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Educational intervention to increase nurses' knowledge, self-efficacy and usage of telehealth: A multi-setting pretest-posttest study

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ABSTRACT

The widespread use of telehealth, providing healthcare remotely, is hampered by various barriers. Dutch nurses currently working in practice never received education in this new way of healthcare delivery. Education is frequently suggested as a strategy to overcome barriers in telehealth use. However, the nature and effectiveness of such education has not yet been specified and tested in practice. In a previous study, we identified 14 nursing telehealth activities and accompanying competencies. In the current study, we established the effectiveness of training in these competencies on nurses' subjective knowledge, self-efficacy and usage of telehealth. A two-day tailored training program in nursing telehealth activities was evaluated in a Dutch context among 37 participants across three settings: (a) twelve primary care (PC), (b) fourteen homecare (HC) and (c) eleven hospital (H) nurses. In each team, telehealth knowledge significantly increased during the training sessions. In each team, nurses' telehealth self-efficacy also significantly increased 6–10 weeks after the training. After the training, the number of remote consultations increased from 2 to 12 in primary care, 12 to 35 in homecare and decreased from 28 to 17 in the hospital setting. We conclude that training nurses in telehealth activities contributes to their knowledge and self-efficacy.

1. Introduction

To maintain quality healthcare, the Netherlands, and various other countries, face major challenges in the supply of adequate nursing workforce. The Dutch Nurses' Dutch Nurses' Association (2017) calculated that by 2025, in the Netherlands alone, 125,000 extra nursing administrators are needed to meet patients' needs. Telehealth services could support older patients to "age in place" by replacing face-to-face visits with e-visits via the use of digital technology (Brunett et al., 2015). In the Netherlands, this approach to providing healthcare is encouraged by the government. In the near future, all Dutch patients living at home should have the possibility to communicate via videoconferencing with their health care providers (Schippers and van Rijn, 2014). However, the widespread use of telehealth is hampered by various barriers (Ariens et al., 2017; Kort and van Hoof, 2012).

In the Netherlands, in 2017, only 5% of the community-dwelling patients have the opportunity to communicate with their healthcare provider through videoconferencing (Wouters et al., 2017). According to a recent Dutch poll (Wouters et al., 2017) 30% of the Dutch community-dwelling patients would like to make use of videoconferencing for health consultations. However, currently only 1% of the primary care nurses used videoconferencing and 8% of the nurses working in hospitals use such an approach. The limited use of telehealth can be partially explained by the lack of adequate education in telehealth (Ariens et al., 2017; Brewster et al., 2014; Kort and van Hoof, 2012).

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Nurses currently working in practice never received education in the provision of telehealth, since this was not part of previous nursing curricula. As a result, in several countries, such as the United Kingdom (Sharma and Clarke, 2014), the Netherlands (Kort and van Hoof, 2012) or United States (Radhakrishnan et al., 2012), telehealth use is hampered in part by a lack of adequate telehealth competencies among nurses (Ariens et al., 2017; Brewster et al., 2014; Gagnon et al., 2012; Kort and van Hoof, 2012). Telehealth education is frequently suggested as a strategy to overcome barriers in telehealth use (e.g., Brewster et al., 2014; European Commission, 2012; Giordano et al., 2011; Sharma and Clarke, 2014; van Houwelingen et al., 2015). However, to our knowledge, this assumption has not been explored in the literature so far. The current study aims to address this research gap.

A commonly used model to evaluate the effectiveness of a training program, is the model of Kirkpatrick, which includes four levels: (1) reaction (participants 'opinions), (2) learning, (established through assessment), (3) changed behaviour (observed in practice) (4) organizational results (e.g., effects on patient care) (Kirkpatrick, 1996)., The higher the level, the higher the impact. Earlier studies (e.g., Gifford et al., 2012; Stromberg, 2011) have explored the effectiveness of telehealth training on Kirkpatrick's level 1 'reaction', i.e., nurses' *perception* of the usefulness of the training, but no studies have addressed a potential added value of training on nurses' perception of learning (level 2a according to Yardley and Dornan (2012) or behaviour (level 3). These higher levels are relevant when considering how to increase the utilization of telehealth. Nurses' confidence in their telehealth competence appears to be positively associated with their willingness to use telehealth (Lam et al., 2014; van Houwelingen et al., 2015). Therefore, it is relevant to evaluate the impact of training on knowledge of telehealth and self-efficacy of nurses (Kirkpatrick level 2a: self-perception of learning (Yardley and Dornan (2012)). Furthermore, insight into the impact of training on telehealth use frequency by nurses (Kirkpatrick level 3: behaviour) is required since many studies (e.g., Brewster et al., 2014; European Commission, 2012; Giordano et al., 2011; Sharma and Clarke, 2014; van Houwelingen et al., 2015) assume that training is an adequate strategy to overcome telehealth barriers, but this has not been established.

Therefore, the current study aims to evaluate the effectiveness of training in telehealth competencies not only on Kirkpatrick level 1 but also on levels 2a and 3. Prior to this evaluation, a course in nursing telehealth activities was developed. In an earlier study, a set of core nursing telehealth activities and required competencies were identified (van Houwelingen et al., 2016) and recommended for use in the development of nursing telehealth training programs. We followed this suggestion and used these activities and competencies as a framework for the development of a telehealth educational intervention comprised of two training sessions. Subsequently, to be able to explore the effectiveness of the training in different settings, it was delivered in three different nursing settings. Although different, all three provided telehealth care, which was our selection criterion. In this study, we report the extent to which this training contributed to telehealth knowledge, self-efficacy and usage in nursing practice.

2. Methods

2.1. Design

In 2016, a multi-setting study was conducted using a pretest-posttest method during a tailored nursing telehealth training program in homecare, primary care and a hospital setting.

2.2. Sampling and setting

During previous research projects with health care organizations located in our region, three organizations expressed their wish to (re) train their nurses in providing telehealth, since their nurses had difficulties with integrating telehealth services into their daily routine. For the current study, aimed at evaluating the effectiveness of a telehealth training program, we approached these three organizations with the offer of providing a nursing telehealth training to integrate nursing telehealth into daily practice. All three teams agreed to participate and already used telehealth, which was our only selection criterion. The teams were employed in primary care, homecare or hospital care in The Netherlands (see Table 1).

