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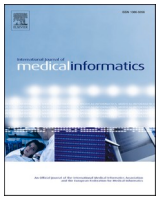

Upscaling telemonitoring in Dutch University Medical Centres: A baseline measurement

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ABSTRACT

Introduction and objective: The Dutch university medical centres (UMC's) are on the forefront when it comes to validation, implementation and research of telemonitoring. To aid the UMC's in their effort, the Dutch Government has supported the UMC's by fostering the 'Citrien eHealth program'. This program aims at nationwide implementation and upscaling of telemonitoring via a collaborative network. To quantify the success of this program, this study aims to provide insights into the current adoption of telemonitoring by health care professionals (HCP) within Dutch UMC's.

Methods: Based on the evaluation framework as adapted from the Normalization Process Theory (NPT) a cross-sectional study was conducted in all Dutch UMC's. Thirty healthcare professionals (HCPs) per UMC were invited to complete the 23-item Normalization MeAsure Development (NoMAD) questionnaire, a tool to assess the degree of normalisation of telemonitoring.

Results: The over-all response rate was 52.4% (124/240). Over 80% of respondents agreed or strongly agreed that they understand how telemonitoring affects the nature of their work, with a mean score of 1.49 (N = 117, SD 0.74). HCPs reported to believe telemonitoring will become a normal part of their work in the near future (N = 124, mean = 8.67, SD = 1.38). Using the Wilcoxon signed-rank test, the difference between current practise and future use of telemonitoring predicts to be statistically significant ($Z = -7.505$, $p \leq 0.001$). Mean scores for appropriate training and sufficient resources are relatively low (2.39 and 2.70 respectively), indicating a barrier for collective action.

Conclusion: This is the first study to assess the implementation of telemonitoring as standard practise across Dutch UMCs. The HCPs in this study are the frontrunners, believing that telemonitoring will become standard practise in the future despite the fact that it is currently not. Based on the results of this study, both educational and implementation strategies including practical skills training are highly recommended in order to scale up telemonitoring widely.

1. Introduction

Remote health data monitoring can be defined as the use of information technology to monitor a patients' status at a distance. [1-3] It is the collection, transmission, evaluation and communication of health data from a patient to the healthcare provider or extended care team from outside a hospital or clinical office (i.e., the patient's home) towards the care setting; using personal health technologies including wireless devices, wearable sensors, implanted health monitors, smartphones and/or mobile apps.[3] Telemonitoring could support self-management, improve (early) detection of disease or clinical deterioration and has the potential to reduce hospitalization and mortality. [4-

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6] In addition, telemonitoring has the potential to monitor patients more frequently or even continuously. As such, telemonitoring could improve quality of care, reduce the amount of time a clinician ends up spending to manage patients and increases the frequency of monitoring without increasing workload on healthcare resources.[6-8].

Telemonitoring is a complex intervention because it typically involves multiple components (e.g. data collection, education, feedback) and various stakeholders across different settings (e.g. community, primary and tertiary care). [9] Even though the COVID-pandemic created an increased need for telemonitoring, sustainable adoption and subsequent implementation of telemonitoring initiatives in the hospital setting is challenging.[10,11] Although several government institutes are focusing on telemonitoring adoption to futureproof healthcare, the majority of projects are pilot- or scientific case studies.

In the Netherlands, eight percent of patients with chronic conditions who monitor their health values communicate health data with their healthcare provider, such as blood pressure or blood sugar levels.[12] In addition, six percent indicate that their healthcare provider monitors their health values remotely and contact them if something is wrong. [13] Nurses and doctors indicate that it requires additional time and effort to monitor self-reported health data of patients, and act on notifications.[14] Finally, in the Netherlands telemonitoring is not embedded in quality documents or guidelines yet. [15] As a result, uptake of telemonitoring and large-scale implementation is limited.

The Netherlands Federation of University medical centres (NFU) is a governmental organization that represents the Netherlands' seven (at the time of this study, eight) university medical centres (UMC's). The Ministry of Health Welfare and Sports (HWS) has asked the UMC's to take the lead in changing the landscape, collaborating in a nation-wide health program that is governed by NFU.[16].

