Experiences of nurses working at a virtual care centre: barriers and facilitators associated with the use of telemonitoring

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Abstract

Background: The healthcare sector is facing massive challenges for several years now, which is going to exceed in the future. To organize healthcare provision differently, innovative care models, like virtual care centres, are necessary for the accessibility of care. Virtual care centres focus on delivering medical specialist care at home. To establish the delivery from care at home telemonitoring is used. Currently, it is unclear how nurses who only deliver virtual healthcare experience the use of telemonitoring, because virtual care centres in the Netherlands are a relatively new concept. The aim of this study is therefore to provide insight into the experienced barriers and facilitators in the use of telemonitoring according to nurses working at a virtual care centre.

Methods: A qualitative study design was applied using semi-structured interviews to identify the experienced barriers and facilitators in the use of telemonitoring at a virtual care centre. The interviews were conducted with nurses working at a virtual care centre in Isala, Rijnstate, Jeroen Bosch Hospital and Albert Schweitzer Hospital. An interview guide was established using topics of literature research on telemonitoring and the Unified Theory of Acceptance and Use of Technology (UTAUT) model. The interviews were conducted online as well as physical. For the data analysis, thematic analysis was applied. Codes were formed openly, followed by the subsequent categorization of these codes into themes.

Results: In total, thirteen interviews were conducted, four at Rijnstate, one at Albert Schweitzer Hospital, three at Jeroen Bosch Hospital and five at Isala. These interviews resulted in six themes, with associated barriers and facilitators in the use of telemonitoring; 1) possible effects of telemonitoring; 2) changing job content nurses; 3) influence of hospital staff on the use of telemonitoring; 4), patient-nurse relationship; 5) required skills and knowledge nurses; and 6) required resources and technology. The use of telemonitoring at virtual care centres is overall experienced as positive, wherein more facilitators than barriers are experienced. Important barriers that were found are 1) (no) connection between the telemonitoring application and the electronic patient record system; 2) the balance between work tasks and insufficient capacity; 3) little trust in virtual care centre executive staff; 4) lack of training about managing patients via telephone calls. A key facilitator that was found is ‘the more profound contact with the patient.’

Discussion: This study addressed the need for further theory development about the experiences of virtual care nurses. The experienced barriers and facilitators can give guidance in certain choices hospitals have to make when setting up a virtual care centre or give guidance to current virtual care centres in improving their centre. The factors facilitating conditions, effort expectancy, and social influence of the UTAUT model have played a crucial role in uncovering barriers and facilitators that may have been overlooked with other models. Inclusion of virtual care nurses in the decision-making process regarding potential changes within the virtual care centre is crucial.

Background

The healthcare sector is facing massive challenges for several years now, which is going to exceed in the future. This is firstly because of the fact that there are a lot of staff shortages within the healthcare sector [1], due to high workload [2], bureaucracy [3], poor career opportunities [4], irregular working hours [2], and insufficient wages [1]. Also the COVID-19 pandemic had a big influence on staff shortages, a lot of nurses got sick and still have trouble with long COVID or mental distress due to COVID [5]. In 2022, the healthcare sector in the Netherlands had to deal with around 67,000 open vacancies [6]. In ten years, these healthcare shortages will be tripled also due to the aging population. The population within the Netherlands is namely expanding to be older [7]. In 2040 the expectation is that 26% of the population will be 65 years or older [8]. Also, the older people get, the more they will visit a hospital, for outpatient visits as well as hospital admissions [9]. Elderly people often have multiple (chronic) diseases [10], more physical restrictions [11], and poorer perceived health [12], which make them visit the hospital more often. Because of an uneven distribution between healthcare staff and patients, which will exceed in the future, healthcare provision should be organized differently. To organize healthcare provision differently, innovative care models are necessary for the accessibility of care [13]. An example of an innovative care model is virtual care centres [14].

Virtual care centres focus on delivering medical specialist care at home [15]. Virtual care centres exist of nurses who coordinate everything involving the provision of care at home, like measurements of symptoms, medication, home care and infusion, which would normally be provided in the hospital setting. In the Netherlands, several hospitals established a virtual care centre. The virtual care centres in the Netherlands are a relatively new concept that received more attention in the COVID-19 pandemic [16]. Also abroad, virtual care centres do exist. Especially in the United States there are some virtual care centres within hospitals, but also virtual care centres that operate on their own. The existence of virtual care centres leads to continuity and quality of care, but also to more person-centred care [17]. Another spearhead for virtual care centres to establish the delivery from care at home is the use of telemonitoring.

Telemonitoring has various definitions in the literature. In this study telemonitoring is defined as: ‘The use of information and communication technologies to monitor and transmit items related to patient health status between geographically separated individuals, permits home monitoring of patients using external electronic devices in conjunction with a telecommunications system’ [18,19]. With the use of telemonitoring, healthcare professionals can supervise patients closely at home, whereby patients measure symptoms of their disease themselves, for example through an application on their mobile phone [19,20]. By having a clear picture of the symptoms, patients can undertake actions themselves and the healthcare professionals can provide feedback through the application. The measured symptoms can also be assessed by the healthcare professionals and when necessary the healthcare professional can undertake actions [18,21]. Telemonitoring can also involve support from healthcare professionals through telephone contact, whereby the healthcare professionals report symptoms that the patient indicates during this contact [19,20,22], also the patients can ask questions about their symptoms to the healthcare professionals. The last form of telemonitoring is the use of implants or sensors to measure symptoms [23]. This is an indirect measure for patients, whereby patients do not have to fill in values themselves. Telemonitoring can be used in a wide range of diseases. At this moment it is mainly used in cardiology [24], neurology [25] and pulmonary medicine [26]. It is seen that telemonitoring could ensure insight in disease progression, therapy compliance and behaviour patterns [24,27] Telemonitoring also ensures shorter hospital stays and prevents unnecessary hospital visits for patients [28]. Despite the potential of telemonitoring, there are still barriers in the use of telemonitoring according to nurses [29].

Negative attitudes, insufficient experience, lack of training and insufficient quality of the technologies are seen as barriers for nurses in the use of telemonitoring [29]. The attitude and the skills of nurses can be facilitators in the use of telemonitoring, even as decreased workload, reduced stress and the opportunity for flexible services according to nurses working with different patient groups in the inpatient and outpatient clinic [30]. Patient characteristics can be facilitators as well as barriers in the use of telemonitoring according to nurses using telemonitoring [31]. Concluded, barriers and facilitators could arise from patients as well as nurses.

Despite the fact that there is a lot of knowledge about the barriers and facilitators in the use of telemonitoring according to nurses working at an inpatient or outpatient clinic, it is unclear how nurses only delivering virtual healthcare experience the use of telemonitoring. This is due to the fact that virtual care centres in the Netherlands are a relatively new concept. The nurses working at a virtual care centre are originally educated to deliver care physically and in their current positions they only deliver it virtually [15]. Lastly, virtual care nurses do not use telemonitoring at one department, they use telemonitoring in different care pathways [15]. Taking these facts into consideration, other barriers and facilitators could be present than the beforementioned ones. These barriers and facilitators can be considered by improving current virtual care centres and supporting virtual care nurses. It can also be considered when setting up new virtual care centres in the Netherlands. By doing so, telemonitoring can be more easily be deployed to provide care at home. The aim of this study is therefore to provide insight into the experienced barriers and facilitators in the use of telemonitoring according to nurses working at a virtual care centre.

Methods

Study design

A qualitative study design was applied using one-on-one semi-structured interviews. The total study period ran from February 2023 till July 2023. The reporting was done according to the Consolidated criteria for reporting qualitative research (COREQ) checklist [32] and the Central Committee on Human Research (CCMO) checklist [33].

Study population

The interviews were conducted with nurses working at a virtual care centre in a hospital. The number of conducted interviews depended on the number of nurses that wanted to participate and on when saturation was going to be achieved. Saturation occurred when an interview no longer provided new information [34]. To participate in the study inclusion criteria were established. The nurses had to work within a virtual care centre in a hospital, regardless the time working there. Also, the nurses had to use information and communication technologies to monitor and transmit items related to a patients' health status. Lastly, the nurses had to be able to speak and understand the Dutch language.

Study setting

The study was conducted at three tertiary teaching hospitals in the Netherlands; Isala, Rijnstate and Albert Schweitzer Hospital, and one secondary hospital; Jeroen Bosch Hospital. The hospitals differed in size, number of patients in virtual care, number and types of care pathways and number of virtual care nurses. All hospitals use the system Hix as their electronic patient record, which they also need to monitor their patients. Also, among other applications, the main telemonitoring application that is used, is Luscii. Moreover, the hospitals use pulse oximeters and blood pressure monitors and telephone calls. Per care pathway the role of the virtual care centre differs. In table 1 below, all characteristics of the different hospitals are given.

