central professional values include human dignity, integrity, autonomy, altruism,

and social justice. The caregivers integrate these values, hand in hand with personal values, in clinical practice.

Several studies raised the most apparent ethical issue: that of the safety of patients (e.g., Greenhalgh et al., 2019; Hebesberger et al., 2017). A robot must be safe to use and cannot risk injuring the patient in any way. For example, in an interview study with physiotherapists using a robotic exoskeleton in physical therapy with patients (Read et al., 2020), the physiotherapists underlined the need for proper training to ensure patient safety. Patients who are new to the robotic device will experience difficulties moving about without their wheelchair and may experience discomfort if the skeleton is not adjusted correctly, and if patients are not properly instructed.

Patients' safety also involves a more psychological aspect, namely their integrity. Wright's (2018; 2019) ethnographic study in an elderly care home in Japan showed that the lifting robot Hug posed a potential danger to the patients' integrity in two ways. Caregivers explained that they found it to be of discomfort for some patients; at the same time the robot replaced their physical touch and closeness with the patients. In this example, the patients' integrity is interpreted as something that is part of – instead of apart from – the physical closeness with the human caregivers. It has been suggested that robots are constructed as a response to a solution rather than as a response to a problem, e.g., the hygiene of patients is constructed as a problem that could be offensive to their integrity. As pointed out in the study by Beedholm, Frederiksen, and Lomborg (2016) the caregivers started to conceive of the patients' integrity as a problem only after the robot was introduced.

Job satisfaction and work identity. Job satisfaction refers to a subjective evaluation that the worker makes of her own job, either in its entirety or with respect to its different attributes (Brief, 1998). Thus, job satisfaction is also related to work identity.

The findings point to a mixed result regarding robots' impact on job satisfaction (Broadbent et al., 2016). In the beginning of an implementation process, the robot may help to create a positive atmosphere and make the staff smile, laugh, and become more talkative (Huisman & Kort, 2019). However, the novelty may fade away after a while when the initial curiousness is stilled (Hebesberger et al., 2017; Melkas et al., 2020; Tuisku et al., 2019; Turja et al., 2020).

The literature includes reports of both positive and negative experiences among caregivers regarding meaningfulness of work content, work identity, and professional development (Hasse et al., 2018; Melkas et al., 2020). By using robots, staff members may start to question their old ways of

working and reflect upon what it means to be a professional caregiver (Beedholm et al., 2015; Hasse, 2013). There are indications that the introduction of robots serves to reconfigure care by deskilling aspects of care labor and recalibrating the distance between the caregivers and care receivers when physical touch and closeness with the patients diminish (Wright, 2018, 2019). The findings also indicate that the demands and professional roles can change for the caregivers when robots are used to organize the work in new ways, for example when performing night rounds through telepresence (Beane & Orlikowski, 2015).

Physical aspects

The second main category consists of physical work environmental risks and possibilities. Physical work environment refers to bodily aspects of the occupational tasks and hazards that the employees are subject to. Regarding caregivers' ways of working, commonly recognized physical work environment problems involve musculoskeletal problems, threats and violence, and an excessive workload.

Musculoskeletal problems. Musculoskeletal disorders within the health care and social care sector are common. Heavy lifting is a major cause for musculoskeletal problems, for example in relation to patient transfer in bed as well as between bed and wheelchair, toilet visits, or showering of patients.

The findings indicate that lifting robots may be used to reduce physical demand, fatigue, and discomfort for caregivers when engaged in activities that demand heavy lifting (Wright, 2018). For instance, in a study regarding a robotic lifting arm that attaches to a power wheelchair, it was found that the lifting arm was significantly less demanding compared to mechanical lifting devices (Greenhalgh et al., 2019).

Threats and violence. Caregivers who work with people with dementia are a vulnerable occupational group due to the syndrome's impact on patients' moods, emotions, and outspoken behavior, and are at great risk of being affected by work accidents caused by threats and violence.

