

ORIGINAL ARTICLE

Barriers and facilitators for the usage of a personal health record for medication reconciliation: A qualitative study among patients

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Aims: Personal health records (PHRs) are more often used for medication reconciliation (MR). However, patients' adoption rate is low. We aimed to provide insight into patients' barriers and facilitators for the usage of a PHR for MR prior to an in- or out-patient visit.

Methods: A qualitative study was conducted among PHR users and non-users who had a planned visit at the outpatient rheumatology department or the inpatient cardiology or neurology department. About 1 week after the hospital visit, patients were interviewed about barriers and facilitators for the usage of a PHR for MR using a semi-structured interview guide based on the theoretical domains framework. Afterwards, data were analysed following thematic analysis.

Results: Ten PHR users and non-users were interviewed. Barriers and facilitators were classified in four domains: patient, application, process and context. We identified 14 barriers including limited (health) literacy and/or computer skills, practical and technical issues, ambiguity about who is responsible (the patient or the healthcare provider) and lack of data exchange and connectivity between applications. Besides that, ten facilitators were identified including being place and time independent, improve usability, target patients who benefit most and/or have sufficient skills, and integration of different applications.

Conclusion: Barriers and facilitators identified at the patient, application, process and context level, need to be addressed to effectively develop and implement PHRs for MR.

KEYWORDS

clinical pharmacy, drug information, medication safety

The authors confirm that the Principal Investigator for this paper is H.A.W. van Onzenoort and that he had direct clinical responsibility for patients.

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1 | INTRODUCTION

In medical care the prevalence of medication errors is high, especially in transitions of healthcare.^{1–3} The gold standard to reduce medication discrepancies is medication reconciliation (MR), the process in which the most accurate list of a patient's current medicines is created by a healthcare professional (HCP).⁴ Although MR is classified as one of the top five strategies to increase patient safety, it is a time-consuming process and its positive effect on clinical outcomes has not yet been sufficiently demonstrated.^{5–10} Moreover, a central role for patients in the process is lacking.⁴

Multiple organizations like the National Patient Safety Foundation, the Institute for Healthcare Improvement and the World Health Organization encourage a more central role for patients and family members in healthcare to improve patient safety.^{11–13} Because of this, personal health records (PHRs), defined as a secure and confidential online environment that gives patients access to personal health information, are more often applied in medical care.^{14–16}

Recent studies have explored the applicability of PHRs for MR. Van der Nat et al. conclude that patients who use a PHR accurately perform MR in a manner that resembles MR by pharmacy technicians.¹⁷ Although usage of a PHR is recommended and patients are capable of using a PHR for MR, in daily practice only half of patients adopt the PHR and use it for MR.^{17,18} This raises the question, which barriers are preventing patients from using a PHR. Until now, only one study has investigated the barriers and facilitators of PHR use for MR. However, this study had a number of limitations: it was only performed with patients who used the PHR (and not with PHR non-users), the interviews were not recorded and transcribed verbatim, and the interview guide was fairly close-ended and not based on a specific conceptual framework.¹⁸ Because of this, it is unclear whether data saturation was achieved and whether all barriers and facilitators for the use of a PHR for MR were identified.

Given the incomplete evidence from the literature about the barriers for using a PHR for MR and the low adoption rate of PHR use for MR, the aim of this study is to explore the barriers and facilitators for use of a PHR for MR prior to an in- or outpatient visit according to both PHR users and non-users.

2 | METHODS

2.1 | Setting

A qualitative multicentre study was conducted at the inpatient cardiology and neurology departments of the Amphia Hospital (Breda, the Netherlands) and the outpatient rheumatology department of the Sint Maartenskliniek (Nijmegen, the Netherlands). The Consolidated Criteria for Reporting Qualitative Research checklist was used to ensure complete and transparent reporting.¹⁹

What is already known about this subject

- Multiple organizations encourage a more central role for patients in healthcare, in which personal health records are more often applied for medication reconciliation.
- According to the technology acceptance model, adoption of a personal health record depends on usability and perceived usefulness.

What this study adds

- Users and non-users of personal health records reported barriers and facilitators for using a personal health record to perform medication reconciliation at the patient, application, process and context level.
- The identified barriers and facilitators need to be addressed to effectively develop and implement personal health records for medication reconciliation.

2.2 | Personal health record for medication reconciliation

In this study, we evaluated a PHR (Zorgdoc®, Eindhoven, the Netherlands) designed for patients to update their own medication list (Appendix 1). Approximately 2 weeks prior to patients' appointments, patients received an automated invitation to update their medication file. During the verification process, patients were asked to verify the medication information derived from the Nationwide Medication Record System, a digital nationwide network which exchanges medication dispensing data from all pharmacies in the Netherlands.^{20,21} When the patient had finished the verification process, an HCP validated the newly entered drug information and the drug list was updated in the electronic health record file.