2.2.1. Prior telehealth experience and training

In the past, all three teams had received a short training or instruction for using the device or application offered by an external provider of the device or application. In homecare consultations involved those using home telehealth videoconferencing with an iPad. In primary care and hospital care settings, electronic consultations were provided using a personal computer, through a secure web-based platform for nurse-patient communications. All three teams expressed a lack of knowledge regarding the integration of telehealth into their daily routine work. At baseline measurements of our study, all three teams had barely made use of telehealth (see Table 6).

2.2.2. Invitation to participate

Nurses were invited by their manager or telehealth project leader to participate in a training consisting of two sessions of 2–3 h. An e-mail was sent with information about the training and research and scheduled appointment slots for the training that could be chosen by the nurses. A total of 37 nurses volunteered to participate in the training and the study: twelve out of a team of fifteen primary care nurses, fourteen homecare nurses of a team of fourteen and eleven hospital nurses out of a team of fifteen. Due to conflicting calendars, two of the nurses in each setting missed the second training session. The training was accredited by the Dutch Nurses and Carers Association, which encouraged nurses to participate since continuing education is required to maintain their registration.

Table 1
Characteristics of participating settings.

Characteristics	Setting 1	Setting 2	Setting 3
Type of setting	Primary care	Homecare	Hospital care
Number of nurses within the team that was invited to participate in the study	15	14	15
Patients	Community-dwelling	Community-dwelling	Dermatology
Location	City of Utrecht	Region of Utrecht	City of Utrecht
Type of telehealth/ remote consultations	Electronic consultation, a secure web-based platform for nurse-patient communications.	A tablet to provide home telehealth videoconferencing, screen-to-screen communication.	Electronic consultation, a secure web-based platform for nurse-patient communications, integrated into the patient portal.
Initiation of remote consultations	The patients initiate the consult by asking a question, and nurses respond. Nurses have a role in stimulating patients to make use of the electronic consultations function.	Both nurses and patients can initiate a consultation through videoconferencing. In practice, consultations are mainly initiated by the nurses.	The patients initiate the consult by asking a question, and nurses respond. Nurses have a role in stimulating patients to make use of the electronic consultations function.

2.3. Ethics approval

The Ethical Review Board of the Netherlands Association for Medical Education (NVMO-ERB) approved this study (ERB number 637). All nurses participated voluntarily in the training program and accompanied research. Prior to the research and training, all potential participants were informed with by a letter about the aim of training and research and were told that they were free to participate or to terminate participation at any time. Furthermore, the nurses were informed that their responses would be processed anonymously, securely stored, and used for research purposes only. No identifying information was collected.

2.4. Educational intervention: tailored training in telehealth activities and educational strategy

Nurses received two 2–3 h training sessions regarding how to integrate nursing telehealth activities in their daily work. The training sessions were delivered by two of the authors, together with a telehealth specialist of the participating organizations. Within the training sessions, nurses worked in small groups of three persons and provided each other with (peer) feedback.

2.4.1. Educational strategy

The training aimed to increase nurses' knowledge and self-efficacy and, as a result, the use of telehealth in nursing practice. Increasing nurses' self-efficacy was our main strategy to increase the number of remote consultations, since a positive self-perception of competence (self-efficacy) is associated with behavioural change (Bandura, 1977). To increase nurses' telehealth self-efficacy, Bandura (1977) strategies to increase self-efficacy were used in the training sessions: (1) performance accomplishments by organizing practices (starting with low complex videoconferencing practices), which gave the participants the opportunity to have successful experiences, (2) using vicarious experience by having participants see others accomplish difficult situations, and (3) verbal persuasion by acknowledging participant skills during telehealth practices.

To increase nurses' telehealth knowledge, they received, prior to the study, a list with relevant questions and answers, covering all knowledge items (also listed in Table 4). During the training, nurses assessed each other's knowledge by discussing these questions, e.g., 'What are the potential benefits of telehealth?'.

2.4.2. Learning objectives

In a previous study we showed which telehealth activities (Dutch) nurses could perform (van Houwelingen et al., 2016). The fourteen nursing telehealth activities of this prior study (e.g., 'Assessing patient

Table 2
Sociodemographic characteristics of participating nurses.

Characteristic	Primary care (n = 12)	Homecare (n = 14)	Hospital (n = 11)
Gender, n (%)			
Female	11 (91.7)	13 (92.9)	10 (90.9)
Male	1 (8.3)	1 (7.1)	1 (9.1)
Age group (yr), n (%)			
≤30	3 (25)	0	2 (18.1)
31–40	2 (16.7)	2 (14.3)	1 (9.1)
41–50	3 (25)	6 (42.9)	2 (18.2)
51–60	4 (33.3)	5 (35.7)	3 (27.3)
>60	0	1 (7.1)	3 (27.3)
Highest completed educational level, n (%)			
Average (general or vocational upper secondary education)	1 (8.3)	1 (7.1)	0
High (bachelor's degree or higher)	11 (91.7)	13 (92.9)	11 (100)
Experience with telehealth, n (%)			
None	4 (33.3)[a]	0	3 (27.3)[a]
1–6 months	1 (8.3)[a]	12 (85.7)[b]	0
6–12 months	5 (41.7)[a]	1 (7.1)[b]	0
1–2 years	1 (8.3)[a]	0	0
>2 years	1 (8.3)[a]	1 (7.1)[b]	8 (72.7)[a]
Daily use of technology, n (%)[c]			
Smartphone	12 (100)	14 (100)	11 (100)
Tablet and/or iPad	6 (50)	11 (78.6)	7 (63.6)
Skype and/or FaceTime	0 (0)	0	0
Internet	12 (100)	13 (92.6)	10 (90.9)
E-mail	12 (100)	13 (92.6)	11 (100)
Computer/Laptop	9 (75)	12 (85.7)	9 (81.8)

[a] Experience with electronic consultations; nurse-to-patient communications within a secure web-based platform.
[b] Experience with home telehealth videoconferencing.
[c]) Participants were asked how often they used these six technologies in their daily life, which they answered on a 4-point scale ranging from 1 = daily to 4 = hardly ever. This table presents the frequencies of participants who responded 'daily'.

Table 3
Satisfaction and perceived usefulness of the training.

