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Application of digital technologies in nursing practice: Results of a mixed methods study on nurses' experiences, needs and perspectives

Digitale Pflegetechnologien: Ergebnisse einer Studie mit Mixed-Method-Design zu den Erfahrungen, Bedarfen und Perspektiven von Pflegefachpersonen

Editor's Choice

Kathrin Seibert[a,b,*], Dominik Domhoff[a,b], Kai Huter[a,c], Tobias Krick[a,c], Heinz Rothgang[a,c], Karin Wolf-Ostermann[a,b]

[a] *University of Bremen, Faculty 11 Human and Health Sciences, Bremen, Germany*
[b] *Institute for Public Health and Nursing Research (IPP), Grazer Str. 4, 28359 Bremen, Germany*
[c] *Research Center on Inequality and Social Policy (SOCIUM), Bremen, Germany*

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ABSTRACT

Introduction: Even though the importance of nurses' participation in the process of technology development is frequently stressed by stakeholders, participation has been described as negligible and limited by nurses' abilities to identify and communicate their needs and ideas for application scenarios or the improvement of digital nursing technologies (DNT) in everyday care practice. Prior research often uses hypothetical scenarios or laboratory settings with little real-world relevance, and the number of studies investigating needs for technology development, application scenarios or requested technologies from the perspective of nurses with experience in technology use is exceedingly small. Against this background, this study aims to investigate needs, application scenarios and perspectives of nurses with practical experience in real-world DNT application in a range of different care settings.

Methods: An explanatory sequential mixed methods design including an online survey (QUANT) and focus group (FG) discussions (qual) was used to explore nurses' perspectives and experiences. A convenience sample of participants was accessed via 19,000 e-mail contacts of directors of nursing (DONs) in care facilities and hospitals throughout Germany. Preliminary results of the online survey were discussed and elaborated in depth in three FGs. Quantitative results of the online survey were included in the development of the interview guideline for and data collection from the FGs. Descriptive, setting-specific analysis was conducted for quantitative data, and qualitative data was analysed by identifying key aspects.

Results: A total of 1,335 participants took part in the online survey, most of whom worked in ambulatory care institutions and held management positions such as DON or team leader. There were 14 FG participants. Ninety-five per cent of the participants of the online survey reported having experience in the use of DNT, predominantly with information and communication technologies (ICT). Overall, DNT were deemed to make work easier, and participants concurred on other positive effects such as increased efficiency or saved time and improved quality of care. Negative effects or concerns were reported less frequently. Reasons for non-adoption included technology-related (e.g. usability, functionality) and non-technology-related (e.g. competencies and context factors) issues, and facilitators for adoption were discussed in the FGs. Key aspects of application scenarios were enhanced technological support of direct nursing care tasks to reduce physical burden and mental stressors. Specifically, participants of the FGs expressed their wish for participative development and a general openness for nurses to be included in the development and testing of digital technologies.

Discussion and conclusion: Although efforts in development, research and theory-building have been increasing over recent years, DNT that go beyond more traditional or common applications within the ICT category (such as electronic nursing records or process planning) are rare. There are already technologies available for many of the expressed needs for which, however, adoption fails or does not happen. The reported barriers and facilitators indicate issues that should be taken into account when developing

* Corresponding author. Kathrin Seibert. Universität Bremen, Fachbereich 11: Human- und Gesundheitswissenschaften, Institut für Public Health und Pflegeforschung, Grazer Str. 4, 28359 Bremen, Germany.
E-mail: kseibert@uni-bremen.de (K. Seibert).

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DNT for application in nursing practice. The study reveals a distinct need for information, counselling, facilitation and organizational development, and brings to light broad opportunities for the collaborative development of guided DNT implementation and evaluation processes. Future development and research activities should preferably be conducted by interdisciplinary research groups.

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ZUSAMMENFASSUNG

Hintergrund: Die Partizipation von Pflegefachpersonen im Prozess der Entwicklung von digitalen Pflegetechnologien (Digital Nursing Technologies, DNT) und deren Möglichkeiten, Bedarfe und Ideen für Technologieentwicklung zu identifizieren und zu artikulieren werden bisher eher als gering beschrieben. Bisherige Untersuchungen nutzen oftmals hypothetische Anwendungs- oder Laborszenarien von geringer alltagspraktischer Relevanz. Studien, die Bedarfe, Anwendungsszenarien oder Technologiewünsche aus der Perspektive von Pflegefachpersonen mit Anwendungserfahrung erheben, liegen bislang nur in geringem Umfang vor. Vor diesem Hintergrund zielte die Studie darauf ab, Bedarfe, Anwendungsszenarien und Perspektiven auf DNT aus der Sicht von Pflegefachpersonen mit praktischer Anwendungserfahrung über unterschiedliche Versorgungssettings hinweg zu untersuchen.
Methode: In einem explanatorischen sequentiellen mixed method Design erfolgten eine Online-Befragung und Diskussionen in Fokusgruppen (FG). Eine Gelegenheitsstichprobe von Pflegefachpersonen wurde über 19.000 E-Mail-Kontakte von Pflegedienstleitungen (PDL) in ambulanten und stationären Pflegeeinrichtungen und Krankenhäusern in ganz Deutschland zu Teilnahme eingeladen. Quantitative Ergebnisse der Online-Befragung wurden für die Erstellung eines Interviewleitfadens herangezogen und in drei FG vertiefend diskutiert. Quantitative Daten wurden deskriptiv unter Berücksichtigung des Versorgungssettings ausgewertet, qualitative Daten wurden durch Identifikation von zentralen Aspekten zusammengefasst.
Ergebnisse: An der Online-Befragung beteiligten sich 1.335 Personen, die mehrheitlich in ambulanten Pflegeeinrichtungen und in Leitungspositionen tätig waren. 14 Personen nahmen an den FG teil. In der Online-Befragung gaben 95 % der Teilnehmenden praktische Erfahrungen mit DNT an. Dabei überwogen Erfahrungen mit Informations- und Kommunikationstechnologien (IKT). Zusammenfassend wurden DNT als arbeitserleichternd beschrieben. Die Teilnehmenden stimmten weiteren positiven Effekten wie effizienterer Arbeit oder Zeitersparnis und verbesserter Qualität der Arbeit zu. Negative Effekte oder Bedenken wurden hingegen seltener berichtet. Gründe für die Nichtnutzung von DNT beinhalteten technologiebezogene (wie Bedienbarkeit) und nicht technologiebezogene (etwa Kompetenzen) Gründe. Fazilitatoren für die Nutzung wurden in den FG diskutiert. Technische Unterstützung direkter Pflegetätigkeit zur Reduktion physischer und psychischer Belastungen der Pflegenden zeigte sich als zentraler Aspekt für Anwendungsszenarien. Besonders die Teilnehmenden der FG betonten ihren Wunsch nach Partizipation und eine generelle Offenheit gegenüber der Einbindung von Pflegefachpersonen in die Entwicklung und Testung von DNT.
Diskussion und Schlussfolgerung: Technologien, die über eher geläufige Anwendungen im IKT-Bereich (wie elektronische Pflege- oder Prozessplanung) hinausgehen, sind trotz zunehmender Entwicklung, Forschung und Theoriebildung im Kontext DNT in der Pflegepraxis selten. Für viele der geäußerten Bedarfslagen existieren Technologien, deren Implementierung im Alltag scheitert oder unterbleibt. Die erfassten Barrieren und Fazilitatoren zeigen Aspekte auf, die bei der Entwicklung von DNT Berücksichtigung finden sollten. Die Studie zeigt einen deutlichen Bedarf an Information, Beratung, Prozessbegleitung und Organisationsentwicklung auf und legt breite Möglichkeiten für eine kollaborative Entwicklung von begleiteten Implementierungs- und Evaluationsprozessen von DNT offen. Zukünftige Entwicklungs- und Forschungsaktivitäten sind bevorzugt durch interdisziplinäre Forschungsgruppen umzusetzen.

