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Original Study

The Effect of Medication Reconciliation via a Patient Portal on Medication Discrepancies: A Randomized Noninferiority Study

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A B S T R A C T

Background: Medication reconciliation has become standard care to prevent medication transfer errors. However, this process is time-consuming but could be more efficient when patients are engaged in medication reconciliation via a patient portal.
Objectives: To explore whether medication reconciliation by the patient via a patient portal is noninferior to medication reconciliation by a pharmacy technician.
Design (including intervention): Open randomized controlled noninferiority trial. Patients were randomized between medication reconciliation via a patient portal (intervention) or medication reconciliation by a pharmacy technician at the preoperative screening (usual care).
Setting and Participants: Patients scheduled for elective surgery using at least 1 chronic medication were included.
Measures: The primary endpoint was the number of medication discrepancies compared to the electronic nationwide medication record system (NMRS). For the secondary endpoint, time investment of the pharmacy technician for the medication reconciliation interview and patient satisfaction were studied. Noninferiority was analyzed with an independent *t* test, and the margin was set at 20%.
Results: A total of 499 patients were included. The patient portal group contained 241 patients; the usual care group contained 258 patients. The number of medication discrepancies was 2.6 ± 2.5 in the patient portal group and 2.8 ± 2.7 in the usual care group. This was not statistically different and within the predefined noninferiority margin. Patients were satisfied with the use of the patient portal tool. Also, the use of the portal can save on average 6.8 minutes per patient compared with usual care.
Conclusions and Implications: Medication reconciliation using a patient portal is noninferior to medication reconciliation by a pharmacy technician with respect to medication discrepancies, and saves time in the medication reconciliation process. Future studies should focus on identifying patient characteristics for successful implementation of patient portal medication reconciliation.

Medication reconciliation has become standard of care to prevent medication transfer errors.[1,2] It is defined as the process of creating the best possible medication history (BPMH) of all drugs, including dose, frequency, and administration route. The BPMH is compared to the admission medication and any unintended discrepancies are resolved. In the Dutch guideline on medication transfer, medication reconciliation is required in all transitions of care within 24 hours.[3]

Despite this guideline, the number of medication discrepancies in patient transfers is high.[2] This number can be substantially reduced when medication reconciliation is performed by dedicated pharmacy staff.[4,5] Pharmacy-led medication reconciliation reduced the proportion of patients with medication discrepancies by 66%.[4] A

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meta-analysis on pharmacist-led interventions in medication reconciliation showed a decrease in medication discrepancies of 42%.[5]

However, performing medication reconciliation is a time-consuming process. The patient interview at admission takes 12 to 16 minutes per patient.[6] The entire process of medication reconciliation takes a median of 50 minutes per patient.[6] Therefore, implementing pharmacy-led medication reconciliation may be hampered by budgetary constraints within hospitals or other health care facilities. One solution to lower the costs is the deployment of pharmacy technicians instead of pharmacists.[7]

Engaging the patient in medication reconciliation could further contribute to cost containment by making the medication reconciliation process less time consuming. Several studies have shown that patients can have a role in medication reconciliation, although often resulting in incomplete medication lists.[8,9] This generally improves when the patient is presented a medication list and is asked to adjust and supplement that list. Medication lists may be presented to patients via a patient portal, after which the medication reconciliation by the patient can be performed electronically.[10–13] Patients are generally satisfied with using the patient portal and think that it could improve communication about medication with health care professionals.[12]

Although these studies show that patients can have a role in medication reconciliation, to our knowledge no studies have been performed in which the quality of patient portal medication reconciliation was compared to medication reconciliation by a pharmacy professional.

Therefore, the aim of this study is to explore whether medication reconciliation by the patient via a patient portal is noninferior to medication reconciliation by a pharmacy technician, with respect to the number of medication discrepancies.

