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Exploring the effects of patients taking a vigilant role in collaborating on their e-medication administration record

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ABSTRACT

Objective: Errors in the electronic medication administration record (eMAR) occur in 25.6% of cases, mainly due to communication errors. The aim of this study is to investigate whether the quality of the eMAR improves when patients play a vigilant role by checking their medication using a patient communication tool linked to their eMAR (eMAR-PCT) to communicate asynchronously with the pharmacist about errors. Effects on health outcomes and self-care are also explored.
Methods: In this quasi-experimental study, polypharmacy patients using five or more medications were randomly selected and invited to use their eMAR-PCTs. Participants also received two digital questionnaires assessing health and self-care (week 0 and 26). Statistical analyses were performed on two subgroups: eMAR-PCT users and non-users.
Results: An inclusion rate of 43.5% ($n = 152$) was achieved. Women were more prevalent than men among the users group (56.4% vs. 43.6%). Among the eMAR-PCT users, 75% logged in more than once, and 17.9% communicated asynchronously with the pharmacist. The content of the e-mails shows that eMAR-PCT was used as intended. No improvement in the quality of the eMAR was found. The self-care variables self-efficacy ($p = .006$) and collaboration with the pharmacist ($p = .021$) showed significant improvement in the users group.
Conclusion and discussion: The results showed no effect on eMAR quality and a modest improvement in self-care. Active digital patient participation to improve the quality of eMAR merits further investigation as, in line with other research, tentatively positive results are shown on self-care. Possibilities for implementation are promising as half of the patients who pledged to use eMAR-PCT actually did, and used it as intended.

1. Background and significance

In the Netherlands pharmacists keep an electronic medication administration record (eMAR) for the patients in primary care who use medication [1,2]. The eMAR is important because medication care is a complex process, and errors are common (25.6% median rate of error) [1,3]. These errors are an important cause of hospital readmission, morbidity and even mortality [4,5] and are often the result of inaccurate communication [6]. Improving the quality of eMARs is therefore of prime importance.

Medication care is complex, and although the patient has a responsibility for adhering to the prescription, a range of professionals also has a shared responsibility in making the right medication available to the right patient at the right time. In the Netherlands, guidelines have been developed to improve the medication reconciliation process. They describe the respective roles of patients, doctors, nurses, nurse practitioners and pharmacists [2,7]. The role of the doctor is to consult the updated eMAR before a new prescription is written. The patients' role is to produce an updated eMAR when the doctor is visited. The role of the pharmacist is to keep an accurate overview of the patient's current medication in the eMAR [2]. This involves a changing role for pharmacists. Initially, his or her primary task was limited to dispensing medication. Gradually, the pharmacist has also become a caregiver in the medication reconciliation process. They now perform medication care tasks such as periodic comprehensive medication therapy reviews of the eMAR with patients and monitoring changes in the eMAR, so that it is always up to date [8–10]. Therefore, he or she is the patient's primary partner for an accurate eMAR. These periodic medication

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reviews take place during face-to-face contacts between patient and pharmacist, but not at every encounter. Communication tools using Internet could complement the process for medication reconciliation by enabling the patients to correct errors in eMAR and to add self-help medications in between the regular periodic reviews and thus may contribute to adequate adherence.

Several options are available to improve the quality of the eMAR. Some actions target the pharmacists' role. Examples include developing practice guidelines (including agreements about communication and data exchange among professionals) and direct involvement in maintaining the quality of eMARs by initiating periodic checks of their accuracy [11–13].

Other actions are directed at the patient's role in avoiding medication errors [12,14]. Initially, patient involvement was instigated by professionals, but it is increasingly prompted by the patients themselves [15]. Patient involvement is viewed as an aspect of self-care; that is deliberate and self-initiated actions that patients can take to enhance their health [1,16]. A potential self-care role that needs to be explored is for patients to be 'vigilant', that is: keeping a watchful eye on the eMAR, always being alert to potential errors and communicating about the errors with professionals [17]. Patients have been shown to play an effective role as 'vigilants' when they are able to access their own eMAR [18,19]. One way this can be realized is by providing digital access to eMARs and enabling patients to make corrections in the eMAR at any convenient time. In non-acute situations, asynchronous communication (such as e-mail) between patient and pharmacist has been shown to be a user-friendly option [12,20–22]. Such communication methods enable both parties to communicate about the eMAR at the time and place of their choice.

