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How digital health affects the patient-physician relationship: An empirical-ethics study into the perspectives and experiences in obstetric care

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ABSTRACT

Background: Digital health technologies are believed to change the patient-physician relationship. Such changes are still speculative, as there are no studies in which both patients and health care professionals are asked for their experiences and perspectives on how digital health affects the patient-physician relationship.

Methods: We performed a qualitative interview study (n = 25) to identify relevant aspects of the patient-physician relationship as perceived by both health care professionals (n = 14) and patients (n = 11) of a digital monitoring platform for hypertensive disorders related to pregnancy. We focus on roles, responsibilities and medical decision-making.

Results: Digital monitoring helps patients to better understand their own condition and contributes to shared decision-making in terms of information exchange. Yet for clinical decision-making both patients and health care professionals argue that health care professionals should stay in the lead. The collected data is by some health care professionals considered hard data that allows objective and more standardized decision-making, while others believe digital monitoring requires further interpretation in order to personalize the clinical care to the patient.

Conclusion: Digital technologies have subtle, yet double-edged, effects on the patient-physician relationship in terms of roles and responsibilities and the value addressed to the digital data. These insights let to 6 ethical recommendations for the implementation of digital health technologies to replace and support clinical care.

1. Introduction

Digital health -the use of data analytics, mobile health, wearables and electronic health records in public health, health care and research- is rapidly being implemented in medical practice. Digital health radically changes the ways how and places where health care is practiced, including how it is organized, as it facilitates health monitoring and improves quality of life literally outside of the traditional healthcare setting [1]. Where it has previously strongly focused on self-monitoring of chronically ill or tracking life style and performance [2,3], digital technologies are now being developed to replace and support care that traditionally takes place in hospitals or outpatient clinics. For example, home telemonitoring has been proposed as a promising alternative to avoid burdensome hospital visits while simultaneously improving health monitoring [1].

Aside from concerns about safety and effectiveness, some authors have warned that digital health will transform the patient-physician relationship; that replacement of patient-physician contact is undesirable and dangerous, because digital technologies carry the risk of missing crucial information when doctors do not 'see' the patient; and that there is a risk of a 'burden of invisible work' for patients – referring to the time investment of patients to play an active role in the diagnostic process [4–9]. Others are worried about the roles and responsibilities of patients, either because they fear 'responsibilization' of patients, meaning that together with tasks they overtake, patients have to bear responsibilities that are traditionally the physicians' [3,4] or about the

Abbreviations: HCP, Health Care Professional; HDP, Hypertensive related Disorders of Pregnancy.

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'domestication' of patients by technology [3,10], meaning that patients will have little opportunity to disobey medical regimes monitored or prescribed by these technologies. Moreover, the role of health care professionals (HCP) is claimed to be affected by the increasing availability of digital data: digital health may empower physicians [11], completely replace physicians [12] or miss human-judgment [13,14]. Moreover, while digital health may be a way to empower patients by making digital data about their health accessible to them [15], these digital data and algorithms may be inscrutable, inconclusive or hard to interpret, which will complicate medical decision-making for both HCP and patients alike [16,17].

These effects of digital health are still speculative, as there are only few empirical studies conducted in clinical settings [9,18,19], in none of which both patients and HCP were interviewed. The implementation phase of digital health technologies allows for ethics parallel research and investigation of the actual use of digital health and the implications for clinical decision-making. A Dutch study, called SAFE@home, that provides a digital health platform that is integrated in the workflow of health care professionals to digitally monitor women at risk for hypertensive disorders related to pregnancy (HDP), provides a promising case to better understand the use and influence of digital technologies on the patient-physician relationship [20,21]. These women used to visit the hospital outpatient clinic frequently, as antenatal monitoring is important to act rapidly on symptoms of pre-eclampsia, to prescribe medication when required and to prevent hospital admission.