Table 1: Characteristics of the included hospitals

Hospital	Type of hospital	Size of hospital (number of beds)	Number of patients in virtual care	Number of care pathways	Type of care pathways	Number of virtual care nurses
Isala	Tertiary teaching hospital	1206	146	12	Outpatient and inpatient	5
Rijnstate	Tertiary teaching hospital	724	No absolute number, +/- 60 a day	9	Outpatient and inpatient	9
Albert Schweitzer Hospital	Tertiary teaching hospital	1045	1575	8	Outpatient	5
Jeroen Bosch Hospital	Secondary hospital	1120	1600	29	Outpatient and inpatient	8

Note. The numbers in the table fluctuate. The given numbers are the numbers at the time of this study.

Recruitment and consent

The nurses working at the virtual care centres in the hospitals were approached by the researcher of the study by email to participate in the study. An information letter and informed consent were included in this email (Appendix 1). The respondents were able to ask questions according to this information letter and decide whether they wanted to participate.

Data collection

The researcher was a student Health Sciences at the University of Twente and had experience with conducting interviews with healthcare professionals. The interviews were conducted between March 2023 and May 2023. The choice for online or face-to-face interviews was left to the respondents.

An interview guide was developed by incorporating topics derived from literature research on telemonitoring. The identified important aspects of telemonitoring formed topics for the guide, which included: the applications utilized, the various care pathways involved, and the relationship dynamics between nurses and patients. Also, the Unified Theory of Acceptance and Use of Technology (UTAUT) model was used to establish topics in the interview guide (Appendix 2) [35]. The UTAUT model is one of the most widely used models in the healthcare sector [36]. The goal of the UTAUT model is to identify factors that influence the use and acceptance of technologies according to users of the technology [37]. Because of the fact that the UTAUT model is frequently used in similar research about factors in the use of technology [38,39] and the goal of the model fits the aim of this study, the UTAUT model was therefore chosen for this study. The UTAUT model consists of four factors, namely, performance expectancy, effort expectancy, social influence and facilitating conditions [36]. The performance expectancy is the extent to which an individual believes that using the technology can contribute to an improvement in job performance [36]. In relation to the context of providing care at home, performance expectancy was defined as the extent to which the nurses expect telemonitoring to contribute to delivering and monitoring care at home. The effort expectancy is the level of effort associated with using the technology [36]. In this context, this was seen as the level of effort it takes the nurses to use telemonitoring. The social influence is the extent to which an individual has the idea that others think that the technology should be used by the individual [36]. In the context of this study, this was defined as the extent to which people around the nurses, like colleagues have influence on the use of telemonitoring by the nurses. The facilitating conditions are viewed as the extent to which an individual believes that an organizational and technical infrastructure exists to support the use of the technology [36]. This term was defined in this study as the extent to which telemonitoring is applicable to the daily jobs of the nurses. The four mentioned factors could have influence on the behavioural intention of the users [36]. The behavioural intention is the willingness from an individual to use a technology. The four mentioned factors can be moderated by individual differences given in the model: age, gender, experience, and voluntariness of use [37]. The full model is shown in Figure 1.

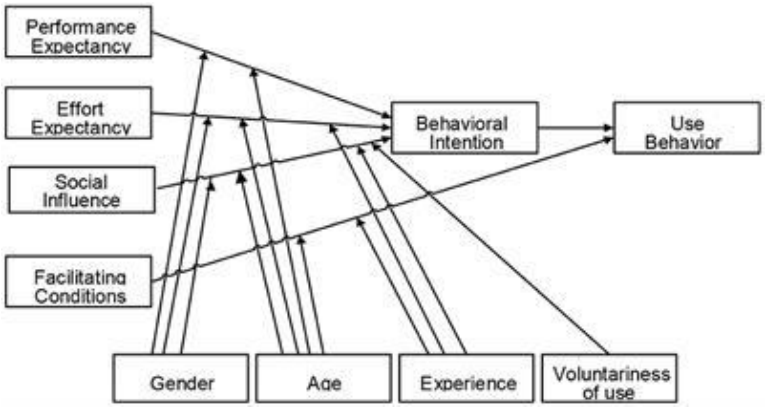

Figure 1 UTAUT model [35]

Demographical data was collected, corresponding with the UTAUT model; gender (male/female/other), age (years) and experience (years of working with telemonitoring and job experience). The interview guide was developed by two researchers and pilot tested with a nurse working at the pulmonary medicine department at Medisch Spectrum Twente in Enschede, who had experience with the use of telemonitoring. Minor changes were made in the interview guide in between the interviews by reformulating, eliminating, and adding questions. All interviews were recorded, using Microsoft Teams and a recording application on the mobile phone. Data analysis

Data analysis

The interviews were transcribed using the program 'Amberscript.' The transcripts were anonymized. The interviews were analysed by the main researcher of the study using the program, Atlas.ti. Inductive thematic analysis was applied [40,41]. Thematical analysis is a process of coding data without a predetermined code frame. It consists of six stages: (1) immersion; (2) generating initial codes; (3) searching for and identifying themes; (4) reviewing themes; (5) defining and naming themes; and (6) writing the report [41]. Coding started after the first interview. This way each interview could provide new insight for upcoming interviews [40,42]. At the end of stage 2 another researcher, LR, a student Health Sciences of the University of Twente joined to review and interpret the coded data. She also coded one interview, which was then discussed with the main researcher. LR also helped in stage 3, 4 and 5 to establish themes. In stage 5 an external researcher, JL, also joined to define and name themes, whereby the themes were discussed amongst each other. Through discussing the themes amongst different researchers, cohesion could be established [43]. The final codebook is given in Appendix 3.

Ethical considerations

Permission for conducting the study was requested from the Behavioural, Management and Social sciences/Humanities and Social sciences Ethical Committee of the University of Twente. The reference number of this study is: 230444. Also, the Daily Board of the Medical Ethics Committee Isala declared that the Medical Research Involving Human Subjects (also known by its Dutch abbreviation WMO) did not apply for this study. The study not resulted in any physical or mental harm for the respondents. There was only the possibility that the nurses would not want to answer all the questions.

Administrative aspects

The handling of the data was done according to the Dutch Personal Data Protection Act [44]. The records of the interviews were stored at the secured workspace of Isala. The files of the transcripts were also stored pseudonymously at the secured workplace of Isala with only access for the researcher. An Excel file of the demographical data corresponding with the transcripts was password protected and also stored at the secured workplace. The data will be saved for 15 years after completion of the study.

Results

Characteristics study population

The final study population consisted of thirteen nurses, all females. The average age was 45 with a standard deviation of 8.2. The nurses have been working at the virtual care centre for an average of 1.6 years. On average, the nurses have been working in healthcare for 24 years, with a standard deviation of 10.3. In Table 2 all the characteristics of the study population are shown.

Table 2 Demographical data of the study population (n=13)

Characteristics	Number (%)	Average	SD
Hospital			
Isala (tertiary teaching hospital)	5 (38)		
Rijnstate (tertiary teaching hospital)	4 (31)		
Albert Schweitzer Hospital (tertiary teaching hospital)	1 (8)		
Jeroen Bosch Hospital (secondary hospital)	3 (23)		
Gender			
Female	13 (100)		
Age (years)		45	8.2
Working in healthcare (years)		24	10.3
Working at virtual care centre (years)		1.6	0.6

Themes

After the data collection, data analysis took place wherein themes were formulated. These themes emerged only from the interview data. Six themes about the experienced barriers and facilitators in the use of telemonitoring emerged: 1) possible effects of telemonitoring; 2) changing job content nurses; 3) influence of hospital staff on the use of telemonitoring; 4) patient-nurse relationship; 5) required skills and knowledge nurses; and 6) required resources and technology. The data analysis resulted in a total of 45 barriers and facilitators, whereby more facilitators (30) than barriers (15) are experienced. Below, the themes are discussed. In Table 3, at the end of the results, a summary is given of the barriers and facilitators per (sub)theme.

Possible effects of telemonitoring

In this theme subthemes are mentioned by the virtual care nurses, namely, possible effects of telemonitoring for the patient and possible effects of telemonitoring for the hospital & executive staff.

Possible effects of telemonitoring for the patient

The importance of potential telemonitoring effects on patients was emphasized by the virtual care nurses. One such effect, as indicated by the nurses, is the possibility of expedited and enhanced recovery for patients who receive care at home, within their own environment. Additionally, in their own environment, there is absence of the white coat syndrome, which patients typically experience in clinical settings. According to the nurses, when patients are not subjected to the white coat syndrome, they tend to provide more accurate and dependable data. Consequently, the recovery of patients within their own environment was unanimously regarded by virtual care nurses as a facilitator in the use of telemonitoring. One nurse said about this:

'The patients can recover at home and recovering at home in your secure place always works more efficiently than if you recover in a clinical place in the hospital where you do not know anyone and do not feel as comfortable and safe as you would feel at home.'(R1).

The nurses highlighted that patients experience a sense of comfort due to the high accessibility of virtual care centres, which is perceived as a facilitator. Patients are able to easily communicate by

sending messages or making phone calls whenever they have inquiries, in contrast to the waiting period associated with physical consultations. Moreover, patients benefit from the elimination of waiting time in hospital waiting rooms and reduced travel time, resulting in decreased time consumption for the patient. Consequently, the nurses unanimously consider the reduction in time consumption as a facilitator in the use of telemonitoring within virtual care settings.