	Primary care (n = 12) Median (Q1-Q3)	Homecare (n = 14) Median (Q1-Q3)	Hospital (n = 11) Median (Q1-Q3)
On a scale of 1-10, to what extent have these expectations been met?	8.0 (7.0–8.0)	9.0 (8.0–10.0)	8.0 (6.5–8.0)
I find the training useful for my job (scale 1–5)*	4.0 (4.0–4.0)	4.0 (4.0–4.8)	4.0 (4.0–4.0)
Investing time in this training was useful (scale 1–5)*	4.0 (3.0–4.0)	4.0 (4.0–5.0)	4.0 (3.5–4.0)
I can apply the content of this training in my job (scale 1–5)*	4.0 (3.8–4.0)	4.0 (4.0–5.0)	4.0 (3.5–4.5)
I derive personal use from this training (scale 1–5)*	4.0 (4.0–4.3)	4.0 (4.0–5.0)	4.0 (3.5–4.0)

Note: Measured directly after the training. Since the data were not normally distributed, median scores are reported. *) Perceived usefulness items derived from the Training Evaluation Inventory (Ritzmann et al., 2014).

Table 4
Nurses' telehealth knowledge before and after the training.

		Primary care ($n = 12$)					Homecare ($n = 14$)					Hospital ($n = 11$)				
	Subjective knowledge of … (scale: 1–5)	**O1** Median (Q1-Q3)	**O2** Median (Q1-Q3)	**O3** Median (Q1-Q3)	**O1 vs O2** *P*-value	**O1 vs O3** *P*-value	**O1** Median (Q1-Q3)	**O2** Median (Q1-Q3)	**O3** Median (Q1-Q3)	**O1 vs O2** *P*-value	**O1 vs O3** *P*-value	**O1** Median (Q1-Q3)	**O2** Median (Q1-Q3)	**O3** Median (Q1-Q3)	**O1 vs O2** *P*-value	**O1 vs O3** *P*-value
1.	policies, procedures and protocols of the organization concerning the deployment of telehealth technologies	3.0 (2.0–3.8)	3.5 (2.0–4.0)	4.0 (2.5–4.0)	.189	.160	2.0 (2.0–3.0)	4.0 (3.3–4.0)	4.0 (4.0–4.0)	.016	.004	3.0 (2.0–3.0)	4.0 (3.5–4.0)	4.0 (2.0–4.0)	.006	.114
2.	the (clinical) limitations of telehealth	3.0 (2.0–4.0)	4.0 (4.0–4.0)	4.0 (4.0–4.0)	.063	.063	3.0 (3.0–3.0)	4.0 (4.0–4.0)	4.0 (4.0–4.0)	.003	.002	3.0 (3.0–4.0)	4.0 (4.0–4.0)	4.0 (2.0–4.0)	.126	.824
3.	how telehealth can be deployed in existing pathways	3.0 (2.0–3.8)	4.0 (4.0–4.3)	4.0 (4.0–4.5)	.009	.017	3.0 (3.0–3.0)	4.0 (4.0–4.0)	4.0 (4.0–4.0)	.002	.004	4.0 (4.0–4.0)	4.0 (4.0–4.0)	4.0 (2.0–4.0)	.246	.623
4.	the laws and regulations concerning the protection and exchange of medical data, e.g., data protection, informed consent and confidentiality	3.0 (2.0–3.0)	3.5 (2.0–4.3)	4.0 (3.0–4.0)	.569	.065	3.0 (2.5–4.0)	4.0 (4.0–4.0)	4.0 (4.0–4.0)	.061	.030	3.0 (2.0–4.0)	4.0 (3.0–4.0)	3.5 (2.0–4.0)	.189	.595
5.	the potential benefits of telehealth	4.0 (2.3–4.0)	4.0 (4.0–5.0)	4.0 (4.0–4.0)	.065	.066	3.0 (3.0–4.0)	4.0 (4.0–4.8)	4.0 (4.0–4.0)	.006	.030	4.0 (4.0–4.0)	4.0 (4.0–4.0)	4.0 (2.0–4.0)	.501	.501
6.	how to collect health-related data for patient monitoring	2.5 (2.0–3.8)	4.0 (3.0–4.0)	4.0 (4.0–4.0)	.083	.015	3.0 (2.0–3.0)	4.0 (4.0–4.0)	4.0 (3.0–4.0)	.003	.009	3.0 (3.0–4.0)	4.0 (3.0–4.0)	4.0 (2.0–4.0)	1.000	.623
7.	which sources patients like to use to find information about their disease	3.5 (2.0–4.0)	4.0 (3.0–4.0)	4.0 (2.5–4.0)	.189	.249	3.0 (3.0–4.0)	4.0 (3.3–4.8)	4.0 (4.0–4.0)	.032	.055	3.0 (3.0–4.0)	4.0 (3.0–4.0)	3.0 (3.0–4.0)	1.000	1.000
8.	the reliability of health information on the web	3.5 (3.0–4.0)	4.0 (3.0–4.0)	4.0 (3.0–4.0)	.110	.563	3.0 (2.0–.0)	4.0 (3.0–4.0)	4.0 (4.0–4.0)	.009	.004	3.0 (2.0–4.0)	4.0 (3.5–4.0)	3.5 (2.8–4.0)	.350	1.000
9.	what to do if the technology does not work	3.0 (2.0–4.0)	3.0 (3.0–3.0)	4.0 (2.5–4.0)	.534	.063	2.0 (2.0–3.0)	4.0 (4.0–4.0)	4.0 (4.0–4.0)	.001	.001	3.0 (3.0–3.0)	4.0 (3.0–4.0)	3.5 (2.8–4.0)	.060	.642
10.	the procedure: what to do in case of an emergency	NA					3.0 (2.5–4.0)	4.0 (4.0–4.0)	4.0 (4.0–5.0)	.017	.007	NA				
11.	how technology can be used in sharing information with colleagues						3.0 (3.0–4.0)	4.0 (4.0–4.8)	4.0 (4.0–4.8)	.008	.008					
12.	relevant protocols						3.0 (2.0–4.0)	4.0 (4.0–4.0)	4.0 (4.0–.0)	.030	.017					
Total score on knowledge of telehealth[1]:		**2.9 (2.6–3.6)**	**3.0 (3.4–3.8)**	**3.7 (3.4–4.1)**	**.002**	**.003**	**3.0 (2.7–3.1)**	**4.0 (3.8–4.1)**	**4.0 (3.8–4.3)**	**.000**	**.000**	**3.3 (3.1–3.6)**	**3.8 (3.7–4.0)**	**3.8 (2.3–3.9)**	**.016**	**.187**

Note: Wilcoxon Signed-Rank Tests were performed to assess significant differences ($P < 0.05$) using Monte Carlo simulation (confidence level of 99%) to assign *P*-values (2-tailed); NA: Not Applicable, these items were not part of the training in this setting since they were not required for the activities in which the nurses were trained and therefore were not measured. [1]We calculated the average score of the subjective knowledge items (for all three observation moments) for each respondent, here above referred to as 'total score'. Again, these average scores were tested for differences. Measuring moments; O1: immediately before the training, O2: immediately after the training, O3: 6 weeks after the training. Items; Knowledge items derived from our prior study (van Houwelingen et al., 2016).