Introduction

Over the past few years there has been an increase in funded research and development for the application of digital technologies in nursing practice (digital nursing technologies, or DNT). This has notably been driven by socio-cultural and demographic challenges of an ageing society in Germany. In addition, a lack of qualified nurses, but also advances in technological development [1–3], and increased complexity in the organization, coordination and implementation of care processes for care-dependents have stimulated the development of DNT (see [4–8]). Nurses themselves, however, have rarely been the direct addressees of technology development, which often rather targets the persons in need of care or support. Empirical findings on nurses' experiences with DNT in Germany mainly report technological readiness, commitment and acceptance of technologies as well as competencies and user experience [1]. Evidence on the effects and efficiency of DNT on direct nursing care in daily, non-laboratory care practice settings is scarce [5,9]. Moreover, only a small amount of available (inter)national research consists of studies with a high level of evidence, and findings on causal and inter-relational relationships are largely yet to be disclosed [1,5,10]. Professionalization theoretic, sociological or ethical considerations on nursing care have also been taking up the ongoing scientific discourse on the topic [11,12]. Possible applications for DNT are manifold, and currently there is still no internationally established classification for types of technologies. Of all varieties of DNT, information and communication technologies (ICT) can be considered the most researched branch of technology and most likely to have been adopted by nursing practice so far [5].

Furthermore, there seems to be an ambivalent relationship between nursing and DNT. Even though existing technical assistance systems have been available for application in nursing care for quite some time now, their uptake in nursing practice has been described as slow and selective [1,4]. Scepticism, reservations and rejection by nurses and decision makers (e.g. [4,6,13]) stand in contrast to curiosity, positive attitudes and an understanding of DNT as an opportunity [1,2,13,14]. Even though developers

have been coming up with demand-tailored technical solutions, they often remain singular solutions, and technology development has been described by nurses as out of line with the reality of daily nursing care [1,2,4,6]. There are ample descriptions of factors conducive to the successful, sustainable use of DNT; nevertheless, widespread, routine use in nursing care is missing. Restricting context factors, insufficient overarching concepts for technology implementation, and nurses' attitudes and characteristics as users influence the utilization of DNT in nursing practice [1,2,4,9,15,16]. The (non)inclusion of nurses in the development of technologies so far may have contributed to the slow pervasion of DNT in nursing practice.

Even though the importance and relevance of nurses' participation in the process of technology development is frequently stressed by developers, scientists and funding bodies, their actual participation has been described as negligible and limited by nurses' abilities to identify and communicate their needs and ideas for application scenarios or improvements to DNT in everyday care practice [1,6]. It should also be noted that prior research often uses hypothetical scenarios or laboratory settings with little real-world relevance, and the number of studies investigating needs for technology development, application scenarios or demanded technologies from the perspective of nurses with experience in technology use is exceedingly small.

Against this background, this study aims to investigate needs, application scenarios and aspects of technology use from the perspective of nurses with practical experience in the real-world application of DNT in different care settings in order to identify facilitators for the pervasion of DNT. Besides findings on the pervasion of DNT in Germany and the effects experienced by nurses working with DNT, nurses' experience with the adoption and non-adoption of DNT as well as their needs and ideas for DNT development were of interest in this study. The following research questions guided the study:

1. Which digital technologies are currently used in institutions of ambulatory and stationary long-term and acute care in Germany?
2. How do nurses rate digital technologies known to them in terms of their effects on nursing care practice?
3. What experiences with the application of digital technologies do nurses describe?
4. What reasons do nurses give for the non-adoption of digital technologies?
5. What are recurring problematic aspects of nursing care practice (not including digital technologies)?
6. What starting points and development potentials can be identified for the application of digital technologies in nursing practice?

The focus on the perspective of nurses is of particular interest in the light of the lack of evidence from national studies on needs and application scenarios for DNT, and is of value for developers and decision makers alike.

Methods

Study design, definition of digital technologies and reporting

An explanatory sequential mixed methods design was used to explore nurses' perspectives and experiences. By combining quantitative and qualitative methods of data collection and analysis, such a design promotes a complex approach to the research topic and a deepened understanding of the object of investigation [17]. Figure 1 shows the sequence of methodical steps of this study over time. The main components of the study are an online survey (representing the quantitative (QUANT) element of the design), the results of which lead to the development of a semi-structured interview guideline, which was subsequently used in focus group discussions (representing the qualitative element (qual)) to deepen our understanding of the quantitative results. Methods for both components are summarized below.

For the purpose of this survey, DNT are defined as interconnected or intelligent (i.e. equipped with sensors and/or actors) technological, electronic applications, assistive devices or solutions for supporting nursing care. Exclusively mechanical/electrical (assistive) devices and medical technologies such as imaging diagnostic or invasive technologies were of no interest in this study.

The reporting follows the guidelines provided by the consolidated criteria for reporting qualitative research (COREQ) [18] and the criteria on mixed methods reporting given by O'Cathain et al. [19].

Execution of the sequential approach

Building on systematic literature searches to classify technology categories within the study (results have been published elsewhere [5]), we conducted a rapid review. We screened published empirical evidence from Germany to summarize national needs assessments and the evidence base of DNT as well as to inform the operationalization of the survey items used in this study. The databases Pubmed and LIVIVO were searched for publications in German or English language available from the year 2000 onwards. Besides the evidence base, methodical aspects that indicated promising recruitment strategies and relevant instruments to facilitate generalization and comparability of survey items were of particular interest. Alongside expert interviews with actors from (nursing) science and practice, these preliminary works contributed to the construction of an online questionnaire which was pretested in terms of comprehensibility and duration of participation. The final online questionnaire consisted of 21 closed-ended and 10 open-ended items and took about 30 minutes to complete. Besides questions on experience with DNT and socio-demographic characteristics, the questionnaire contained a scale for rating DNT and their effects on nursing practice following Bräutigam et al. [13]. This scale was used to rate one random category of technology with which nurses reported having had experience. As a brief measure of technology commitment the scale developed by Neyer et al. [20] was employed to attain comparability of the results with prior national research. Quantitative data was collected from March to May 2019 in an online survey using EFS SURVEY version FALL 2018, in a convenience sample of nurses and nurse leaders in nursing homes, ambulatory care services, day care centres and hospitals throughout Germany who reported on their practical experience using or testing digital technologies on a regular basis in nursing care. Participants were accessed via 19,000 e-mail contacts of directors of nursing (DONs) in care facilities and hospitals in throughout Germany. Recruitment for the survey was further supported through the promotion of the study by nationwide associations of care providers and interest groups as well as the promotion of the study at two leading national nursing conferences and through personal contacts of the study team members. Descriptive analysis of the closed-ended items of the online survey included setting-specific stratification and was conducted using statistical analysis software R version 3.6.1. Open-ended items were summarized in the style of a content analysis deductively structured by the single questions of the survey, but allowing for an inductive generation of categories using the software MAXQDA 2018.

The preliminary results of the online survey were discussed and elaborated in-depth in May and June 2019 in three focus groups

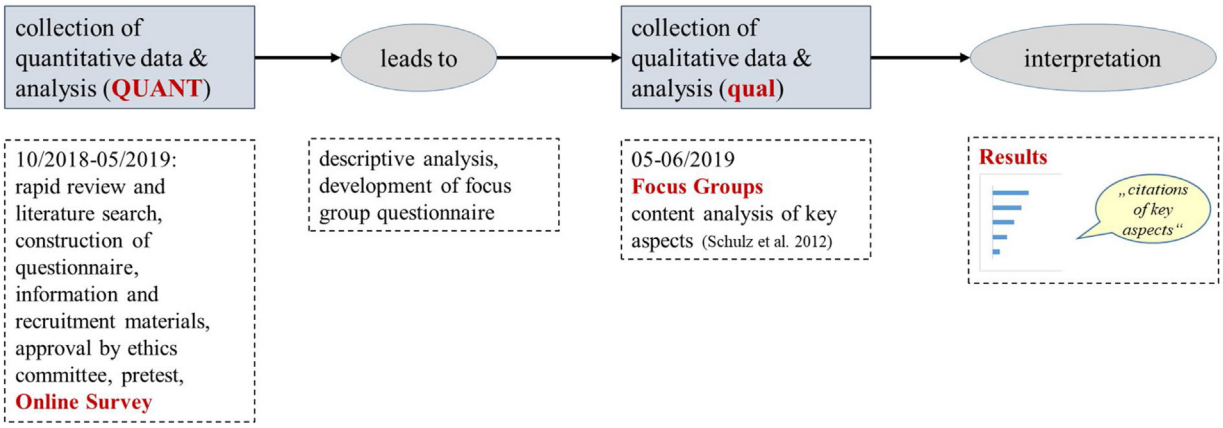


Figure 1. Sequence of methodical steps in the study process.