Patients, health practitioners, hospitals, health insurers and governments all play a role in successful implementation of telemonitoring. Studying current practices and needed actions for health practitioners for successful integration provides valuable insight into the mechanisms behind the adoption of telemonitoring, allowing for more effective future action. In addition, measurement of current normalisation provides a baseline for future evaluation. Hence, the current research focuses on the routinely use of telemonitoring within Dutch university medical centres by questioning, *"To what extent is telemonitoring currently common practice in Dutch University Medical Centres?"*

2. Methods

2.1. The Citrien program implementation and upscaling

This research is carried out in the context of the 'Citrien program eHealth', an eHealth program requested and supported by the government in which the UMC's act at the forefront of future-proofing the healthcare system in the Netherlands.[17] Currently, the UMC's collaborate within the "Citrien program Implementation and Upscaling" trajectory, which started in 2019. Three telemonitoring applications previously selected to be ready for national implementation are scaled up:

1. Telemonitoring for patients with cardiac rhythm abnormalities or heart failure, where blood pressure monitoring is indicated (TM Cardio)
2. Telemonitoring of blood pressure in pregnant women with elevated risk on pre-eclampsia at home (TM Antenatal)
3. Continuous wireless monitoring of vital functions during clinical care pathways on the hospital wards (TM Vitals)

A detailed description of this program is provided elsewhere [18].

2.2. Design and setting/population

The study design is a cross-sectional web-based survey using an online questionnaire to collect healthcare professionals' views on the normalisation of telemonitoring use. The data were collected between May 2020 to January 2021 from all (at that time) eight Dutch UMC's.

Telemonitoring of cardiac patients will be adopted in outpatient departments of cardiology or will be outsourced to private clinics where telemonitoring is adopted. Telemonitoring of blood pressure in pregnant women will be adopted in outpatient obstetric departments. Continuous wireless monitoring for remote monitoring of vital functions will be adopted on surgical or internal medicine clinical wards, selected per UMC based on the academic profile.

2.3. Normalization Process theory

The Normalization Process Theory (NPT) was chosen as theoretical basis. NPT is a middle-range socio-behavioural theory, which has been used to assist process evaluations. [19,20] NPT offers a framework with four constructs to assess how complex interventions, such as telemonitoring, become integrated into health practice through individual and collective implementation.[21] According to the theory, the implementation of a complex intervention is operationalized by four generative mechanisms (see Textbox 1) and requires collective and continuous investment in sense making, commitment, effort and appraisal. The Normalisation MeAsure Development (NoMAD) instrument was developed as a tool for using NPT to assess implementation determinants, comprising the four core constructs. [22-24].

2.4. Questionnaire

Citrien program project leaders within each UMC recruited participants for each telemonitoring project to take part in the survey. The local project leader within each UMC sent an email to ten self-selected health care professionals involved in the adoption of a telemonitoring project, containing a link to an online survey. During this baseline study there were eight UMCs. We aimed for a total of 240 respondents, with a minimum of 30 respondents per UMC and 10 per project. This is a pragmatic choice, because project leaders have noted at this stage of the scaling up that no>10 care providers are involved in the telemonitoring projects. Three reminders were sent.

The NoMAD instrument was selected as questionnaire. This instrument measures individual's opinions on the levels of adoption of telemonitoring in daily work. [21-23] The NoMAD survey has a Dutch version, acting as a validated instrument for measuring implementation. To fit the purpose of questioning better on the issue of telemonitoring, this instrument was adapted (See appendix 1). [24] In addition, questions were posed to determine respondents' demographic and working characteristics. The NoMAD questionnaire was adapted, pre-tested and prepared for distribution by author JK. The questionnaire was sent out in each UMC by the project leader.

2.5. Analysis

Data was analysed using SPSS Statistics for Windows (IBM, V.26.0). The non-parametric Wilcoxon signed-rank test was used to analyse differences in current and future normalisation of telemonitoring. Counts and frequencies were used to describe the sample and summarise NoMAD responses.

To analyse the uptake and normalisation of telemonitoring the three telemonitoring projects were considered as separate cases. As nationwide upscaling can also be seen as the sum of local implementation the scaling- up of telemonitoring per UMC will also be analysed, and as eight UMCs participated, this resulted in an eight times N = 1 analysis.