Table 5
Nurses' telehealth self-efficacy before and after the training.

		Primary care ($n = 12$)					Homecare ($n = 14$)					Hospital ($n = 11$)				
	Level 2a: Self-efficacy - nursing telehealth activities (scale: 1–10)	**O1** Median (Q1-Q3)	**O2** Median (Q1-Q3)	**O3** Median (Q1-Q3)	**O1 vs O2***P*-value	**O1 vs O3** *P*-value	**O1** Median (Q1-Q3)	**O2** Median (Q1-Q3)	**O3** Median (Q1-Q3)	**O1 vs O2** *P*-value	**O1 vs O3** *P*-value	**O1** Median (Q1-Q3)	**O2** Median (Q1-Q3)	**O3** Median (Q1-Q3)	**O1 vs O2** *P*-value	**O1 vs O3** *P*-value
1.	Providing health promotion remotely	7.0 (6.0–7.0)	7.0 (6.8–8.0)	7.0 (6.5–8.0)	.403	.236	6.0 (6.0–7.5)	8.0 (7.0–8.0)	7.0 (7.0–8.0)	.020	.149	8.0 (7.0–8.0)	8.0 (6.5–8.0)	8.0 (7.8–9.0)	.685	.378
2.	Assessing patients' capacity to use telehealth	7.0 (6.0–8.0)	7.0 (6.0–8.0)	8.0 (7.0–8.0)	.939	0.96	7.0 (6.0–7.0)	8.0 (7.0–8.8)	8.0 (7.0–8.0)	.124	.089	8.0 (7.0–8.0)	8.0 (7.0–9.0)	8.0 (7.8–9.0)	.471	.170
3.	Supporting patients in the use of technology	6.0 (4.0–7.0)	7.0 (6.0–8.0)	7.0 (5.5–8.5)	.016	.030	5.0 (3.5–6.0)	7.5 (7.0–8.0)	7.0 (7.0–8.0)	.002	.002	6.0 (5.0–8.0)	7.0 (5.5–8.0)	7.0 (6.0–8.3)	.054	.040
4.	Instructing patients and family care givers in self-care[1]	NA					6.0 (6.0–7.0)	8.0 (7.3–9.0)	7.5 (7.0–9.0)	.001	.005	NA				
5.	Training patients in the use of technology as a way to strengthen their social network						5.0 (4.0–6.0)	7.0 (7.0–8.0)	7.5 (7.0–8.0)	.002	.003					
6.	Providing psychosocial support[1]						7.0 (6.0–8.0)	8.0 (7.3–9.5)	8.0 (7.3–8.8)	.011	.007					
7.	Guidance and peer consultation[1]						6.0 (5.5–7.0)	8.0 (8.0–8.0)	8.0 (7.0–8.8)	.002	.002					
8.	Monitoring body functions and lifestyle[1]						7.0 (6.0–7.0)	8.0 (7.3–8.8)	8.0 (7.3–8.0)	.004	.005					
9.	Encouraging patients to undertake health promotion activities[1]						6.0 (6.0–7.0)	8.0 (7.3–8.8)	8.0 (7.0–8.0)	.003	.023					
	Total score on telehealth self-efficacy[2]:	**6.3 (6.0–7.0)**	**7.2 (5.9–8.0)**	**7.0 (6.5–8.2)**	**.171**	**.024**	**6.2 (5.7–6.6)**	**7.8 (7.2–8.5)**	**7.6 (7.3–8.2)**	**.001**	**.002**	**7.0 (6.3–7.7)**	**7.7 (6.7–8.2)**	**7.8 (7.2–8.4)**	**.096**	**.034**

Note: Wilcoxon Signed-Rank Tests were performed to assess significant differences ($P < 0.05$), using Monte Carlo simulation (confidence level of 99%) to assign *P*-values (2-tailed); NA: Not Applicable, these activities were not part of the training in this setting, since they were not applicable to their care provision. [1] Via videoconferencing. [2] We calculated the average score of the self-efficacy items (for all three observation moments) for each respondent, here above referred to as 'total score'. Again, these average scores were tested for differences. Measuring moments; O1: immediately before the training, O2: immediately after the training, O3: 6 weeks after the training. Items; self-efficacy items derived from our prior study (van Houwelingen et al., 2016).

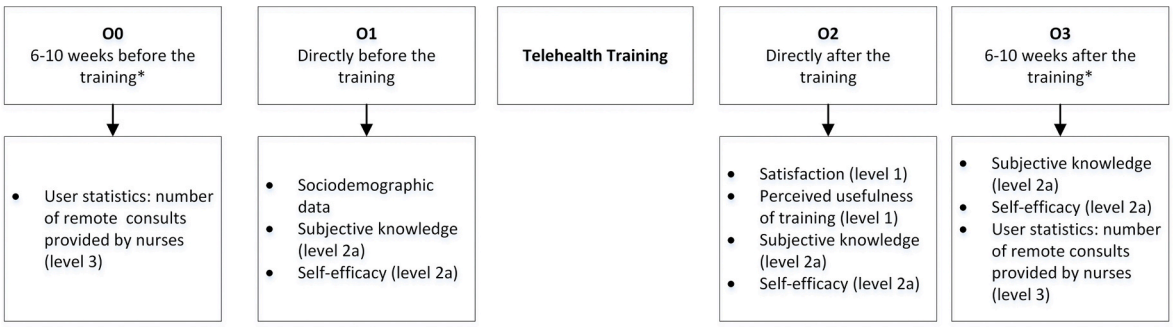

Fig. 1. Outcome measures per observation moment and corresponding Kirkpatrick hierarchy levels (according to Yardley and Dornan (2012): 1 = reaction, 2a = perception of learning, 3 = behaviour). *) We aimed to collect the number of consultations over a period of at least 12 weeks. In two settings, the project leaders of the participating organizations provided us with data over a longer period of time; data were tracked over a period of 20 weeks (10 before, 10 after the training) in the primary care setting, 16 weeks in the homecare setting, and 12 weeks in the hospital setting.

capacity to use telehealth', 'Monitoring body functions and lifestyle remotely using videoconferencing') (van Houwelingen et al., 2016) (see Appendix 1) were used as a framework in the development of this new educational intervention. The goal of our educational intervention was that nurses would acquire these nursing telehealth activities and related knowledge, attitudes and skills.