2.3 | Recruitment

Patients who had a planned admission at the cardiology or neurology department of the Amphia Hospital between 18 January 2021 and 5 February 2021 or patients who had an outpatient visit at the rheumatology department of the Sint Maartenskliniek between 11 and 15 January 2021 were invited by telephone to participate in this study, following a random sampling method. Eligible patients were included when they were 18 years or older and able to speak and understand the Dutch language. The participants were divided in two groups:

- PHR users: patients who completed the verification in the PHR.
- PHR non-users: patients who did not complete the verification in the PHR. This group also included former PHR users.

All participants were included after obtaining verbal consent. We aimed to interview at least five PHR users and non-users of both the in- and outpatient setting.^{22,23} If data saturation (defined as no additional information is provided in the last three interviews²³) was not achieved, more interviews were performed until data saturation was actually achieved. The study (20-704) was approved by the Medical Ethics Committee of Utrecht, the Netherlands.

2.4 | Theory-based interview guide

Our semi-structured interview guide consisted of five main questions, multiple corresponding in-depth questions and four final questions (Appendix 2). The interview guide was designed by four researchers (D.N., V.H., B.v.d.B. and H.O.) and was based on the Theoretical Domains Framework, a framework which focuses on behaviour change.²⁴ The questions were created using seven domains (Appendix 2) of the Theoretical Domains Framework as these domains were most relevant for patients' behavioural changes of using a PHR for MR. After the interview guide was created, it was tested with three volunteers and further optimized.

2.5 | Procedure

About 1 week after the hospital visit, the randomly selected patients (using [RANDOM.org](https://random.org)²⁵) were called by phone to participate in this study. Patients who agreed to participate in the study received a written invitation consisting of a letter with a description of the study, an invitation for the interview, and a questionnaire to prepare themselves for the interview. This latter questionnaire consisted of the five main questions reported in the interview guide (Appendix 2).

The semi-structured interviews (with a mean duration of 15–20 minutes) were conducted by phone in January and February 2021 by one researcher (D.N.) who had completed several interview training sessions. Interviews were audio recorded and transcribed verbatim.

2.6 | Statistical analysis

Transcripts were thematically analysed using the software program Atlas.ti.^{26,27} Firstly, relevant text fragments were identified and open coding was applied by two researchers independently (D.N. and B.v.d.B. or H.O.). Disagreements were discussed until consensus was achieved. Subsequently, open codes were placed into categories during axial coding. During this process, codes were collated into potential subthemes of barriers and facilitators. All data relevant to each potential subtheme were placed together. The different subthemes were compared and comparable subthemes were taken together and

a clear name of each overarching barrier and facilitator was created. Finally, the barriers and facilitators were divided into overarching domains during selective coding. The axial and selective coding were performed by one researcher (D.N.) and then critically reviewed by three researchers (H.O., B.v.d.B. and V.H.). Discrepancies were discussed with all researchers until consensus was achieved. Quotes were translated from Dutch to English by one researcher (D.N.) and reviewed by a second researcher (H.O.). Descriptive statistics were used to describe the characteristics of the study population. Descriptive statistics were provided using mean ($\pm$ standard deviation) or median (interquartile range [IQR]) values depending on the (non-)parametric distribution of measured variables.

3 | RESULTS

3.1 | Study sample

In total, 45 patients were approached, of whom 10 PHR users and 10 PHR non-users participated (Figure 1). The characteristics of the study sample are shown in Table 1. PHR users (median age: 62 [IQR: 43–65] years, 30% male) used a median number of 6 (IQR: 2–7) drugs. PHR non-users (median age: 51 [IQR: 45–70] years, 40% male) used a median number of 8 (IQR: 3–11) drugs.

3.2 | Pros and cons of the online personal health record compared to medication reconciliation performed by a healthcare professional

Six PHR users and three PHR non-users preferred the PHR to MR performed by an HCP. The most frequently mentioned advantages of the PHR compared to MR performed by an HCP were: convenience, efficiency of the process, accessibility and clarity of the drug list in the PHR and a good preparation for the hospital visit. The most frequently mentioned drawbacks of the PHR were: lack of personal contact, no opportunity to ask a question of a professional, and the labour intensity of the process.

3.3 | Barriers and facilitators

The overall perception of the PHR varied between patients. The median overall score of the PHR (out of 10) rated by PHR users and non-users was 8 (IQR: 8–8) and 6 (IQR: 4–8), respectively. Altogether, we identified four key domains in which the barriers and facilitators were categorized. These domains were:

- **Patient**—regarding factors related to the patient.
- **Application**—regarding factors derived for the PHR.
- **Process**—regarding factors related to the MR process.
- **Context**—regarding external factors which affect the use of the PHR.