Methods

Study Design

This prospective open randomized controlled noninferiority study was conducted at the preoperative screening appointment. Medical ethical approval of the study was granted by the Medical Ethical Committee of the hospital. Patients were contacted by telephone at least 1 week prior to the preoperative screening appointment to ask if they were willing and able to participate in the study. Patients were randomly assigned to the intervention group or control group. The randomization list was created by an independent trial coordinator using Microsoft Excel's (2010) data randomizer function in blocks of 200 patients. Owing to the nature of the intervention, patients and pharmacy technicians were not blinded. The patients in the intervention group were invited to use the electronic patient portal medication reconciliation system (eMR) 1 week prior to the preoperative screening appointment. The patients in the control group received usual care in which medication reconciliation (MR) was performed at the preoperative screening appointment by pharmacy technicians. Because the quality of the patient portal medication reconciliation was yet unknown, medication reconciliation by a pharmacy technician was repeated in all intervention patients after they had completed the reconciliation in the patient portal.

Study Population

All patients of 18 years and older with an appointment at the preoperative screening who had used at least 1 medication were eligible for inclusion. Patients were included between September 2018 and February 2020. Patients who were not able to communicate in Dutch and patients who were not able to perform medication reconciliation on an electronic device were excluded.

Usual Care

The usual care medication reconciliation process at the preoperative screening appointment consisted of several steps. First, the community pharmacy medication dispensing list was retrieved through the electronic Nationwide Medication Record System (NMRS).[14] Second, this list was combined with the medication in the hospital electronic patient record. Subsequently, every medication on the combined medication list was discussed with the patient in a face-to-face interview to establish current dosage and use. Using a checklist (Supplementary Table 1), the patient was explicitly asked for any missing medication and for specific over-the-counter medication. The result of the medication reconciliation was the BPMH.

Intervention

The patient portal was developed by Zorgdoc (Zorgdoc Nederland BV, Eindhoven, the Netherlands). The medication reconciliation application in the patient portal was developed in cooperation with health care professionals and patients to make the application user friendly. Some hospitals in the Netherlands already use the patient portal.[15] The patient portal consists of a protected digital environment in which a patient can log in and is guided through the steps of medication reconciliation. The patient portal uses both the NMRS and the medication available in the hospital electronic patient record (Hix, Chipsoft BV, Amsterdam, the Netherlands) as a starting point for medication reconciliation. These medications are shown in comprehensive blocks (Figure 1). For each medication, the patient can confirm the use, adjust the dose/frequency, indicate not using it at all, or not recognizing the medication. After this, the patient is offered the opportunity to add medication. Furthermore, the standard questions (if patients use any over-the-counter medication, medication that is used less frequently, or with different administration routes) are also asked in the patient portal. Because patients were able to add medication as "free text," a validation step was included in which a researcher checked the data for impossibilities and updated the medication in the hospital electronic record.

Outcome Measures

The primary outcome was the number of medication discrepancies compared with the NMRS. This primary outcome was chosen because of the nature of the intervention. Ideally, the BPMH is the gold standard to which the results of medication reconciliation should be compared. However, in our situation it would be impossible to obtain a BPMH in the same patient without introducing recall bias. The NMRS is not optimal, but by using it in both groups as the comparator, no bias will be introduced.[14] Therefore, a medication discrepancy was defined as any difference between the medication list resulting from the eMR or MR, with the NMRS. The discrepancies were classified as omission (not on the NMRS but on the (e)MR), commission (on the NMRS but not on the (e)MR), or dose or frequency change.

Secondary outcomes were the time investment of the pharmacy technician for the medication reconciliation in the MR group compared with the eMR group, and the patient satisfaction with the patient portal medication reconciliation or usual care was reported. Time investment of patients fulfilling the eMR was also reported.

Data Collection

The following patient characteristics were collected from the patient record: age, gender, medical specialty, and comorbidities. Data from the medication reconciliation process were collected: number of medications on NMRS, number of medications after (e)MR, and number of discrepancies between NMRS and the result of (e)MR. For