Survey items relating to the four NPT constructs were then analysed by examining descriptive statistics. Scores for each participant were

Textbox 1
Four generative mechanisms of Normalization Process Theory.

Generative mechanism	Description	Components
Coherence	The sense-making work that people do individually and collectively when they are faced with the problem of operationalizing some set of practices.	Differentiation Communal Specification Individual Specification Internalization
Cognitive participation	The relational work that people do to build and sustain a community of practice around a new technology or complex intervention.	Initiation Enrolment Legitimation Activation
Collective action	The operational work that people do to enact a set of practices, whether these represent a new technology or complex healthcare interventions.	Interactional Workability Relational Integration Skillset Workability Contextual Integration
Reflexive monitoring	The appraisal work that people do to assess and understand the ways that a new set of practices affect them and others around them	Systemization Communal Appraisal Individual Appraisal Reconfiguration

created by taking their mean scores for each construct and dividing it by the number of valid responses, which stopped data from being skewed where respondents stated a question was not applicable. Lower scores represent better-perceived implementation in relation to each mechanism, except for relational integration. To get an overview of all telemonitoring projects, mean construct scores and frequency distribution of item responses is presented. Differences between TM projects with $\geq$ 0.5 in mean sub construct scores are described.

3. Results

3.1. Baseline characteristics of participants

In total, 240 health care professionals were invited to participate in the survey. After three reminders, 124 (52%) invitees responded and completed the full survey. The characteristics of participants (Table 1) show a variety in age, UMC and working years. The mean response per UMC was 15.5 responses, with a range 2–50.

From the descriptive analysis of the mean scores of the 16 NPT subconstructs for all the respondents, relational integration and systemization are noticeable mechanisms. Further analysis of the 16 sub constructs of (un)successful implementation are presented with mean scores and frequency distribution of item responses in Fig. 1 resp. Fig. 2.

3.2. Familiarity and perceived normalisation

Participants reported to be familiar with the concept of telemonitoring (N = 96, mean = 7.11, SD = 2.26). They reported that they believed telemonitoring to become a more normal part of their work in the near future (N = 124, mean = 8.67, SD = 1.38). Using the Wilcoxon signed-rank test, it showed that the difference between practise and future use was statistically significant ($z = -7.505$, $p \leq 0.001$).

3.3. The extent of normalisation

Respondents report a positive attitude towards telemonitoring. Over 80% (N = 110) of respondents agreed or strongly agreed that they understand how telemonitoring affects the nature of their work, with a mean score of 1.49. Seventy-three % (N = 91) of respondents strongly agree that they see the potential value of telemonitoring for their work (mean score 1.33), with the highest mean score of 1.10 for the TM antenatal group.

Most respondents (86%) feel that they are the right people to be involved in telemonitoring. The mean score for this sub construct CP.2 legitimation is 1.53. Especially the group of respondents involved in TM antenatal care and TM vitals feel legitimate. Fifty-nine % of respondents who reported not being involved in telemonitoring agreed on this legitimation, however there was also a group of respondents who did not agree, disagreed, or considered this legitimation did not apply to them.

Respondents agreed to continue to support telemonitoring, with a mean CP.4 Activation score of 1.26. The relational integration CA.2 score was more ambiguous. Thirty-three % of respondents disagree that telemonitoring disrupt their working relationships. Where in TM cardiac care still 38% of respondents agreed on disruption of working relationships, the respondents not involved in telemonitoring only agreed in 7% or stated this not applicable for their situation (21%). There is also some ambivalence in confidence in other people's ability to use telemonitoring, with the respondents not involved in telemonitoring having the highest CA.3 Relational integration mean score (1.50).

People involved in telemonitoring vitals (62%) and cardiac care (86%) agreed that they have access to information about telemonitoring (RM.1 Systemization). Fewer respondents in TM antenatal care (34%) and respondents not involved in telemonitoring (21%) agreed on this sub-construct.

Table 1
Characteristics of respondents.