The nurses emphasized that another important effect for patients is the increased awareness they develop regarding their illness. Through the telemonitoring application, patients have access to their own data, which, according to the nurses, can lead to a greater understanding of their health indicators. These values serve as a starting point for patients to engage in a reflective thought process when a value deviates from usual. Additionally, the nurses noted that patients gain access to more information about their care pathway through the telemonitoring application. This information may include instructional videos on surgical procedures or e-learning modules about medications. The increased awareness of their illness is regarded by the virtual care nurses as a facilitator in the use of telemonitoring.

Possible effects of telemonitoring for the hospital and executive staff

The nurses have identified the potential effects on the hospital and its staff as an important factor to use telemonitoring. According to the nurses, employing telemonitoring in the patient's home environment helps conserve hospital beds for patients who require them more urgently. The more efficient management of bed occupancy is therefore considered a facilitator in the use of telemonitoring. Given the prevalent staff shortages and high workload experienced by hospital executive staff, the nurses noted that telemonitoring allows for the treatment of a larger number of patients with fewer nurses. Furthermore, the nurses mentioned that the executive staff can experience relief as some of their patients are transferred to virtual care centres. This alleviation of staff occupancy for the outpatient and inpatient clinic is viewed by the nurses as a facilitator in the use of telemonitoring. A nurse said about this:

'The advantage is mainly that less staff is needed, I can see many more patients than when I am at the inpatient clinic, because then I had six patients, and now I sometimes have thirty, which you can all do something for in a day. Fewer nurses are needed and there simply are not any. So, that is the biggest added value eventually, that you need less staff.'(R11).

Changing job content nurses

All nurses who had previous experience working in the inpatient clinic of a hospital unanimously reported that their roles at the virtual care centre were significantly less physically demanding. Consequently, they also experienced a reduction in physical complaints. However, the nurses acknowledged that decreased physical activity could potentially have negative implications for their overall health. Nevertheless, the general consensus among the nurses is that less physical strain is commonly perceived as a facilitator in the use of telemonitoring. One nurse said about this:

'It [working at an inpatient clinic] does break you, I could not have kept that up until I reach the age of 65. That is simply not possible, with the current shortages you cannot work in an inpatient clinic until you are 65. It is really bizarre.'(R3).

Furthermore, the nurses highlighted that they have experienced a change in their working hours compared to their previous positions, which they considered to be an improvement. Specifically, in Isala, Jeroen Bosch Hospital, and Albert Schweitzer Hospital, the nurses exclusively work during

daytime shifts. However, in Rijnstate, the nurses have the additional responsibility of working evening shifts, in addition to the standard daytime shifts. A nurse said about this:

'I had all shifts, evening, night, daytime, I was also called out of bed at night. I do not have that anymore. I have a regular job.'(R13).

The nurses emphasized that their workplace offers a high degree of flexibility. They have the opportunity to work remotely, which they find to be highly satisfying. The improved working hours and flexible work environment are regarded by the virtual care nurses as facilitators in the use of telemonitoring.

Furthermore, nurses from Isala and Albert Schweitzer Hospital expressed concerns about insufficient staff capacity. They have observed that care pathways are expanding rapidly, but the teams are not growing proportionately to accommodate this growth. Consequently, the nurses feel that they are falling behind and unable to keep up with the demands. This experience arises from their experience of having to handle a wide range of tasks without sufficient nursing support, resulting in a high workload. The nurses mentioned that even when working five days a week, it is impossible to complete all tasks. The insufficient staff capacity is therefore perceived as a barrier in the use of telemonitoring. A nurse said about this:

'We are growing fast, but this team is not growing fast enough. We are now really up against limits.'(R4).

It is worth noting that not only nurses experiencing insufficient staff capacity face high workloads, but even those who perceive sufficient capacity also encounter similar challenges. This high workload stems from the nurses having to handle various tasks, including patient care, establishing new care pathways, and writing protocols. Striking a balance among these tasks is perceived as difficult. While patient care should ideally be the primary focus, the nurses find it impossible to prioritize it over other responsibilities. Currently, nurses in Isala, Rijnstate, and Albert Schweitzer Hospital are engaged in diverse tasks, while in Jeroen Bosch Hospital, there is a division between setting up care pathways and patient care. The imbalance between patient care, setting up new care pathways, and writing protocols is regarded as a barrier by the nurses. A nurse said about this:

'I sometimes find it difficult, patient care comes first, but we also participate in those project groups with the design and start-up of new care pathways and how do we keep a balance in patient care and project work? I have had to cancel meetings in the past period. I see a bottleneck there at the moment.'(R4).

Despite the challenges posed by the high workload, the virtual care nurses find their work enjoyable. They particularly derive motivation from the innovative aspects of their roles, such as setting up new care pathways and implementing virtual care. They value their contribution to this evolving field and the growth of digital healthcare. Furthermore, actively participating in shaping the future of healthcare adds to their personal and professional development, preparing them for forthcoming changes in the healthcare sector. Therefore, the nurses perceive the innovative nature of their job as a facilitator in the use of telemonitoring.

Lastly, the role of virtual care nurses significantly differs from their previous positions in terms of the number of patients they take care of. Nurses working at virtual care centres reported that they are able to serve a greater number of patients compared to their roles in inpatient or outpatient settings. Additionally, they receive more frequent measurements from the patients, which provides them with a

deeper understanding of the patients' conditions. The nurses noted that this allows for early detection and prompt response to any deviations in the measurements. The ability to care for more patients and having more frequent measurements are therefore perceived as facilitators by the nurses in the use of telemonitoring. A nurse said about this:

'Heart failure patients used to come to the outpatient clinic once every two weeks to have their blood pressure measured by a doctor or nurse in a white coat and then the medication was set to that blood pressure. Now the patients simply go home and measure their blood pressure five days a week. And on the basis of this, we also adjust the medication much faster if necessary.'(R9).

Influence of hospital staff on the use of telemonitoring

The nurses mentioned influences on their use of telemonitoring from management, executive hospital staff and virtual care colleagues.

Influence of the management

All nurses expressed a positive influence of the hospital and virtual care centre management on the use of telemonitoring. The management is described as highly enthusiastic and dedicated, providing the necessary resources and support to ensure the success of the virtual care centres. This includes providing all required resources and offering opportunities for nurses to attend congresses and professional development events. The support from the management is greatly appreciated by the nurses and is considered a facilitator in the use of telemonitoring. One nurse said about this:

'We are in an incredibly positive light, with the management and the board, we are given the space on all sides to pioneer and join events and symposia, and I think that is very important. We really need to have the board and management behind us.'(R13).

Influence of executive hospital staff

According to the nurses' perspective, the executive staff of the hospital plays a positive role in influencing the use of telemonitoring for virtual care nurses. The nurses stated that the executive staff assists in establishing specific care pathways within telemonitoring. They provide valuable information about the care pathways and make decisions regarding the content to be included in the program for patients. The nurses also highlighted that they have easy access to the executive staff for any questions they may have, both during the initial setup of a care pathway and when facing challenges during its implementation. The provision of information by the executive staff regarding care pathways is seen as a facilitator in the use of telemonitoring. One nurse said about this:

'They determine what they want in the monitoring, and you actually do it together, also with the nurses, they are also involved and together you look at what is the best way to develop a care pathway.'(R8).

However, the nurses also noted that the executive staff can have a negative influence on the use of telemonitoring. Since virtual care centres are a relatively new concept, there is a lack of familiarity among the hospital executive staff regarding their existence and potential benefits. Consequently, not all medical specialties actively refer patients to the virtual care centre, and the virtual care nurses have to lobby to encourage patient enrolment. The unfamiliarity of the executive staff with the virtual care centre is perceived as a barrier in the use of telemonitoring. Additionally, some doctors and nursing specialists express a lack of trust in the virtual care centre. They prefer to personally oversee the care of their patients and may be hesitant to rely on remote monitoring and virtual care. The limited trust from the executive staff towards the virtual care centre is seen as a barrier by the virtual care nurses. A nurse said about this:

'The doctors and nursing specialists are very afraid that we might act too late on high blood pressure and that the patient will come in or have to be sent in with preeclampsia or something. So, the doctors keep that very much to themselves.'(R4).

Influence of virtual care colleagues

The nurses highly value the support of their virtual care colleagues, considering it a crucial facilitator in the use of telemonitoring. The nurses appreciate the accessibility of their colleagues due to the small team sizes. The easy dissemination of information and the ability to seek help, information, or feedback from one another create a collaborative and supportive environment. Furthermore, the diverse backgrounds and varied experiences of virtual care colleagues from different positions enable mutual learning and knowledge sharing among the nurses. This exchange of knowledge is highly valued and contributes to the successful use of telemonitoring.

Patient-nurse relationship

In this theme two subthemes are mentioned, namely, nature of the contact and behaviour of patients.