The reviewed literature indicates that social, or companion, robots may be useful tools to distract and divert patients' challenging behaviors (e.g., aggressions, shouting, spitting, fighting), and may thereby support care providers in their work. Several studies have shown possible signs of a less stressful work situation when diverting patients' challenging behaviors. For example, a study of patients' acceptance of the socially assistive robot Betty – a vaguely anthropomorphic robot that can respond to patients and can provide patients with music, books, and games – suggest that the

robot could be used to engage patients in a work environment that is heavily task-focused (Loi et al., 2018). In another study in which Paro was tested with 23 dementia patients, the interventions reduced emotions of fear, shouting, and repulsive behavior (Bemelmans et al., 2016). By reducing the challenging behavior of patients, social robots can potentially contribute to a safer work environment.

Workload. Introducing robots in working life is generally assumed to make the ways of working more effective and less time consuming. However, the findings indicate a more complex reality.

Positive aspects regarding the work environment may be achieved when caregivers use robots as tools for monitoring patients. One example is when robots are used to monitor patients during night shifts, which reduces the amount of rounds the caregivers need to do (Obayashi & Masuyama, 2020). In a study of healthcare providers using Paro in their work. some of them reported that Paro could be successfully used as a tool for companionship in order to reduce the need for supervision of patients (Jung et al., 2017). In a similar fashion, robots have been noted to be used as tools for taking charge and leading entertainment activities such as Bingo (Louie & Nejat, 2020). In this regard, robots may be used as replacement of human caregivers for the performance of certain activities, thus reducing the workload.

The findings also include examples of situations where caregivers did not recognize the use of robots as labor saving, but rather as a tool that adds more labor to the caring situation and their work tasks (Demange et al., 2019; Huisman & Kort, 2019; Melkas et al., 2020; Nickelsen, 2019; Read et al., 2020; Wright, 2018). For example, the purpose of the robotic bathtub is supposed to be labor saving since it replaces human activity (i.e., washing) with robotic activity. However, the findings in the study by Beedholm et al. (2015) point not to a reduction of the workload, but to a transformation of work tasks. Instead of performing the cleaning activity, the caregivers needed to be present and supervise the washing and be ready to assist the patients and to support them if they experience problems with the robot in any way. Caregivers reported similar issues when using the eating robot Bestic: although the patients were eating by themselves with support of the robot, the caregivers had to be present and observe the situation and be of assistance during the whole meal (Nickelsen, 2019).

Discussion

Our results demonstrate an intricate relationship between caregivers' ways of working with robots and work environment. We have shown examples

Table 3. Comparing caregivers' ways of working and work environment using robots.

	Ways of Working Distracting, Entertaining, Socializing, Lifting, Eating, Monitoring, Washing, Training			
		Observer		Participant
Work Environment	**Psychosocial**	–	Ethical Issues	–
		–/+	Emotional Demands	–/+
		–/+	Job Satisfaction & Work Identity	–/+
	Physical	+	Threats & Violence	+
		+	Work Load	–
		+	Musculoskeletal Problems	+

of how caregivers use robots in ways that create active situations with the patients, as well as situations in which the caregivers act as passive observers of the patients when using the robots. Depending on how caregivers use robots in relation to their patients, it affects their role and presence in the caring situation. Some robots may be more adapted to either participation or observation; however, most robots can be used in both ways. Thus, the relationship between the type of robot and caregivers' ways of working does not simply depend on the robot, but rather depends on the caregivers' preferences and actions in any given situation involving the patients (Pfadenhauer & Dukat, 2015). Furthermore, the findings suggest that the use of robots may have both positive and negative effects on the caregivers' work environment, much depending on how they are used. To conceptualize the relationship between the use of the robots and the work environment, we propose an analytical model, as illustrated in Table 3.

The role of observer in caregiving situations raises ethical issues regarding the risk of reducing social encounters and empathic connection with the patients. On the other hand, the observer role, with its limited involvement, reduces harmful aspects of social and physical contact, such as mental demands, stress, threats, and violence as well as the risk of musculoskeletal problems and overall workload. However, the working time is not simply reduced; rather, the work is transformed, and sometimes new elements are added to the workflow. Accordingly, the observer role actualizes questions of professional values and work identity due to changes in workflow and decision making.