(FGs) whose participants were recruited from the participants of the online survey. All participants of the online survey who had given consent to be contacted by the study team for further participation in the study and who had submitted a valid e-mail address (n = 67) were invited to take part in the FGs and received information on content and consent via e-mail. An interview guideline was developed which entailed discussion generating questions on four topics (future perspectives, DNT in daily nursing practice, non-adoption of technologies and effects on daily nursing practice). To facilitate comparability of results and orientation for the two members of the study team who guided the discussions (KS, DD), the interview guideline was included in a structured sequence plan for the FGs which also contained instructions on moderation and use of stimuli. To generate discussion, results of the online survey were presented and visualized in single-page hand-outs and presentation slides for each topic. Introductory questions for each topic were presented to each of the three FGs as well as further flexible questions in line with methods described in Schulz et al. [21]. The FG sessions lasted between 2¾ and 3 hours and took place at public locations in the north, east and south of Germany with only the participants and the interviewers being present. After a brief personal introduction of the participants and researchers, including information on the latter's personal interest in the topic and reasons for conducting the study, one member of the study team guided the FGs, while the other wrote minutes. In addition, digital audio recordings and hand-written visualizations of key aspects of the discussion secured the results of the discussion. Participants also each filled in a paper-based socio-demographic questionnaire. Analysis of the FGs followed a deductive approach, which included the identification of key aspects from the digital audio recordings and hand-written minutes. As described by Schulz et al. [21], minutes and hand-written documentation were structured along the guiding questions of the FG and synoptically combined in an Excel-spreadsheet, which was then transferred into a category system using MAXQDA 2018. One member of the study team (KS) developed the initial category system and the other (DD) assessed the initial categories for plausibility and comprehensiveness. Finally, the audio recordings were replayed to ensure integrity. The resultant material was then structured and summarized using the key aspects method [22,23], i.e. an aspect of the discussion repeatedly addressed by the participants across the FGs was rated as a key aspect and illustrated by prominent anchor-citations transcribed from the audio recordings.

Synthesis of quantitative and qualitative results and researchers' background

Quantitative results of the online survey were included in the development of the interview guideline and data collection of the FGs (Mixing [17]). Results for the QUANT and the qual strand of this study are reported complementarily in relation to the research questions given above. As the online survey and the FG were conducted in German, results were initially compiled in German and then translated to English for publication. Primary translation was performed by the authors responsible for data collection and analysis and then validated by a third party native speaker with the same institutional background as the authoring team, who had access to the German language results. The study design was conceptualized by the authoring team, which comprises health, nursing and social science researchers with comprehensive expertise in conducting quantitative and qualitative research. The authors primarily responsible for data collection and analysis (KS, DD) both hold a nursing degree and have been working in different clinical settings for acute in and outpatient care. They have conducted prior research in and on the German long-term care system and have gained expertise in quantitative and qualitative research methods over several years.

Ethical aspects and consent

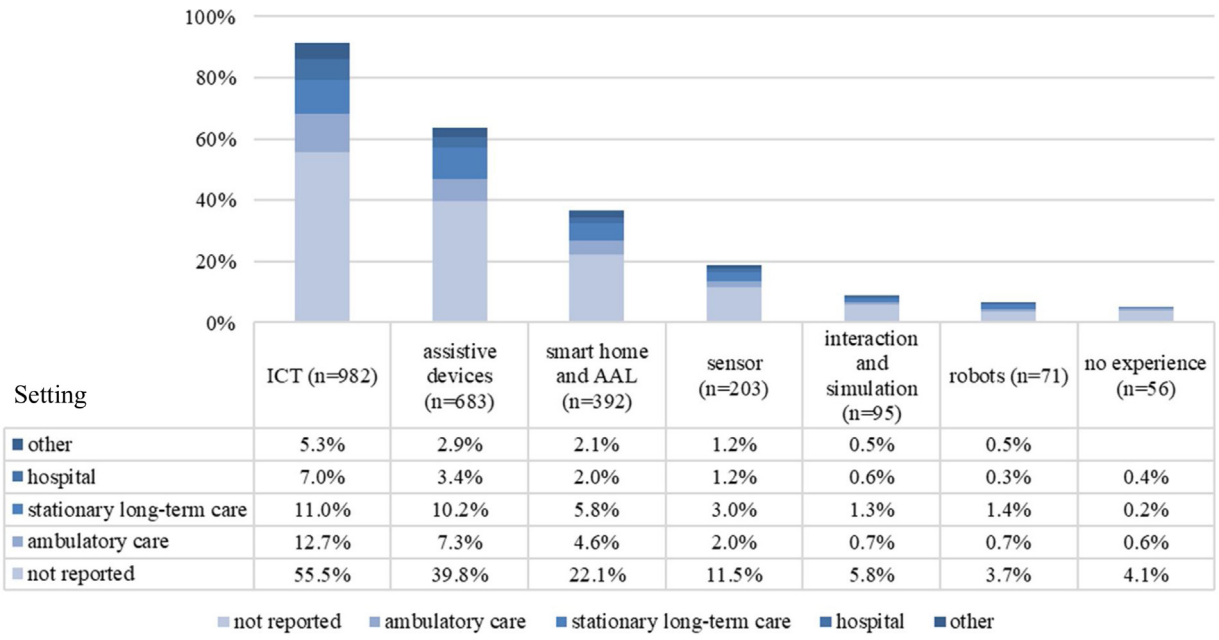
Participation was voluntary; all participants received comprehensive information on all parts of the study and were only eligible for participation after giving written informed consent. Participants of the online survey were completely anonymous to the study team. The FG participants submitted contact information through an online questionnaire not linked to the answers of the online survey. Answers and citations of the FG were pseudonymised for data analysis and are reported anonymously. Each FG participant received reimbursement for their travel expenses, which they had not been informed about when invited to take part. The study was approved by the ethics committee of the German Society of Nursing Science (DGP e.V.) on 4th March 2019 (application no. 19-001).

Results

Results are presented in relation to the research questions given above. Where appropriate, results of the online survey are supplemented by results of the FGs. As the analysis of the online survey did not show a setting-specific trend, a differentiation according to setting will only be presented for the results on the current use of technologies.

Participants' characteristics

Depending on filters and answering options, the reported number of answers for single items may vary. The online survey was accessed 4,000 times, and 1,335 persons provided answers on their



Setting	ICT (n=982)	assistive devices (n=683)	smart home and AAL (n=392)	sensor (n=203)	interaction and simulation (n=95)	robots (n=71)	no experience (n=56)
other	5.3%	2.9%	2.1%	1.2%	0.5%	0.5%	
hospital	7.0%	3.4%	2.0%	1.2%	0.6%	0.3%	0.4%
stationary long-term care	11.0%	10.2%	5.8%	3.0%	1.3%	1.4%	0.2%
ambulatory care	12.7%	7.3%	4.6%	2.0%	0.7%	0.7%	0.6%
not reported	55.5%	39.8%	22.1%	11.5%	5.8%	3.7%	4.1%

Figure 2. Nurses' experience with certain groups of digital nursing technologies, differentiated by place of work, multiple selection possible, online survey (n = 1,074).

experience with DNT. About one third of participants provided information on socio-demographic characteristics and type of work setting. They came from all over Germany, the majority working in ambulatory care institutions (35.3 %, n = 144) followed by inpatient long-term care institutions (30.1 %, n = 123), run by non-profit organizations in 45,8 % of cases (n = 187 of 408 answers). Of the responders, 70.4 % (n = 280 of 398 answers) were female, 40.6 % held a management position (n = 202 of 497 answers) and about half (50.6 %, n = 198 of 391 answers) had been working in nursing for more than 20 years since obtaining their first formal qualification. The scale of a brief measure of technology commitment, the participants showed a more positive attitude towards DNT as an overall trend.

Fourteen persons from the invited sample of 67 took part in the FGs. The sample of participants from seven federal states largely corresponds to the characteristics of the participants of the online survey. Half had been working in nursing for more than 20 years and now worked in an ambulatory care setting. Mostly female nurses holding management positions took part, and institutions run by private providers predominated in the sample. All FG participants had had experience in implementing DNT in the work setting and had either been monitoring these implementation processes or had been members of a health care team faced the implementation and application of DNT. These technologies included mobile tracking of ambulatory care distribution, tablet applications for support and occupation of care-dependent persons, and self-guided learning for nurses as well as e-learning platforms, ICT (electronic patient/care records), motion sensors, emotional robots (namely the robotic seal PARO, a type of social assistance robot that is being applied as an elderly care intervention which aims at evoking positively connotated experiences through interaction [24]) and voice recognition software.

Appendix A shows sociodemographic characteristics of the participants of the online survey and focus groups.