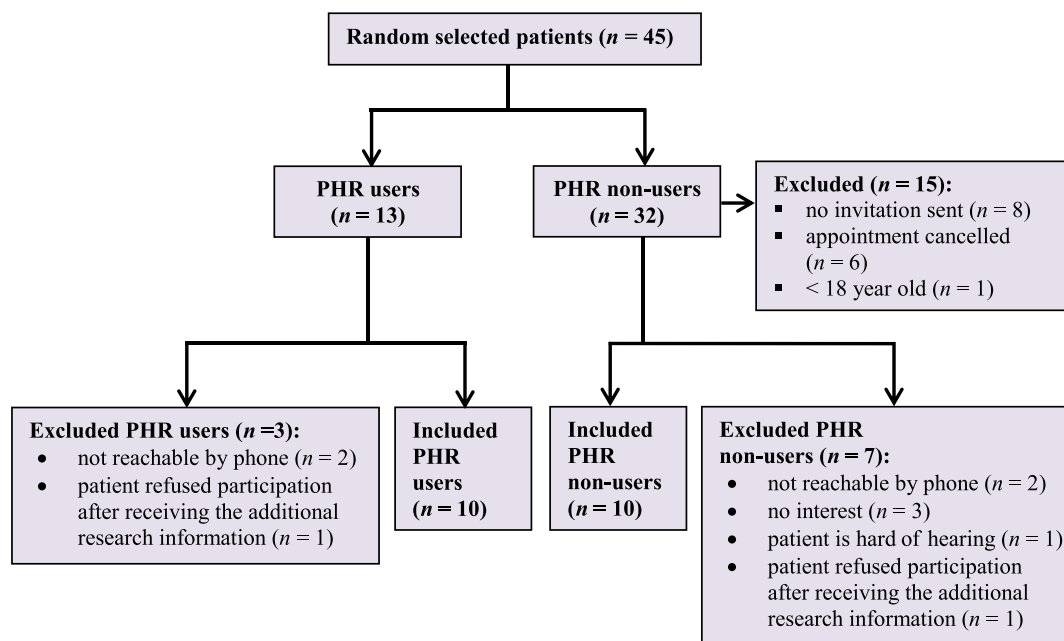


FIGURE 1 Flowchart of the study sample selection. The flowchart displays the selection of the personal health record (PHR) users and non-users of the cardiology, neurology and rheumatology department. At the end of the study, 10 PHR users and 10 PHR non-users were included

TABLE 1 Characteristics of the study sample (n = 20)

Characteristics	Inpatients (n = 10)		Outpatients (n = 10)	
	PHR non-users (n = 5)	PHR users (n = 5)	PHR non-users (n = 5)	PHR users (n = 5)
Age (years, median [IQR])	48 (36–65)	63 (43–66)	65 (48–73)	63 (41–67)
Men, n (%)	2 (40)	2 (40)	2 (40)	1 (20)
Experience with digital devices (score from low [score 1] to high [score 10]), median (IQR)	7.0 (6.5–7.0)	8.5 (7.3–9.5)	7.0 (5.8–9.0)	8.0 (7.3–8.4)
Number of drugs, median (IQR)	4.0 (1–9)	7.0 (3–11)	8 (7–17)	6 (1–7)
Number of comorbidities, median (IQR)	1 (1–5)	4 (3–6)	5 (4–7)	2 (2–3)
Medical department, n (%)				
Rheumatology	0 (0)	0 (0)	5 (100)	5 (100)
Neurology	4 (80)	2 (40)	0 (0)	0 (0)
Cardiology	1 (20)	3 (60)	0 (0)	0 (0)
Consult performed by telephone, n (%)	0 (0)	0 (0)	3 (60)	4 (80)
Future use of the PHR, n (%)	1 (20)	5 (100)	2 (40)	5 (100)
Usage of online care, n (%)	2 (40)	3 (60)	3 (60)	3 (60)
Preferred method of medication reconciliation, n (%)				
MR performed by an HCP	3 (60)	0 (0)	3 (60)	1 (20)
PHR	1 (20)	4 (80)	2 (40)	2 (40)
No preference for a PHR or MR by an HCP	0 (0)	1 (20)	0 (0)	2 (40)
No MR	1 (20)	0 (0)	0 (0)	0 (0)

HCP, healthcare professional, IQR, interquartile range; PHR, personal health record.

The identified key domains and their barriers and facilitators are shown in Figure 2. The facilitator “more frequent update of medication list by healthcare providers” was only reported by PHR non-

users. All other barriers and facilitators were reported by both PHR users and non-users. In the following section the barriers and facilitators are further described.