In this paper, we focus on the Safe@Home study and explore the perspectives and experiences of both patients and HCPs on two specific aspects of the patient-physician relationship in the context of digital health: 1) the roles and responsibilities when using a digital health technology in perinatal care, 2) the ways in which technologies influence medical decision-making as perceived by the users of this digital health technology.

2. Method

We performed a qualitative interview study to identify relevant aspects of the patient-physician relationship as perceived by both HCP and patients of a digital monitoring platform for HPD. The research ethics committee of the University Medical Center Utrecht determined that this study was exempt from the Medical Research Involving Humans Act (reference number 18–898-C).

2.1. Sample

We collected a wide range of experiences and perspectives from users of the digital monitoring technology. We have included patients who daily used the digital health technology to monitor their blood pressure, and HCPs, including nurses, residents and obstetricians working in the digital monitoring team as part of their clinical work. In total we have included 25 people (patients n = 11; HCP n = 14) (see Table 1). Inclusion criteria for the study were: 1) having experience with the digital monitoring platform 2) being competent to provide informed consent, 3) being able to conduct the interview in Dutch or English.

2.2. Data collection

All interviews took place in the Netherlands, either via phone or in a meeting room of the University Medical Center Utrecht. Using purposeful sampling [22], interview participants were recruited via the ongoing digital monitoring study (SAFE@HOME). In brief, this study concerns a blended care approach, where traditional care is partly replaced by digital health technology. Pregnant women with a high risk of HPD use a mobile app to measure their blood pressure at home, the data is reviewed by HCP each working day and the hospital contacts the pregnant women when their measurement indicates HPD symptoms [20,21]. All interviews were conducted in Dutch. The semi-structured format, based on the literature and input from clinicians, provided

Table 1
Participant demographics.

Patients		Intervieweesn = 11	Health care professionals		Interviewees n = 14
Maternal age (years)	*Mean* ± *SD*	34.18 ± 2.529	Age (years)	Mean ± *SD*	39.01 ± 10,69
BMI	*Mean* ± *SD*	23.88 ± 2.496	Gender	Number (%)	
			1. Male		1 (7,2%)
			2. Female		13 (92,8%)
Level of education	Number (%)		Work experience (years)	Number (%)	
1. Middle-level applied education		3 (27.3%)	1. 0–3		
2. Higher-level applied education			2. 4–10		4 (28,6%)
3. Scientific education (university)		6 (54.5%)	3. > 10		4 (28,6%)
					6 (42,9%)
		2 (18.2%)			
HDP during prior pregnancy	Number (%)		Profession	Number (%)	
1. None					
2. Chronic hypertension		3 (27.3%)	1. Nurse		6 (42,9%)
3.Gestational hypertension		1 (9.1%)	2. Resident		2 (14,3%)
4. preeclampsia/HELLP		2 (18.2%)	3. Obstetrician		6 (42,9%)
5. Not applicable (nulliparous)					
		3 (27.3%)			
		2 (18.2%)			
Initial diagnosis at start of SAFE@home study	Number (%)		Hospital type	Number (%)	
1. Preeclampsia in prior pregnancy			1. Academic		7 (50%)
2. Chronic hypertension		2 (18.2%)	2. Peripheral		7 (50%)
3. Cardiac disease					
4. Renal disease		5 (45.5%)			
		3 (27.3%)			
		1 (9.1%)			
HDP current pregnancy	Number (%)				
1. None		2 (18.2%)			
2. Chronic hypertension		3 (27.3%)			
3. Gestational hypertension		2 (18.2%)			
4. Preeclampsia					
		4 (36,4%)			

participants with the opportunity to discuss matters they believed needed emphasis, while offering guidance throughout the interview (Tables 2–4).