	Telemonitoring cardiac care		Telemonitoring antenatal care		Telemonitoring vital functions		Not involved in telemonitoring		Total	
n=	*29*	23,4	*32*	25,8	*34*	27,4	*29*	23,4	*124*	100
	n	%	n	%	n	%	n	%	n	%
Sex										
Female	17	58,6	21	65,6	22	64,7	23	79,3	83	66,9
Male	12	41,4	11	34,4	12	35,3	6	20,7	41	33,1
Age										
<21					1	2,9			1	0,8
22 < 34 yrs.	13	44,8	7	21,9	14	41,2	7	24,1	41	33,1
35 < 44 yrs.	9	31,0	14	43,8	5	14,7	10	34,5	38	30,6
45 < 54 yrs.	1	3,4	8	25,0	8	23,5	8	27,6	25	20,2
55 < 64 yrs.	5	17,2	3	9,4	6	17,6	4	13,8	18	14,5
>65 yrs.	1	3,4							1	0,8
Job description										
Medical Doctor	14	48,3	21	65,6	12	35,3	11	37,9	58	46,8
Physician assistant			1	3,1					1	0,8
Nurse practitioner	9	31,0							9	7,3
Nurse	1	3,4	1	3,1	11	32,4	9	31,0	22	17,7
Nursing counsellor							1	3,4	1	0,8
Oncology nurse					1	2,9			1	0,8
Midwife			3	9,4	1	2,9	3	10,3	7	5,6
Clinical Obstetrician			2	6,3			2	6,9	4	3,2
Medical Assistant							1	3,4	1	0,8
Technical Physician					1	2,9			1	0,8
Researcher	3	10,3	2,0	6,3	2	5,9			7	5,6
Project leader / innovations leader					2	5,9			2	1,6
Manager	1	3,4	1	3,1	3	8,8	1	3,4	6	4,8
Operational manager							1	3,4	1	0,8
Strategic advisor			1	3,1					1	0,8
IT consultant	1	3,4							1	0,8
Healthcare purchaser					1	2,9			1	0,8
University Medical Centre										
AMC	3	10,3	7	21,9	3	8,8	8	27,6	21	16,9
EMC			4	12,5			1	3,4	5	4
LUMC	10	34,5			1	2,9	0	0,0	11	8,9
MUMC+	4	13,8	3	9,4	6	17,6	0	0,0	13	10,5
RadboudUMC	4	13,8	13	40,6	16	47,1	17	58,6	50	40,3
UMCG	1	3,4	1	3,1	1	2,9			3	2,4
UMCU	7	24,1	2	6,3	7	20,6	3	10,3	19	15,3
VUMC			2	6,3					2	1,6
Work years										
< 1 year	4	13,8	3	9,4	3	8,8			10	8,1
1 to 2 yrs.	1	3,4	2	6,3	4	11,8	1	3,4	8	6,5
3 to 5 yrs.	11	37,9	4	12,5	11	32,4	4	13,8	30	24,2
6 to 10 yrs.	6	20,7	5	15,6	2	5,9	10	34,5	23	18,5
11 to 15 yrs.	4	13,8	8	25,0	6	17,6	4	13,8	22	17,7
> 15 yrs.	3	10,3	10	31,3	8	23,5	10	34,5	31	25

4. Discussion

4.1. Primary findings

To our knowledge, this is the first study conducted providing an overview of the actual use of telemonitoring across university hospitals nationwide. The difference between present practise and future use was found to be statistically significant, indicating that telemonitoring is thought to be helpful but has to be incorporated into standard care. Although our study confirms that normalisation of telemonitoring in Dutch UMC's is limited, healthcare providers score well for coherence and cognitive participation. This is an important prerequisite for wider adoption and systematic scale-up.

In a study on shared decision-making, 'coherence' appeared to be the prerequisite toward successful normalisation. [25] From that perspective, the mean scores and frequency distribution for coherence in this study are promising. Respondents scored highest agreements for enrolment and activation in implementation of telemonitoring, with mean scores of 1.25 respectively 1.26. Although this seems promising for upscaling telemonitoring, it can be questioned since this was a baseline measurement and the Wilcoxon signed-rank test confirmed telemonitoring was not yet embedded in usual care.

Resources and training are possible barriers for implementation of eHealth.[26,27] The mean scores for the sub-constructs of collective action and skill set workability in this study confirm that this is also a possible barrier for normalisation of telemonitoring in UMC's. According to the normalisation process theory framework, this barrier can be addressed for example by using educational strategies like practical skills training. [26,28].