It is as yet unclear in the literature whether patient access to the eMAR and asynchronous communication about errors are effective strategies for increasing accuracy because little specific research has been undertaken. In other fields of care, results have been obtained using digital multi-component interventions, including asynchronous communication between patient and caregiver. Systematic reviews have shown that such interventions do not affect health outcomes [16,17]. Significant results have been shown for such aspects of self-care as empowerment, self-efficacy and improved collaboration between patient and caregiver [23,24].

These findings justify more detailed research into effective strategies for helping primary care patients collaborate with their pharmacists to improve the accuracy of eMARs through electronic access and asynchronous communication. This focus is also supported by earlier research that suggests that patients are interested in digital communication with their health care providers [25,26].

2. Objective

The aim of this study is to investigate the effects of patient participation in the medication reconciliation process through the use of a patient communication tool (eMAR-PCT) linked to their eMAR. The primary research question is whether the use of the eMAR-PCT is feasible and secondly whether the use of eMAR-PCT increases the accuracy of the eMAR. We also explored whether the use of the eMAR-PCT affects health outcomes and self-care-related variables (i.e., the patient's perception of medication adherence, patient's self-efficacy and the collaborative relationship between patient and pharmacist)?

3. Materials and methods

The design of this study is quasi-experimental. The patients were invited to use the intervention (eMAR-PCT) and data were gathered during 26 weeks. At the start of the study and after 26 weeks, the participants also completed digital questionnaires that assessed health and self-care variables. The patients' experiences with the eMAR-PCT were evaluated via digital questionnaires after eight weeks. The study took place between July 2012 and January 2014. Permission to perform the study was granted by the Medical Ethics Committee of the University of Utrecht.

3.1. Intervention

The eMAR-PCT is a module on the pharmacist's website with a personal patient login. The eMAR-PCT offers the patient the possibility of looking at the prescribed use (method, dose and frequency) of medications at any time and allows easy communication with their pharmacists about errors or changes and adding self-help medication, for instance, by facilitating questions via email.

Patients were invited to check their eMAR after every change in prescription and to notify their pharmacists when corrections needed to be made. They were also asked to report any use of self-help medications and to pose questions they had about medication use.

3.2. Patient population and recruitment procedure

In this project, the use of the eMAR-PCT was evaluated in home dwelling polypharmacy patients who use five or more different medications [2]. These patients were not only complex due to the polypharmacy; also multimorbidity and the fact that they were home dwelling inhibited medication reconciliation. Patients from two pharmacies in The Netherlands were recruited. Two inclusion criteria were applied: the use of five or more medications and access to a computer with an Internet connection and a mobile telephone, which is needed for verification purposes to log on to the eMAR-PCT.

The recruitment procedure was as follows: pharmacists composed a list of patients who used five or more medications. A randomized and stratified selection was made of the entire population of eligible patients to assure a weighted sample of four subgroups (male/female, 65+/65-years), using the SPSS randomization procedure. The patients were invited by telephone to participate in this study. Patients who showed interest were invited for an initial consultation, during which the pharmacist explained the purpose of the study and the login procedure and asked for permission to share the eMAR with the researcher for the purpose of this study. After receiving informed consent from the patient, the pharmacist provided the researcher with the patient's email address. The researcher sent the participating patients a link to the first digital questionnaire via e-mail. The researcher checked for a response to the questionnaire on a weekly basis and, if necessary, sent a reminder to the patient, with a maximum of four reminders.

3.3. Variables and measures

To answer the research questions, the following variables were measured:

Actual use of the eMAR-PCT was registered in the system.

- The number of patient logins to the eMAR-PCT.
- The number of emails sent by the patient.
- The content of the patient's emails.
- The number of emails sent by the pharmacist.
- The content of the pharmacist's emails.

The *Effect of eMAR-PCT use* was measured in terms of the quality of the eMAR and the patient's quality of life and self-care.