2.3. Coding and data analysis

The interviews were recorded after obtaining informed consent, transcribed verbatim, and pseudonymized using a code of letters and numbers in the process. Transcripts were checked against recordings for accuracy. We focused on identifying broad themes, by inductive and deductive analysis. The data was thematically analyzed by means of a constant comparative method, which means that data analysis is an iterative process to develop codes, concepts and identify overarching themes. This analysis was assisted by the scientific software Nvivo12™, a tool for the qualitative analysis of large bodies of textual, graphical, audio, and video data. For the deductive analysis, to allow for coding based on topics revealed in relevant literature, we started with an a-priori coding, which included: patient-physician relationship, responsibilization, medical decision-making and roles. The interview transcripts were then reviewed by the research team and further emerging codes were added to the coding scheme. The inductive analysis combined methods of close reading and constant comparison to reveal the following themes from the data: responsibilities, roles and (shared) decision-making. These were subsequently systematically reviewed for supporting or conflicting evidence concerning emerging themes and codes. Codes and their meanings were discussed among the research team prior to coding for guaranteeing inter-coder reliability. Results were reported using the Consolidated Criteria for Reporting Qualitative research checklist [22].

Table 2
Quotes illustrating Changing Roles and Responsibilities.

	Quote
1A	*"The fact that I didn't have to go to hospital every time. And that by having these measurements every day you become more aware of it. Because you know that you are going to measure at a certain time every day, so then you develop a certain routine. You also know that you have hypertension, it is nice to have that overview, is the dose right, how am I doing, how do I deal with my high blood pressure. You can check-in yourself. "(P2)*
1B	*"I mean, of course you don't have control over your blood pressure, but the fact that you have access to that information is helpful. It does however also cause me to worry, because it occupies me more than when I would have it measured my blood pressure once a week in the hospital."(P6)*
1C	*"It's a bit of a burden, sure, but in the end it's all for a good cause. And we expect them to call us if there is anything wrong. We look at the measurement every morning before eleven. So if there is anything the matter after that time, they should just call the midwives just like any other pregnant woman."(HCP1)*
1D	*"I believe I have had 1 or 2 experiences that someone [a HCP] reacted a bit irritated to my doubts: "you did not have to call for this, or you should have measured it again in an hour." Something along that line.. I find that difficult indeed. Because you also try to take your responsibility as a patient: I had to call in time, for example when I was not sure? But when I called, I felt like a troublemaker, you know?" (P8)*
1E	*"I sometimes had a measurement to which I expected them to call me. I was like I don't have the time and don't feel like going to the hospital now, I actually feel really good. I will wait half an hour, or you know maybe I am too short after the taking my pill measured it. And then I was a bit stubborn that I thought, well, I'll wait until I measure again, yes you know when I actually feel pretty good. "(P2)*
1F	*"In my experiences, some people simply don't send in their measurement or forget to measure altogether - you have to chase them sometimes. I mean it is their responsibility [..] I find that quite difficult. "(HCP5)*
1G	*"If you don't feel well, then I think that as a mother you should undertake action. [..]. I am responsible for keeping track of my blood pressure and filling it in in the app. And, you know, it's reassuring that if it is high or deviating, that someone [a HCP] is watching and will take action." (P2)*
1H	*"In my opinion, you should stay in the lead as a health care professional[…] It is our responsibility to monitor and provide clinical recommendations, to make treatment decisions. It is not the responsibility of the patient to decide: I'll simply take another tablet of my medication." (HCP2)*
1I	*"You have the responsibility and you can't just get rid of it. Whereas in the clinic, you know, you can discuss with your colleagues or supervisor: 'Could you re-measure, because I don't trust it.' And now you have to do with the data that you see in front of your screen at that moment. If you are unsure, or have doubts about the measurement, you will call the patient and ask more questions. So yes, it depends on my actions whether someone will be seen that day. I could in that sense also make a mistake, assess the data as fine, while the patient might become very ill that day and have complications. And then in hindsight, you think: have I overlooked something? So yes, you are getting careful. "(HCP1)*
1 J	*"Well you see, I have this responsibility for this patient, and I don't want to bear that responsibility for this patient. I cannot determine the clinical follow-up" (HCP14)*

Table 3
Quotes illustrating: The value of digital data in medical decision-making.