Nature of the contact

The nurses working at virtual care centres have a distinct difference in patient interaction compared to their previous positions, as they do not physically see patients. While video calls may occasionally be used, they are not the primary mode of communication. Interestingly, the nurses generally find the contact they have with patients through telemonitoring to be more profound. To gain a comprehensive understanding of the patient's condition, the nurses need to delve deeper by asking more questions and actively listening to the patient. This deeper level of engagement results in a stronger connection with the patient. The process of asking more questions and attentively listening to the patient is perceived as a facilitator. Furthermore, the nurses have the opportunity to care for patients over an extended period, particularly. This longer-term involvement enables the establishment of a stronger bond with the patient. The ability to provide care for the same patient for an extended duration is therefore viewed as a facilitator in the use of telemonitoring. A nurse said about this:

'Much deeper than the physical contact in the inpatient clinic, which is often only short. And certainly, if you have a small contract, you do not care for the same people for three days. Now I have been taking care of some people for two years already.'(R9).

Additionally, the nurses at virtual care centres experience having more time for patients as they are not distracted by other patients or the presence of family and friends during consultations. Unlike in outpatient or inpatient clinic settings where nurses may quickly enter a patient's room even when pressed for time, virtual care nurses only initiate telephone calls when they have allocated time available. This experience of more time for the patient is seen as a facilitator in providing care through telemonitoring. It allows nurses to give their undivided attention to each patient, leading to more meaningful and effective communication. A nurse said about this:

'I very often had too little time for the patient in the inpatient clinic. It really was a race against time. It was medication, washing, helping to get dressed. And not for one patient, that was for six patients. Which sometimes meant that I no longer had the overview, so that I could not provide the care I wanted. My time for the patient now is better, because I have a 20-minute phone consultation, which is also only scheduled when I do have the time. Those minutes I did not have per patient in the inpatient clinic where visits in the room of the patient were made quickly.'(R11).

Furthermore, the nurses highlighted the increased frequency of contact moments with patients compared to their previous positions, particularly in outpatient clinics. In the past, nurses would

typically see patients in outpatient clinics once every six months. However, with telemonitoring, scheduled telephone calls are now conducted on a weekly or bi-weekly basis. This more frequent contact allows the nurses to develop a deeper understanding of their patients and fosters an environment where patients feel more open to discussing their feelings. Having more time for each patient and more frequent contact moments are perceived as facilitators in the use of telemonitoring.

While the nurses generally do not miss the physical contact with patients, as they perceive telemonitoring as a means to provide the same or even more meaningful care, it is important to note that some nurses have acknowledged the importance of physical contact in communication with patients. They recognize that certain actions, such as placing a hand on a patient's shoulder, cannot be replicated in the current telemonitoring setup. The absence of physical contact is therefore perceived as a barrier. One nurse said about this:

'It is nice if you can put a hand on a shoulder every now and then and that is not possible now.'(R13).

Behaviour of patients

According to the nurses, patient behaviour plays an important role in shaping the patient-nurse relationship. One aspect highlighted is the honesty of patient responses. The nurses have observed that certain patients may exploit the medication or care application by providing inaccurate information to access additional medications or care services. Additionally, patients may not always provide truthful responses, either unintentionally or deliberately, as they may occasionally fill in values without careful consideration. These behaviours can have an impact on the reliability of the information provided by patients. The nurses recognized these challenges and perceived the dishonest responses of patients as a barrier in the use of telemonitoring. One nurse said about this:

'If a patient thinks: if I put in a high value now, then I will receive more care. Or maybe I will get my beloved pill Oxycodone for the pain.'(R4).

The nurses have noted that the nature of the questions posed to patients can also impact the honesty of their responses. Specifically, in care pathways that involve inquiries about lifestyle, the nurses find it challenging to obtain truthful answers from patients. This reluctance to disclose certain information can hinder the nurses' ability to gather accurate and comprehensive data. The nurses recognized this issue as a barrier and understand that the design and phrasing of questions play a crucial role in encouraging patients to feel comfortable and open in sharing their experiences and concerns. One nurse said about this:

'*With CVA, for example, we ask about alcohol consumption or things like that. Are people going to be honest?'(R13).*

Indeed, the issue of patient honesty is not exclusive to the virtual care setting and can be encountered in the inpatient and outpatient settings as well. However, in the virtual care setting, where nurses do not have direct physical contact with patients, they find it more challenging to discern when patients are being dishonest. The absence of face-to-face interactions and non-verbal cues makes it harder for nurses to gauge the accuracy and sincerity of patient responses. As a result, nurses in the virtual care setting need to invest additional effort and be extra vigilant in identifying instances where patients may not be providing honest information.

Also, the therapy compliance of the patients can have influence on the use of telemonitoring according to the nurses. When patients do not adhere to the prescribed therapy or fail to comply with the required measurements, it becomes more challenging for the nurses to monitor them remotely. The absence of

essential data and missing values hinder the nurses' ability to assess the patient's condition accurately and provide appropriate care. As a result, nurses have to invest additional time and effort to engage with non-compliant patients and obtain the necessary measurements, leading to increased time consumption for the nurses. The low therapy compliance observed among some patients is therefore considered a barrier in the use of telemonitoring by the nurses.

The way patients perform self-measurements, such as monitoring their blood pressure or oxygen levels, can significantly influence the results that nurses receive in telemonitoring. It is crucial for patients to receive clear instructions and guidance on how to obtain valid measurements using these devices. When patients are not adequately educated on the correct techniques or fail to follow the instructions, the recorded values may be invalid. One nurse said about this:

'Very often people put a pulse oximeter on, put it on the fingers, see the first count and off again. Then you often have an unreliable measurement.'(R1).

Considering age, the nurses' perspective suggests that age alone is not a determining factor in the ability to use telemonitoring applications. Older patients can mostly successfully use telemonitoring technologies. Concluded, the digital skills of the patients are experiences as a facilitator in the use of telemonitoring, as well as a barrier. A nurse said about this:

'I also find it surprising that even if the patients are 80 or 90 plus, quite a lot of them still participates and actually do it surprisingly well. So, it is also something that I think in the next generation will be even easier.'(R7).

Required skills and knowledge nurses

The nurses mentioned different skills and knowledge that they perceive as needed to use telemonitoring. Subthemes are translating clinical views, personal skills, knowledge, and digital skills.

Translating clinical view

The nurses' ability to translate their clinical expertise and intuition into a virtual setting is crucial in the absence of physical contact with patients. They emphasized the importance of developing a 'clinical ear' to effectively assess patients' conditions based on the information they provide through telemonitoring. By closely reviewing the values and measurements recorded by patients, nurses can identify trends, abnormalities, or changes that may require further attention. Additionally, active listening during telephone calls allows nurses to gather valuable information about patients' symptoms, concerns, and overall well-being. A nurse said about this:

'In the outpatient and inpatient setting, we talk about a clinical view, you see a patient and you can actually read a lot from it, now you don't see the patient, but you have to develop your clinical view based on the trends that you see, based on the patient's story, what you can get out of the patient record. I developed a clinical ear, and your gut feeling remains.'(R4).

The nurses' observation about the lack of specific training on managing patients via telephone calls in the virtual care setting is an important point. Transitioning from physical care to remote care requires the nurses to adapt their approach to effectively gather information, assess patients' conditions, and provide appropriate care through telephone interactions. A nurse said about this:

'Training on how you really do those telephone conversations to get as much information as possible from a patient, for example, how do you get a complete picture of your patient through telemonitoring I think for now that is still a barrier.'(R13).

Personal skills

Effective telephone communication is considered essential for the nurses, when engaging with patients. Mastering communicative skills is acknowledged as a valuable facilitator by the virtual care nurses. Their ability to provide reassurance and support to patients over the phone, extract pertinent information from them, and provide clear instructions on the use of telemonitoring technologies are vital aspects of their role. Moreover, these communicative skills are also indispensable for exchanging information with executive healthcare staff and management, as well as for fostering effective internal communication within the virtual care team. A nurse said about this:

'Communication is of course important. The triage you need to properly ask patients and ask peer coaching from colleagues, as in what do you do, and why? And providing feedback, because you are with a small team, that is very important.'(R5).

In order to optimize the efficacy of telephone calls, nurses emphasize the importance of incorporating empathetic and convincing skills. The mastering of empathetic and convincing skills is thus regarded as facilitators in the use of telemonitoring. Nurses underscore the importance of empathizing with patients and effectively gauging their individual needs to determine the appropriate mode of interaction. Furthermore, nurses acknowledge the necessity of employing convincing skills to motivate patients to undertake specific actions, as remote intervention by nurses is not feasible in such circumstances. A nurse said about this:

'You have to be able to empathize and then estimate what kind of patient you have, is it possible to make a joke to bring the relaxation.'(R12).

The nurses emphasized that due to the diverse range of tasks and high workload, possessing flexible and stress-resistant skills is essential for effectively functioning within a virtual care centre. Given that the nature of their work necessitates adaptability, a workday at the virtual care centre is characterized by constant changes. As a result, nurses must possess the ability to efficiently manage rapid adjustments and unexpected demands. Mastering flexible and stress-resistant skills is experienced as facilitators in the use of telemonitoring. One nurse said about this:

'You have to be very flexible. You really should not have a nine to five mentality, because then you will not make it here. Yesterday I had a training, today I might go home at half past three. On the other hand, I am going to have a meeting on Monday on my day off. So, you really have to be flexible.'(R3).