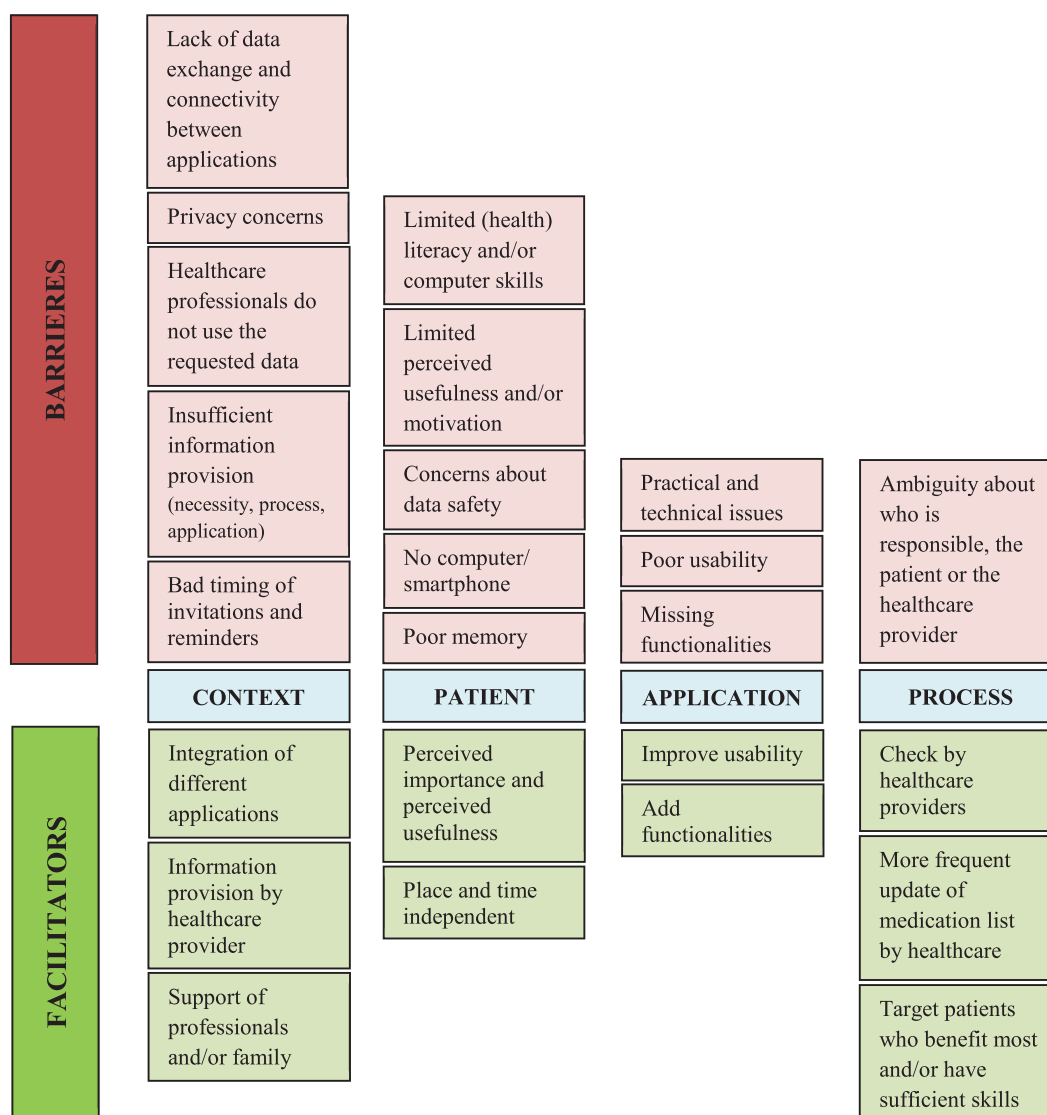


FIGURE 2 Overview of identified barriers and facilitators for using an online personal health record for medication reconciliation prior to an in- or outpatient visit. The barriers and facilitators were categorized into four domains: context, patient, application and process

3.4 | Barriers

3.4.1 | Patient-related barriers

A frequently mentioned barrier for using a PHR reported by participants was the patient's lack of IT skills. Furthermore, patients presumed that especially elderly have a lack of IT skills, which makes it hard for them to use a PHR:

"I am older and I have some experience with the computer but I do not know if I fully understand this."
(Female, 78 years old, outpatient PHR non-user).

Besides IT skills, low literacy and the comprehensibility of the information were reported as barriers for using a PHR:

"I use pills for blood pressure. I do not know what their names are. Then they asked: 'do you use this?' What is it? I do not know at all which drug it is" (Male, 49 years old, outpatient PHR non-user).

Other reasons reported by patients that keep people from using a PHR were: poor memory, no access to a computer and no trust in a PHR. Furthermore, some patients indicated a limited perceived usefulness as a barrier for using a PHR. Patients mentioned several situations in which a PHR was not useful for the MR process: when medication changed frequently, when there were no drugs in use and when there were no drug changes until the next hospital visit. These were also reasons why patients argued that a PHR is superfluous. Other patients indicated that a lack of motivation kept them from using a PHR.

3.4.2 | Application-related barriers

Many patients reported that they presumed that using a PHR was too difficult for the elderly. However only some of the patients mentioned that a PHR was too difficult to use by themselves:

“I actually do not know how to use it” (Female, 78 years old, outpatient PHR non-user).

Problems with signing up and/or logging in to the PHR were the most frequently mentioned application-related barriers. Patients indicated that they had problems with receiving the login code, adjusting their account information, and requesting a new password. PHR malfunctioning, incompleteness and slowness were also reported.