	Quote
2A	*"You both have [access to] your information. I can see the trend on my app and the doctor can also see that. So you can discuss that together. I do have the idea that a slightly more deliberative form of consultation is possible, that you look together: ok, how should I understand this, for example, and sometimes a doctor can reassure you." (P8)*
2B	*"Some people, you know, their blood pressure increases once they are in the hospital. I also was tensed to go to the hospital, and then it can show a high blood pressure in the hospital, while it's back to normal once you're back home. This app, you know when you measure every day, provides a more accurate picture for your physician."* (P4)
2C	*"… And being able to interpret it correctly. For me it was like: if I [my blood pressure] is really over 90 now and then, and [according to the protocol] actually 90 is the limit, but they know with you we regularly see this and that. Then you know, that is just very nice if you have a doctor who can help you understand and can also interpret the measurements. So not only use the hard limit values, but also be able to look at your complete picture [..] And tell you what it means for you.."* (P8)
2D	*"I had, I had that a few times that I felt really bad. And I really had the feeling that my heart was beating too fast, while the measurement indicated that I was doing fine. I really didn't understand, and then I would do it [measure] 20 more times. And I thought, it can't, it can't be, but of course it just stayed the same. So yes, that's kind of funny. (…) I thought, [the measurement] is incorrect. But, yes, in the end I thought well it's probably reliable, because I've already done it 20 times, so I have to let it go."* (P11)
2E	*"At one point I noticed, because it went both ways for me, that I, or the measurement was normal and I did not feel well, or vice versa. The blood pressure is therefore not necessarily an explanation for signs, or other symptoms of something. So at some point I knew some of the signs that could indicate high blood pressure, and I have to take them seriously, and then I have to take a measurement to see if it is indeed the case. But the other way around, I also knew that I could also feel normal with very high blood pressure."* (P2)
2F	*"In my opinion: it is a helpful tool to have insights in symptoms and blood pressure, but you surely have to reflect upon what these data mean for further clinical decisions. The tool is helpful, but it won't provide you with an answer what to do."* (HCP2)
2G	*"Well, you can interpret it better anyway, I think. You can no longer just say, everything above 140/90 is wrong, and everything below is good. So having someone [a colleague] there who only says it is above or below this value. No, you have to have some skills to interpret. And certainly also if you have to call patients about the complaints they have. Then you have to ask the right questions. I certainly think that work experience is crucial in that respect." (HCP13)*
2H	*"But actually these are hard data. The protocol indicates what the thresholds are: with value × the patient has to visits the clinic, with value y we take a blood sample. With value z we do extra measurements in the hospital. So even if you don't know how to interpret it, the flow chart will tell you what to do." (HCP1)*

Table 4
Recommendations.

#	Recommendation
	Digital technologies can support shared decision-making by engaging and informing patients, but physicians should remain responsible for determining suitable clinical intervention.
	Patients should be adequately informed to strike a safe balance between compliance and autonomy when using digital technologies
	Shifting tasks and accompanying responsibilities from physicians to nurses should be accompanied with adequate training and mentoring, to enable them to bear these responsibilities
	Health care professionals should be sensitized to strike a balance between standardization and contextualization for clinical decision-making with digital technologies
	To realize personalized care of patients, health care professionals have to interpret and contextualize the measured digital data
	Health care professionals will have to maintain skills to recognize mistakes in digital measurements and assessments

3. Results

Characteristics of the patients and HCP that took part in this study are shown in Table 1.

