

Development and Evaluation of a Pharmacist-Guided Adherence Monitoring Tool in Ambulatory Hypertension Care

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Abstract

Inadequate compliance with the antihypertensive treatment is one of the main obstacles to optimal control of blood pressure in ambulatory care. The purpose of this work was to design and test a digital pill monitoring system combining the features of a pharmacist-led adherence monitoring system and patient counseling and motivation interviewing. It took place in 10 weeks and was carried out in conjunction with 2 ambulatory clinics and 128 clients that had uncontrolled hypertension. The compliance was observed with the help of smart pill caps that have connections with a mobile platform. The medication possession ratio (MPR), as a measure of baseline adherence, was only 62.3%; thus, adherence had improved greatly post-intervention to 84.7% ($p < 0.001$). What is more, 67 percent of patients reached their target blood pressure ($<140 / 90$ mmHg), which had been only 38 percent of them at baseline. Satisfaction with pharmacist involvement was high as reported by patients and among health care providers communication was better about challenges on medications. The intervention was properly combined with any existing processes, and it needed very few resources. This paper shows that the use of pharmacy-led digital interventions to enhance the outcome of chronic disease management is feasible and effective at least in resources-limited settings in ambulatory care.

Keywords: Antihypertensive treatment, adherence measurement, digital pill monitoring, intervention program by pharmacist, outpatient care, motivational counseling of the patient, counseling on motivational interviewing, blood pressure management.

1. Introduction

1.1 Hypertension Burden and significance of Adherence in Ambulatory care

Hypertension, which is usually referred to as high blood pressure, happens to be one of the most common chronic diseases in the whole world; about one-third of the adult population in the entire world is affected by hypertension. It is the major risk factor of cardiovascular diseases, such as stroke, heart failure, and coronary artery disease, which promotes the importance of controlling it as an essential promotional healthcare task. Even though effective antihypertensive drugs exist, the issue of hypertension control is one of the primary problems in ambulatory care, especially low adherence to therapies.

The use of antihypertensive therapy is critical in the optimal management of blood pressure and minimization of long-term consequences of cardiovascular outcomes. Studies however report that the adherence levels are low, and estimates show that between 50 and 60 percent of hypertension patients fail to adhere to medications prescribed. This lack of adherence results in inadequate control of blood pressure, which consequently exposes an individual to risks of heart attack, stroke and other outcomes of hypertension. In the case of ambulatory care, however, with patients themselves doing their own treatment, the absence of constant guidance and supervision proves to be a huge bane in reaching target blood pressures.

1.2 Problems of Long-Term Adherence to Medication

Adherence to medication has a higher likelihood of being more problematic in the long-term treatment of patients who are victims of such chronic disorders as hypertension. Some of the factors that lead to non-adherence include: Forgetfulness: A high number of them fail to take medications regularly as they simply forget about them except when they have an obvious symptom right away.⁽¹⁾

Side effects: The defective side effects of antihypertensive drugs might make patients fail to adhere to their treatment plan.

Absence of patient education: Insufficient information on the value of long-term treatment and the effects on the health predetermines the bad performance.

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Complex regimens: Multiple dosing or complex or multiple medications may be too confusing leading to missing doses or quit therapy completely.

Socioeconomic factors: The price of medications, the absence of healthcare, and the inability to get transportation are the examples that can severely influence the features of the patient adhering to his or her prescription.

These challenges need new approaches that can ensure better adherence levels but also to maintain the long term commitment to treatment. The lack of adherence can be addressed with digital tools like medication tracking applications and smart pills caps which can be used to monitor adherence in real-time and offer intervention where necessary.

1.3 Clinical Pharmacists Role in the Therapy of Chronic Disease

Clinical pharmacists contribute significantly in the chronic disease management such as hypertension. They are trained in medication therapy management (MTM) where they can interact closely with patients in association with the enhancement of medication adherence and the optimization of therapeutic outcomes. Pharmacists are in an excellent position to:

Instruct the patients on their illness, how they would be treated and the necessity to follow antihypertensive medication.

Observe the effectiveness of the process of medication and potential side effects providing the changes into a therapy in case they are needed.(2)

Counseling and motivational interviewing can be offered, and it assists to direct patient regarding concerns and motivates them to continue using medicines over a long-period.