- The *quality of the eMAR* was measured by registering the corrections made to the eMAR during verification consultations between the pharmacist and the patient at week 0 and at week 26. During the verification consultations, the pharmacist presented the patient with the eMAR and asked him/her to verify the correctness of it. Corrections were assessed within the following activities: starting a new medication, stopping a medication, changing the timing of administration, and changing the medication's dosage. In the analysis, all of the corrections were considered together.
- *Quality of life* was measured digitally at week 0 and at week 26 using the 12-Item Short Form Health Survey (SF-12) [27]. This widely used questionnaire consists of eight domains (physical functioning, role physical, bodily pain, general health, vitality, social functioning, role emotional and mental health), which are summarized in two subscales: the mental components (MCS) and physical components (PCS) of health. Both scales have a minimum score of 0 (low quality of life) and a maximum score of 100 (high quality of life). The responses to the SF-12 are based on the patient's perceptions.
- Self-care-related outcomes were also measured digitally at week 0 and week 26. The measurement of these outcomes focused on three parameters:
  - *Therapy adherence* patient-perceived adherence to medication prescriptions was measured using two items from the Cardio Vascular Risk Management questionnaire [27] adapted to this target group. The questions, with five-point scales, asked after the frequency of adherence to medication and patients expectations of their adherence. The sum score varied from two (high adherence) to ten (low adherence)
  - *Self-efficacy* (confidence in one's own abilities) in relation to therapy adherence was measured with an adapted version of the Diabetes Management Self-efficacy Scale [28]. The original Diabetes Management Self-efficacy Scale consisted of 20 items, which in factor analysis showed two factors regarding general situations and difficult situations. In this study we used a shortened and adapted version of four items referring to difficult situations. The focus was changed from diabetes to medication management. The questions focused on self-efficacy in medication management in difficult situations such as parties or holidays, integrating new medications in the daily routine and asking questions about medication dispensed by the pharmacist. Five-point scales were applied and the sum score varied from four (low self efficacy) to 20 (high self efficacy). The reliability of the modified scale, using Cronbach's alpha, was reasonable at .67
  - *Collaborative relationship* with the pharmacist was measured using a self-developed questionnaire consisting of six 5-point scale items (e.g., In the previous half year, I have experienced my pharmacist acting as a partner in keeping my eMAR up to date and My pharmacist's answers have been helpful for me). Scores were minimally 6 (good collaborative relationship) to maximum of 30 (less collaborative relationship). Content validity was tested by a panel of chronically ill patients, and also discussed with pharmacists. The questionnaire was shown to be reliable (Cronbach's alpha = .86). The patients were also asked to provide an overall rating of their collaborations with the pharmacist using a 10-point scale.
- *Patients' characteristics* were measured at week 0 using a digital questionnaire that queried the following information:
  - Date of birth.
  - Sex.
  - Socioeconomic status (SES), derived from the postal code using standard algorithm [28].
  - Highest level of education.
  - Health status (number of chronic illnesses).
  - Internet skills.

Statistical analyses

Two subgroups of patients were identified: users (those who logged in to the eMAR-PCT at least once) and non-users (those who never logged into the eMAR-PCT). The differences between these two groups were analyzed in terms of mean scores with standard deviation or frequencies and percentages using Student's T test resp. Chi-square tests. The analyses were performed with SPSS version 20. The results were considered significant if $p \leq .05$; p-values between .05 and .10 were regarded as a trend toward significance.

4. Results

4.1. Sample characteristics

Starting with the pharmacists' patient records, 517 people met the inclusion criterion of using five or more medications. Contact was established with 349 people; 164 did not have access to the Internet and a mobile phone or chose not to participate. The main reasons for non-participation were lack of interest, illness or language issues. The remaining 185 patients met with their pharmacist for the initial consultation, after which 33 withdrew from the study. Ultimately, a total of 152 out of 349 people entered the project, resulting in an inclusion rate of 43.5%.

Of those included in the sample ($n = 152$), some never logged into their eMAR-PCT ($n = 74$, 49%), and some logged into their eMAR-PCT at least once ($n = 78$, 51%). The first group constitutes the non-users in this study, and the last group constitutes the users.