3.1. Reshuffling roles and responsibilities – benefits, expectations and burden

3.1.1. The role and responsibilities of patients

Patients named both the benefits and the burden of measuring their own blood pressure. Overall patients are positive about the possibilities to measure their own blood pressure at home (11/11, see Quote 1A). Some patients also considered the measuring to be burdensome, medicalizing or consider it somewhat stressful to be occupied with monitoring their own health (6/11, see Quote 1B) yet they can bear the responsibility to measure their own blood pressure (6/11). Both patients and HCPs reason that patients bear the responsibility to collect reliable data, meaning that they should measure every weekday, at the same time with the same medical device. A few argued that it is also the patients' responsibility to contact a HCP when having doubts or worries about their health or measured data (8/25, see Quote 1C). Some HCPs also stress that they only receive a measurement once a day and should any symptom occur after that time, it is the patient's responsibility to contact the HCP; similar to any other pregnant woman not using this technology. Despite the protocol informing patients when to call in, patients were not always sure when to call and appreciate the possibility to contact the HCP any time, which they did when they desired reassurance, only one patient said she was torn between not wanting to feel like a burden versus clarity and reassurance about her measurements (See quote 1D). Some HCPs mentioned they often had to remind patients to send in their data, resulting in distrust in the patients' abilities to measure and monitor their own symptoms (4/25, See quote 1F). Some patients describe that they sometimes 'game the system' by tweaking their measurements (2/11, See quote 1E). These patients would on purpose re-measure while relaxing in order to be able to send in data that did not require to go to the hospital at times that a hospital visit was not necessary according to them, or simply not fitting into their daily schedule.

3.1.2. The role and responsibilities of HCPs

Patients expect that HCPs undertake action when blood pressure deviated from the norm (5/11). They argue that HCPs have clinical expertise to judge whether a patient should be consulted and have knowledge to determine how deviating measurements should be dealt with (13/25 HCP, see quote 1G). Patients feel reassured and relieved that the monitoring is not solely their responsibility (2/11) and some patients trust that the HCP undertakes action in case the patient underestimates the gravity of the situation (2/11). All patients said that it is up to the HCP to decide about the need for additional tests, the interval of clinical visits, and medication or hospitalization. The majority of patients agree that the decisional-authority with regard to medical decision-making should stay with the HCP because of their clinical expertise (6/11). Also, most HCPs said it is their responsibility to make clinical decisions based on the data and argued that they should keep a leading role when making medical decision (8/14, see quote 1H).

HCPs perceived some challenges in their role as 'first digital signallers'. For example, one HCP compared the monitoring of patient data with measuring blood pressure at the clinic, where it is considered more convenient to discuss with colleagues or supervisors if one is unsure about the measured data (see quote 1I). Additionally, two nurses argued that the introduction of the digital monitoring technology has caused a shift of tasks from physicians to nurses (2/14) which means that tasks and responsibilities that were originally the physicians were now being transferred to other HCPs. One of these nurses explicitly mentioned that the role of being a first signaller was a responsibility for which she did not feel well equipped (See quote 1J).

4. The value of digital data in medical decision-making: Between standardization and interpretation

4.1. Using information

Aside from the changing roles with regard to monitoring and reporting data, the use of the digital technology in the clinical setting also influenced how patients and HCPs use information for the interpretation and deliberation in medical decisions. Patients argued that the information derived from remote monitoring was empowering in terms that it was helpful to understand their own medical condition, to prepare for consults with HCPs, to bring in their own views when discussing with HCPs about treatment options, and to better understand which questions and values are important for clinical decisions (11/11). One patient also said that having access to her data had influenced which questions she asked during consultations (1/11); some others said that having access to the data contributed to shared decision-making based on having a shared knowledge base or to be "on the same page" (2/11, see Quote 2a). Almost all patients and all HCPS trusted the data from the digital monitoring technology to be accurate and reliable (24/25). HCPs saw the benefits that measuring at home prevents white coat-hypertension, daily measuring provides a more comprehensive picture and the standardization of the measurement with the same device at the same time is considered to be valuable (see quote 2B). Some HCPs and patients argued that the digital data was helpful to determine a personalized 'normal' blood pressure for a particular patient (7/25, See quote 2C). Patients stressed that such a 'personalized' cut-off point would be desirable. Furthermore, patients experienced that the measurements and how they feel, did not always correspond, which they considered surprising. They could feel ill, while having a normal blood pressure, or measure hypertension while feeling all right (5/11; See quote 2D and 2E).