The frequent disagreement on systemization - the work undertaken by participants to determine how effective and useful the new set of practices is - in the antenatal TM group and the group that is not involved in TM is remarkable. Based on this sub-construct it is not clear if evidence of effectiveness is absent, or if participants lack to inform themselves. In case of absence of solid empirical evidence, key decision makers may doubt the effectiveness of eHealth, which, in turn, limits investment and its long-term integration into the mainstream health care system.[29].

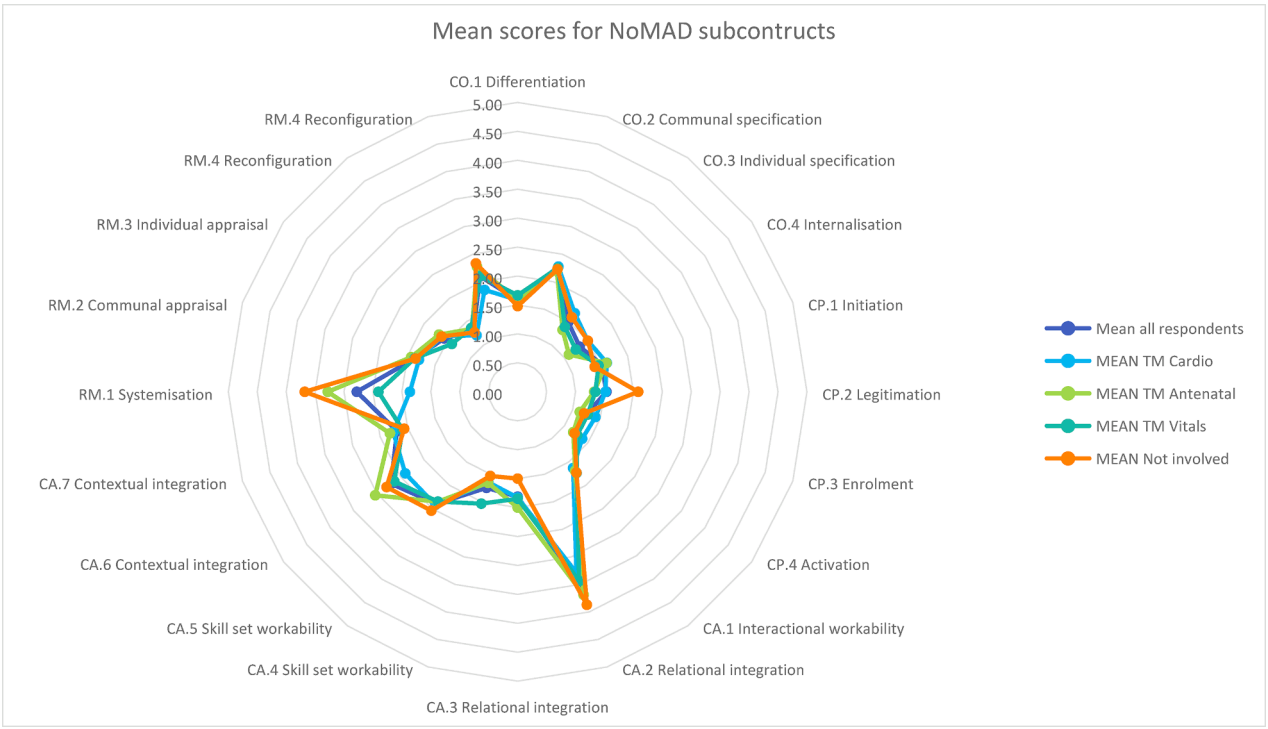

Fig. 1. Spider chart showing mean scores of 1) all responses, 2) cardiac TM, 3) TM antenatal care, 4) TM vitals and 5) not involved in TM for the 16 NPT sub constructs. Likert scale of 1 (strongly agree) tot 5 (strongly disagree). TM: telemonitoring. CO: coherence, CP: cognitive participation, CA: collective action, RM: reflexive monitoring.