Current use of digital technologies

The vast majority (94.8 %) of the 1,074 participants of the online survey reported having had experience with the application of DNT in their respective clinical practice settings. Figure 2 presents results on nurses' experience with six overarching types of DNT relating to the clinical practice setting. Figure 3 differentiates these results by specific types of technologies in the overarching categories. Experience with ICT was reported by 91.4 % of nurses. In the ICT category, experience with electronic patient/care records and electronic planning of care processes in ambulatory care prevailed at over 70 % of the given answers. Experience with assistive devices was reported by 63.6% of nurses, sit-to-stand aids and support for heavy-load tasks being the predominant technologies in this category. About one third of nurses reported experience with smart home/Ambient Assisted Living (AAL) technologies, which mainly include safety and lighting technologies. The sensor category was reported by 18.9 % of nurses, with 12.1 % reporting experience with wearable sensors, while ambient and other sensors were reported less frequently. Less than 10 % of nurses had had experience with robots or simulation and interaction technologies. Specific technologies from the robot category were reported by a maximum of 26 persons, who referred to emotional robots (mainly PARO). Fifty-six participants reported having had no experience with the application of digital technologies in nursing practice, concluding the online survey with this statement.

Effects of digital technologies on nursing care practice

The participating nurses were asked to rate one randomly selected technology, chosen from the categories listed in Figure 3, that they reported using in their daily practice. This was done by 667 participants. Figure 4 shows the results for the overall rating of DNT. In addition, Appendix B shows the results on technology rating differentiated by technology category, which will be briefly summarized here. Across all categories, nurses reported that DNT tend to make their work easier and tended to agree or agreed with other positive effects such as an increase in efficiency, saving time- and improved quality of care. The effect of easing the work was most prominent with assistive devices. Effects of technologies on the independent planning of work tasks were rated diversely and with no clear trend. Participants tended to disagree with negative effects such as an increased feeling of control and frequent work disruptions. Diverse answers were given to the question whether a technology substitutes single tasks of nurses' work but they can

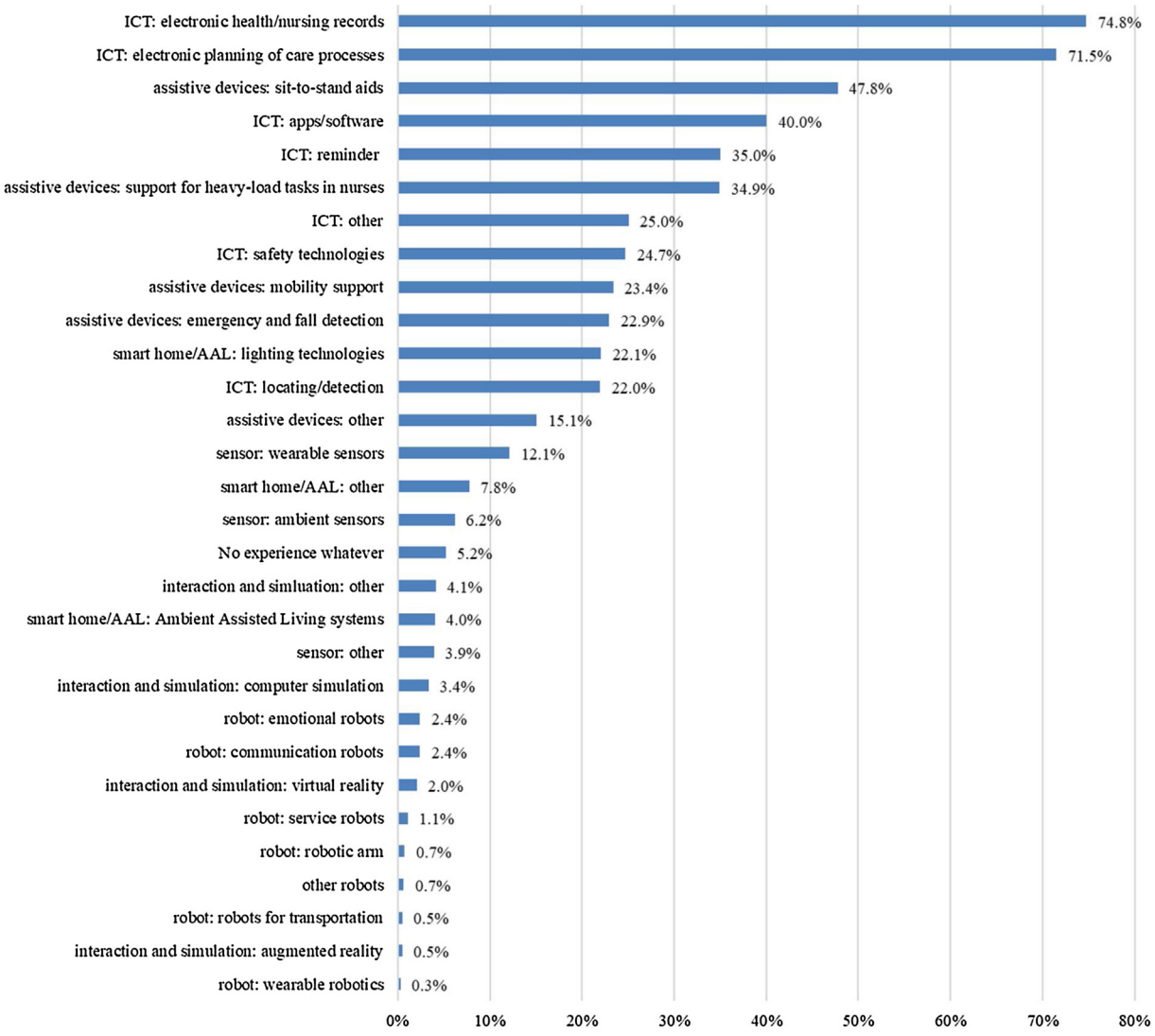


Figure 3. Experience differentiated by single technologies, multiple selection possible, online survey (n = 1,074).

be summarized as a neutral rating with a tendency to agree more in the case of ICT. The question whether technologies would lead to the obsolescence of their own work in the future was rated as not applicable by the majority, with another large section of participants disagreeing or tending to disagree. Communication and collaboration within the nursing team and with other health care professionals is generally seen to have improved through ICT, though some participants disagreed. The application of robots is seen to improve communication and collaboration between nurses and patients/care-dependent persons.

The FGs were used to identify desired and experienced effects in nursing practice, and also criteria relevant to the participants for deciding whether a digital technology should be implemented. Sixty-one aspects of the FG discussions were grouped into 15 categories, of which 13 were considered key aspects of the discussion on effects of digital technologies on nursing care practice. Appendix C presents the coding tree for all topics and grouped aspects of the FGs. Table 1 shows categories, the number of grouped aspects and anchor-citations for each category. Participants discussed their experiences with the effects of new forms of communication and information transfer. Desired effects of any technology used were described as a decrease in nurses' physical and psychological burden and an increase in saved time that can then be applied to direct care activities. Clinical outcomes such as pain relief and improved well-being as well as assurance of patients' care processes by sharing and assessing digital data were also deemed desirable. Effects of technology use on the quality and distribution of work were considered relevant or desired, while the concept of quality remained rather vague. Criteria for adoption and non-adoption focused on benefits gained, which mainly translated to any form of reduced workload. In addition, the absence of work disruptions by the technology and an overall simplicity of use were regarded as essential for adoption.

Reasons for non-adoption of digital technologies

Out of 662 participants in the online survey, 33.5 % had experienced a DNT procured for testing or permanent use being rarely used or left unused. The most technology-related reason for non-adoption, given by 58 % of 180 responders, was that the technology did not seem user-friendly. The next most common reason given was a non-evident benefit of the technology in everyday practice (35 %) (Figure 5). Non-technology-related reasons included lack of acceptance of the technology by nursing staff (70 %), lack of technology competencies (48 %) and lack of acceptance of the technology by patients/care-dependents (35 %) (Figure 6).