4.2. Interpretation & standardization

Some HCPs stressed the importance to take contextual factors into account when interpreting digital data, as the data itself is not sufficient to determine clinical follow up (9/14, see quote 2F). This includes information found in the electronic patient record or follow-up questions to the patient, in order to better interpret the symptoms the patients have reported. A few HCPs argued that in case they were not sure how to interpret the data, an extra anamnesis over the phone is helpful as only a 'real' person can tell how she feels (2/11). Other HCPs argued that no special skills are needed to interpret the digital data, as blood pressure measurements were considered 'hard data' that speak for themselves (4/14). Some HCPs argued that confidence in their interpretation of the data is influenced by their work experience (7/14), the more experience one has, the better one can interpret the digital data, as one develops what was referred to as a trained gut feeling (see Quote 2G). Others, who consider the digital tool to provide 'hard' data, argued instead that work experience should not make a difference in interpreting data, because HCPs should follow the protocol with pre-determined cut off points (2/14, See quote 2H). They also argued that digital data has the benefit that one is not 'distracted' by factors that otherwise may influence the interpretation of the data and the clinical follow-up, such as whether the patient is easily worried. Similarly, some HCPs mention that the digital data enabled more objective and standardized clinical decision-making (3/14).

5. Discussion

The empirical findings illustrate how digitalization affects the patient-physician relationship in terms of roles and responsibilities and the value addressed to digital data within this relationship. The effects described in this empirical study are modest, compared to the speculative debate in the academic literature. The effects are also double edged:

with both positive and negative implications.

The SAFE@Home study described in this paper is an excellent example of a digital technology that replaces some of the care traditionally provided in hospitals or out-patient clinics. Currently, several interventions are being developed that moderate or replace traditional clinical care, especially so called 'blended care' such as our case study, where traditional care and digital tools are combined, are increasingly popular [24]. The ubiquity of mobile phones and tablets also simplified the ways of communication between patients and physicians when compared to the early days of tele-monitoring: alarms can now be directly built in the app and can be automatically integrated in the electronic patient record and do not have to faxed of phoned, thereby decreasing the amount of invisible work required from patients [3]. The technological improvements and the increasing digital literacy of both patients and HCPs also contribute to the expansion of digital technologies in patient groups aside of the chronically ill or healthy people, who have been using digital technology to track their health and lifestyle for several years [2,3,25]. Pregnant women are relatively young and generally digitally literate, meaning that many of the worries that have been uttered in the context of digital tools for chronically ill patients, such as being digitally illiterate or overburdened with conducting own measurements, are less problematic in other contexts of digital health care [26].

5.1. Collecting data: Responsibilization and digital literacy

While a feasibility study of the SAFE@Home study indicated that the compliance rate of users (patients) of this platform was up to 93% [20], in our study some HCPs argued they often had to remind patients to send in their data. Patients were overall motivated and able to use the device, which was also found in quantitative studies with this population [24,27]. Together with the increasing skills of HCPs, this is promising for future digital health applications in this patient group. Moreover, our study indicates that patients are able to find ways to tweak their data or game the system, by using their knowledge about how the digital technology works, to match their own interests or goals. The worries about 'domestication' due to digital technologies, as speculated in the literature, were not found in our study. It shows that patients are able to strike a balance between complying and remaining in charge. Yet safe use of the digital monitoring technology also demands that patients are aware about the potential risks when not sending in their data or tweaking their data. Similarly, HCPs should be aware of how patients understand their role and responsibility with regard to digital monitoring, especially when HCPs remain responsible for clinical follow-up, as stressed by both patients and HCPs in this study (See recommendation 1). This also stresses the importance of educating potential users on how to use the technology safely, especially in conditions where 'feeling fine' is not a good indicator for how well the medical condition is under control (See recommendation 2). Furthermore, our study indicates that responsibilization may play a role in shifting responsibilities among HCPs; from physicians to nurses. Further exploration into responsibilization of nurses and assistive medical personnel would be desirable and informative for better understanding the burden and safe use of such technologies in clinical settings (see recommendation 3).