3.4.3 | Process-related barriers

Some patients questioned whether the patient or HCP was responsible for entering drug information in a PHR. Some patients indicated that reporting a correct drug list in a PHR was not their responsibility, but it was the work of an HCP:

“And then I see all old medicines that were changed a long time ago, are still shown in it. Then I wondered who should take care of that” (Female, 78 years old, outpatient PHR non-user).

3.4.4 | Context-related barriers

Patients indicated that they were dissatisfied that different HCPs use different applications for the same purpose, without any data transfer between these systems:

“It is not necessary to enter something in this computer, in the other and then again in the third one” (Male, 68 years old, outpatient PHR non-user).

In addition, some patients reported that using a PHR was unnecessary because the information was already registered in the systems of HCPs:

“The data are known by the general practitioner, the data are known by the neurologist or by the doctor that treats you. So, I think this is superfluous” (Female, 38 years old, inpatient PHR non-user).

Furthermore, patients felt that the information they had entered into a PHR was not used by HCPs and this was a barrier for using a PHR the next time:

“I informed what has been changed in my medication, so which drugs I use and which I do not use. When I was admitted at the hospital, I noticed that my old drug list was still documented [in the system] ... Then I thought: I correctly noted it and nothing has been changed” (Female, 48 years old, inpatient PHR non-user).

Another barrier reported by patients was a lack of good information about the aim and existence of a PHR. For example, patients indicated that it was unclear what the purpose of the application was, the way patients received feedback on the entered information and who had access to the data.

Some of the patients suggested that the right moment to send the invitation for the PHR to the patients was relevant for using a PHR. Patients suggested that if an invitation was sent too early, medication could be changed in the meantime or people could forget it.

Finally, patients reported that privacy concerns dissuaded people from using a PHR. Patients indicated that the information reported in a PHR was privacy sensitive and they were concerned about the possibility of a PHR being hacked, resulting in disclosure of sensitive information:

“And I do not like having personal information on the internet. ... Because your documents can appear everywhere” (Female, 38 years old, inpatient PHR non-user).

3.5 | Facilitators

3.5.1 | Patient-related facilitators

According to the patients, the perceived importance of reporting drug information in the PHR was a stimulus to use a PHR. They indicated that reporting a correct drug list in the PHR provided clarity for themselves and for HCPs about their actual drug use. Furthermore, it was relevant for correct use of their drugs and for emergency situations:

“And if you are hospitalized urgently, they see an actual drug list” (Female, 47 years old, outpatient PHR non-user).

Besides the perceived importance, some patients were satisfied that they became more engaged in their own healthcare by using a PHR. Patients were also pleased that they were able to choose a suitable moment for using the PHR and that no involvement of HCPs was required:

“I can consult it myself and I am not dependent on others to look at my information” (Male, 53 years old, inpatient PHR non-user).

3.5.2 | Application-related facilitators

To improve the usability of a PHR, current functionalities can be improved. Patients suggested that a good usability and simplified and/or sorted information in the PHR increase the usage of PHRs:

“If something is special for blood pressure or is a blood thinner, you report behind the drug: blood thinner or blood pressure” (Male, 49 years old, outpatient PHR non-user).

Patients also reported that new functionalities should be added to PHRs used for MR. For example, the possibility to interact digitally with an HCP and/or to implement drug monitoring in the PHR to prevent drug interactions and duplication.

3.5.3 | Process-related facilitators

According to the patients, hospitals should target the use of PHRs to patients who benefit most and/or have sufficient skills to use the application. Patients suggested that patients with sufficient IT skills and/or drug knowledge and younger people are able to use a PHR for MR. Besides a targeted approach of using a PHR, a few patients indicated that a back-up or additional check by an HCP was desirable to assure correctness of the information reported in a PHR:

“I think you can use the app in addition to personal contact. That you always have a fall back in place” (Female, 41 years old, inpatient PHR user).

Furthermore, PHR non-users indicated that HCPs have to update more frequently patients' medication lists. If the drug list in a PHR is more up to date, patients have to report fewer changes in the PHR and the usage frequency of the PHR can be reduced, both increasing the usage of a PHR.

3.5.4 | Context-related facilitators

According to the patients, HCPs play an important role in increasing the usage of a PHR, by motivating patients to use it:

“It is really at request of the pharmacy: ‘Would you please take a look at your drugs?’ Then I do it accordingly” (Female, 71 years old, outpatient PHR user).

Patients also suggested that more information about the existence and purpose of the application should be provided by HCPs. Some patients also would like to have more feedback on their reported information in the PHR.

Besides better information provision, patients indicated that HCPs should support patients, especially the elderly, in using the

PHR. Patients reported that HCPs can help them, for example with the difficult drug names and computer usage. Besides the HCPs, patients reported that informal caregivers of the patients may also help the patients to use a PHR.