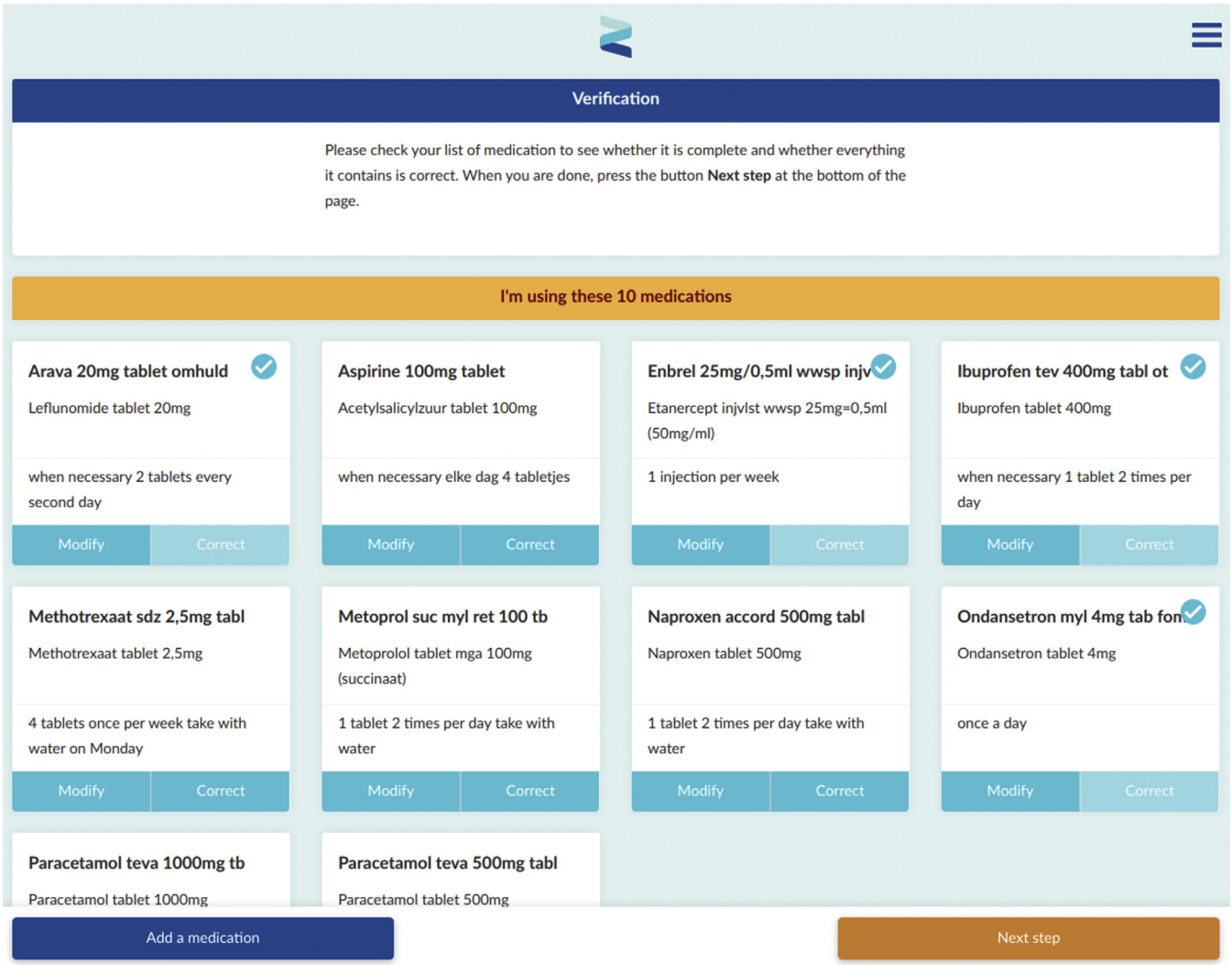

Fig. 1. Screen shot of the patient portal Zorgdoc.

every discrepancy, medication name, dose, frequency, type of discrepancy (omission, commission, or dose or frequency change), and Anatomic Therapeutic Chemical (ATC) code were collected. Furthermore, in both groups, patient satisfaction was determined using a questionnaire with 3 to 6 statements with a visual analog scale from 1 to 10.

All patients scored the following 3 statements: "I (would) like to do my medication reconciliation from home"; "I am satisfied with the medication reconciliation method"; and "I prefer the medication reconciliation in the hospital." The second statement was used to determine overall satisfaction with the medication reconciliation method. For the eMR group, another 3 statements were scored: "The patient portal was easy to use"; "I felt confident using the patient portal"; and "It took me some time to get going with the patient portal." For eMR patients, the questionnaire was shown after completing the medication reconciliation process in the electronic tool. Patients in the usual care group received the questionnaire on paper after the MR interview and were asked to fill out the questionnaire in the waiting room. When patients reported technical or medication-related issues, this was also recorded. The time investment of the medication reconciliation interview by the pharmacy technician was calculated by recording the start and end time of the interview on the study form. Finally, the time to complete the eMR was automatically collected.