2.4.3. Tailored program

In each setting, we first discussed which of the fourteen activities would be applicable, to achieve tailored training programs. For example, since the primary care and the hospital team did not use a videoconferencing system, nursing telehealth activities involving videoconferencing were not applicable in these settings. This resulted in a training of nine different telehealth activities in the homecare setting and three activities in the primary care and hospital settings (see Table 5). Nurses learned how to increase the use of telehealth by (1) initiating remote consultations and (2) encouraging patients to ask questions via the electronic consultation system. A detailed description of our educational intervention is provided in Appendix 1, written in accordance with the 'guideline for reporting evidence-based practice educational interventions and teaching (GREET)' (Phillips et al., 2016).

2.5. Data collection

We collected data using a questionnaire and user statistics on the first three levels of the Kirkpatrick hierarchy (Yardley and Dornan, 2012) at four time points: 6–10 weeks before the training (observation O), immediately before the training (observation 1), immediately after the training (observation 2) and 6–10 weeks after the training (observation 3) (see Fig. 1). The questionnaire was constructed by the authors. Prior to data collection, we followed the guidelines by Artino et al. (2014) to collect validity evidence for the questionnaire. Four nurses and one general practitioner, working in one of the participating organizations, were interviewed to assess and improve the relevance and clarity of the questionnaire items. Below, we explain the method for collecting data in each level.

2.5.1. Sociodemographic data

The survey began with five sociodemographic questions concerning gender, age, educational level, experience with telehealth, and daily use of technology (in private life).

2.5.2. Level 1, reaction (satisfaction and perceived usefulness with regard to the training)

Nurses expressed their satisfaction with regard to the training in two ways. First, using a closed question to rate their satisfaction on a 10-point scale (1–10) (higher scores indicating higher satisfaction). Second, four items followed regarding the perceived usefulness of the training, derived from the 'Training Evaluation Inventory' (Ritzmann et al., 2014).

2.5.3. Level 2a, perception of learning (subjective knowledge about telehealth and self-efficacy)

Before and after the training, nurses rated their confidence in their knowledge about telehealth on a 5-point Likert scale. Since each telehealth activity required a specific set of knowledge items, the number of knowledge items that was part of the training differed among settings (see Table 4). Furthermore, nurses rated their confidence in acquiring the nursing telehealth activities in which they were trained before and after the training (see Table 5). We used Bandura's guide for constructing self-efficacy scales (Bandura, 2006). Accordingly, a 10-point scale was used, ranging from 1 = 'not at all able to' to 10 = 'totally able to'.

2.5.4. Level 3, behaviour: number of remote consultations

In each setting, the number of remote consultations initiated by both nurses and patients was automatically registered. In homecare settings, remote consultations involved those using home telehealth videoconferencing with a tablet. In primary care and hospital care settings, electronic consultations were provided through a secure web-based platform for nurse-patient communications. We aimed to collect the number of consultations over a period of at least 12 weeks. In two settings, the project leaders of the participating organizations provided us with data over a longer period of time; data were tracked over a period of 20 weeks (10 before, 10 after the training) in the primary care setting, 16 weeks in the homecare setting, and 12 weeks in the hospital setting. To protect the anonymity of the participants, these data were collected and analyzed on a group level.

2.6. Data analysis

The distribution of the data was visually explored for normality using histograms and tested with Kolmogorov-Smirnov tests. Since most data were not normally distributed, median and interquartile range scores were reported (with regard to training satisfaction, knowledge of telehealth and self-efficacy). Subsequently, nonparametric tests were performed to assess significant differences on the three different Kirkpatrick levels.

For level 1, the median and interquartile scores of the items with regard to the satisfaction and perceived usefulness of the training were analyzed and reported for each nursing setting separately.

For level 2a, subjective knowledge of telehealth and self-efficacy in nurses was compared between the pre- and post-tests using Wilcoxon Signed-Rank Tests. For each setting, we explored whether the knowledge items and self-efficacy items were significantly different between observation 1 (pre-test) and observation 2 (directly after the training) as

well as between observation 1 and observation 3 (six weeks after the training).

Additionally, to summarize the findings, we calculated the average score of the subjective knowledge items (for all three observation moments) for each respondent as well as the average score of the self-efficacy items. Again, these average scores were tested for differences between observation 1 and observation 2 and between observation 1 and observation 3 using Wilcoxon Signed-Rank Tests.

For level 3 (behaviour), the user statistics (number of remote consultations) were analyzed with descriptive statistics. For each setting, we reported the total number of remote consultations in the 6–10 weeks before the training and the total number of remote consultations provided in the 6–10 weeks after the training.

A *P*-value of <0.05 was defined as statistically significant. To increase the power of the Mann-Whitney U tests and Wilcoxon Signed-Rank Tests, we used the Monte Carlo simulation (with a confidence level of 99%) to assign *P*-values. Data analyses were performed using SPSS (IBM Corp. Released 2015. IBM SPSS Statistics for Windows, Version 23.0. Armonk, NY: IBM Corp) and the statistical package R (version 3.2.3 (2017-03-06), The R Foundation for Statistical Computing).

3. Results

3.1. Sociodemographic characteristics

In total, 37 nurses participated in the study: Twelve primary care nurses, fourteen homecare nurses and eleven hospital nurses. The training comprised of two sessions, each lasting 2–3 h, with one or two weeks between the two sessions.

The length of experience with telehealth varied; hospital nurses had adequate experience (eight of eleven nurses >2 years), and most primary care nurses had 6–12 months experience or less. Most homecare nurses (twelve of fourteen) had just started using telehealth (1–6 months of experience). All other demographic details are listed in Table 2.

3.2. Level 1: reaction (satisfaction and perceived usefulness of the telehealth training)

In each setting, the extent to which training expectations were met differed; a median value of 8.0 (scale 1–10) was found in the primary care and hospital setting, and a median value of 9.0 was found in the homecare setting. All items with regard to the perceived usefulness of the training were scored with a median value of 4.0 (5-point scale) (see Table 3).