Patients also reported that sharing information between different applications and HCPs was required to increase the usage of those applications. Patients also indicated that this will contribute to a wider use of PHRs:

“Maybe it is easier to share medication overviews. That would be nice, because I am or have been treated at three hospitals, and transferring the information is always quite difficult” (Male, 29 years old, outpatient PHR user).

4 | DISCUSSION

This qualitative study provides insight into patients' perspectives on barriers and facilitators of a PHR used for MR prior to an in- or outpatient visit to the hospital. We categorized barriers and facilitators into four domains: patient, application, process and context. In total, 14 barriers and 10 facilitators were identified.

To our knowledge, this is the first study that applies the Theoretical Domains Framework of behaviour change to identify barriers and facilitators of PHR users and non-users for supporting the MR process. The barriers identified by Marien et al., who also observed barriers of PHR users, were largely comparable to those found in our study: lack of IT skills, difficulties with medication names, incorrectness of past medication history data, missing functionalities, uncertainties about security and privacy, and lack of data exchange and connectivity.¹⁸ In our study, the interviewed patients assumed that the elderly had more difficulties with using an online PHR. This is probably related to the lower adoption rate of electronic devices by the elderly, which is also supported by Olson et al., who indicate that older adults are selective in the type of technologies they use and are likely to be slower to adopt new technologies.²⁸ However, as computer and internet use by the elderly has increased over the past years, we expect that in a few years the number of elderly not capable of using a PHR for MR will be small.^{29,30}

Concerning the facilitators, Marien et al. reported a need for integration and connectivity between healthcare systems and the implementation of more (software) functions in the PHR.¹⁸ These facilitators were also mentioned by participants in our study. In addition, in our study eight more facilitators for the use of a PHR for MR were identified. For example, patients reported that they became more engaged in their own care when using a PHR for MR and they were less dependent on HCPs.

An explanation for the identification of both more barriers and facilitators compared to Marien et al. may be the study design. In our study both PHR users and non-users were included, the interview guide was based on a conceptual framework for behaviour change, and the interviews were recorded and transcribed verbatim.¹⁸

Moreover, the interviews were performed until data saturation was achieved. Based on all the aforementioned aspects, we assumed that in our research (in contrast to Marien et al.) most barriers and facilitators of PHRs used for MR were identified.

Not surprisingly, we identified that the overall score of the PHR was higher for PHR users compared to PHR non-users. Despite the small sample size, our score for the PHR rated by PHR users was comparable (8 versus 8.1) with the mean score of patient satisfaction of using a PHR for MR rated by PHR users ($n = 233$) in the study of Ebbens et al.³¹ This may indicate that our study population is representative of the Dutch population.

It was surprising that three patients reported that they preferred a PHR over MR performed by an HCP, when they did not use the PHR. The reasons why they had not used the system despite their preference were: forgetfulness, unclear that a response to the invitation was desirable and login problems. This confirms the need to address the observed barriers and facilitators, which may increase the usage and acceptance of the PHR. The majority of the reported facilitators are feasible. For example, practical and technical issues can be solved, and the PHR can be improved by adding or adjusting functionalities. Also, the information provision from HCPs can be improved. Prior to a visit, HCPs can inform patients about the usefulness and necessity of checking their drug list in a PHR, and they should emphasize the importance of patient empowerment. This will increase the adoption of PHRs and gives patients a more central role in their own healthcare.

However, some facilitators are more difficult to address. First, the improvement of the data exchange and connectivity between applications is hard to address because multiple organizations are involved and it is complicated by legal aspects.^{32,33} Second, adjusting patients' attitude and behaviour is difficult because behavioural change is a complex process: first patients need to believe there is an advantage to changing their behaviour and subsequently they must be willing to put an effort into making the change happen by deciding when and how to do it.³⁴ Third, targeting patients who will benefit most and/or have sufficient skills to use a PHR is difficult. Several factors have to be explored: from which age are patients capable of using the PHR? What IT skills are required to use this PHR? If these questions are answered, an algorithm may be developed to calculate a risk score (based on patient characteristics) for the occurrence of clinically relevant medication discrepancies in the drug list generated with a PHR compared to MR performed by an HCP. Based on such an algorithm, it may be possible to target low-risk capable patients to use PHRs for MR. Patients who do not reply to the invitation should be contacted by an HCP. The HCP should educate patients how to use the system. In a recurrent population, like outpatients, this will be an investment which may positively influence patient-related factors. Furthermore, HCPs should ask patients about their choice for better understanding patient choices for not using the PHR to improve process-, application- and context-related factors.

As indicated above, changes in multiple domains are required to improve the usage of PHRs for MR. To determine where to start with the improvements, the key barriers of using a PHR for MR should be

explored. Based on our study and the study of Marien et al., we assumed that there are three key barriers: low perceived usefulness, lack of IT skills and lack of integration and connectivity between applications.¹⁸ To improve the applicability of PHRs for MR in usual care, we assume that it is important to focus on better information provision about both why MR is important and the benefits for the patient of using a PHR and give patients more education about how to use a PHR. In addition, national guidelines should stimulate or maybe obligate healthcare professionals to prioritize digital exchange of all patients' medication data (not only drug dispensing data, but also the current medication overview) between different institutions. This will contribute to more integration and connectivity between applications of different institutions with probably positive consequences for patients' adoption of PHRs for MR.