Knowledge

Each nurse unanimously expressed the amount of knowledge required regarding various care pathways within the virtual care setting. This knowledge encompasses a broader scope compared to what a nurse typically possesses in the inpatient or outpatient contexts. However, based on the nurses' collective experiences, the amount of knowledge remains substantial. Particularly for nurses who transition to the virtual care centre after working in other healthcare settings, acquiring proficiency in all care pathways at ones can be challenging. Moreover, the nurses noted that staying abreast of the constantly evolving new care pathways is highly demanding. Consequently, the nurses identified the extensive knowledge of a lot of different care pathways as a barrier in the use of telemonitoring. A nurse said about this:

'When you have a certain care pathway under control, then there is a new one. There are also colleagues who start working here now, they have to know all the care pathways we have all at ones, that is a lot.'(R6).

According to the nurses' statements, acquiring knowledge about new care pathways entails taking initiative to arrange clinical lessons with specialized professionals in the respective fields. These self-arranged lessons are regarded as beneficial and compatible with their existing responsibilities. The convenience of online training formats is highlighted as a contributing factor, as it allows nurses to engage in these educational activities alongside their other tasks. (Online) training is therefore seen as a facilitator in the use of telemonitoring. One nurse said about this:

'It is being recorded. Sometimes they are via Zoom, and they are also recorded, so you can watch them later. From Luscii we also regularly receive a catch-up video, those are nice short videos of three minutes.'(R12).

Digital skills

The nurses emphasized the importance of possessing proficiency in managing technological tools and applications, as it directly impacts their ability to provide comprehensive care to patients. Given that nurses extensively engage with technology in their daily tasks, possessing sufficient digital skills is crucial. These digital skills encompass not only regular usage but also the ability to troubleshoot potential malfunctions that may arise. Mastering these digital skills is considered a vital facilitator in the use of telemonitoring. A nurse said about this:

'Of course, we have to be digitally skilled, you have to know how to manage applications. We work in Teams a lot, so you have to know digitally what you have to do and what's out there, and the applications are actually the most important aspect, what you need to know, what you need to be able to handle, because you are of course constantly working with the applications.'(R10).

Required resources and technology

In this theme two subthemes are discussed, namely, workplace, protocols, and technology.

Workplace

To properly use telemonitoring, the nurses mentioned needed recourses in their workplace. They stated that they need, a headset, a high-low desk, an ergonomic computer mouse, an ergonomic chair, a telephone, a double screen, enough office capacity, internet connection and a good acoustics in the office. Overall, the nurses perceived the resources as well organized and by missing resources, the management is very willing to provide these. The availability of the resources is overall seen as a facilitator in the use of telemonitoring. One nurse said about this:

'If the resources are not properly arranged, it is explained by us whether to what extent it is necessary. The management together with us than looks at what are the possibilities, never dig in the sand'(R5).

In the context of Isala, the nurses' work extends to the general practice centre where certain challenges have been identified. One such challenge is the absence of a double screen, which causes frustration among the nurses. Additionally, the absence of a joint office in the general practice centre poses difficulties in terms of collaboration and consultation among colleagues. Lack of a double screen and joint office are perceived as barriers by the nurses in Isala.

Protocols

To appropriately perform their work tasks, nurses must adhere to protocols. According to the nurses these protocols are key in making sure all nurses work according to the same standards. The nurses mentioned that the protocols provide direction in approaching and estimating patients. Using protocols is therefore seen as a facilitator in the use of telemonitoring. One nurse said about this:

'Those [the protocols] are very nice, it is very clearly stated who does what and which pathways you must follow, so suppose there are deviations, then it is simply stated very clearly what you must do, and which values you may or may not accept.'(R10).

The nurses highlighted the time-consuming nature of setting up protocols and the subsequent need for frequent revisions. The responsibility for developing protocols lies with the virtual care nurses, in consultation with the associated care pathway. However, the nurses expressed frustration due to the extensive rectification process that follows protocol development. This frustration stems from the fact that establishing care pathways for virtual care is a relatively new undertaking, resulting in continuous new insights and evolving requirements once a care pathway is in use. Rectifying protocols is therefore experienced as a barrier. One nurse said about this:

'What I see is that it [setting up protocols] just takes a lot of time and energy and that often when the program is set that you actually make quite a few adjustments very quickly, within two weeks.'(R7).

Technology

About the specific telemonitoring application Luscii, the nurses are unanimous in their opinion. They perceive Luscii as a very user-friendly application, with clear information and instructions on how to use the application, for patients as well as nurses. Also, the values that result from the measurements in the application are very readable for the nurses. The user-friendliness of Luscii is therefore seen as an important facilitator in the use of telemonitoring. The nurses are less positive about Hix, the electronic patient record system. According to the nurses, Hix is a complicated system. The nurses have to perform a lot of actions, which makes it very user-unfriendly, and thus a barrier. A nurse said about this:

'Hix just remains a bit of a cumbersome system, I would have a lot of wishes for that, but a lot of things are just not technically possible. Hix has a lot of click work, which makes it not very user-friendly.'(R7).

The primary focus of the nurses regarding technologies revolves around the connection of the telemonitoring applications, primarily Luscii, with the electronic patient record system Hix. In most hospitals, Hix and Luscii are connected; however, this connection has not yet been established in Rijnstate. In Rijnstate, Luscii operates as a standalone application without a connection with Hix. Consequently, nurses have expressed the need to perform extensive copying, pasting, and switching between the different applications. This situation is not only perceived as frustrating but also poses potential safety risks, as nurses must diligently ensure that they are accessing the correct patient information across various applications. A nurse said about this:

'You have to switch back and forth from one to the other. You need to convert data, you can copy wrong things from the record, so that would be nice if that is connected.'(R8).

Also, nurses working at a virtual care centre where the applications are connected encounter difficulties. While there is a connection from Luscii to Hix, the reverse connection is lacking. Consequently, it is not possible to access information in Hix regarding patients receiving care from the virtual care centre. To identify virtual care patients, the nurses must manually review a separate list that includes their names. This manual process is perceived as burdensome by the nurses. The (no) connection between the telemonitoring application and the electronic patient record system is therefore identified as a barrier in the effective use of telemonitoring. A nurse said about this:

'Patients call, and they are at home and then I look at Hix and I actually want to know if and why the patient belongs to us, and I cannot immediately retrieve that, so then you have to ask the patient what kind of treatment they are in. In the end you just want to see right away on the cover page, this patient belongs to us and that I can click straight through to our screen, but that is not possible, then you have to look up the patient separately in a list that we have created ourselves. So, you can go one way, but not the other.'(R12).

Experienced barriers and facilitators per (sub)theme

In Table 3, the specific barriers and facilitators are given for every subtheme.

Table 3 Barriers and facilitators experienced by the virtual care nurses per (sub)theme

Theme	Subtheme	Barriers	Facilitators
Possible effects of telemonitoring	Possible effects of telemonitoring for the patient		Recovery of patients in their own environment, High accessibility virtual care centre, Reduction in time-consumption, Increased awareness of illness
	Possible effects of telemonitoring for the hospital and executive staff		More efficient management of bed occupancy, Alleviated staff occupation outpatient and inpatient clinic
Changing job content nurses		Insufficient staff capacity, Imbalance between patient care, setting up new care paths and writing protocols	Less physical strain, Improved working hours, Flexible work environment, Innovative nature of job, Taking care of more patients, More frequent measurements
Influence of hospital staff on the use of telemonitoring	Influence of the management		Support of the management
	Influence of executive hospital staff	Unfamiliarity of the executive staff with virtual care centre, Little trust in virtual care centre executive staff	Information provision of executive staff about care paths
	Influence of virtual care colleagues		Support of the virtual care colleagues

Patient-nurse relationship	Nature of the contact	Lacking physical contact	Asking more questions and attentively listening to the patient, Providing care for the same patient for an extended duration, More time for the patients, More frequent contact moments
	Behaviour of patients	Dishonest responses of patients, Low therapy compliance patients, Digital skills patients	Digital skills patients
Required skills and knowledge nurses	Translating clinical view	Lack of training about managing patients via telephone calls	
	Personal skills		Mastering communicative skills, Mastering empathetic skills, Mastering convincing skills, Mastering flexible skills, Mastering stress resistant skills
	Knowledge	Extensive knowledge of a lot of different care paths	(Online) training
	Digital skills		Digital skills virtual care nurses
Required resources and technology	Workplace	No double screen, No joint office	Resource availability
	Protocols	Rectifying protocols a lot	Using protocols
	Technology	User-unfriendliness Hix, (No) connection between the telemonitoring application and the electronic patient record system	User-friendliness Luscii

Other requirements for the use of telemonitoring

In addition to the barriers and facilitators discussed, the virtual care nurses identified several other requirements that are essential for the effective use of telemonitoring. First, the technologies employed must be user-friendly and accessible for both nurses and patients. It is crucial that both parties can handle and comprehend the technologies used. Sufficient-quality technology is necessary to ensure reliable measurements of vital signs, and devices such as pulse oximeters and blood pressure monitors should be appropriately calibrated for accurate readings. Furthermore, attention must be given to

access control for the applications. Currently, only authorized executive staff and the virtual care centre have access to the applications, which helps prevent unauthorized access and safeguard patient records. However, there is a concern that in certain situations, unauthorized doctors could potentially benefit from accessing measurements or messages within the applications, highlighting the need for access control measures. Lastly, the virtual care nurses emphasized the importance of telephone consultations to obtain a comprehensive understanding of patients. They believe that solely relying on the applications is insufficient. Therefore, when utilizing telemonitoring through applications, it is necessary to complement it with telephone calls to ensure a holistic approach to patient care.