Data Monitoring

All data were collected in OpenClinica, version 3.12.2 (OpenClinca LLC, Waltham, MA). Data were processed by a researcher, and 10% of the data was checked by another researcher and compared to the patient record. If any error was discovered, another 10% of the data was checked for errors. This was repeated until no errors were found or all data were checked. Furthermore, after finishing the data collection in OpenClinica, the data were checked for missing and impossible values and corrected. After correction, the database was locked and extracted for analysis.

Data Analysis

The sample size calculation was based on a noninferiority design, with a noninferiority margin of 20% resulting in an absolute margin of 0.6 based on literature and clinical practice using an unpaired *t* test.[1] In a 3-day analysis of the medication reconciliation results at the preoperative screening, on average 3.8 medication discrepancies were

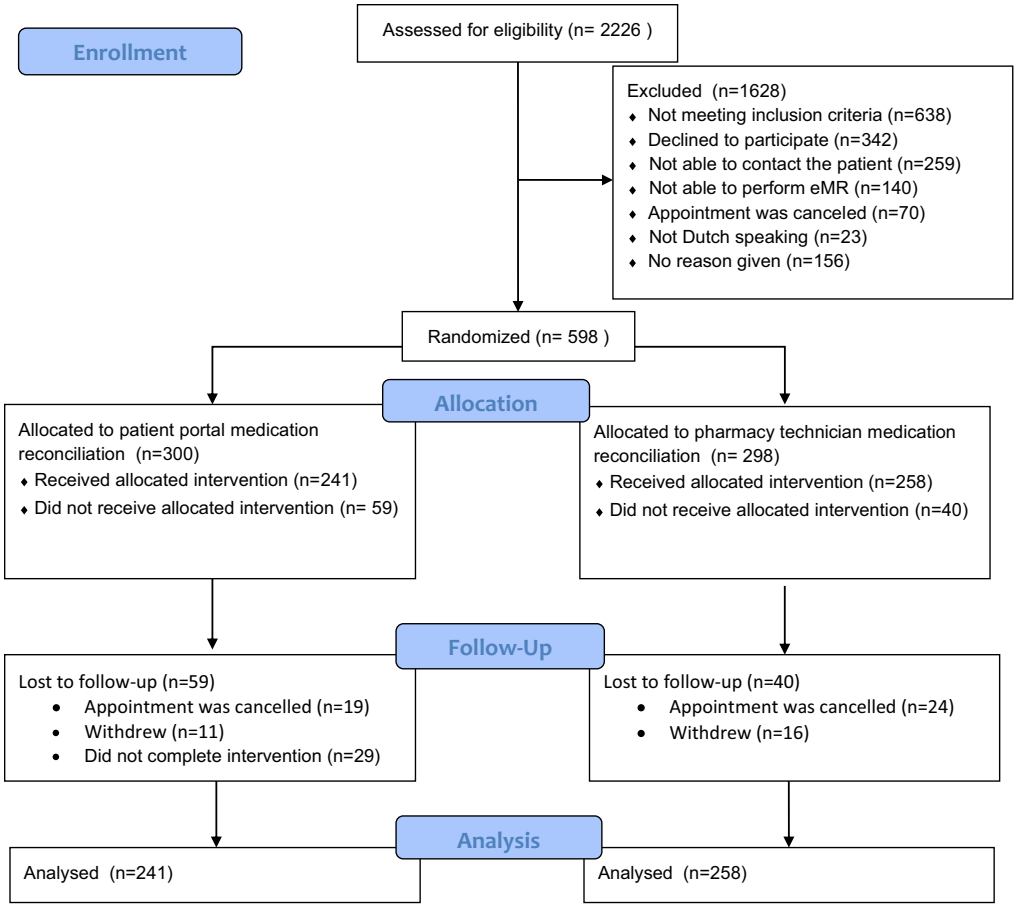

Fig. 2. Study flow.

seen with a standard deviation of 3.7. With a power of 0.8 and alpha of 0.05, a sample size of 470 patients per group was calculated. However, because of the short period of measurement, the standard deviation was very high and an interim analysis after the first 200 patients was used to calculate the standard deviation and recalculate the sample size with an alpha of 0.025 to correct for multiple testing. This recalculated sample size using an alpha of 0.025 resulted in a group size of 234 per group.