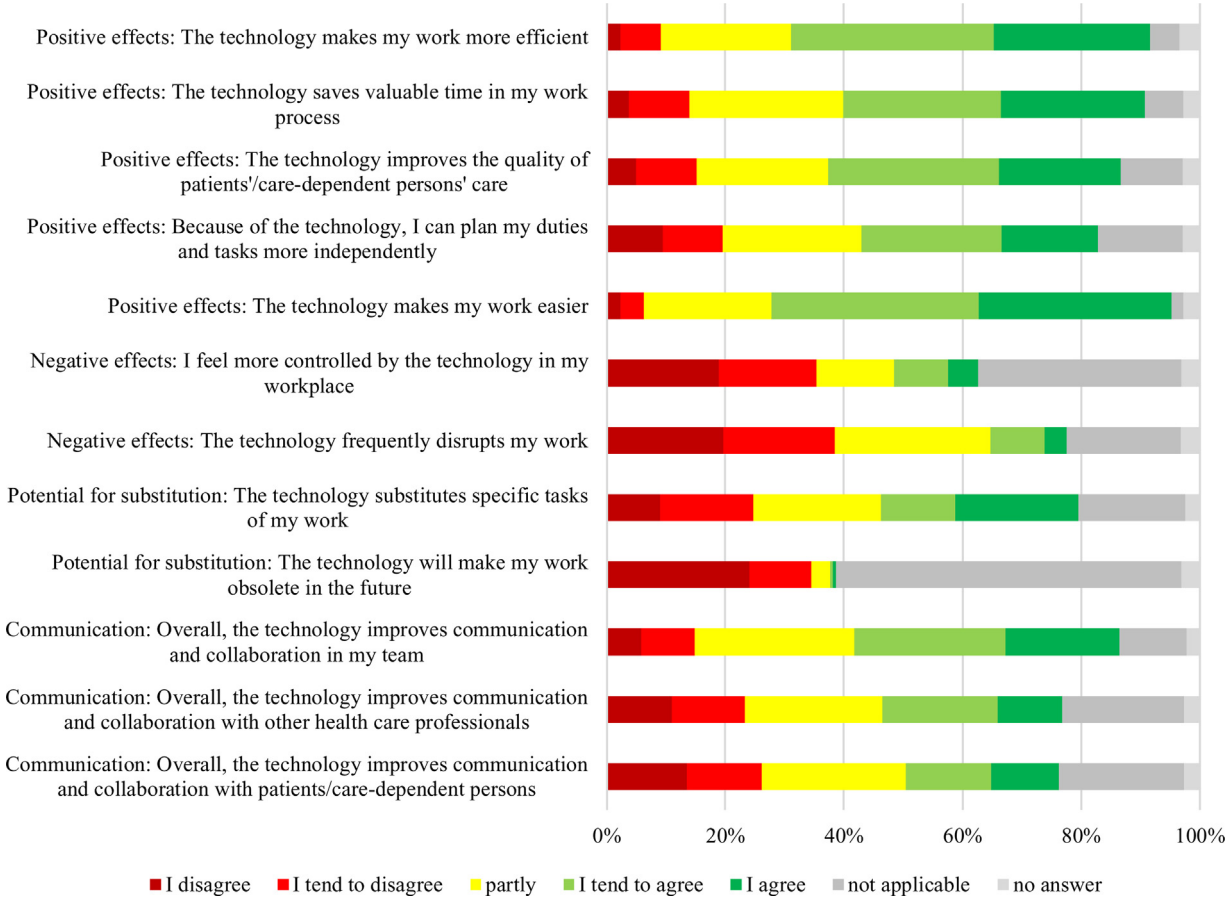


Figure 4. Rating of technologies used in clinical practice, online survey (n = 667).

Technology-related and other reasons for non-adoption and facilitators for adoption of digital technologies in the workplace were discussed in depth in the FGs. Eleven categories emerged as key aspects in this respect (Table 2). Aspects describing technology-related reasons for non-adoption and adoption included functionality as well as design and usability of DNT. From the participants' viewpoint, DNT are more likely to be adopted when they cater to the individual needs of an organization (especially software), are uncomplicated and easy to use, have been developed collaboratively with participating nurses, and are provided with an on-going support package. Adoption is also facilitated if nurses are included in the decision to adopt a specific device, giving them opportunities to get used to new technologies and a guided, customized implementation process. Participants frequently addressed nurses' and patients' reservations and (limited) competencies as barriers to adoption, and highlighted the role of leadership and management style as an indicator for both non-adoption and adoption. Further aspects relate to context factors such as time needed for implementation processes and the potential need for a legal regulation on the use of technology in nursing. Meaningful application scenarios were also brought up: If nurses are unable to integrate a new DNT into on-going work processes and lack the skills and (where needed) creativity to operate interventional technologies as intended, it seems likely that such technologies will be used less often or remain unused. The same holds true for technologies for which the application is perceived to be time-consuming and without any evident benefit compared to analogous/already existing devices.

Recurrent problematic aspects of nursing care and development potentials for the application of digital technologies in nursing care practice

Participants in the online survey and the FGs were asked to describe and prioritize areas of daily nursing care practice with recurrent problematic/challenging situations – without a specific DNT already known to them or envisaged by them that might solve or alleviate this problem. For problematic situations concerning the patients/care-dependent persons themselves, 416 participants of the online survey prioritized the aspects of mobility (n = 283, 68.0 %), cognitive and communicative functioning (n = 238, 57.2 %) and behaviour and mental health problems (n = 221, 53.1 %). For the nurses themselves, 432 participants prioritized mental burden (n = 363, 84.0 %), physical burden (n = 363, 84.0 %) and intensification of work tasks (n = 320, 74.1 %). For the process of communication and organization at the workplace, 398 participants prioritized communication processes involving other health care professionals (n = 215, 54.0%), members of the nursing care team (n = 174, 43.7 %) and patients' relatives (n = 158, 39.7 %).

Participants of the FGs agreed with the results of the online survey and predominantly described recurrent problem areas in everyday practice for which they wished for timely and occasion-related future applications of DNT (Table 3). Especially support in direct patient care was of interest for them and they voiced needs and ideas targeting nurses' physical and mental support, such as robotic assistance for heavy-load tasks, or ideas for the use of patient data and the improvement of intersections in

Table 1
Categories, number of grouped aspects and anchor-citations for effects on nursing practice, focus groups.

Category* (Number of grouped aspects)	Anchor-citation
Process: Securing health care (n=4)	*"When digital data is used to make health care safe [. . .]). Ensuring that the doctors' appointment isn't forgotten, [. . .] that a new pack of pharmaceuticals is procured before the old one runs out [. . .] enhanced safety [. . .] when the doctor is regularly informed about a new prescription working or not." FG2, social care worker, ambulatory care*
Process: Storage & transfer of information (n=3)	*"That I have everything at a glance. [. . .] I can just look it up in the electronic records." FG2, social care worker, ambulatory care*
Outcome: nurses' psychological relief (n=9)	*"When using the technology, it should relieve work stress for me" FG1, DON, ambulatory intensive care*
Outcome: nurses' physical relief (n=7)	*"What is also important for me in a digital technology: Will physically burdensome tasks be reduced by it?" FG2, nursing team leader, psychiatric acute care*
Outcome: Storage & transfer of information (n=6)	*"This [technology] notably eased collaboration so that nurses didn't feel as if they hadn't been informed or were ill-informed [. . .] it improved communication within the team so that everyone was on the same page regarding information." FG1, manager in ambulatory care*
Outcome: Time: savings & utilization (n=6)	*"That I save time by using the technology, that I can use up for clients or residents [. . .] and be able to talk to them a little more than I am usually able to do." FG1, DON, ambulatory intensive care*
Outcome: Patients: clinical outcomes (n=5)	*"To use an assistive device in such a way that [the care-dependent person] is free of pain, [. . .] that I don't have to yank at them. [. . .] This way they are not afraid and feel comfortable." FG1, DON, long-term care*
Outcome: distribution and organization of work (n=2)	"That [work] no longer intensifies for individual nurses but is distributed better within the organization." FG3, nursing team leader, acute orthopaedic care
Quality of work (n=2)	*"[. . .] the quality of work is improved and the human error factor is reduced to a minimum." FG1, manager, ambulatory care*
Criteria for adoption: requirements on the technology (n=6)	*"Making work easier is a positive criterion for adoption" FG3, nursing team leader, acute orthopaedic care* *"The technology needs to be effective and easy to use. So that anybody can use it easily."*
FG1, DON, ambulatory intensive care	*"„For me, whether or not [DNT] disrupts workflow is very important. [. . .] That is a good reason for deciding whether to use something or not." FG1, nurse, acute geriatric care*
Criteria for adoption: Requirements on implementation (n=3)	*"How much time does the implementation take and how much time does the application in practice actually take? How long is a nurse busy when using the technology? [. . .] from an employer's perspective: how demanding is it for me to educate all of my staff, but also how demanding is the application for individual nurses?" FG1, manager, day-care and assisted living*
Criteria for non-adoption (n=3)	*"When I am implementing any product [. . .] if I can't say that all in all it makes work easier somehow [. . .] – and the benefit has to be making work easier – then I wouldn't do it. I have no idea why I should otherwise." FG3, manager, ambulatory care* *"An absolute criterion would be frequent disruption of work. I don't think anybody wants that." FG3, nursing team leader, acute orthopaedic care*
Adverse & non-intended effects (n=3)	*"Misuse of a technology [. . .] when a tablet that's being used to document care provision is used to take pictures and upload them [to the internet]." FG2, social care worker, ambulatory care*