5.2. Value of data: Standardization and interpretation

Our study indicates that the value addressed to digital data varies among HCPs, which is relevant for the use of digital technologies and for the ideal of shared decision-making (SDM). While some consider the data to be straightforward and determine medical follow up based on the data and pre-determined cut-off points, which has the benefit to harmonize clinical decision-making in a digital monitoring team, others focus more on the 'trend' line and interpret the data in the light of a broader picture of the particular patient (see recommendation 4). While 'personalization' is one of the main hopes to be accomplished by digital health, the opposite can be accomplished when HCPs handle pre-determined cut off points too strictly (see recommendation 5) and it may hamper shared decision-making when HCPs focus solely on the data and do not integrate the experiences and wishes of patients in their clinical follow up. When HCP do not feel able or do not see the necessity to interpret the data themselves by drawing on their clinical expertise and by exploring contextual factors, the remote monitoring may become burdensome for patients and frustrating when they are continuously called and have to visit the hospital. Eventually, HCPs may even lose their trained gut feeling to assess and interpret data in a meaningful way, when they focus only or too much on the data alone; which may be referred to as 'deskilling'. This indicates that for ethically sound use of such digital technologies, HCPs will have to develop new skills as well as maintain old ones. Aside from having to be able to interpret the data of the digital tool as part of the clinical expertise, HCP also have to develop the ability to recognize mistakes in measurements and assessments (see recommendation 6), especially when they will depend more on such tools or when the interpretation of the data is further automatized [28]. This was hardly reflected upon by HCPs, while patients explicitly stressed that they trust the HCP will know what should be done. Furthermore, remarkably little was mentioned about 'soft' skills such as communicating, building trust and understanding, which are aspects that one would expect to be relevant in the patient-physician relationship when communicating via digital tools about medical conditions.

5.3. Limitations

Our results must be interpreted in the context of the following limitations. First, selection bias (self-selection) can have influenced the results, as participants of the prospective study agreed to take part in this innovative strategy with digital monitoring and may thus have a positive attitude in general towards digital technologies. Second, we have not interviewed women who declined to participate in the SAFE@home study and the women willing to participate in this interview study may have had a relatively positive experience of this specific technology. Third, the interviewed patients were fairly highly educated, and may therefore not be representative for pregnant women in other socio-economic situations. Fourth, the included health care professionals had relatively little experience with the digital platform –they used the technology approximately a year - meaning that their experiences and reflections may have changed over time due to a learning effect. Furthermore, although saturation was reached on the codes and themes identified, further research could investigate these topics in more depth and could focus on the motives and reasons not to use digital technologies during pregnancy.

6. Conclusion and recommendations

Digital technologies have subtle, yet double-edged: both positive and negative, effects on the patient-physician relationship in terms of their roles and responsibilities and the value addressed to the digital data. The current study nuances some of the more prominent worries with regard to the patient-physician relationship in digital times, by outlining the implications of digital health in a case study where digital technologies were used to monitor pregnant women at high risk for pregnancy complications. These insights let to the following 6 recommendations for the implementation of digital health technologies to replace clinical care.

7. Declarations

7.1. Ethics approval and consent to participate

The research ethics committee of the University Medical Center Utrecht determined that this study was exempt from the Medical Research Involving Humans Act (research proposal no. 18–898-C). Each participant gave verbal consent to the interview, its recording and the pseudonymized analysis of the interview data prior to the start of the interview.

7.2. Consent for publication

Not applicable

7.3. Availability of data and materials

The interview guide is available in the supplementary information. The datasets generated and analysed during the current study are not publicly available, because individual privacy could be compromised.

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Authors' contributions

KJ, MB & AB were responsible for the concept and design of the study. KJ was responsible for the recruitment of the interview participants, data collection and initial drafting of the manuscript. KJ conducted the thematic analysis with practical support of ML (See below in de acknowledgement) and substantial input from AB. All authors have critically revised and substantially cntributed to the manuscript. All authors aprove of the final version of the manuscript.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.preghy.2021.05.017.

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