Data analysis was performed using IBM SPSS Statistics, version 25 (IBM Corp, Armonk, NY). The number of discrepancies in the 2 groups were compared using an unpaired 2-sample *t* test. An intention-to-treat and a per protocol analysis were performed. In the intention-to-treat analysis, the median number of medication discrepancies was used to estimate the missing results of the patients lost to follow-up. The mean difference with 95% confidence interval (CI) was reported. Secondary endpoints were reported using descriptive statistics. Overall patient satisfaction with the method of medication reconciliation was tested using an unpaired 2-sample *t* test.

Results

Between September 2018 and February 2020, 2226 patients visited the preoperative screening. In total, 598 patients were randomized, 300 to the electronic medication reconciliation and 298 to the usual care group. Figure 2 shows numbers of eligible patients and reasons for exclusion. Ninety-nine patients were lost to follow-up; therefore, 499 patients were included in the analysis. Of the 99 patients lost to follow-up, 29 patients that were randomized to eMR did not complete the patient portal eMR, 8 due to technical reasons, 2 patients because they tried but were not able to, and 19 unknown. These 29 patients did not differ significantly in patient characteristics from the rest of the study population. No data on medication discrepancies are available for these patients. Table 1 shows the baseline characteristics of the 499 patients of which a primary endpoint can be reported.

The 990 excluded patients were significantly older, on average 62.2 ± 14.9 years, and 42% male.

The mean number of medication discrepancies in the eMR group was 2.6 ± 2.5 and 2.8 ± 2.7 in the MR group. The absolute difference of 0.2 is smaller than the predefined noninferiority margin of 0.6. in addition, the difference was not statistically significant in the per

Table 1
Baseline Characteristics

	MR (n = 258)	eMR (n = 241)
Age, mean ± SD	58.6 ± 14.2	58.9 ± 13.9
Sex male, n (%)	120 (46.5)	120 (49.8)
Number of medications before MR, mean ± SD	5.9 ± 3.9	5.1 ± 3.3
Number of medications after MR, mean ± SD	6.7 ± 4.5	6.1 ± 3.9
Comorbidities, n (%)		
Hypertension	110 (42.6)	105 (43.6)
Cardiac disease	87 (33.7)	82 (34.0)
Asthma/COPD	43 (16.7)	33 (13.7)
Blood disease	32 (12.4)	24 (10.0)
Diabetes mellitus	43 (16.7)	33 (13.7)
Stomach problems	51 (19.8)	45 (18.7)
CVA/stroke	23 (8.9)	20 (8.3)

COPD, chronic obstructive pulmonary disease; CVA, cerebrovascular accident.

protocol analysis (mean difference −0.23, 95% CI −0.69 to 0.22). In the intention-to-treat analysis (300 eMR and 298 MR) with an estimated number of discrepancies of 2 (the median in both groups) the mean number of discrepancies were 2.5 ± 2.3 and 2.7 ± 2.5, respectively. The difference between the 2 groups was also not statistically significant (mean difference −0.24, 95% CI −0.62 to 0.15).

Patient Satisfaction

The response to the questionnaire was 97% (n = 233) in the eMR group and 79% (n = 203) in the MR group. Patients in the usual care group were more satisfied with the MR method than patients in the eMR group; this was statistically different (mean difference −0.6, 95% CI −0.8 to 0.3). With an average of 8.7 and 8.1, respectively, both methods have high patient satisfaction. Patients in the eMR group assessed the patient portal as easy to use and felt confident using the system, although they needed some time to get going with the patient portal (Figure 3). Both patient groups prefer medication reconciliation from home compared with the hospital, but the difference is larger in the eMR group (Figure 4).