As we have already performed a usability study of PHRs used for MR and a pilot study to discover some barriers to the usage of PHRs for MR,³⁵ we have chosen to perform thematic analysis in this study. With this type of analysis, a more goal-oriented reading was performed with time advantages compared to other qualitative methods like content analysis where "open reading" is applied.^{36,37} In addition, the main difference between thematic analysis and content analysis lies in the opportunity for quantification of data with content analysis, which was not required for our research.³⁷

Our study has several strengths. First, our multicentre study was performed in both the in- and outpatient setting, which increases the external validity of our results. Second, the coding of our data was performed by two researchers independently, decreasing the risk of bias. Third, the semi-structured interview guide was based on a conceptual framework for behaviour change. Since this framework is synthesized from 128 constructs identified in 33 behaviour change theories, the risk of omitting important areas which cause a behaviour change was minimized.³⁸ Fourth, the patients were sensitized prior to the interview by sending them a short questionnaire. This allowed the patients to think about the barriers and facilitators of the PHR in advance, making it more likely that all barriers and facilitators were discussed during the interview. Finally, both PHR users and non-users were included in this research. We observed that the PHR non-users identified an additional facilitator compared to the PHR users. So including both PHR users and non-users resulted in a more complete overview of the barriers and facilitators of a PHR used for MR.

A limitation of the study was that we did not perform a member check. This potentially negatively affects the internal validity of our study. However, all transcripts were translated verbatim and read by at least two researchers reducing the risk of misinterpretation of the information. A second limitation was that the study was performed with one PHR which was investigated for one purpose (MR). Other PHRs used for MR or PHRs used for other purposes can have other barriers and facilitators. However, we expect that at least the described key barriers will also appear in other PHRs.

Finally, in order to mitigate patient-related barriers and reduce healthcare disparities between those who are able to use a PHR and those who are not, patients will need education on PHRs and their

optimal use. Furthermore, additional research is required to investigate how to select and target those patients who have sufficient skills to use a PHR and are most likely to benefit from it.

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COMPETING INTERESTS

The authors had no conflicts of interest to declare.

CONTRIBUTORS

All authors contributed to the conceptualization of the study and its methodology. D.J.v.d.N. was responsible for data curation. Formal analysis and validation were conducted by D.J.v.d.N., B.J.F.v.d.B. and H.A.W.v.O. V.J.B.H. also validated the study. D.J.v.d.N. was the project administrator and wrote the original draft. B.J.F.v.d.B. and H.A.W.v.O. supervised the project. All authors reviews and edited the final version.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

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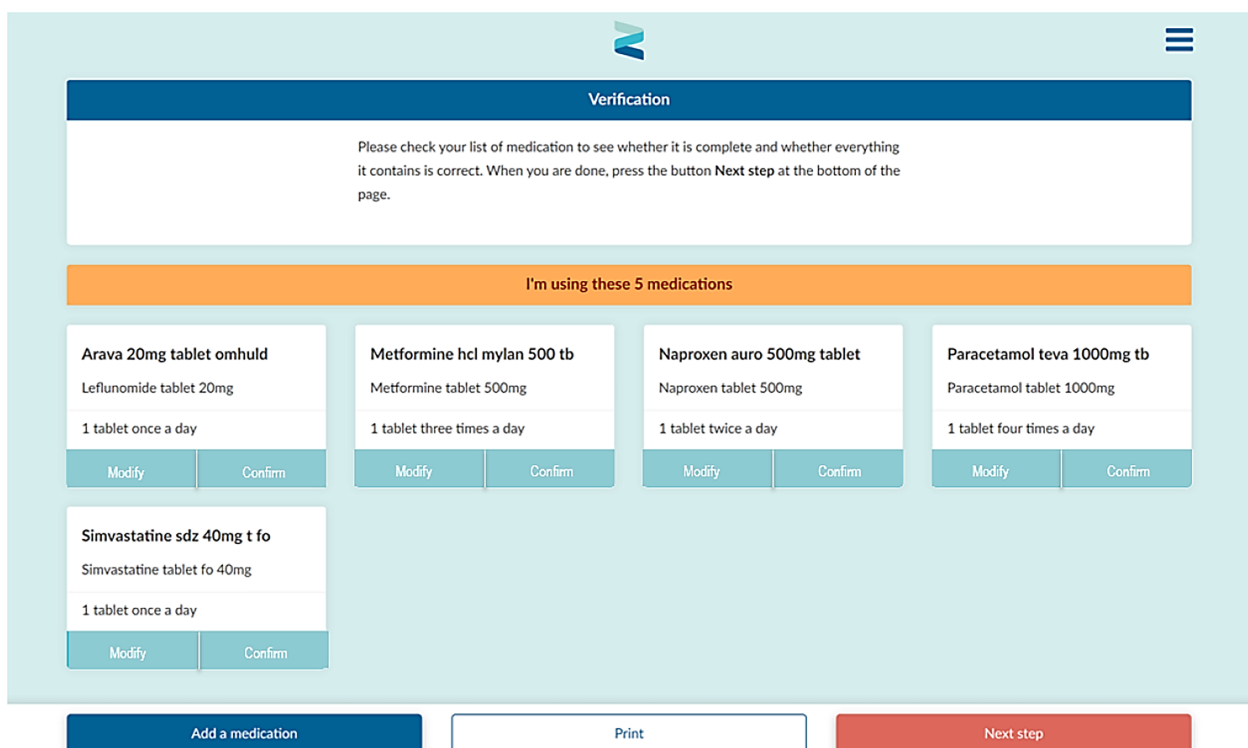
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APPENDIX 1