The role of participant means that caregivers' involvement in interactions with patients are transformed rather than limited as the robot is introduced. Risks such as musculoskeletal problems and violence are reduced as caregivers use robots to distract or calm patients. This changed involvement in caregiving situations raises ethical issues related to the safety and integrity of the patient. Furthermore, participating actively in the interaction with the patient using the robot is likely to increase the workload. For example, the use of Paro, a social robot, may reduce patients' distress

and provide more positive interactions between caregiver and patient, but it may also require the caregiver to monitor patients so that they do not break the robot.

Accordingly, our review points out the existence of intertwined effects. i.e., certain ways of working using robots may affect more than one environmental aspect. More knowledge is needed about the transformation of routines when robots are introduced in care work. Furthermore, we found that little is known about the longitudinal effects of robots on the working life and work environment of caregivers. The research we have reviewed is often performed in an initial phase when introducing or implementing robots in care facilities. Thus, we know little about robots' long-term effects on working life. Questions regarding workplace learning are completely absent in the existing literature. Missing is also research about legal and ethical aspects of using robots – not just in regard to patients' and clients' integrity and safety but also to employees. In addition, the quality varies between the studies we have reviewed. While some studies (e.g., Broadbent et al., 2016, and Huisman & Kort, 2019) included a robust sample to investigate robots' effect on caregivers' work environment, other studies (Louie & Nejat, 2020, and Read et al., 2020) were based on few cases and can therefore be seen as raising important questions about robotic use, rather than answering them. Thus, the research points to the fruitfulness of examining the relation between the intended use of robots and their actual role in care work. Existing studies have approach important topics, but it is clear that the work environmental effects of caregivers' use of robots needs further examination.

With this review we hope to contribute with a better understanding of the working life and work environment of caregivers who use robots in their work. We also hope to engage working life researchers to investigate the use of robots in care facilities and other institutions where robots are currently implemented. Based on our findings, it is clear that a critical perspective is needed. Introducing innovative robotics in organizations with a human work force that deal primarily with patients will create unintended consequences. Depending on human action, robots become entangled in interactions and social orders that will challenge their protocol and purpose, creating unforeseen problems and consequences for robots as well as humans. Such challenges point to the need of a research field that can identify problems and inform decision-making.

Note

1. The actual titles for the occupational groups who work in care settings may vary in different countries.

Acknowledgements

We would like to thank the two anonymous reviewers for their constructive comments.

Disclosure statement

The authors report no conflict of interest. This manuscript has not been published and is not under consideration for publication elsewhere.

Funding

This work was supported by the AFA Insurance in Sweden under Grant 190170.

Notes on contributors

Marcus Persson is an associate professor in sociology at Linköping university, Sweden. His research focus on socio-technical relationships and implications for people's working life when introducing new technology. He is currently involved in several research projects regarding the use of robots, e.g., care workers use of social robots in elderly care, and the implementation of robot process automation in public sector organizations.

David Redmalm is senior lecturer in sociology at Mälardalen University, Sweden. His research focuses on how the distinction between human and animal structures both abstract theory and everyday life. He also studies how animals are used in organizations – as symbols, as products and as co–workers.

Clara Iversen is a senior lecturer in sociology at Uppsala University, Sweden. Her background is in social psychology and her research interests concern how participants in social and health care encounters manage shared understanding. She is currently studying helpline interactions and interactions between people and social robots.

ORCID

Marcus Persson http://orcid.org/0000-0003-2818-8001
David Redmalm http://orcid.org/0000-0001-9902-1191
Clara Iversen http://orcid.org/0000-0002-6941-5760

References

AFA Insurance. (2020). *Allvarliga arbetsskador och långvarig sjukfrånvaro inom vården [Serious work injuries and prolonged sick leave in healthcare]*. Sweden/Stockholm: AFA Insurance.

Beane, M., & Orlikowski, W.J. (2015). What difference does a robot make? The material enactment of distributed coordination. *Organization Science*, *26*(6), 1553–1573. doi:10.1287/orsc.2015.1004

Beedholm, K., Frederiksen, K., Frederiksen, A.M.S., & Lomborg, K. (2015). Attitudes to a robot bathtub in Danish elder care: A hermeneutic interview study. *Nursing & Health Sciences*, *17*(3), 280–286.