Time Investment for Medication Reconciliation Interview

For 234 patients in the eMR group and 210 patients in the MR group, data on duration of the medication reconciliation (eMR) or patient interview (MR) were available. The average time for the patient to complete the electronic medication reconciliation tool including the patient satisfaction questionnaire was 14.9 ± 13.8 minutes. The average time for the pharmacy technician to perform the medication reconciliation interview was 7.8 ± 5.2 minutes. The average time for the researcher to validate the results from the eMR tool for all eMR patients was 1 minute. In this study, data from the electronic tool needed to be transferred to the electronic hospital record, this took 3.9 ± 2.3 minutes. Medication reconciliation with the electronic tool saved on average 2.9 minutes per patient, and if information could be automatically transferred to the hospital system, this could save on average 6.8 (2.9 + 3.9) minutes per patient.

Discussion

This study shows that medication reconciliation with a patient portal is noninferior to medication reconciliation by a pharmacy technician. Earlier studies have shown that patient portal medication reconciliation is feasible but did not compare it with usual care.[10–13]

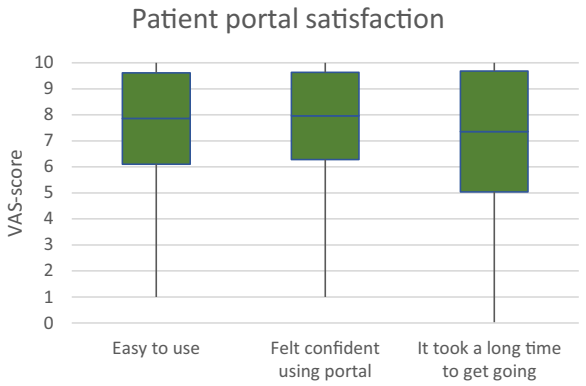

Fig. 3. Patient portal satisfaction. Per statement mean ± standard deviation are shown within the box, upper and lower limit with lines.

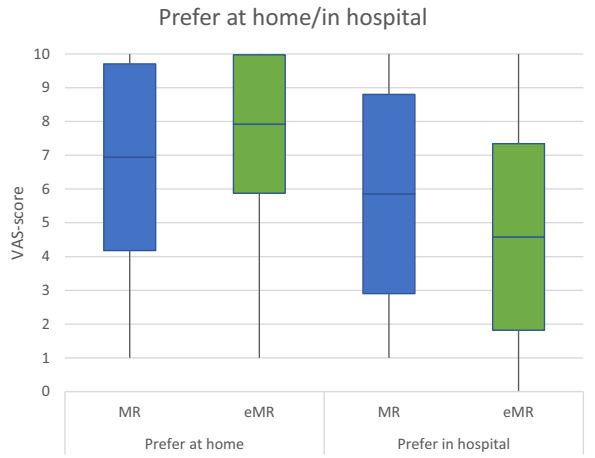

Fig. 4. Patient preference about the location of the medication reconciliation (MR). For each statement mean ± standard deviation are shown within the box, upper and lower limit with lines. Blue: usual care (MR); green: patient portal medication reconciliation (eMR).

Unfortunately, at the time this study was performed, it was not possible to link the results of the electronic medication reconciliation to the electronic hospital record. Therefore, the researcher verified the result of the patient portal medication reconciliation and manually transferred the medication overview to the electronic hospital record. Ideally, when implementing the patient portal medication reconciliation, the automatic transfer is also implemented, saving more time. However, even when medication needs to be transferred manually, the patient portal medication reconciliation still saves time.

Patients were generally satisfied with the patient portal medication reconciliation method, compared to earlier results.[11,12] Although patients in the usual care group were significantly more satisfied with the medication reconciliation method than patients in the patient portal group, the difference was small. Both patient groups indicated that they preferred medication reconciliation at home above medication reconciliation in the hospital. This indicates that patients are willing to perform medication reconciliation at home although they are more satisfied with the face-to-face medication reconciliation interview in the hospital.

Limitations and Strengths

To our knowledge, this is the first randomized study comparing medication reconciliation via a patient portal with usual care. Using the application in a daily clinical setting has proven that a patient portal can be implemented in clinical practice in at least a subgroup of patients.