3.3. Level 2a: knowledge about telehealth before and after the telehealth training

In each team, based on the total score of the knowledge items, nurses' knowledge about telehealth significantly ($P < 0.05$) differed immediately after the training (see Fig. 2). Between observations 1 and 2, the median values and corresponding first and third quartile (Q1-Q3), measured on a 5-point scale, shifted from 2.9 (Q1-Q3: 2.6–3.6) to 3.7 (Q1-Q3: 3.4–3.8) in the primary care setting, 3.0 Q1-Q3: 2.7–3.1) to 4.0 (Q1-Q3: 3.8–4.1) in the homecare setting, and 3.3 (Q1-Q3: 3.1–3.6) to 3.8 (Q1-Q3: 3.7–4.0) in the hospital setting.

Six to 10 weeks after the training, this increase was maintained in the primary and homecare settings, with median values of 3.7 (Q1-Q3: 3.4–4.1) in primary care and 4.0 (Q1-Q3: 3.8–4.3) in homecare. Hospital nurses' knowledge at observation 3 (median 3.8, Q1-Q3: 2.3–3.9) was also higher than knowledge at observation 1 (median 3.3, Q1-Q3: 3.1–3.6), but this difference was not significant ($P > 0.05$).

In terms of item level, listed in Table 4, the data show that most differences between observations 1 and 2 were found in the homecare setting; 10 out of 11 items increased significantly ($P < 0.05$) compared to only 1 out of 9 items in the primary care and hospital settings. A comparable pattern was observed between observations 1 and 3; 10 out

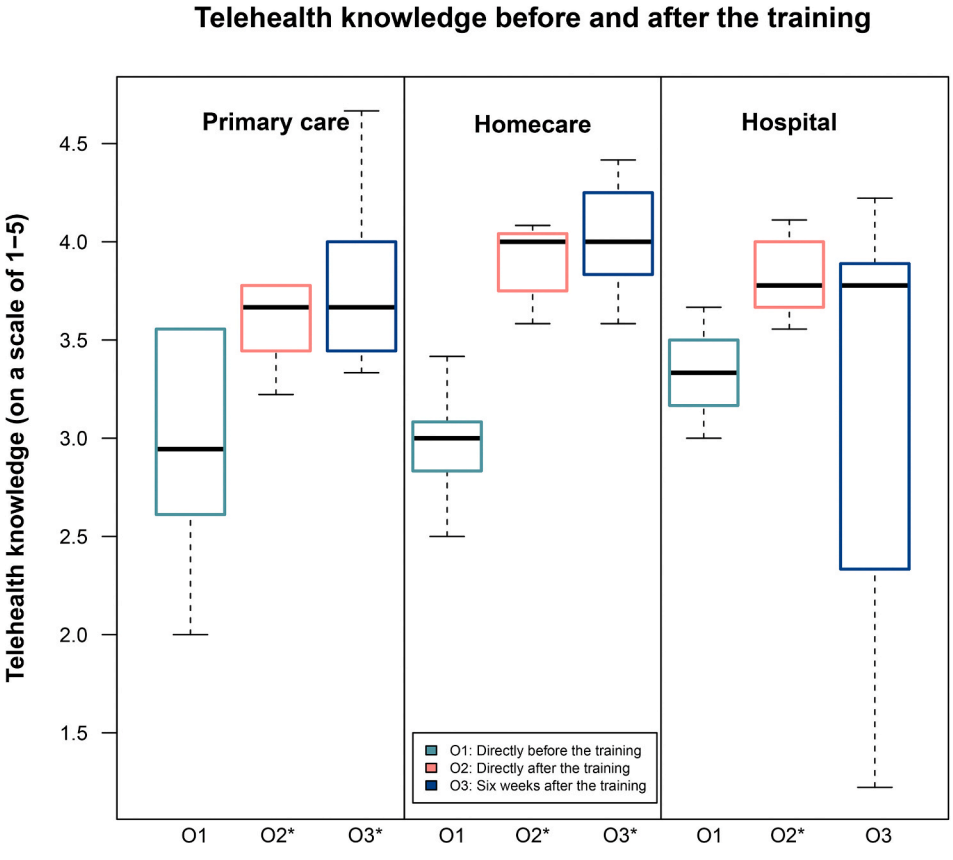

Fig. 2. Nurses' knowledge about telehealth before and after the training, measured in primary care (n = 12), homecare (n = 14) and hospital (n = 11) settings. Box plot shows median, upper/lower quartile and extreme values. Maximum whiskers of O1 and O2 of primary care do not appear because the maximum values equal the third quartiles. Wilcoxon Signed-Rank Tests, using Monte Carlo simulation (confidence level of 99%) to assign *P*-values (2-tailed), were performed to assess significant differences between O1 and O2 and between O1 and O3. *) Significantly higher ($P < 0.05$) than the pretest, observation 1 (O1).