Beedholm, K., Frederiksen, K., & Lomborg, K. (2016). What was (also) at stake when a robot bathtub was implemented in a Danish elder center: A constructivist secondary qualitative analysis. *Qualitative Health Research*, *26*(10), 1424–1433. doi:10.1177/1049732315586550

Bemelmans, R., Gelderblom, G.J., Jonker, P., & de Witte, L. (2016). How to use robot interventions in intramural psychogeriatric care: A feasibility study. *Applied Nursing Research : ANR*, *30*, 154–157.

Bernabei, V., De Ronchi, D., La Ferla, T., Moretti, F., Tonelli, L., Ferrari, B., … Atti, A.R. (2013). Animal-assisted interventions for elderly patients affected by dementia or psychiatric disorders: A re*view*. *Journal of Psychiatric Research*, *47*(6), 762–773. doi:10.1016/j.jpsychires.2012.12.014

Brief, A.P. (1998). *Attitudes in and around organizations*. London: Sage.

Broadbent, E., Kerse, N., Peri, K., Robinson, H., Jayawardena, C., Kuo, T., … MacDonald, B. (2016). Benefits and problems of health-care robots in aged care settings: A comparison trial. *Australasian Journal on Ageing*, *35*(1), 23–29. doi:10.1111/ajag.12190

Cameron, S.J., Armstrong-Stassen, M., Kane, D., & Moro, F.B.P. (2008). Musculoskeletal problems experienced by older nurses in hospital settings. *Nursing Forum*, *43*(2), 103–113.

Chan, Z. C. Y., Tam, W. S., Lung, M. K. Y., Wong, W. Y., & Chau, C. W. (2013). A systematic literature review of nursing shortage and the intention to leave. *Journal of Nursing Management*, *21*(4), 605–613.

Chen, T.L., & Kemp, C.C. (2011). A direct physical interface for navigation and positioning of a robotic nursing assistant. *Advanced Robotics*, *25*(5), 605–627. doi:10.1163/016918611X558243

Dag, M., Svanelöv, E., & Gustafsson, C. (2017). Experiences of using Bestic, an eating aid for people with intellectual disabilities. *Journal of Intellectual Disabilities : JOID*, *21*(1), 87–98.

Demange, M., Pino, M., Kerhervé, H., Rigaud, A.S., & Cantegreil-Kallen, I. (2019). Management of acute pain in dementia: A feasibility study of a robot-assisted intervention. *Journal of Pain Research*, *12*, 1833–1846.

Frennert, S., & Östlund, B. (2018). Narrative review: Welfare Technologies in Eldercare. *Nordic Journal of Science and Technology Studies*, *6*(1), 21–34. doi:10.5324/njsts.v6i1.2518

Gabrielle, S., Jackson, D., & Mannix, J. (2008). Older women nurses: Health, ageing concerns and self-care strategies. *Journal of Advanced Nursing*, *61*(3), 316–325.

Gleason, S.C. (2014). Don't fear the cyborg: Toward embracing posthuman and feminist cyborg discourses in teacher education and educational technology research. *Canadian Journal of Science, Mathematics and Technology Education*, *14*(2), 120–134. doi:10.1080/14926156.2014.903320

Gómez-Urquiza, J.L., Aneas-López, A.B., Fuente-Solana, E.I., Albendín-García, L., Díaz-Rodríguez, L., & Fuente, G.A., (2016). Prevalence, risk factors, and levels of burnout among oncology nurses: A systematic review. *Oncological Nursing Forum*, *43*(3), 104–120.

Graneheim, U.H., & Lundman, B. (2004). Qualitative content analysis in nursing research: Concepts, procedures and measures to achieve trustworthiness. *Nurse Education Today*, *24*(2), 105–112. doi:10.1016/j.nedt.2003.10.001

Grant, M. J., & Booth, A. (2009). A typology of reviews: An analysis of 14 review types and associated methodologies. *Health Information and Libraries Journal*, *26*(2), 91–108.