Screen shot of patient views of the personal health record



The screenshot displays a web-based interface for a patient's personal health record. At the top, there is a blue header with a logo and a hamburger menu icon. Below the header is a 'Verification' section with a message: 'Please check your list of medication to see whether it is complete and whether everything it contains is correct. When you are done, press the button **Next step** at the bottom of the page.'

The main section is titled 'I'm using these 5 medications' and contains five medication cards. Each card displays the medication name, strength, and dosage instructions, along with 'Modify' and 'Confirm' buttons.

Medication	Strength	Dosage
Arava 20mg tablet omhuld	Leflunomide tablet 20mg	1 tablet once a day
Metformine hcl mylan 500 tb	Metformine tablet 500mg	1 tablet three times a day
Naproxen auro 500mg tablet	Naproxen tablet 500mg	1 tablet twice a day
Paracetamol teva 1000mg tb	Paracetamol tablet 1000mg	1 tablet four times a day
Simvastatine sdz 40mg t fo	Simvastatine tablet fo 40mg	1 tablet once a day

At the bottom of the interface, there are three buttons: 'Add a medication' (blue), 'Print' (white), and 'Next step' (red).

During the verification process, the personal health record presents the combined information from both the professionals and the patient file in a simple and understandable drug list. Patients are asked to modify or confirm the shown medication information. If there is a difference between the listed drugs and how patients actually use the drugs, patients note the correct dose, formulation, frequency, route of administration and/or strength in their personal health record. Patients are also able to stop medication that is no longer in use and add new medication. In addition, patients are able to report adverse events and comments related to their reported drug list.

APPENDIX 2

Semi-structured interview guide

Main questions		
1.		How do you feel about the PHR?
2.		Why did you (not) use the PHR?
3.		What is your opinion about the usability of the PHR?
4.		What is your opinion about the perceived usefulness of the PHR?
5.		Why do other people do or do not want to use the PHR?
Theme	Domain of the theoretical domain framework	In-depth questions
Capability	Skills	- Have you used online care before (e.g., for scheduling an online appointment or ordering medication)? - Which skills are required to use a PHR? - Did you experience practical or technical issues when using the PHR?
	Knowledge/information	- What did you already know about the PHR before using it? - What drug information did you use to check your medication list in the PHR? - Was it clear what to do in the PHR (stop/change/add medication)? - When you received the invitation for filling in the PHR, was the goal clear to you? - Was the information in the PHR clearly legible/understandable?
Opportunity	Environmental context & social influences	- What information do people need from doctors or pharmacy to use the PHR? - How do people in your surroundings think about using online healthcare services? - At what moment do you have the opportunity to use a PHR? - Has someone in your surroundings helped you with using the PHR? - Has someone in your environment prevented you from using the PHR? - Do you receive help from others to take your medication (on time)? - Did you require education and/or training about how to use the PHR?
Motivation	Emotion	- What thoughts entered your mind when you received the invitation from the PHR? - Why did you/did you not use the PHR? - Which feelings determines whether or not to use a PHR? - Which feelings of other people play a role in whether or not to use a PHR? - What emotions can be evoked in people when using a PHR?
	Memory	- Did you manage to remember to use the PHR on time? - What do people need to remember to use the PHR on time?
	Motivation	- What was your greatest motivation to use the PHR? - What motivates other people to use a PHR? - What are the consequences if people do not use a PHR? - What are the (dis)advantages/consequences of the PHR, for: yourself; the specialist; the pharmacist; and other patients? - What are the advantages and disadvantages of using a PHR compared to discussing your drug list with a pharmacy assistant? - What are the advantages and disadvantages of using a PHR compared to discussing your drug list with the specialist?

(Continues)

Final questions**Final questions**

1. Would you like to continue/start using the PHR for MR in the future?
2. What score would you give to the PHR on a scale from 1 (low) to 10 (high)? Why do you not give one point higher or lower?
3. What kind of future do you see for PHRs?
4. If you were allowed to make one change to improve the PHR, what change would you make?