The first questionnaire was returned by 105 participants; 115 returned the second questionnaire. The patients who returned the questionnaires were compared with those who did not. A significant difference ($p = .000$) in returning the questionnaires was shown between the users (76.9%) and the non-users (37.8%). There was also a significant difference in gender ($p = .003$), with women more prevalent among the responders. Age, SES, and computer and Internet skills did not differ between the two groups.

The sample characteristics are shown in Table 1. Approximately 90% of the participants reported having chronic conditions; 30% reported having two or more chronic conditions. The majority of the participants completed secondary education or higher; 10% reported elementary education as their highest level. The majority met the average SES for the Netherlands, 10% had a lower SES, and 25% had higher a SES. Three out of four participants used the Internet on a daily basis; 2% rarely used it. The majority of the sample (70%) assessed their Internet skills as average or good.

A comparison of the users and non-users showed no significant differences between the two groups except for gender: women were overrepresented in the user group.

4.2. Actual eMAR-PCT use

An analysis of the actual use of the eMAR-PCT showed that 78 patients used the eMAR-PCT, with the following results:

4.2.1. Number of logins to the eMAR-PCT

Nineteen patients (24.4%) logged into their eMAR-PCT once. Thirty-two (40%) viewed it two to five times during the six-month period. The remaining users viewed their eMAR-PCT six to ten times ($n = 13$, 16.7%), eleven to twenty times ($n = 10$, 12.8%), or more than twenty times ($n = 4$, 5.1%).

Table 1
Characteristics of the eMAR-PCT users and non-users.

Variables	Categories	Total $n = 152$ (%)	Users $n = 78$ (%)	Non-users $n = 74$ (%)	p
Sex					.036
	Male	51.3%	43.6%	59.5%	
	Female	48.7%	56.4%	40.5%	
Age					.745
	0–65 years	53.3%	55.1%	51.4%	
	66–100 years	46.7%	44.9%	48.6%	
Education					.142
	Elementary	9.7%	8.8%	11.1%	
	Secondary	51.6%	59.6%	38.9%	
	Higher	38.7%	31.6%	50.0%	
SES					.968
	1	11.8%	11.5%	12.2%	
	2	61.8%	62.8%	60.8%	
	3	26.3%	25.6%	27.0%	
Pharmacist					.468
	1	15.8%	16.7%	14.9%	
	2	84.2%	83.3%	85.1%	
Chronic conditions					
	Yes	88.8%	90.3%	86.8%	.370
	Number of chronic conditions reported				.138
	0	19.7%	12.8%	27.0%	
	1	50.7%	55.1%	45.9%	
	2	19.1%	21.8%	16.2%	
	3	6.6%	7.7%	5.4%	
	4	3.3%	1.3%	5.4%	
	5	.7%	1.3%	.0%	
Internet use					
	Intensity of use				.513
	(Almost) daily	78.4%	82.4%	72.9%	
	Multiple times per week	12.1%	10.3%	14.6%	
	A few times per week	6.9%	4.4%	10.4%	
	Rarely	2.6%	2.9%	2.1%	
	Self-assessed computer skills				.318
	Moderate	21.6%	16.2%	29.2%	
	Average	40.5%	45.6%	33.3%	
	Good	30.2%	29.4%	31.2%	
	Very good	7.8%	8.8%	6.2%	

4.2.2. E-mails

All users were offered the opportunity to send e-mails to their pharmacist through the eMAR-PCT. Fourteen users (17.9%) actually did so. These fourteen were compared with the non-e-mailers in terms of gender, age, education, SES, chronic diseases and Internet skills. A significantly larger portion of the users group used the Internet daily ($p = .035$); on average, they logged in fifteen times and sent a total of 37 emails. The majority sent one email during the six-month study period ($n = 8$; 53%). Six users who sent emails did so between two and six times; one sent thirteen emails.

Most emails from the patients to their pharmacist addressed substantive matters related to the nature of their medication care:

- Accuracy of eMAR-PCT ($n = 21$), corrections and additions.
- Questions about medication ($n = 3$).
- Technical matters ($n = 8$): the functional use of the eMAR-PCT (e.g., 'Can my partner also log into his eMAR-PCT?'), technical problems relating to the eMAR-PCT.
- Service questions ($n = 3$): home delivery of medication and the respective roles of the physician and pharmacist (e.g., 'Whom do I need to contact for a repeat prescription?').
- Canceling *eMAR-PCT use* ($n = 2$) because it did not meet the patient's expectations.