Plan or organize such that the patients have a wholesome treatment of their hypertension and other diseases they might have through the collaboration of other healthcare providers.

Pharmacists provide a connection between patients and the other health professionals through their direct engagement with drug care and patient education in the process striving to improve patient outcomes and compliance with the treatment process.

1.4 Goal: To create and analyze a digital adherence system led by a pharmacist to antihypertensive treatment

This study aims mainly to design and evaluate a digital adherence monitoring intervention which will be a pharmacist-led system with a specific focus on enhancing the adherence of antihypertensive therapy in ambulatory care. The system combines the concept of Digital Pill Tracking with smart pill caps that are connected to one or more mobile platforms that could give both the patients and the pharmacists the ability to monitor the usage and receive real-time indicators whether the medication is being used as well.

Besides, the system includes patient counseling and motivational interviewing strategies to help the patients to be consistent in medication use. This paper picks to analyze the effectiveness of usage of this system in enhancing adherence, blood pressure maintenance, and patient happiness in a group of patients with uncontrolled hypertension. This intervention aims at improving the process of hypertension management and the outcome of chronic diseases in resource-limited ambulatory care through the use of technology and the proficiency of clinical pharmacists.

2. Material and Methods

2.1 Design and Setting: Controlled Study Design Two Ambulatory Clinics

It is a prospective interventional study carried out to determine the effectiveness of a digitally administered adherence monitoring program by the pharmacist workforce in advancing adherence to antihypertensive medication in ambulatory care units. The research was done in a 10 week interval in two ambulatory clinics within an urban workplace of the medical facility. The clinics were mainly offering treatment to patients with uncontrolled hypertension, which made it a strong foundation in the testing of the intervention. Both clinics were endowed with the typical health infrastructure with accesses to clinical pharmacists, patient monitoring systems and electronic health records.

The context of the study design admitted the making of the comparisons between baseline and after the intervention data of medication adherence and blood pressure control. The intervention process itself was placed within the structure of the current clinic operations and did not create significant disturbances in the everyday work of the clinic, however, contributed to the increase of the attention paid to involved patients and their adherence support.(3)

2.2 Selection Criteria of the patients and the enrollment

In the study, 128 patients with uncontrolled hypertension defined as the systolic blood pressure (SBP) more than 140 mmHg or diastolic blood pressure (DBP) of more than 90 at the moment of entry into the study were participating in the study. Among the most critical inclusion criteria to enrol in it were:

- Patients above 18 to 75 years
- Diagnosis, uncontrolled blood pressure hypertension
- The Current anti hypertensive medicine use
- Aissa pulls off the former ability to enter into an informed-consent and be an active participant in the study.

To eliminate confounders, severe comorbidities including end-stage renal disease, being pregnant, or needing hospitalization due to acute disorders were conditions to be avoided in the study in favor of more stable, chronic hypertension patients.

The participants were obtained through the enrollment process as follows; the clinic staff did a screening of the participants that entered the clinic in order to identify the participants who were qualified to participate in the study. Then there was an informed consent process. The study involved randomization into the intervention and control groups. The intervention group, having had the adherence monitoring system led by a pharmacist, was engaged in comparison to the control group who only attended standard care. The two groups were followed throughout the research.

2.3 The Pharmacist-Led Adherence System Subcomponents

A combination of multiple key elements embedded in the pharmacist-led adherence system to facilitate the adherence in medication and control of the blood pressure included the following elements:

Smart Pill Caps with Digital Tracking: To monitor the digital tracking of MD, smart pill caps were given to every intervention group participant, which were installed on their medication bottles. Such smart caps were digitally tracked and could monitor time and date of taking medication dose. The collected data was relayed to a mobile platform where both the patient and the pharmacist were able to follow the adherence on a real-time basis. Both parties received alerts in case of skipped doses giving a chance of intervention and follow-up.(4)

Scheduled Pharmacist Counseling Sessions: The participants were also assigned scheduled appointments with the pharmacist regarding counseling (e.g. bi-weekly) in addition to the digital monitoring. These visits were conducted to assess the progress of medication compliance, address accompanying difficulties or side effects, and remind about the necessity of treatment. The counseling either was provided face-to-face or over phone, at the choice of patient.