Discussion

Interpretation of results

The aim of this study was to provide insight into the barriers and facilitators in the use of telemonitoring experienced by nurses working at a virtual care centre. Through semi-structured interviews, six significant themes were identified, within which various barriers and facilitators were highlighted by the virtual care nurses. The experiences of the nurses exhibited remarkable similarities across the different themes, with the exception of their perception of staff capacity sufficiency. Key findings from the study encompassed the following aspects: 1) (no) connection between the telemonitoring application and the electronic patient record system; 2) the balance between work tasks and insufficient capacity; 3) little trust in virtual care centre executive staff; 4) lack of training about managing patients on telephone; and 5) the more profound contact with the patient. These key findings are discussed in the sections below.

(No) connection between the telemonitoring application and the electronic patient record system

An important finding of this study was the identified barrier regarding the connection between the telemonitoring applications and the electronic patient record system. Existing literature on the use of technology in healthcare emphasizes the impact of user friendliness and quality of standalone technologies on their use [26,38,45]. However, the barrier '(no) connection between the telemonitoring application and the electronic patient record system' specifically addresses the challenges of using multiple technologies together, which has been found to be user-unfriendly. In the context of telemonitoring, the use of a telemonitoring application, Luscii in conjunction with Hix, the electronic patient record system, is common practice. However, these two applications either lack a connection or have an inefficient connection. Consequently, nurses are required to carry out additional tasks to ensure effective and efficient usage of both applications. The interview guide for this study incorporated the UTAUT model. The identified barrier '(no) connection between the telemonitoring application and the electronic patient record system' aligns with the UTAUT factor of facilitating conditions [35]. The connection between the telemonitoring application and the electronic patient record system is considered a component of the technical infrastructure supporting the use of telemonitoring. Notably, previous literature using the UTAUT model in the context of healthcare technology did not specifically mention the connection between applications as part of the facilitating conditions factor, which makes it an unexpected barrier [46]. By utilizing the UTAUT model in the interview guide and exploring technology-related questions, this particular barrier was identified in the current study. Nevertheless, also other models, such as the Technology Acceptance Model (TAM) [47] or the Diffusion of Innovation Theory [48], could potentially have identified the barrier related to the connection between applications as well. The UTAUT model however exhibits a greater emphasis on facilitating conditions compared to both the TAM and Diffusion of Innovation model, as a result of which, the UTAUT model proved useful in capturing this experienced barrier.

Imbalance between patient care, setting up new care pathways and writing protocols & insufficient staff capacity

In this study, the nurses experience high workload next to the insufficient capacity, due to the imbalance in work tasks. On the other hand, the work tasks also include setting up new care pathways, which they stated as the innovative and motivating part of their jobs. This finding seems a bit adversative. In literature it is seen that high workload negatively affects the job satisfaction [49]. However, in this study it seems that the nurses do not experience less job satisfaction, it actually seems a motivator. Moreover, in literature about facilitators in the use of telemonitoring in the outpatient and inpatient clinic, it is seen that the use of telemonitoring results in a decreased workload [30]. This is very contrary from this study, wherein a high workload is experienced by the virtual care nurses. This

could be due to the higher intensity of telemonitoring' use in virtual care centres compared to the outpatient and inpatient clinic. In literature about the UTAUT model, in the factor performance expectancy, the applicability of technology in the daily job is mentioned [35], which aligns with the barrier 'imbalance between patient care, setting up new care pathways and writing protocols' [50]. The UTAUT model was therefore helpful to identify this barrier. Insufficient staff capacity is also identified with the factor performance expectancy, which includes the organizational infrastructure for the use of technology. In earlier research about technology and the UTAUT model, insufficient staff capacity was identified as a barrier in the use of a healthcare technology [51]. Indeed, the TAM [47] and the Job-Demand-Resources Model (JD-R Model) [52] may also have identified the imbalance in work tasks and insufficient capacity. Within the framework of the TAM, the factor effort expectancy assumes a position of greater prominence compared with the UTAUT model. This discrepancy arises due to the TAM's narrower perspective, encompassing fewer factors than the UTAUT model [45]. So, using the TAM could have identified more barriers or facilitators in the factor performance expectancy. The Job-Demand-Control Model may not align directly with the specific focus of the current study, as it primarily pertains to job content rather than technology use [52].

Little trust in virtual care centre executive staff

A key finding in this study was the barrier 'little trust in virtual care centre executive staff'. Existing literature on telemonitoring indicates that hospital staff, particularly doctors, may be hesitant to relinquish direct patient care [53]. They have concerns about potential gaps in patient monitoring and the possibility of missing crucial deterioration when transitioning to virtual care. Doctors also express apprehension regarding the level of data protection for their patients. The findings of current study align with previous studies on telemonitoring, and the trust concerns expressed by healthcare professionals [53]. Moreover, this barrier aligns with the social influence factor of the UTAUT model [36]. Social influence encompasses the perception that others believe the technology should be used by an individual. Previous research on the use of technology and the UTAUT model has also demonstrated the influence of other hospital staff on nurses' use of specific technologies [50]. Indeed, it is possible that the TAM [47] and the Diffusion of Innovation Theory [48], could have also identified this barrier. However, the TAM may have required more extensive questioning or exploration to explicitly uncover the influence of social factors. In contrast, the UTAUT model encompasses social influence as one of its core factors, making it more directly applicable for capturing the barrier 'little trust in virtual care centre executive staff'. The Diffusion of Innovation Theory is more focused on implementing a technology in a broader social context. The UTAUT model was therefore the most suitable to identify this barrier.

Lack of training about managing patients via telephone calls

Another important finding in this study was the identified barrier 'lack of training about managing patients via telephone calls.' Existing literature has shown that insufficient experience and lack of training can act as barriers to the use of telemonitoring in inpatient and outpatient settings [29]. However, the literature primarily focuses on insufficient experience in using the technology itself and the lack of training specifically related to using the specific technology. Interestingly, the specific aspect of managing patients via telephone calls has not been explicitly identified in previous studies [24,30], possibly because nurses in outpatient settings are already somewhat accustomed to telephone consultations and may have prior experience in this area. Additionally, in the UTAUT model utilized in this study, the nurses' experience aligns with the factor of effort expectancy, which is generally associated with the level of effort required to use a particular technology [35]. However, in this study, the perceived effort is not related to using the technology itself by the virtual care nurses, but rather to the challenges associated with managing patients via telephone calls, which are considered challenging

when transitioning to telemonitoring. Indeed, similar findings may have emerged when considering the TAM and the Diffusion of Innovation Theory. However, the TAM [47] and the Diffusion of Innovation Theory [48] place less emphasis on the specific factor of effort expectancy, which is a distinguishing factor in the UTAUT model. By considering effort expectancy as a distinct factor, the UTAUT model provides a more comprehensive understanding of the experiences in the factor effort expectancy.

More profound contact with the patient

Furthermore, a key finding in this study was the more profound contact between nurses and patients in virtual care compared to physical care. The experiences of having increased time for patients, extended duration of providing care to the same patient, more frequent contact moments, and the need for asking additional questions and actively listening to patients contribute to the development of a stronger bond between the nurses and their patients. The result of more profound contact stands out because existing literature often suggests that telemonitoring can lead to decreased attentiveness and a more distant patient-nurse relationship [54,55]. However, some studies indicate that the use of telemonitoring can actually strengthen and deepen the patient-nurse relationship [26,56] The finding of more profound contact in virtual care contrasts with the factors outlined in the UTAUT model [36]. The UTAUT model primarily focuses on factors related to technology acceptance and usage. However, this study identified the enhanced patient-nurse relationship as an additional facilitator, which aligns with earlier studies on self-monitoring and the UTAUT model that have also identified the patient-provider relationship as an influential factor [57].

Theoretical implications

To our knowledge, this is the first study providing the experienced barriers and facilitators in the use of telemonitoring according to nurses who work at a virtual care centre. As expected, other barriers and facilitators are experienced at the virtual care centres compared to the outpatient and inpatient clinic. An important facilitator that did not result from studies in the inpatient and outpatient setting, but resulted from this study, is ‘less physical strain’. This may be due to the fact that telemonitoring in the inpatient clinic is used besides physical care, whereas the nurses still have to be physically active [58]. An important barrier that is very different from the barriers in the inpatient and outpatient setting, is the barrier ‘knowledge of a lot of different care pathways’. In the outpatient and inpatient clinic telemonitoring is used by the nurses within one specific care pathway. In the virtual care centre, the nurses use telemonitoring in several care pathways. This may have let to the finding of this barrier in this specific study. Also, existing literature suggests that an excessive amount of knowledge among nurses can potentially result in its less effective application in practical settings, which can be a barrier [59]. By acknowledging the differences in barriers and facilitators between inpatient and outpatient clinics, and the virtual care centres, the necessity for additional theoretical development regarding the experiences of virtual care nurses is addressed.