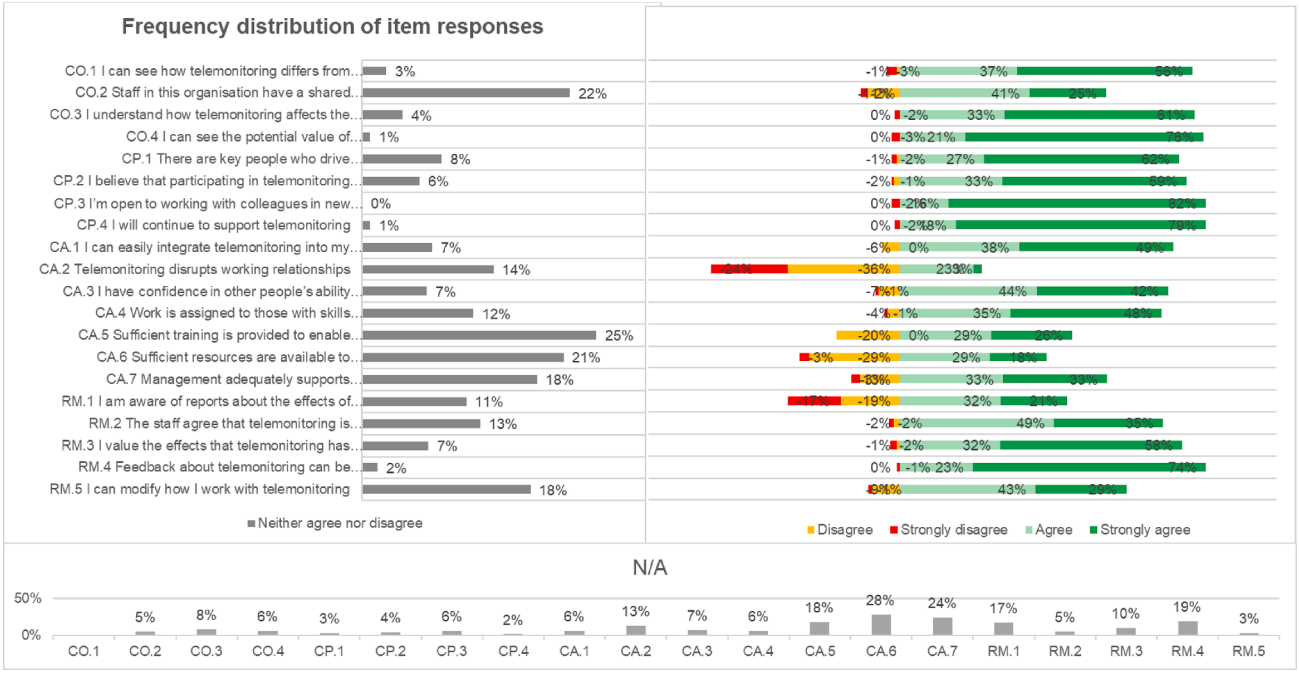

Fig. 2. Frequency distribution of item responses. The NoMAD questionnaire is represented by 4–7 questions per construct of Normalization Process Theory. Constructs are Coherence (CO), Cognitive participation (CP), Collective Action (CA), Reflexive Monitoring (RM). The upper part of the figure shows the percentage of respondents reporting strongly disagree, disagree, agree of strongly agree. The grey bar coupled to the y-axis indicates the percentage of participants rating an item as 'neither agree nor disagree'. The lower part of the figure shows the percentage of respondents who choose not to rate a specific item (not applicable).

4.2. (Inter) national comparison of adoption rates and utilisation of telemonitoring

An earlier study in the Netherlands into the adoption of eHealth, performed in 2014, surveyed the uptake of two telemonitoring projects in Dutch hospitals, including two UMC's.[30] In that study, respondents were either the Chief Information Officer (CIO) or the information technology (IT) manager with some knowledge of eHealth, not

providing care themselves. In our study, >90% of recruited participants were health care providers in a lead-role position, interested or closely involved in telemonitoring projects. Although our survey was performed six years later and our participants are more closely involved in healthcare, our study confirms that telemonitoring despite strategic efforts from the Government and the UMC policies, is still not considered routine care. There are no (regional) agreements nor national guidelines on the coordination of the telemonitoring process and a policy regarding the practical coordination of (digital) healthcare is needed.[10].

The results of this study are largely consistent with international studies. Adoption rates and utilisation of telemonitoring varies widely. [10] Studies from Austria, Norway, Lithuania, the UK and Sweden reported telemonitoring "not available or not part of routine care". A study from Denmark and a corresponding website report 16 telemonitoring projects operational from 2015 to 2020, mainly focused on cardiovascular disease. [31,32].