The pharmacists' emails to their patients ($n = 22$) were in reply to the patients' e-mails ($n = 15$) or alerts to the patients about the possibilities provided by the eMAR-PCT ($n = 7$). The reply e-mails were about the accuracy of the eMAR ($n = 9$), technical questions ($n = 4$) and services ($n = 2$).

4.3. Effects of eMAR-PCT use

The quality of eMAR is shown in Table 2. At the second verification consultation, corrections were necessary for approximately 20% of the eMARs. There was no significant difference in the number of corrections between the users and the non-users.

The participants did not perceive a significant change in their health (quality of life) during the six-month study period.

Two of the three variables pertaining to self-care showed significant changes in the user group: self-efficacy in relation to medication use ($p = .006$) increased, as did the collaborative relationship with the pharmacist ($p = .021$). Among the non-users, there were no changes.

5. Discussion

This study aimed to evaluate the effects of patients' use of an eMAR-PCT on the accuracy of the eMAR. Regarding the primary outcome, no significant difference was found in the number of eMAR corrections between users and non-users of eMAR-PCT. A significant increase in the secondary outcome of self-care, specifically in the areas of self-efficacy and collaboration with the pharmacist, was

Table 2
Effects of the eMAR-PCT: outcome variables.

Variables	Sample	*N*	Mean (SD) (Week 0)	Mean (SD) (Week 26)	Difference	*P*
Quality of the eMAR						
Number of eMARs with corrections	Users	70		16 (22,9%)		.169
	Non-users	44		8 (18,2%)		
Number of corrections	Users	70		.5 (1.2)		
	Non-users	44		.4 (.9)		
Quality of life						
Physical	Users	53	57.5 (26.5)	59.1 (27.6)	1.7	.445
	Non-users	24	54.7 (24.1)	52.9 (23.9)	−1.8	.238
Mental	Users	53	75.0 (22.7)	71.3 (24.3)	−3.6	0.194
	Non-users	25	76.5 (13.1)	72.5 (19.9)	−4	.587
Health rating on a 10-point scale	Users	54	7.0 (1.4)	7.0 (1.8)	0	.832
	Non-users	24	7.0 (1.3)	7.0 (1.2)	0	.833
Therapy adherence						
	Users	55	9.5 (.9)	9.6 (.7)	.2	.168
	Non-users	25	9.4 (.7)	9.4 (.9)	0	.852
Confidence in one's own abilities						
	Users	53	18.7 (2.1)	19.3 (1.6)	.6	.006
	Non-users	24	18.0 (2.3)	18.5 (2.7)	.5	.433
Collaborative relationship with the pharmacist						
Aspects of collaboration	Users	50	14.4 (4.1)	15.7 (4.4)	1.3	.021
	Non-users	22	15.8 (4.9)	16.2 (4.4)	.4	.588
Rating on a 10-point scale	Users	55	7.6 (1.3)	7.5 (1.4)	0	.830
	Non-users	25	7.4 (1.4)	7.1 (1.7)	−.3	.448

identified for the eMAR-PCT users. The health outcomes (quality of life) did not differ significantly between the two groups.

5.1. Substantive findings

The number of errors found in the eMAR did not differ greatly from the mean rate of errors reported in other studies, though 20% is lower than the 26% in the literature and is a relatively good result for the participating pharmacists [1]. However, because 80% of the eMARs did not contain errors, the likelihood of realizing improvements is small. Moreover, a half-year follow-up period may be too short for many changes in medications, and thus errors, to occur.

In the small group ($n = 14$) of patients who communicated asynchronously and participated in both verification consultations, no eMAR corrections were needed. The e-mailers were active users, and all of the e-mails were relevant. No significant differences were found between the e-mailers and the rest of the users. This result may indicate that active use of the eMAR and communicating errors is effective in realizing accuracy.

The fact that the patients' quality of life was minimally influenced was not surprising because the sample consisted of patients with chronic conditions. Substantial changes in their health were not to be expected during the relatively short study period. Quality of life depends on multiple factors in addition to medication use. Pecina et al. found similar outcomes concerning eHealth among older patients with comorbidities [29].