Practical implications

The experienced barriers and facilitators can give guidance in certain choices hospitals have to make when setting up a virtual care centre or give guidance to current virtual care centres in improving their centre, to support the nurses. Some specific measures are given regarding the key findings. Due to the fact that the nurses experience a barrier in the connection of the telemonitoring application with the electronic patient record system, it can be of great added value, that the management, together with the virtual care nurses, look at how the applications are connected at this moment and in what way this could be improved. Currently, Luscii and Hix, either lack a connection or have a unidirectional connection from Luscii to Hix. An improvement in this regard may involve establishing a connection

between the applications that meets the preferences and needs of the nurses. Also, a connection can be established from Hix to Luscii. A potential improvement could be the implementation of a hotkey within Hix that enables direct access to Luscii for patients receiving care from the virtual care centre. By implementing such improvements, the user friendliness of the applications together can be enhanced, resulting in a more streamlined telemonitoring process [38,45]. Also, it became clear that the balance between work tasks and the insufficient capacity are barriers. This may have as an implication that the management of the hospitals critically examines how the work tasks are currently organized, and what the wishes are from the nurses in how to divide the tasks. The management should also get a vision in if the number of patients and tasks fit to the current capacity. When this is not the case, the management should look for options to expand the capacity or abbreviate the number of patients or tasks. According the literature, capacity management plays a crucial role in healthcare organizations as it not only facilitates an understanding of the available capacities within the organization, but also ensures an optimal alignment between these capacities and the constantly evolving demand for care, as well as the expanding responsibilities assigned to nurses [60]. Moreover, the management can set up an (online) training about how to manage patients via telephone calls. The provision of education regarding patient handling has the potential to bolster the confidence of virtual care nurses in their ability to assess patients [61]. Also, education for the executive staff could be established about the working method of the virtual care centre and dealing with patient data within the centre. It is namely seen that education leads to more trust among healthcare professionals [62].

Strengths and limitations

The findings of this study need to be clarified in light of several limitations and strengths. First, in the study only female nurses were included, which may have an effect on the transferability for male nurses. According to the UTAUT model, gender could namely influence performance expectancy, effort expectancy and social influence [35]. Incorporating male nurses into the study could shed light on the importance of barriers and facilitators related to performance expectancy [63]. This is because men tend to place a greater emphasis on performance expectancy as a determinant of their behavioural intention, compared to women. Conversely, when considering the factor of social influence, male nurses may assign less importance to it, as women typically attribute stronger value to social influence in shaping their behavioural intention. Therefore, when men would be included in the study, other barriers and facilitators could be present. Also, the study population had an average age of 45 years, which means that the largest part of the study population had an age between 35 and 55. This is representative for the general hospital executive staff population in the Netherlands [64]. The UTUAT model states that age could influence all factors of the model, so by having a representative study group, different views on the different factors, are being highlighted [35]. However, no real differences in experiences were seen between different ages in the study population. Moreover, the nurses all have relatively short experience with working with telemonitoring within the virtual care centre. Also, experience is mentioned in the UTAUT model and could have influence on performance expectancy, social influence and facilitating conditions [35]. Due to the fact that the years of experience of the nurses do not differ a lot from one another, differences in experiences in the mentioned factors of the model, may not have been highlighted completely.

For setting up the interview guide, the UTAUT model was used. This model is also used in several earlier studies in their interview guides, whereby none of these studies mentioned limitations by using the UTAUT model [38,39]. The UTAUT model has demonstrated its validity in effectively capturing the patterns of use and acceptance of healthcare technologies [37]. This model incorporates elements from eight other existing models that explore the acceptance and use of technology among users [65]. Consequently, the UTAUT model provides a more comprehensive and expansive perspective on

telemonitoring use compared to relying solely on one of these individual models. Also, minor changes were made in the interview guide in between the interviews. This iterative process have led to the researcher coming closer to the studied object; establishing experienced barriers and facilitators in the use of telemonitoring by virtual care nurses, which was effective in getting the needed answers [66]. Furthermore, the interviews were conducted physically as well as online. Given respondents choice in how their interview is performed is important in optimal sharing of experiences of the nurses [67]. It also enhanced the inclusion of respondents [67]. However, online interviews provide shorter responses, less information about the context and respondents value the relationship with the researcher as less important [68]. These factors may have influenced the obtained answers because eleven out of thirteen interviews were conducted online. Lastly, the virtual care centres in the included hospitals, differed from the way they are organized. Because of the different organization it may be difficult to compare findings among the hospitals. However, the inclusion of different organized hospitals also may have led to a more diverse insight of the experiences of nurses working at a virtual care centre [40].

Recommendations future studies

To provide ongoing insight in the experiences of virtual care nurses, it is crucial for future research to examine the evolving technology landscape within virtual care centres. With continuous advancements, the technology used in these centres is subject to constant change [69]. Consequently, the barriers and facilitators encountered by nurses in their practice will also evolve over time. Therefore, it is recommended that ongoing research endeavours focus on comprehending these changes and their implications for the barriers and facilitators experienced by nurses in virtual care settings. This will enable a deeper understanding of the dynamic nature of technology and its impact on healthcare delivery [69]. Additionally, it is suggested to extend the study to other hospitals that are in the process of setting up virtual care centres. Nurses in these hospitals would have less experience with telemonitoring, offering a unique perspective on the challenges encountered when implementing a virtual care centre from scratch. This broader inclusion of hospitals would also enhance the diversity of the study population, potentially capturing insights from nurses with different demographic characteristics (e.g., gender, age). Moreover, this study revealed variations in the organization of different virtual care centres. Future studies could focus on assessing and comparing the organizational models of virtual care centres, exploring how nurses experience different organizational approaches, and identifying areas where hospitals can learn from one another. This would contribute to the knowledge base surrounding effective implementation strategies and best practices for virtual care centres [70].

Conclusion

This study offers an overview of the barriers and facilitators experienced by nurses in the use of telemonitoring within a virtual care centre. Overall, the use of telemonitoring in virtual care centres is perceived positively, with more facilitators than barriers identified. The factors: performance expectancy, effort expectancy, social influence and facilitating conditions, outlined in the UTAUT model have proven to be instrumental in identifying both barriers and facilitators in the use of telemonitoring. Notably, the factors facilitating conditions, effort expectancy, and social influence have played a particularly crucial role in uncovering barriers and facilitators that may have been overlooked with other models. The findings of this study can give guidance in certain choices hospitals have to make when setting up a virtual care centre or give guidance to current virtual care centres in improving their centre, to support the nurses in their challenging jobs. There should be an implicit focus on the perceived barriers that are fixable by the management. Inclusion of virtual care nurses in the decision-making process regarding potential changes within the virtual care centre is

crucial. This ensures their perspectives and expertise are considered, ultimately supporting nurses in their challenging roles within virtual care settings.

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Appendix 1 Information letter and informed consent

Information letter for the study " Experienced barriers and facilitators in the use of telemonitoring according to nurses working at a virtual care centre."

Aim of the study
This study is being led by Alyssa Wegman, a student of the master's in health sciences at the University of Twente.

The aim of this study is to gain more insight into the experienced barriers and facilitators in the use of telemonitoring according to nurses working within a virtual care centre. Because virtual care centres are a fairly new concept, it is still insufficiently known how nurses who work there experience the use of telemonitoring. By identifying the barriers and facilitators in the use of telemonitoring, this can contribute to making it easier to move physical care to care at home.

In order to find out the barriers and facilitators, I would like to ask you to participate in the research. The data from this research will be used for a master thesis.

What is my approach?
You are participating in a study wherein I gather information by interviewing you and recording your answers via a recording. A transcript of the interview will also be made. I start the interview with an introduction about the study and about the interview. Then I ask for some demographic data, namely age, years of working with telemonitoring, work experience in healthcare and level of education. You will then be asked a number of questions relating to your experiences with barriers and facilitators in the use of telemonitoring. Additional questions may be asked during the interview for clarification. At the end, the interview will be closed, and you will be explained what the next steps are. It is the intention that you answer as extensively as possible, there is no right or wrong answer. The interview will last approximately 30 minutes.

The collected research data will be shared with Isala in Zwolle exclusively for the purpose of the study.

Potential risks and inconveniences
There are no risks associated with your participation in this study. You do not have to answer questions you do not want to answer. Your participation is voluntary, and you can stop your participation at any time without further consequences.

Compensation
You will not receive any compensation for participating in this study.

Confidentiality of data
I do everything I can to protect your privacy as well as possible. No confidential information or personal data will be disclosed in any way that would allow anyone to recognize you. Your given answers will be anonymized so that the answers cannot be traced back to you. Furthermore, your identity will not be mentioned in any publication resulting from this interview. The collected data is stored on a secure server of Isala.