*) excluded, not identified as key aspect: Category "Indicators and measures", category "Outcome: costs: savings & utilization"; DON= Director of Nursing

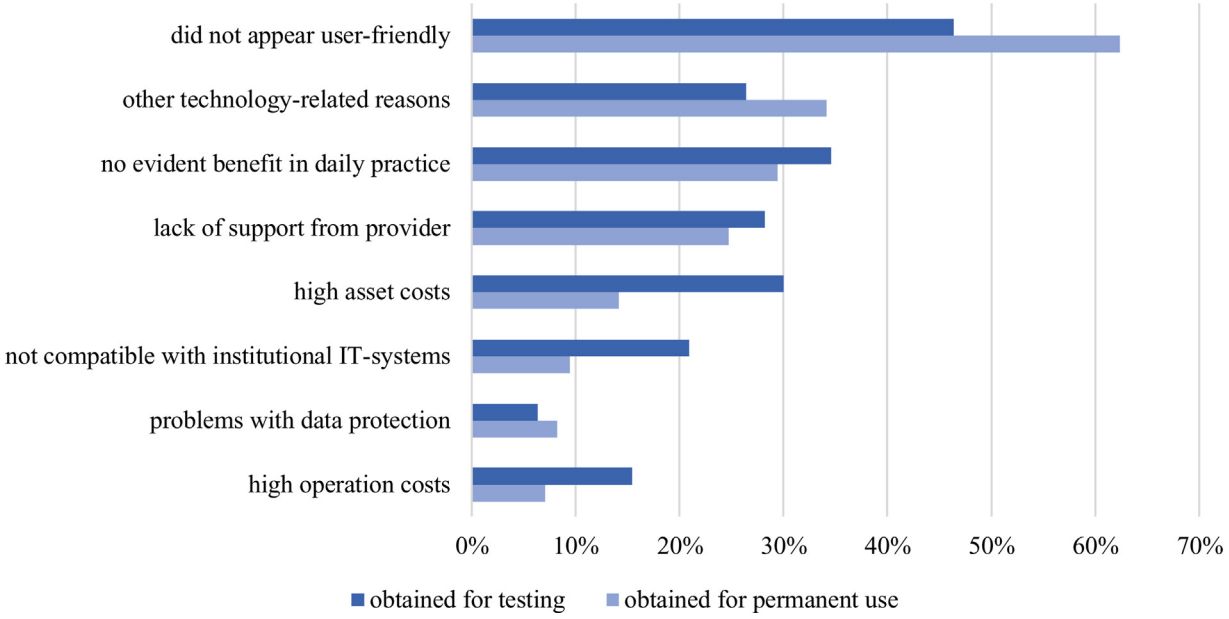


Figure 5. Technology-related reasons for non-adoption, multiple selection possible, online survey (n = 180).

the care-process. The substitution of all tasks that were considered odd-job tasks dealing with supply and disposal of materials seemed favourable but participants also recurred to context factors – mainly a lack of knowledge about already available DNT, a perceived lack of adaptation of technologies used in other contexts, and a lack of suitable implementation strategies, but also a need for digital skills and competencies in nurses, for funding and for organizational development.

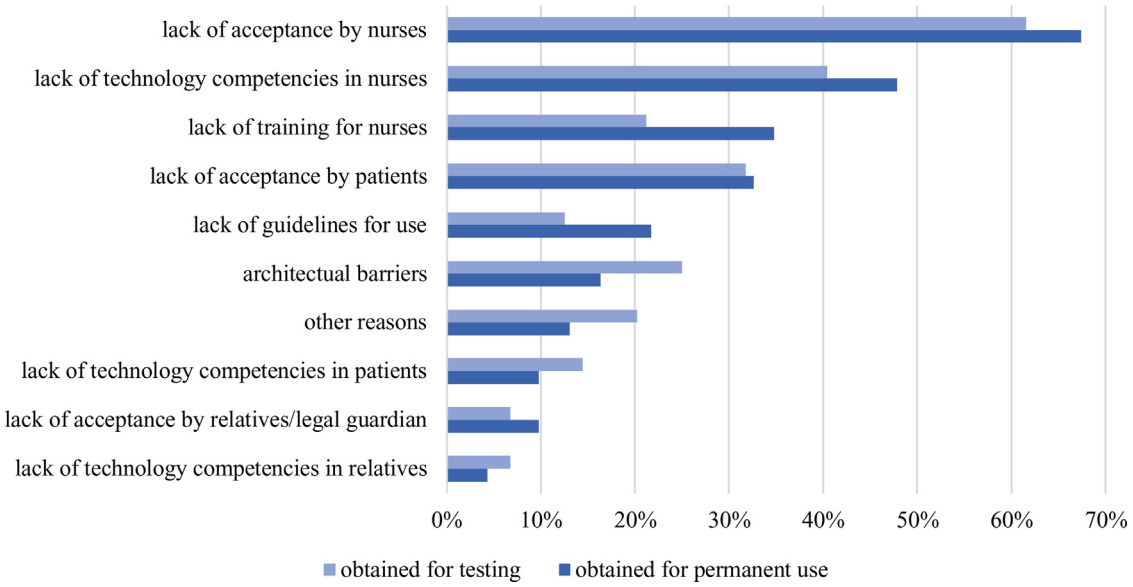


Figure 6. Other reasons for non-adoption, multiple selection possible, online survey, (n = 180).

Table 2
Categories, number of grouped aspects and anchor-citations for reasons of non-adoption and facilitators of adoption, focus groups.

Category* (Number of grouped aspects)	Anchor-citation
Nurses' and patients reservations (n=6)	*"Employees' scepticism [regarding a tablet] was a little strong. But in the end, it failed because the residents did not accept it." FG1, manager, long-term care*
Collaboration and Communication with developers/support (n=5)	*"What might also play a part is that it hasn't been developed collaboratively. There really ought to be a nurse expert involved [in the development process]." FG3, nursing team leader, acute orthopaedic care*
Functionality (n=5)	*"I don't know of any computer programme that does it the way I want it to. [. . .] I want a simple solution, which isn't there. And then I start drawing up excel sheets again." FG3, manager, ambulatory care*
Leadership style and management of an institution (n=4)	*"Two, three people favoured [the technology] and they had connections to the management board. [The technology] was purchased and everyone had to learn how to work with it." FG2, nursing team leader, acute psychiatric care*
Possibilities of use of the technology (n=4)	*"We once introduced this [seal, PARO] to a senior living group. The employees had asked for it, but they somehow couldn't apply it as an intervention in a meaningful way. It was there for two weeks and activities were organized together with the residents, but the seal was described as dull and uninteresting. So we got rid of it again. The provider even came for a day to work out application scenarios with them." FG1, DON, long-term care*
Design and Usability (n=3)	*"The technology must be foolproof!" FG1, manager, ambulatory care*
Essential context factors (n=3)	*"The time needed [to train nurses in the use of the technology] is not considered at all, but it should be. I cannot just take it out of the budget for further education and training. This is two weeks of lost working time otherwise spent on direct patient care. This time should be reimbursed separately." FG1, nursing team leader, acute psychiatric care*
Complexity (n=2)	*"It was so complex that in a way it overwhelmed our care assistants." FG2, social care worker, ambulatory care*
Facilitators (n=2)	*"I always had been more success when there was a choice. I had different devices at hand and decided [together with the employees]: Which one makes sense? Which is easy to operate? Which has more visual appeal? With which one do you feel confident? And the ones that we picked together as a team were the ones that were better accepted." FG1, DON, long-term care*
Alternative (analogue) solutions (n=2)	*"I get him out of bed faster on my own than I would using the assistive device." FG1, DON, intensive ambulatory care*
Implementation (n=2)	*"The technology itself is good, but the time needed to train people to use it properly isn't there. Nothing works by itself. Nothing is user-friendly if you don't engage with it." FG2, social care worker, ambulatory care*

*) excluded, not identified as key aspect: Categories "nurses competencies", "Structure: architectural context", "Regulations on data protection", "Costs"

FG participants furthermore specified desired applications of DNT (Table 4), and described application scenarios for technologies supporting clinical decision processes and allowing autonomy in nurses' actions without the need to directly contact other health care professionals. They also envisaged technologies supporting communication and enabling work processes to be organized on a care and case mix basis, reducing uncertainty in unforeseeable everyday tasks, e.g. by making reasons for patient alarms more transparent. Ideas for monitoring and self-guided attendance in nurses' further education were also expressed, and the patients' perspective was taken up in discussions about restricted mobility in rural areas, the need for an organization that pools information on available DNT, and the functionality of devices primarily developed for a care task taking the perspective of both nurses and patients into account.