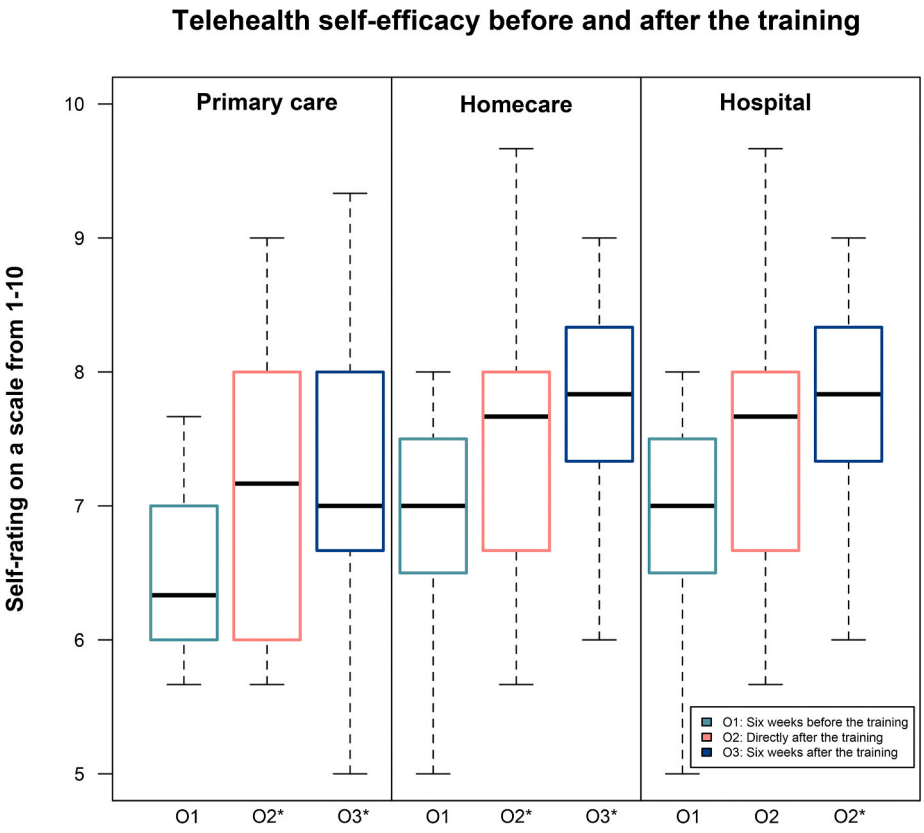

Fig. 3. Telehealth self-efficacy before and after the training, measured on a 10-point scale in primary care (n = 12), homecare (n = 14) and hospital (n = 11) settings. Box plot shows median, upper/lower quartile and extreme values. Wilcoxon Signed-Rank Tests, using Monte Carlo simulation (confidence level of 99%) to assign *P*-values (2-tailed), were performed to assess significant differences between O1 and O2, and O1 and O3. *) Significantly higher ($P < 0.05$) than the pretest, observation 1 (O1).

of 11 items increased significantly in the homecare setting, 2 out of 9 in the primary care setting, and none in the hospital setting.

3.4. Level 2a: telehealth self-efficacy before and after the training

Fig. 3 shows that only the telehealth self-efficacy of homecare nurses had significantly ($P < 0.05$) increased immediately after the training based on the total score of the self-efficacy items. Self-efficacy shifted from a median value of 6.2 (Q1-Q3: 5.7–6.6) before the training to 7.8 (Q1-Q3: 7.2–8.5) immediately after the training (using a 10-point scale). The telehealth self-efficacy of the nurses working in the primary care and hospital setting also increased, but this difference was not significant.

However, six to 10 weeks after the training (O3), telehealth self-efficacy in each team of nurses was significantly increased compared to their self-efficacy prior to the training (O1). Between O1 and O3, nurses' telehealth self-efficacy shifted from median values of 6.3 (Q1-Q3: 6.0–7.0) to 7.0 (Q1-Q3: 6.5–8.2) in the primary care setting, 6.2 (Q1-Q3: 5.7–6.6) to 7.6 (I Q1-Q3: 7.3–8.2) in the homecare setting, and 7.0 (Q1-Q3: 6.3–7.7) to 7.8 (Q1-Q3: 7.2–8.4) in the hospital setting.

With regard to item level (Table 5), the data again show that most differences between observations 1 and 2 were found among the homecare nurses; 8 out of 9 self-efficacy items increased significantly ($P < 0.05$), but self-efficacy with regard to 'Assessing patient capacity to use telehealth' did not improve. In the primary care setting, 1 out of 3 items significantly increased, and no items differed in the hospital setting. A comparable pattern was observed between observations 1 and 3; 7 of the 9 self-efficacy items increased significantly in the homecare setting, and only 1 out of 3 items increased in the primary care and hospital settings.

3.5. Level 3: number of remote consultations before and after the telehealth training

The number of remote consultations provided by nurses (Kirkpatrick level 3), observed 6–10 weeks before and after the training, increased from 2 to 12 in the primary care setting and 12 to 35 in the homecare setting and decreased from 28 to 17 in the hospital setting (Table 6).

4. Discussion

This multi-setting pretest-posttest study evaluated the effectiveness

Table 6
Number of telehealth activities before and after the training.

	Primary care (*n* = 12)		Homecare (*n* = 14)		Hospital (*n* = 11)	
	1–10 weeks before training	1–10 weeks after training	1–8 weeks before training	1–8 weeks after training	1–6 weeks before training	1–6 weeks after training
Number of remote consultations*	2	10	12	35	28	17

Note: *) In homecare, home telehealth videoconferencing using a tablet; in primary care and hospital electronic consultations, a secure web-based platform for nurse-to-patient communications. Numbers apply to the whole group of nurses within one setting. We aimed to collect the number of consultations over a period of at least 12 weeks. In two settings, the project leaders of the participating organizations provided us with data over a longer period of time; data were tracked over a period of 20 weeks (10 before, 10 after the training) in the primary care setting, 16 weeks in the homecare setting, and 12 weeks in the hospital setting.

of a training program in nursing telehealth activities and related competencies on knowledge, self-efficacy and use of telehealth in nurses. In each of the three settings, nurses' knowledge was significantly increased immediately after the training. In the primary care and homecare settings, this increase was maintained 6–10 weeks after the training. Homecare nurses' self-confidence to be able to provide telehealth, in other words, their self-efficacy, increased during the training. Furthermore, 6–10 weeks after the training, telehealth self-efficacy was significantly higher than before the training among nurses from all three settings. With regard to Kirkpatrick (1996) level 3 (behaviour), we found that the number of remote consultations provided by nurses had increased in two of the three teams after receiving the training. However, in the third team, the number of telehealth consultations after the training was lower than before the training. Our study design limits us in explaining the decrease in the number of remote consultations after the training in the hospital setting. However, prior research about the use of this specific portal, that was being used in the same participating hospital, showed that the use of it not only depends on the nurses, but also on patients' characteristics such as their eHealth literacy (Hoogenbosch et al., 2018).

The number of knowledge and self-efficacy items that changed after the training differed among the settings (Tables 4 and 5). Based on the number of items that improved significantly and the number of remote consultations before and after the training, most changes occurred in the homecare setting and the fewest occurred in the hospital team. The fact that the training had the highest impact on homecare nurses corresponds with the findings in level 1, satisfaction of the training. Homecare nurses valued their satisfaction of the training with a median value of 9.0, whereas the two other settings valued the training with a median of 8.0, both on a 10-point scale. A possible explanation is that the homecare nurses were trained in nine different telehealth activities, whereas the primary care and hospital nurses received training in only three activities since the six other activities were not applicable to their organization, due to the fact that they did not (yet) make use of videoconferencing equipment.

The fact that the participating hospital nurses had more experience with telehealth prior to the training compared to the primary care nurses could provide another explanation for the finding that they appeared to benefit the least from the training. Perhaps this training is most suitable for nurses with relatively little (i.e., 1–6 months) experience in using telehealth. Additionally, the baseline scores of the hospital nurses on the self-efficacy items were already higher, and therefore less improvement was possible.