Owing to the informed consent procedure before inclusion in the study patients may not be representative for the general population. It could be that more educated patients are more likely to consent to the study, but data on socioeconomic status or educational level were not collected. The patients who did not participate were on average 3.5 years older than the included patients. This is also seen in the study of Witting et al[8] where the ability of self-reporting medication decreases with increasing age. However, in a systematic review, Jonker et al[16] concluded that older (>65 years) surgical patients consider eHealth interventions to be feasible. Also, of the 270 patients randomized to the patient portal medication reconciliation, 29 did not use the application. This illustrates that a patient portal tool will never be suitable for every patient, and alternative ways to perform medication reconciliation will still be needed. However, patients who used the electronic medication reconciliation are very satisfied with the use of the patient portal.

Furthermore, patients in the patient portal group performed their medication reconciliation at home and therefore had access to their medication bottles or boxes. When performing medication reconciliation in the hospital, the medication bottles or boxes are not available. Therefore, the patient portal medication reconciliation might be more accurate than the control. However, the current gold standard medication reconciliation in the Netherlands does not include medication bottles.[17]

Finally, this study is performed in the Netherlands with use of the NMRS. Not all countries have such a system; therefore, the results in this study might not be generalizable to all countries. However, the patient portal medication reconciliation can always be used with electronic medication records from the own hospital.

Implications for Future Research

This study showed that medication reconciliation via a patient portal is noninferior to usual care medication reconciliation. After completing this study, the digitization of health care has accelerated due to the COVID-19 pandemic. To minimize face-to-face contact during the pandemic, alternative ways to perform medication reconciliation are needed. This study has shown that a patient portal medication reconciliation is noninferior to a face-to-face interview and can therefore be safely used in situations where in-person contact needs to be avoided. How many patients will be able to use this method remains to be determined in clinical practice. Implementation studies exploring barriers and facilitators for use of a patient portal are needed in order to maximize the feasibility of this time efficient intervention.

Conclusion and Implications

Medication reconciliation using a patient portal is noninferior to medication reconciliation by a pharmacy technician and saves time in the medication reconciliation process.

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Supplementary Table 1
Medication Reconciliation Checklist at the Preoperative Screening

Task	Description	Done?
Preparation	• Look up the patient in the electronic patient record (EPR) • Check the patient's current medication list • Call the patient from the waiting room to the consultation room	
Introduction	• Check patient identity (name + date of birth) • Introduce yourself and briefly explain the activities: A conversation with the pharmacy to map out your medication use at home, so that the anesthesiologist/surgeon can get started with this in preparation for the admission. • State that you cannot give any information about the upcoming admission, such questions can be posed to the medical attendant/surgeon/anesthesiologist, whom the patient will meet after this pharmacy interview.	
Medication reconciliation	• Explain that it concerns medicines and dosages that the patient is using currently in the home situation. • Discuss the medication from the nationwide medication record system (NMRS) or fax from the community pharmacy or brought along medication list. • Ask for each medication on the list whether the patient is still taking it. • If so, discuss the preparation, strength, and dosage ○ Weekly or monthly: check the last use (or next use) • Check if the medication in the EPR is still up-to-date • Ask whether any medication is still in use that is not on the lists.	
Other medication	• Inquire whether the patient is using other drugs that have not been discussed, for example special dosage forms (patch, inhaler, drops/spray, cream/ointment, insulin) or over-the-counter medication (analgesics, drugs for acid-related disorders, melatonin, valerian, or St. John wort). These over-the-counter medications are also entered into the EPR	
Allergies	• Allergies are discussed with the anesthesiologist.	
Conclusion of interview	• Explain that all medication is recorded in the EPR. • Inform the patient about the medication during admission: ○ Please take the medication with you for the entire admission, which remains in possession of the patient. In case of longer admission, medication will be supplied by the hospital pharmacy, unless the patient wants to continue to use his/her own medication (check the box "used from home" in the EPR) ○ Special preparations: please bring your own (inhalation medication, dermatic preparations, nitrate spray, eye drops) • Give the patient the information letter with this explanation about the medication. • Check whether everything has been clear and whether the patient has any questions. • Finish the conversation.	
Processing in electronic patient record	• Enter the missing medication as home medication in the EPR, as the patient uses at home, based on your notes. ○ Choose as much as possible medication that is in stock in the hospital pharmacy. Check "used from home" for special preparations. • If necessary, discuss results with the anesthesiologist/surgeon/pharmacist.	