4.3. Strengths and limitations

The respondents in our study are likely to be a self-selecting group. It is to be assumed that the early adopters, who are the bigger advocates of digital health and telehealth in particular, skew general outcomes on the questionnaire towards the positive side. In addition, as project leaders from each UMC approached the respondents, it is likely that a social desirably effect is in play here, and the 'hot stuff' effect -contributing to favourable outcome. Another limitation is the response rate of 52.4%. With such a response rate, one might wonder how important telemonitoring really is to healthcare providers to date. The response rate of 52.4% of the study is however reported to be quite reasonable for surveys in health studies or -organisations. [33,34] However, while the response rate in this study was comparable to other implementation studies that used the NoMAD questionnaire [35,36], the non-response rate in this study could probably have led to an overestimation of the normalisation. Hence, results of study are likely not to be representative of the general opinion of health care providers in the UMC's. However, as widespread implementation is most likely to succeed using the early adopters as role models, fuelling interest and implementation among their peers, this is not necessarily a problem. Indeed, literature reports that if persons are perceived as role models, considered a reliable and trustworthy person by their peers and their organization, future adoption under their wings may well succeed. [37,38] The remarkably low response from three UMC's must be regarded upon as bias. This does not allow for a comparison of normalisation between UMC's. A possible explanation for the low response rate of these centres is that the Citrien program is still ongoing, and program priorities are outweighed against pressing day-to-day ICT issues, digital health priorities and ambitions and most importantly, available staff. Which, especially in the immediate post-COVID era, is a challenge.

Another limitation to study is that N/A was frequently scored, especially for the constructs collective action and reflexive monitoring. This can be explained by the fact that at that time, the projects were still in the start-up phase.

The NoMAD-questionnaire is a validated questionnaire, adapted, pre-tested and prepared in our study. One question was added; "As a result of the outbreak of the new coronavirus, have you accelerated your involvement in this telemonitoring application?". In this study, the normalisation process theory was used with its validated NoMAD-questionnaire. NPT is an implementation theory, and has been widely used as an evaluation framework. [38] There are other frameworks that can be used, such as the Consolidated Framework for Implementation Research (CFIR) [39], the Nonadoption Abandonment, Scale-up, Spread and Sustainability (NASSS) [40] or the Reach, Effectiveness, Adoption, Implementation, Maintenance (RE-AIM) framework.[41] NPT was used in this study because the theory of NPT fits the complex context of the implementation of telemonitoring in eight UMC's. [42].

This study made a comparison between various telemonitoring projects. Although the core topic is the same, every UMC has slightly different completion of the telemonitoring projects, for example using different technologies or different workflows. This may lead to incorrect comparisons when it comes to upscaling. Finally, this study was conducted among healthcare providers in UMC's. The results in this study are therefore not generalizable to non-UMC hospitals, private clinics or other healthcare settings.

5. Conclusion

Although front-runner health care providers (HCP) in the Dutch University Medical Hospitals believe that telemonitoring will become common practice, to date telemonitoring is not yet embedded in usual care. The use of telemonitoring is regarded upon as future part of the skillset of the HCP and the potential value of telemonitoring is undisputed. The low mean scores for the sub constructs of collective action in this study confirm that current skills of the HCP are a possible barrier for normalisation of telemonitoring. Based on the results of this study, it is recommended to use educational and implementation strategies including practical skills training in order to scale up telemonitoring.

Summary table

What was already known on the topic	What this study added to our knowledge
• In the Netherlands, only six percent of people with a chronic condition who self-monitor their health values indicate that their healthcare provider monitors their health values remotely and contact them if something is wrong. • Even though the COVID-pandemic created an increased need for telemonitoring, sustainable adoption and subsequent implementation of telemonitoring initiatives in the hospital setting is challenging	• Health care providers (HCP) in the Dutch University Medical Hospitals believe that telemonitoring will become common practice, yet to date telemonitoring is not embedded in usual care. • The use of telemonitoring is regarded upon as future part of the skillset of the HCP and the potential value of telemonitoring is undisputed. • It is recommended to use educational and implementation strategies including practical skills training in order to scale up telemonitoring.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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