4.1. Strengths and limitations

To the best of our knowledge, this is one of the first studies examining the effectiveness of a training in telehealth on the use of telehealth in nursing practice. Nonetheless, caution is required for several reasons when generalizing our findings. Our study included a small sample with ten to fourteen participants per setting. To increase the reliability of our findings, we improved the power of our analyses in level 2a by using Monte Carlo simulation to assign *P*-values. However, this was not possible for our findings on the number of remote consultations (level 3). Since these data were collected on a group level, we could not use Wilcoxon Signed-Rank Test to explore significant differences.

Another limitation in our statistical testing is that we performed multiple comparisons, which increased the likelihood of a type I error, i.e., 'concluding that a significance difference if present when it is not' (Armstrong, 2014, p. 502). Therefore, as a type of sensitivity analysis, we applied a post hoc Bonferroni test (Armstrong, 2014) to our results in Tables 4 and 5 (comparisons of scores on the knowledge and self-efficacy items between observations 1 and 2, and observations 1 and 3). After dividing the *P*-value of 0.05 by the number of comparisons and using this adjusted *P*-value as a statistical significance threshold (Bonferroni correction), five of the 31 significant differences we found in nurses' knowledge (Table 4) remained significant. Four of these five differences were observed in the homecare setting. With regard to self-efficacy, we found 22 significant differences (Table 5). Eight of these differences remained statistically significant after applying the Bonferroni correction. All eight differences were observed in the homecare setting. This post hoc sensitivity analysis supported our conclusion that the training had the greatest impact on homecare nurses.

Furthermore, the quantitative approach of our study limited the ability to explain the results of the training. By using a pretest-posttest design, it cannot be proven that the findings observed after the training are actually a direct result of the training. Also, the influence of confounding factors could not be completely excluded. These facts limit us in explaining the decrease in the number of remote consultations after the training in the hospital setting.

Our findings do, however, indicate that training is an effective strategy to help nurses gain knowledge and self-efficacy with regard to telehealth. Therefore, we recommend repeating our approach in future research, preferably in an experimental design using a larger sample. In the current study we used a multi-setting design, to explore the effectiveness of the training in multiple settings. Using groups with more comparable characteristics, in future research, could increase the possibilities to compare results. A mixed-method sequential explanatory design might help to gain a deeper understanding of the working mechanisms of the effectiveness of training.

4.2. Integration with prior work

We found a significant increase in telehealth self-efficacy of nurses 6–10 weeks after the training. This result matches the study by Gifford et al. (2012), in which participants received a three-day program of face-to-face expert instruction in behavioural telehealth competency. The authors found that participants improved their overall behavioural telehealth competency scores by over 50%. In addition to study of Gifford et al. (2012), our study collected data on nurses' telehealth knowledge, and moreover, on Kirkpatrick level 3 (behaviour), the number of remote consultations before and after the training.

The variance found in the effectiveness of the training on nurses' use of telehealth (level 3, behaviour), emphasizes that acquiring (confidence in) competencies is no guarantee of success. A lack of adequate competencies is only one of the barriers to the implementation of telehealth (Ariens et al., 2017; Kort and van Hoof, 2012). Although the hospital nurses in the current study were satisfied with the training and their self-efficacy differed significantly 6–10 weeks after the training, the number of remote consultations decreased. Since the electronic consultations in this hospital setting (and primary care) are often initiated by patients, the frequency of use depends partially on factors beyond the control of nurses. This is in contrast to the homecare setting, where consultations are mainly initiated by the nurses.

The frequency of telehealth use by nurses can be affected by several other barriers, such as the business case, commitment, or design of the device (Kort and van Hoof, 2012). Furthermore, financial aspects can play a role (Ariens et al., 2017). In the Netherlands, funding for telehealth services in hospital care will be further realized and regulated from 2018 onwards (Dutch Healthcare Authority [Nederlandse Zorgautoriteit (NZa)], 2017). The limited (financial) possibilities of hospitals may also impede the use of telehealth by hospital nurses.

4.3. Implications for practice and training

The current study indicates that training helps to improve nurses' knowledge of telehealth and self-efficacy, which could support the further integration of telehealth services in daily work. When health care organizations seek ways to further implement the use of telehealth, they could consider delivering training comparable to the type described in this study. Since the homecare setting appeared to have benefited the most from our training, we believe that nursing settings with

characteristics comparable to the homecare setting in our study (i.e., (a) relatively less experience in using telehealth and (b) a setting in which most nursing telehealth activities are applicable) could benefit from our training. Previous studies found a significant association between nurses expectations of the ease of use of telehealth and their willingness to use these services (Gagnon et al., 2012; van Houwelingen et al., 2015). Our training increased nurses self-efficacy and subsequently motivated homecare nurses to increase the number of remote consultations by changing work routines from traditional face-to-face care to a situation in which care is partially delivered remotely.

Today, executing nursing telehealth activities is still a new type of care provision for most nurses. Further research is necessary to explore whether similar training leads to comparable improvements in other organizations with different characteristics, such as culture, business case, and/or facilities. A key element of our training was the focus on the 'integration of telehealth' in daily practice. To achieve this, we recommend starting telehealth training programs with a focus on improving nurses' knowledge and self-efficacy since self-efficacy is an important predictor of behavioural change (Bandura, 1977). For most nurses, using telehealth is a new type of care provision and therefore requires behavioural change. Our study showed that training could motivate nurses to change behaviour.

5. Conclusions

The changes in healthcare toward an ongoing increase in technology involvement requires additional competencies for nurses and a new way of working. On a global level nurses experience a lack of adequate training in how to use telehealth services. The current study evaluated the effect of providing nurses with the required training. After receiving training in nursing telehealth activities, the number of remote consultations increased in two of the three teams. Furthermore, we found that training in nursing telehealth activities contributes to subjective telehealth knowledge and self-efficacy of nurses, which are important factors for encouraging the use of telehealth. This study emphasizes the importance of adequate telehealth education for nurses. Adequate education could accelerate the widespread use of telehealth and as a result support patients to age in place by receiving care remotely.

CRediT authorship contribution statement

Thijs van Houwelingen: Conceptualization, Methodology, Formal analysis, Investigation, Writing - original draft, Visualization, Project administration. **Roelof G.A. Ettema:** Methodology, Formal analysis, Writing - review & editing, Visualization, Supervision. **Nienke Bleijenberg:** Methodology, Writing - review & editing. **Harmieke van Os-Medendorp:** Investigation, Formal analysis, Writing - review & editing. **Helianthe S.M. Kort:** Methodology, Writing - review & editing, Supervision. **Olle ten Cate:** Methodology, Writing - review & editing, Supervision.

Declaration of competing interest

None.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.nepr.2020.102924.

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