Regarding self-care, the users group showed a significant increase in self-efficacy regarding medication use, and they reported an improvement in their collaboration with the pharmacist. However, these improvements in collaboration did not result in a higher general rating of the pharmacist, as such ratings might also be influenced by the physical environment or the general service level, among other factors. Therapy adherence did not differ among the groups.

Our findings are in line with recent systematic reviews of the effects of web-based interventions on patient empowerment, which show that eHealth has a tentatively positive effect on self-care elements such as self-efficacy [30,31]. This merits further investigation because these changes may support a more active vigilant role of the patient in monitoring the eMAR in the future.

5.2. Methodological issues

The study sample successfully attained equal representation among the groups of patients who used eMAR-PCT and those who did not. It is interesting to note that apart from gender, no distinguishing characteristics were identified between the questionnaire responders and non-responders. This result is consistent with the findings of Kontos et al. in a large study examining the predictors of eHealth usage. They found that being female was a predictor of all types of eHealth use, including sharing medical records and communicating about them [36]. Age and SES did not influence eMAR-PCT use. To minimize the risk of bias the differences in technology adoption were assessed but no differences in intensity of computer use and perceived computer competency were found. This was also the case for the variables 'adherence' and 'self-efficacy'. The groups were found to be quite comparable which suggests that there is no reason not to generalize the results of this study.

A methodological issue that merits some attention is the inclusion of patients in innovative eHealth studies. The inclusion rate of patients in this digital form of patient participation in medication care was quite high (approximately 43.5%). An explanation could be that the sample was selected from the group of polypharmacy patients who probably had experience with errors in the eMAR and who were approached by their own pharmacists to communicate about these errors. In comparison to a large study in England in which people were invited by letter to activate digital access to their health record, one-third took the first steps to enter the study and a quarter actually activated the patient portal [32]. In the first phase of innovation, it can be helpful to take into account several factors, particularly how patients perceive the innovation, the characteristics of potential adopters, and organizational aspects [33]. These characteristics have not been well studied [34,35]. In this study, the only characteristics that seemed to be relevant for the adoption of eMAR-PCT use were being female and, in the case of e-mail use, being a daily user of the Internet. SES seemed irrelevant, as did age and education level.

5.3. Feasibility issues at the intervention level

A precondition for obtaining any results with healthcare innovations such as eMAR-PCT is that patients use it as intended. Because the eMAR-PCT was used by more than half of the patients in the sample, we concluded that it seemed usable. One in five eMAR-PCT users not only looked at their record but also corresponded about what they saw with their pharmacist via e-mail. These e-mailers were active users who logged in fifteen times on average. The content of the e-mails indicate that the eMAR-PCT was used as intended. We found no indications that the user group had specific characteristics.

In this study the main focus was on feasibility of the intervention. The eMAR-PCT seems to work and might therefore be a valuable additional tool in the medication reconciliation process to keep the eMAR up to date. The added value of eMAR-PCT is that patients' monitoring of the eMAR is enabled in a user-friendly way; they can perform the monitoring at their own convenience. This could increase the chance of the much-needed patient participation in the medication reconciliation process. From the viewpoint of Rogers' theory on diffusion of intervention [37], the rate of adoption is actually relatively high as 43.5% is close to the tipping point of 50%, when the intervention will be broadly diffused. Specifically as the eMAR and eMAR-PCT were only introduced two years before the study and many innovations take over ten years to be implemented [38].

An important question, however, remains unanswered: why did non-users not use the system? This is an important but difficult question for further implementation, as already described by Rogers [37]. All the participants in the study, users and non-users, had initially promised their pharmacist that they would use the eMAR-PCT and about half became non-users. A search for characteristics of early adopters did not show up significant items. Patients are at the decision-stage of implementing an innovation and many individual aspects (such as personal traits, motivation and meaning of the innovation) have influence, as a result empirical evidence is difficult to find [37,39]. It remains unclear at this point why a motivated group did enter the study and did not use eMAR-PCT. Further (qualitative) research needs to be performed.