Out of all aspects, the categories listed in Table 5 comprise those aspects rated most important by the FG participants themselves. They articulated and emphasized especially the importance of the inclusion and participation of nurses in the development process. Understanding and experiencing nursing care practice and the

Table 3
Categories, number of grouped aspects and anchor-citations for future of application of digital technologies, focus groups.

Category* (Number of grouped aspects)	Anchor-citation
Situative support (n=27)	*"A fully digitalized patients' room [. . .] where I can work with a hologram [. . .] where data will get projected automatically." FG1, manager, long-term care* *"Can an intelligent system – and I am thinking of artificial intelligence here – help with prioritizing [care tasks in times of understaffing]?" FG3, nursing team leader, acute orthopaedic care* *"I can also envisage offering exoskeletons to my employees to ensure back-friendly positioning and patient transfer." FG2, nurse, acute care*
Data: transfer, sharing and access (n=8)	*"The simplification of points of intersection between health care professionals." FG3, nursing team leader, acute orthopaedic care*
Competencies of users (n=5)	*"Basic knowledge, very simple things in handling computers that the trainee nurses don't know about." FG1, manager, ambulatory care*
Obsolete analogue practice (n=4)	*"Everything that is annoying: all those mundane tasks, cleaning, waste disposal – there's a lot to be automatized. [. . .] Then I would have employees in place who don't do simple tasks that don't need brainpower.ËFG3, Manager, ambulatory care*
Interconnection of technologies (n=4)	*"To not have ONE technology that is an isolated system [. . .] it would be much cleverer to have something where systems and technologies [. . .] communicate with each other." FG1, DON, long-term care*
Patients' needs (n=4)	*"If I want to get what is specifically needed to support an 83-year-old, what will it cost me? Within what timeframe? Which provider would install the full package?" FG1, nurse, acute hospital care*
Information on and rating of products (n=3)	*"That there is an assessment of which assistive device might be suitable when the assessment [for needs according to the statutory nursing care insurance] takes place." FG2, social care worker, ambulatory care* *"Or developers could go to an organization that evaluates [the technology] 'how good is it?' and then it gets implemented. [An organization] that says 'yeah, we are going to push this further, we support that' or 'this already exists'." FG1, manager, day care and assisted senior housing*
Translation and dissemination (n=2)	*"You wouldn't believe how many doctors don't even have an e-mail address you can use to send them something." FG2, social care worker, ambulatory care*
Learning from others (n=2)	*"This already exists [in online wholesale trade]. Why don't we use such intelligent possibilities in everyday practice? [. . .] I know they have it in medical emergency headquarters management: call routing is a case in point." FG3, manager, ambulatory care*
Perception of technology (n=2)	*"Robotics itself is expedient. Not robotics as in fully autonomous, but complementary. Healthcare and nursing will never be without human beings. . .it is practised from human to human, and the machine ought to offer support." FG3, nursing team leader, acute orthopaedic care*
Requirements on technology	*"[Employees] don't want to excessively deal with something to know how to operate it, they want to operate it intuitively." FG3, nursing team leader, acute orthopaedic care*

*) excluded, not identified as key aspect: Categories "data protection", "use of data", "context and politics", "professional image", "innovation", "technologies as preventive tools"

reality of care-dependent persons' daily life was considered crucial for the development of suitable DNT, as was the rating and evaluation of technologies by actual nurses. Participants also expressed the need for a uniform use of terms and concepts when dialogue between developers and nurses takes place, and they pointed out settings they felt were underrepresented in innovation strategies. For instance, they felt that normal acute hospital care is overlooked for intensive care settings. Context factors such as regulations on data protection and reimbursement for institutions or digital infrastructure were considered important, as too were strategies for information and translation of knowledge on available and suitable DNT for professional and public actors. Lastly, participants agreed on highlighting the ethical, legal and social dimensions of DNT as an aspect of special relevance.

Discussion

This mixed methods study investigates needs, application scenarios and perspectives of nurses with practical experience in the real-world application of DNT in a wide range of different care settings.

Regardless of the care setting the participants of the online survey were working in, experiences predominantly existed for ICT, e.g. electronic patient records, process planning and documentation, as well as for assistive devices and smart home/AAL solutions. Experience with sensory, robot and augmented/virtual reality technologies, however, was only sparsely represented in the online survey sample. This finding is in line with results from prior research [2] and upholds the trend of a slow or selective uptake of DNT in nursing practice, even though efforts on funding, development, research and theory-building have been steadily increasing [4].

The overall rating pointed to a sample generally more partial to DNT that had experienced effects such as an easement of work, an increase in efficiency and saved time, and improvements in quality of care, which had also been reported as perceived and/or anticipated in other studies [13]. Participants repeatedly expressed the need for enhanced technological support in direct nursing care tasks in order to reduce physical burden and mental stress. This result may serve as a starting point for collaborative development and the adaption of technologies. But it should also be noted that for a large number of the needs for DNT articulated in this study, solutions are already available. However, implementation and adoption have allegedly failed or not even been attempted [25]. The reported reasons for non-adoption in this study comprise various dimensions. Next to technology-related reasons, such as perceived limitations in functionality or usability and a non-evident benefit of the application, lack of acceptance and competencies of nurses and patients are the dominant reasons for non-adoption. The experiences reported with unsuccessful or failed DNT implementation point to a lack of technologies customized for nursing practice. Along with desired effects and facilitators for adoption (e.g. the level of tailoring of a technology to organizational needs, collaborative development and inclusion of nurses in decision processes on the use of specific devices), the results are in line with findings from research on the development of frameworks to assess adoption and non-adoption of DNT such as the FITT (Fit between Individuals, Task and Technology, [16]) or the NASSS (Nonadoption, Abandonment, Scale-up, Spread and Sustainability, [26]) frameworks, as well as with national studies on technology use in different care settings (e.g. [2,15]). It should be noted that the debate on long-term uptake,

Table 4
Categories, number of grouped aspects and anchor-citations for desired applications of digital technologies in nursing practice, focus groups.

Category* (Number of grouped aspects)	Anchor-citation
Autonomy in action and decision-making (n=6)	*"That is a regular thing [on wards]: an unresponsive person is found on the floor [...] That there are [digital] glasses that [help me to get information and decide what to do]"FG1, DON, intensive ambulatory care*
Communication (n=4)	*"Communicating with other health care professionals. That communication processes improve. You still have to make phone calls all the time nowadays." FG1, DON, intensive ambulatory care*
Care and case-mix adapted organization of work	*"There is a huge problem that can be summarized under the heading [registered nurses], which I would call 'work-time models, absenteeism and turn-over'. I wish for a technological support for care team planning and peaks of care activities, a decision support, we have those care hours and the largest care effort is there and so forth [. . .]. This is what I see in my daily practice: who starts work when and who leaves when?" FG1, manager, long-term care*
Predictive technology	*"Patient alarms [. . .] is it something concerning 'Open that bottle of water for me' or is it something where I need to stop what I am doing immediately because it is urgent. This is why patient alarms are so stressful: because I don't know if it's more important than what I am doing... did a fall occur or did someone jam their fingers in the balcony door or is it something that can wait for ten minutes [. . .] the alarm should have some kind of built-in differentiation. That would be helpful." FG1, DON, long-term care*
Further education	*"I would like employees to be able to engage in their requested further education when their own time management – meaning their work but also private schedule, allows it. By an online tool for example." FG1, manager, ambulatory care*
Functionality	*"Mobilization, when the patient is not independent, a reciprocal relationship. [Technology] is needed on both sides." FG3, nurse team leader, acute orthopaedic care*
Information and consulting	*"From the viewpoint of nurses as well as care-dependent persons seeking advice [. . .] Where can I get it summarized? Where is the central organization for consulting and information? How could an intersection look in that regard?" FG1, manager, ambulatory care*
Mobility in urban and rural areas	*"For me, mobility is a huge problem. Even the person whose functional mobility is limited but who can leave their home on their own but is not able [no longer] to drive a car, in rural areas, public transport might be all right in larger cities but in rural areas it is a nightmare." FG1, DON, intensive ambulatory care*
Management of overlapping care processes	*"[. . .] The topic discharge management [. . .] Which brings us back to intersections." FG3, manager, ambulatory care*

*) excluded, not identified as key aspect: Categories "Assessment", "Administration", "Documentation", "Involvement of communities", "Social Networks", "Contact to (specialist) physicians", "Mobility and transfer"

Table 5
Categories, number of grouped aspects and anchor-citations for highlighted aspects, focus groups.