Greenhalgh, M., Landis, J.M., Brown, J., Kulich, H., Bass, S., Alqahtani, S., … Cooper, R.A. (2019). Assessment of usability and task load demand using a robot-assisted transfer device compared with a hoyer advance for dependent wheelchair transfers. *American Journal of Physical Medicine & Rehabilitation*, *98*(8), 729–734. doi:10.1097/PHM.0000000000001176

Håkanst, C. (2014). *Swedish working life. Research formation and conceptual development of a research field in transition*. Luleå: Luleå University of Technology.

Hasse, C. (2013). Artefacts that talk: Mediating technologies as multistable signs and tools. *Subjectivity*, *6*(1), 79–100. doi:10.1057/sub.2012.29

Hasse, C. (2018). How robots challenge institutional practices. *Learning, Culture and Social Interaction*, *26*, 100223. doi:10.1016/j.lcsi.2018.04.003

Hebesberger, D., Koertner, T., Gisinger, C., & Pripfl, J. (2017). A long-term autonomous robot at a care hospital: A mixed methods study on social acceptance and experiences of staff and older adults. *International Journal of Social Robotics*, *9*(3), 417–429. doi:10.1007/s12369-016-0391-6

Honarvar, B., Ghazanfari, N., Raeisi Shahraki, H., Rostami, S., & Lankarani, K. B. (2019). Violence against nurses: A Neglected and Health-threatening Epidemic in the University Affiliated Public Hospitals in Shiraz, Iran. *The International Journal of Occupational and Environmental Medicine*, *10*(3), 111–123.

Huisman, C., & Kort, H. (2019). Two-year use of care robot Zora in Dutch nursing homes: An evaluation study. *Healthcare*, *7*(1), 31. doi:10.3390/healthcare7010031

Jacobs, K., Hellman, M., Markowitz, J., & Wuest, E. (2013). Psychosocial Work Environment. In M. D. Gellman, & J. R. Turner (Eds.), *Encyclopedia of behavioral medicine*. New York: Springer.

Jung, M.M., van der Leij, L., & Kelders, S.M. (2017). An exploration of the benefits of an Animal like robot companion with more advanced touch interaction capabilities for dementia care. *Frontiers in ICT*, *4*, 16. doi:10.3389/fict.2017.00016

Kachouie, R., Sedighadeli, S., Khosla, R., & Chu, M.-T. (2014). Socially Assistive Robots in Elderly Care: A Mixed-Method Systematic Literature Review. *International Journal of Human-Computer Interaction*, *30*(5), 369–393. doi:10.1080/10447318.2013.873278

Kangasniemi, M., Karki, S., Colley, N., & Voutilainen, A. (2019). The use of robots and other automated devices in nurses' work: An integrative review. *International Journal of Nursing Practice*, *25*(4), e12739.

Karasek, R., & Theorell, T. (1990). Healthy Work. *Stress, productivity, and the reconstruction of working life*. New York: Basic Books.

Krägeloh, C.U., Bharatharaj, J., Sasthan Kutty, S.K., Nirmala, P.R., & Huang, L. (2019). Questionnaires to measure acceptability of social robots: a critical review. *Robotics*, *8*(4), 88. doi:10.3390/robotics8040088

Lai, P.K., & Lim, P.H. (2012). Concept of professional socialization in nursing. *International e-Journal of Science, Medicine and Education*, *6*(1), 31–35.

Lee, K. (2015). Technology and dehumanization of medicine. In: Schramme T., Edwards S. (eds) *Handbook of the Philosophy of Medicine*, 1–13. Springer, Dordrecht. https://doi.org/10.1007/978-94-017-8706-2_69-1

Loi, S.M., Bennett, A., Pearce, M., Nguyen, K., Lautenschlager, N.T., Khosla, R., & Velakoulis, D. (2018). A pilot study exploring staff acceptability of a socially assistive robot in a residential care facility that accommodates people under 65 years old. *International Psychogeriatrics*, *30*(7), 1075–1080. doi:10.1017/S1041610217002617

Lopez, S.H. (2006). Emotional labor and organized emotional care: Conceptualizing nursing home care work. *Work and Occupations*, *33*(2), 133–160. doi:10.1177/0730888405284567