5.4. Feasibility issues at the organizational level

A considerable investment by the pharmacists was needed to enroll patients in this study in a primary care setting. In a Dutch study on eHealth, health care professionals confirmed that they do not always recognize the potential of eHealth solutions such as eMAR-PCT for self-management and prevention [40]. Professionals might also question whether eHealth solutions are worth the effort, considering the time investment that is needed to get the innovation running. In this study, we also found these factors to be issues. The response was influenced by the amount of time required to approach the patients about entering the study and arrange the consultations with the pharmacist. One reason these actions required considerable time was that mobile phone numbers and email addresses were not included in the care providers' standard patient records. As a result, contacting patients was time-consuming and often ineffective. Furthermore, multiple phone calls were required before contact was made with many of the patients. For eHealth research, it would be helpful if it became standard procedure in health care to note patients' e-mail addresses and mobile phone numbers.

The procedure involved in this study was quite demanding, as the patients were expected to visit the pharmacist twice for verification consultations, answer two questionnaires and use eMAR-PCT to check and update their eMARs. For the pharmacists, getting the participants to come in for both verification consultations required more effort than expected; consequently, the number of corrections in the eMAR was not known for all of the users because not all of them attended both consultations. Additionally, there was a relatively low response to the questionnaires among the non-users, although the users and non-users did not differ in Internet skills or use. Apparently, the non-users did not feel the need to communicate digitally about their medications. The fact that they did not use eMAR-PCT may have also been a factor in their failure to return the second questionnaire.

Summary points

What was already known on this topic?

- Medication errors, mainly due to communication errors, occur often and are a frequent reason for hospital readmission.
- Patient involvement in healthcare delivery is increasingly viewed as self-care.
- In non-acute situations, asynchronous communication (such as e-mail) between patient and pharmacist has been shown to be a user-friendly option for communication about medication-use.
- In other fields of care, digital multi-component interventions, including asynchronous communication between patient and caregiver, are proven to be effective. Significant results have been shown for aspects of self-care (empowerment, self-efficacy and improved collaboration between patient and caregiver).

What this study added to our knowledge?

- Patients' digital access to their electronic medication administration record and communication about their medication has a positive effect on self efficacy and collaboration with the pharmacist.
- Patients use the electronic medication administration record tool adequately, they communicate errors in the eMAR, and ask question about the use (intake) of medication.
- Use of the electronic medication administration record does not seem to be influenced by age or SES, meaning that the tool is also suitable for elderly and low income groups.

Authors contribution

All authors have a delivered a substantial contribution to the study from the conception until the final version was approved.

5.5. Lessons learned

The use of eMAR-PCT by patients seems a promising intervention, even though we could not determine whether it lead to a significant increase in the accuracy of the eMAR. This is in line with a study in the United States within the VA, where it is concluded that it is certainly feasible to improve medication safety by enabling patients to interact through a web portal [19]. This is a promising expansion.

Perhaps this study was performed too early in the adoption of this intervention. We tried to implement a new innovation broadly, whereas by starting with a group of enthusiasts we would certainly have required less recruitment time.

We have learned that the use of eMAR-PCT was associated with two significant improvements in self-care: First, an increase in self-efficacy for medication—use was shown because the patients' confidence about making the right decisions about medication-use in different situations increased. Second, the collaborative relationship between the patients and the pharmacists increased

significantly. This improved collaboration is a start for the type of participation that is envisioned in modern health care policy; that is, the patient plays a vigilant role and shares the responsibility for checking the eMAR with the pharmacist. A comprehensive approach is needed, although the effect is limited. These are elements that can help increase patient self-care in health care, and they are consistent with the findings in a Cochrane review on this subject [12]. It is also promising to find that the active users who both looked at their eMAR regularly and e-mailed the pharmacist about what they saw did not need to correct eMARs.

6. Conclusion

Active patient participation in checking the quality of medication records through the eMAR-PCT is an innovation that merits further investigation. Half of the patients who pledged to use the module actually did. A significant characteristic of these early adopters of the innovation was that they were female. Patient emails showed that the users understood the purpose of the eMAR-PCT. No effect on eMAR quality was found. The modest improvement in the area of self-care may be expected to positively support active self-care behavior. Further research with a longer study period is needed to test whether active digital communication by chronically ill patients in medication reconciliation has effects on clinical outcomes.

Conflicts of interest

The authors have no conflicts of interest to declare.

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