Category* (Number of grouped aspects)	Anchor-citation
Participation and user perspective (n=9)	*"Product assurance from a nursing point of view is needed. Where nurses evaluate [technologies]. What is feasible on a practical level? This is something that is lacking, though it is usually present in the business economy." FG3, nurse team leader, acute orthopaedic care*
Requirements for technologies and development (n=7)	*"A uniform nomenclature, so that when developers and users talk to each other, they understand each other by talking the same language." FG3, nurse team leader, acute orthopaedic care*
Establishing context factors (n=5)	*"If I want to implement the network everyone is talking about, then an infrastructure needs to be available." FG3, manager, ambulatory care*
Information and translation (n=4)	*"It is important that there is a central organization that provides guidance for interested persons, relatives, on the use of digital technologies. [. . .] Everyone is talking about digitalization but nobody tells you what you can do to use digital technologies in nursing." FG2, social care worker, ambulatory care*
Ethical, legal and social aspects (n=3)	*"Where is the human being in that? How do they feel about it? Big discussion because of this [robotic seal] everywhere. Is it ethically justified?" FG1, manager, long-term care*

*) excluded, not identified as key aspect: Category "Limitations of technology"

non-adoption and abandonment also holds true for other health care technologies and disciplines [26] and therefore should not be considered as a specific barrier/limitation generated by the setting *nursing practice* itself when it comes to facilitating development and research in this field. On the contrary, the reported barriers and facilitators point out issues to take into account when developing DNT for application in nursing practice.

Participants repeatedly stressed the importance of a perceptible benefit from technology use as a criterion for adoption. Said benefit might include various possible outcomes for the care-dependent persons themselves, care providers and overall care provision – all of which should be of interest when evaluating the effects of DNT in the nursing practice setting. This observation prepares the ground for a discussion on the relevance of certain outcomes and suitable research designs to assess them. On one hand, digital technologies hold new possibilities of using real-time data for evaluation and feedback, but on the other hand are often not tested in long-term studies due to the progressive nature of the development process and short product cycles. In this regard, it also needs to be considered, that nurses' might hold high expectations of DNT, that may lead to disillusionment when expected benefits fail to materialize or development of suitable DNT falls short of these expectations. Nonetheless, there seem to be broad opportunities and starting points for the collaborative development of DNT and their guided implementation and evaluation processes, and a distinct need for information, counselling, facilitation and organizational development also emerged from the FGs.

Quite clearly, the desire for participative development and a general openness for nurses to be included in the development and testing of DNT was expressed multiple times, mostly by nurses with additional management responsibilities. This points to an opportunity to include potentially creative, eager users for whom suitable means of involvement and participation beyond laboratory test settings must as yet be considered unexploited [1,13]).

Development of DNT that includes iterative processes of co-creation and participation could meet the participants' desire to be heard and allows a deeper understanding of nurses' (and patients') needs and the reality of daily care practice. This point has previously been described to be of relevance for advancing technology development in nursing practice [1]. In the light of evident shortages of skilled nursing staff in acute and long-term care and proposed models for restructuring staffing levels [27], the implementation of nurse participation, accompanied by a need for pertinent resources, might pose a particular challenge for technology development.

Limitations to the methodical approach of the study need to be taken into account when interpreting the results. Three aspects seem to be of particular relevance in this regard: Mainly nurses with additional or exclusive management roles took part in the online survey and FGs. The recruitment strategy might have contributed to the higher number of DONs and managers, as they were the persons who received the initial invitation to participate and were asked to forward the invitation to employees. About every fifth participant of the online survey represented the group of nurses working exclusively with patients. Assuming that these nurses are the ones most likely to use DNT to support direct care tasks, the empirical findings of this study should not be regarded as conclusive for this group of nurses. Furthermore, the non-topic-specific issue of positive or negative sample selections should be addressed. The recruitment strategy chosen favours participants from institutions with established means of digital communication. The intrinsic motivation to participate mostly remains unknown for the participants of the online survey. The brief measure of technology commitment suggests an overall positive trend on the part of the participants towards DNT. Participants of the FGs reported high motivation and curiosity. It should be borne in mind that diverging – presumably more negative – experiences are missing from the sample. Considering these factors, findings on the quantity of DNT in nursing practice and on willingness to be included in collaborative development may not be representative of the profession as a whole. Nonetheless, findings on reasons for non-adoption and implementation barriers could also be considered as valid, as we regard the included sample as experienced representatives who incorporate observations of their colleagues' interaction with DNT in their answers. Lastly, the chosen definition of digital technologies, which was known to all participants, may have influenced participation and answers. The high proportion of nurses reporting experience with assistive devices might be an indicator that participants of the online survey also included exclusively electrical devices in their answers which we excluded as DNT in this study. It should also be noted that the categories of technologies included in the online survey are partially fuzzy when it comes to participants choosing "other type" in a specific category as an answer. As terms for technologies in a specific category were given by the survey instrument, but no overarching definition of each category was presented to the participants, participants' understanding of the categories remains unknown. In addition, the distinction of the type of technological system versus its function has not been consistently incorporated in the survey items (such as electronic reminders as a function and apps/software as a type of system in the ICT category). A more distinct development of the online survey items would have contributed to the precision of the results in this regard. In contrast to other studies, which often confront nurses with hypothetical scenarios when rating or discussing the application of DNT for nursing practice, this study only included nurses with experience in DNT use in daily practice. This may contribute to a more favourable perspective of nurses towards DNT in this study, but holds the advantage of illustrating the possibilities arising with the application of DNT.

Despite the aforementioned weaknesses of the study, and contrary to reported limitations of nurses' abilities to express their need for technological support [6], participants were indeed able to articulate their needs in daily nursing practice. Notably the qualitative parts of the study helped to bring this knowledge to light and strengthen the case for conducting mixed methods and qualitative research when evaluating complex application scenarios for digital technologies.

Conclusion

This study provides detailed information on the needs, perspectives and experiences of nurses in relation to technology application, endorsing and extending previous empirical findings. Even though efforts in development, research and theory-building have been increasing over recent years, DNT that go beyond more common applications within the ICT category (such as electronic nursing records or process planning) are rare. While 95 % of the participants of the online survey were experienced in the use of DNT, there is great potential for its further development and application. Of particular interest are technologies such as robotic systems that provide nurses with physical support and enhancement, or technologies that generate and/or use patient data to facilitate inter-professional and inter-sectoral communication and optimized care processes. There was clear evidence among a selected group of nurses of their desire for participative development and a general openness among nurses to being included in the development and testing of DNT. There are already DNT available for many of the expressed needs, for which adoption fails or doesn't happen. In combination with the emphasized need for information, counselling and support of processes and organizational development, various potential starting points emerge for future development and research activities, preferably conducted by interdisciplinary research groups. These should also comprise aspects of implementation in daily practice and evaluation of DNT throughout all phases of the technology development process. As this study focused on nurses as participants, future research on DNT should also incorporate the perspectives of other stakeholders such as patients, relatives or policy makers, to contribute to a deeper understanding of the topic. An overarching framework for the evaluation of DNT could support the development, implementation and adoption of digital technologies that cater to the needs of nursing practice.

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Conflicts of interest

The authors declare no conflict of interest.

CRediT author statement

Kathrin Seibert conceptualized aims and research questions in line with the underlying reserach project of this study and the methodological approach, developed the study instruments, collected and analysed quantitative and qualitative data and systematized the results, wrote the first draft of the manuscript and was responsible for revisions of the manuscript.

Dominik Domhoff supported the conceptualization and development of study instruments, collected and analysed quantitative and qualitative data and systematized the results. Read and advised the first draft of the manuscript and especially contributed to the discussion of the results.

Kai Huter advised the methodological approach, contributed to the specification of survey items and read and advised the first draft of the manuscript.

Tobias Krick advised the methodological approach, contributed to the specification of survey items and read and advised the first draft of the manuscript.

Heinz Rothgang is head of the underlying research project and acquired the funding, advised the methodological approach, contributed to the specification of survey items and read and advised the first draft of the manuscript.

Karin Wolf-Ostermann is head of the underlying research project and acquired the funding, advised the methodological approach, contributed to the specification of survey items and the data analysis, read and advised the first draft of the manuscript.

Appendix A, B and C. Supplementary data

Supplementary data associated with this article can be found, in the online version, at doi:10.1016/j.zefq.2020.10.010.

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