Lorenz, K., Freddolino, P., Comas-Herrera, A., Knapp, M., & Damant, J. (2019). Technology-based tools and services for people with dementia and carers: Mapping technology onto the dementia care pathway. *Dementia (London, England)*, *18*(2), 725–741. doi:10.1177/1471301217691617

Louie, W.Y.G., & Nejat, G. (2020). A social robot learning to facilitate an assistive group-based activity from non-expert caregivers. *International Journal of Social Robotics*, *12*(5), 1159–1176. doi:10.1007/s12369-020-00621-4

McArthur, C. (2019). Enhancing Opportunities for Physical Activity Among Long-Term Care Residents: A Narrative Review. *Journal of Clinical Outcomes Management*, *26*(2), 90–96.

Melkas, H., Hennala, L., Pekkarinen, S., & Kyrki, V. (2020). Impacts of robot implementation on care personnel and clients in elderly-care institutions. *International Journal of Medical Informatics*, *134*, 104041.

Mordoch, E., Osterreicher, A., Guse, L., Roger, K., & Thompson, G. (2013). Use of social commitment robots in the care of elderly people with dementia: A literature review. *Maturitas*, *74*(1), 14–20. doi:10.1016/j.maturitas.2012.10.015

Moyle, W., Bramble, M., Jones, C., & Murfield, J. (2018). Care staff perceptions of a social robot called Paro and a look-alike Plush Toy: A descriptive qualitative approach. *Aging & Mental Health*, *22*(3), 330–335. doi:10.1080/13607863.2016.1262820

Moyle, W., Jones, C.J., Murfield, J.E., Thalib, L., Beattie, E., Shum, D., … Draper, B.M. (2017). Use of a Robotic Seal as a Therapeutic Tool to Improve Dementia Symptoms: A Cluster-Randomized Controlled Trial. *Journal of the American Medical Directors Association*, *18*(9), 766–773. doi:10.1016/j.jamda.2017.03.018

Munn, Z., Peters, M.D.J., Stern, C., Tufanaru, C., McArthur, A., & Aromataris, E. (2018). Systematic review or scoping review? Guidance for authors when choosing between a systematic or scoping review approach. *BMC Medical Research Methodology*, *18*(1), 143. doi:10.1186/s12874-018-0611-x

Nelson, A.L., Fragala, G., & Menzel, N.N. (2003). Myths and facts about back injuries in nursing. *American Journal of Nursing*, *103*(2), 32–40.

Nickelsen, N.C.M. (2019). Imagining and tinkering with assistive robotics in care for the disabled. *Paladyn, Journal of Behavioral Robotics*, *10*(1), 128–139.

Nørskov, M. (2014). Human-Robot Interaction and Human Self-Realization: Reflections on the Epistemology of Discrimination. *Sociable Robots and the Future of Social Relations: Proceedings of Robo-Philosophy*, *273*, 319–327.

Obayashi, K., & Masuyama, S. (2020). Pilot and Feasibility Study on Elderly Support Services Using Communicative Robots and Monitoring Sensors Integrated with Cloud Robotics. *Clinical Therapeutics*, *42*(2), 364–371. doi:10.1016/j.clinthera.2020.01.001

Papadopoulos, I., Koulouglioti, C., & Ali, S. (2018). Views of nurses and other health and social care workers on the use of assistive humanoid and animal-like robots in health and social care: A scoping review. *Contemporary Nurse*, *54*(4-5), 425–442. doi:10.1080/10376178.2018.1519374

Petersen, S., Houston, S., Qin, H., Tague, C., & Studley, J. (2016). The utilization of robotic pets in dementia care. *Journal of Alzheimer's Disease*, *55*(2), 569–574. doi:10.3233/JAD-160703

Pfadenhauer, M., & Dukat, C. (2015). Robot caregiver or robot-supported caregiving? *International Journal of Social Robotics*, *7*(3), 393–406. doi:10.1007/s12369-015-0284-0

Read, E., Woolsey, C., McGibbon, C. A., & O'Connell, C. (2020). Physiotherapists' experiences using the Ekso bionic exoskeleton with patients in a neurological rehabilitation hospital: A qualitative study. *Rehabilitation Research and Practice*, *2020*, 2939573. doi:10.1155/2020/2939573

Rezaei, S., Karami Matin, B., Hajizadeh, M., Soroush, A., & Nouri, B. (2018). Prevalence of burnout among nurses in Iran: A systematic review and meta-analysis. *International Nursing Review*, *65*(3), 361–369. doi:10.1111/inr.12426

Ribeiro, T., Serranheira, F., & Loureiro, H. (2017). Work related musculoskeletal disorders in primary health care nurses. *Applied Nursing Research*, *33*, 72–77.