The research data will be kept for a period of 15 years. The data will be deleted after the expiry.

The research data will be made available to persons outside the research group only in an anonymous form if necessary (for example for a scientific integrity check).

Finally, this research was assessed and approved by the ethics committee of the Faculty of BMS (domain Humanities & Social Sciences) of the University of Twente and the local feasibility committee of Isala.

Voluntariness

Participation in this study is completely voluntary. As a participant, you can stop participating in the study at any time or refuse to allow your data to be used for the study, without giving reasons. Termination of participation has no adverse consequences.

If during the study you decide to stop participating, the data collected during the interview will not be used further in the study.

Do you want to stop the research, or do you have questions and/or complaints? Please contact the research leader; Alyssa Wegman

a.b.wegman@student.utwente.nl

For objections regarding the design and/or execution of the study, you can also contact the Secretary of the Ethics Committee / domain Humanities & Social Sciences of the Faculty of Behavioural, Management and Social Sciences at the University of Twente via ethicscommittee-hss@utwente.nl. This research is being carried out by the University of Twente, Faculty of Behavioural, Management and Social Sciences. If you have specific questions about the handling of personal data, you can also direct these questions to the UT's Data Protection Officer by sending an email to dpo@utwente.nl.

Finally, you have the right to submit a request to the research leader to inspect, change, delete or adjust your data.

By signing this informed consent, I acknowledge the following:

1. I have been sufficiently informed about the study by means of a separate information letter. I have read the information letter and then had the opportunity to ask questions. These questions have been adequately answered.

2. I voluntarily participate in this study. There is no express or implicit compulsion for me to participate in this research. It is clear to me that I can terminate participation in the study at any time without giving any reason. I don't have to answer a question if I do not want to.

In addition to the above, it is possible to give specific permission for various parts of the study, below. You can choose whether or not to give permission for each part. If you want to give permission for everything, you can do so via the check box at the bottom of the statements.

3. I give permission to process the data collected from me during the study as included in the attached information letter.	YES ☐	NO ☐
4. I give permission to make recordings (sound) during the interview and to elaborate my answers in a transcript.	☐	☐
5. I give permission to use my answers for quotes in the study publications.	☐	☐
6. I give permission to store the interview data and to use it for future research and for educational purposes.	☐	☐

I consent to everything described above.	☐

Name respondent:

Name researcher:

Signature:

Signature:

Date:

Date:

Appendix 2 Interview guide

Thank you very much for agreeing to participate in my study. I am Alyssa Wegman, Health Sciences student at the University of Twente. At the moment I am working on my master assignment, which is about experiences of nurses working within a virtual care centre with the use of telemonitoring. The aim of my study is to find out barriers and facilitators in the use of telemonitoring according to the experiences of nurses. So, it really is about your experiences in your own use of telemonitoring and the barriers and facilitators you experience in using it. I conduct several interviews with nurses working within a virtual care centre. In my research, telemonitoring means the digital tracking and monitoring of a patient from a distance, whereby data about the patient is collected. Think, for example, of video calls, apps such as Luscii and the use of wearable sensors.

Before we begin, I would like to point out that there are no right or wrong answers. Your name will not be mentioned anywhere else. I can use quotes in the publication, but these will also be anonymized. The data will be stored on a secure server of Isala for a maximum of 15 years. You have the option to stop this interview at any time and you can always ask for clarification if you do not fully understand a question. In the information letter I sent you by e-mail, you gave permission for the interview to be recorded, do you still support this? The interview will last approximately 30 minutes. Do you have any questions before we start the interview?

1. First of all, can you tell me a bit about yourself and your professional background? Think of your age, gender, level of education.

- How long have you been working in healthcare, in which positions/departments?

- For how long are you working with telemonitoring now?

- How many days a week you work at the virtual care centre?

2. Which telemonitoring technologies are you using in your daily job?

- For which diseases do you use telemonitoring?

3. What were your expectations of telemonitoring before using telemonitoring? What were the similarities and differences with now?

Performance expectancy

4. Can you say something about how you expect telemonitoring to contribute to the provision and monitoring of care at home?

- Does telemonitoring fit in with other tasks you have, such as setting up/designing new care pathways?

- How do you experience the use of protocols?

- How do you see the added value of the current situation, i.e., the use of telemonitoring for the provision of care, compared to the old situation, the provision of physical care? - What do you think is the added value for yourself?

- Do you expect the measurements you perform during telemonitoring to be just as reliable as 'physical' monitoring? - How do you experience reading the values entered by the patient in the apps?

Effort expectancy

5. Can you tell me about the effort it takes you to use telemonitoring?

- Can you tell us about the effort it took you, to learn how to use telemonitoring?

- How much has your work situation changed since you started doing this job?

- Can you tell me about the skills you need to use telemonitoring?

- Can you tell me about the knowledge you need to use telemonitoring?

- Do you notice differences in the use of telemonitoring per patient group for yourself?

Social influence

6. To what extent do doctors and/or nurses from the inpatient clinic and outpatient clinic influence your use of telemonitoring?

7. To what extent does the management influence your use of telemonitoring?

8. To what extent do colleagues within the centre influence your use of telemonitoring?

9. To what extent do patients influence your use of telemonitoring?

Facilitating conditions

10. Can you tell me something about how telemonitoring fits into existing care processes?

- Can you tell me something about the resources and/or facilities (techniques) you have to make telemonitoring fit into your daily work situation? - How are these arranged within the hospital? - How do you deal with possible malfunctions in the technique?

- Do you think there is sufficient capacity, in terms of personnel, to use telemonitoring?

- How do you feel about the amount and type of training you receive on telemonitoring, and does this fit into your daily job?

- What do you think of the current technology available to enable telemonitoring? Think of apps, smartphones/devices, internet connection?

Behavioural intention

11. Can you tell me about your benefits of continuing to use telemonitoring?

12. Can you tell me something about the points for improvement with regard to telemonitoring in the virtual care centre?

13. To what extent are you willing to continue using telemonitoring in the future?

Extra

14. What do you think of the patient-nurse relationship during telemonitoring? Do you also hear what patients think of this?

12. Are there any further barriers/facilitators in the use of telemonitoring that have not been discussed but are relevant?

13. Do you have any questions?

14. May I ask for further clarification, if necessary?

Appendix 3 Codebook

(Online) training							Required skills and knowledge nurses
Accessibility apps			Other requirements for the use of telemonitoring				
Accessibility centre					Possible effects of telemonitoring		
Applicability telemonitoring					Possible effects of telemonitoring		
Applications						Required resources and technology	
Ask questions and listen				Patient-nurse relationship			Required skills and knowledge nurses
Awareness of illness patient					Possible effects of telemonitoring		
Bed occupation					Possible effects of telemonitoring		
Communicative							Required skills and knowledge nurses
Connection applications						Required resources and technology	
Convincing							Required skills and

							knowledge nurses
Digital skills							Required skills and knowledge nurses
Division of work tasks	Changing job content nurses						
Empathetic							Required skills and knowledge nurses
Flexible							Required skills and knowledge nurses
Flexible workplace	Changing job content nurses						
Global knowledge care pathways							Required skills and knowledge nurses
High workload	Changing job content nurses						
Honesty patients				Patient-nurse relationship			
Independent							Required skills and knowledge nurses
Information care pathway clinic/policlinic		Influence of hospital staff on the use of telemonitoring					
Innovative ness	Changing job content nurses						
Insufficient capacity	Changing job content nurses						

Knowledge care pathways							Required skills and knowledge nurses
Knowledge/trust executive staff		Influence of hospital staff on the use of telemonitoring					
Lacking physical contact				Patient-nurse relationship			
Learning telemonitoring							Required skills and knowledge nurses
Managing patients							Required skills and knowledge nurses
More frequent measurements					Possible effects of telemonitoring		
More patients	Changing job content nurses						
More time for patient				Patient-nurse relationship			
Nature of training							Required skills and knowledge nurses
No visual contact				Patient-nurse relationship			
Outcome hospital/patient most important					Possible effects of telemonitoring		

Patients dealing with technologies				Patient-nurse relationship			

Patients' recovery in own environment					Possible effects of telemonitoring		
Personal occupation					Possible effects of telemonitoring		
Physical strain	Changing job content nurses						
Profound contact				Patient-nurse relationship			
Quality technologies			Other requirements for the use of telemonitoring				
Rectifying protocols						Required resources and technology	
Reliability measurements			Other requirements for the use of telemonitoring				
Resource availability						Required resources and technology	
Resources workplace						Required resources and technology	

Stress-resistant							Required skills and knowledge nurses
Sufficient capacity	Changing job content nurses						
Support management		Influence of hospital staff on the use of telemonitoring					
Support virtual care colleagues		Influence of hospital staff on the use of telemonitoring					
Therapy compliance patient				Patient-nurse relationship			
Time consumption patient					Possible effects of telemonitoring		
Translating clinical view							Required skills and knowledge nurses
Using protocols						Required resources and technology	
Working for nurses			Other requirements for the use of telemonitoring				
Working for patients			Other requirements for the use of telemonitoring				