Savela, N., Turja, T., & Oksanen, A. (2018). Social Acceptance of Robots in Different Occupational Fields: A Systematic Literature Review. *International Journal of Social Robotics*, *10*(4), 493–502. doi:10.1007/s12369-017-0452-5

Schuster, M., & Dwyer, P.A. (2020). Post-traumatic stress disorder in nurses: An integrative review. *Journal of Clinical Nursing*, *29*(15-16), 2769–2787.

Sharkey, A. (2014). Robots and human dignity: A consideration of the effect of robot care on dignity of older people. *Ethics and Information Technology*, *16*(1), 63–75. doi:10.1007/s10676-014-9338-5

Sorour, A.S., El-Maksoud, M., & Abd, M. (2012). Relationship between musculoskeletal disorders, job demands, and burnout among emergency nurses. *Advanced Emergency Nursing Journal*, *34*(3), 272–282. doi:10.1097/TME.0b013e31826211e1

Sucharew, H., & Macaluso, M. (2019). Progress Notes: Methods for Research Evidence Synthesis: The Scoping Review Approach. *Journal of Hospital Medicine*, *14*(7), 416–418.

Tuisku, O., Pekkarinen, S., Hennala, L., & Melkas, H. (2019). Robots do not replace a nurse with a beating heart": The publicity around a robotic innovation in elderly care. *Information Technology & People*, *32*(1), 47–67. doi:10.1108/ITP-06-2018-0277

Turja, T., Taipale, S., Kaakinen, M., & Oksanen, A. (2020). Care workers' readiness for robotization: Identifying psychological and socio-demographic determinants. *International Journal of Social Robotics*, *12*(1), 79–90. doi:10.1007/s12369-019-00544-9

Vandemeulebroucke, T., Dierckx de Casterlé, B., & Gastmans, C. (2018). The use of care robots in aged care: A systematic review of argument-based ethics literature. *Archives of Gerontology and Geriatrics*, *74*, 15–25. doi:10.1016/j.archger.2017.08.014

Wada, K., Shibata, T., Saito, T., & Tanie, K. (2004). Effects of robot-assisted activity for elderly people and nurses at a day service center. *Proceedings of the IEEE*, *92*(11), 1780–1788. doi:10.1109/JPROC.2004.835378

Woo, T., Ho, R., Tang, A., & Tam, W. (2020). Global prevalence of burnout symptoms among nurses: A systematic review and meta-analysis. *Journal of Psychiatric Research*, *123*, 9–20.

Wright, J. (2018). Tactile care, mechanical Hugs: Japanese caregivers and robotic lifting devices. *Asian Anthropology*, *17*(1), 24–39. doi:10.1080/1683478X.2017.1406576

Wright, J. (2019). Robots vs migrants? Reconfiguring the future of Japanese institutional eldercare. *Critical Asian Studies*, *51*(3), 331–354. doi:10.1080/14672715.2019.1612765

Yasobant, S., & Rajkumar, P. (2014). Work-related musculoskeletal disorders among health care professionals: A cross-sectional assessment of risk factors in a tertiary hospital. *Indian Journal of Occupational and Environmental Medicine*, *18*(2), 75–81. doi:10.4103/0019-5278.146896

Zhao, S.-H., Shi, Y., Sun, Z.-N., Xie, F.-Z., Wang, J.-H., Zhang, S.-E., … Fan, L.-H. (2018). Impact of workplace violence against nurses' thriving at work, job satisfaction and turnover intention: A cross sectional study. *Journal of Clinical Nursing*, *27*(13-14), 2620–2632.