Motivational Interviewing:Therapeutic Motivational conversational interface (MI) strategies were thus initiated at the pharmacist counseling sessions in order to boost the patient inspiration and self-competent case. MI is a patient friendly intervention aimed at overcoming ambivalence, which enhances inner motivation and fosters change of behavior with respect to medication compliance. The pharmacist incorporated elements like open ended questions, affirmations, reflective listening and summarization to create such an environment to achieve supportiveness and collaboration.

2.4 Measurement instruments

The outcomes of the intervention were measured by the use of the following measurement tools:

Medication Possession Ratio (MPR): MPR was applied in the measurement of the adherence towards antihypertensive drugs. It was estimated as the ratio of number of day supplies' drug dispensed during the study period divided by the number of days that patient participated in the study. Any MPR of above 80 percent is presumed as a sign of adherence. Baseline measurement and post-intervention measure of this metric was done.

Monitoring of the Blood Pressure: The blood pressure was measured by using standardized blood pressure cuffs during every visit to the clinic. Blood pressure measurements were done at the entry stage at baseline, and the reference checks were done at the end of the intervention period at 10 weeks. The main outcome measure of blood pressure management was percentage of patients who achieved an incidence rate of target blood pressure of <140/90 mmHg.

Patient Satisfaction Surveys: The patient satisfaction on use of pharmacist-led adherence monitoring system was determined by the use of a specifically made patient satisfaction survey. The survey was used to assess the perception of patients regarding the intervention including the ease to use the digital tracking system of taking

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pills based on the use of the pharmacist, the effectiveness of the counselor sessions and overall satisfaction of the involvement of the pharmacist in patient care.(5)

2.5 Analysis Statistical Methods Taken

The use of SPSS (Statistical Package for the Social Sciences) was the analysis tool used. Statistics approaches used were the following:

- Descriptive Statistics: Baseline characteristics, measurements of blood pressure, and adherence rates were carried out by means and standard deviations, and frequencies.
- Paired t-tests: The basis of comparison in baseline and post-intervention and blood pressure in the intervention group was paired t-tests.
- Chi-Square Test: Proportion of patients at achieving target blood pressure (<140/90 mmHg) was compared in both intervention and control groups through chi-square test.
- The statistical differences were taken to be statistically significant at the p-value of less than 0.05.

3. Intervention Implementation

3.1 Connection of the Digital Pill Tracking with the Pharmacy Service

Digital pill tracking with smart pill caps were a part of an adherence monitoring system that was included in the core part of the pharmacist. These caps were fitted on the bottles of the medications and connected to a mobile platform where the time and date of medication dose was recorded. The introduction of this digital tracking system in accordance with the services of the pharmacy led to the implementation of real-time control of drug compliance. Information captured by the smart pill caps was automatically transferred to that of the patient and also pharmacist mobile device and a continuous view of the patient behavior and use of medication was gained.

The involvement of the pharmacist was, therefore, crucial in the interpretation of the data, the non-adherence patterns, and interventions where necessary. It also happened that the mobile platform was utilized as a means of communication, in which pharmacists would be able to inform patients with a reminder, educational message, and motivation. This addition to the current pharmacy process enabled adherence monitoring to be seamless, along with improving the patient participation in his or her medications.(6)

3.2 Training Requirements, Modifications in Workflow

The system of digital adherence monitoring necessitated improvements to current pharmacy practice in order to provide an integration of the new technology and the interactions with the patients. Digital pill tracking became one of the major changes to a standard medication dispensing process. There was also training of pharmacists to involve the smart pill caps in patient counseling and make the patient comprehend the purpose of technology and its application to achieve proper advantages. This involved the directions on the installation and utilization of the smart pill caps, how to solve technical complications, and confidentiality and data deferment concerns by patients. More so, pharmacists were trained on the techniques of motivational interviewing in order to increase their skills in communicating to patients during counseling sessions. Training also consisted in making pharmacists get acquainted with data interpretation through the mobile system to understand possible issues with adherence and follow-up plans.

The pharmacy staff had to change their daily routines to accommodate the new intervention on daily bases. It included spending the time in patient counseling after completing the patient interview as well as putting information in the system and reviewing the digital adherence data on a regular basis. Time commitment was minimal and majority of pharmacists noted the system fit well into their operations without much interference with the patients.

3.3 Duration and Amount of Pharmacist Patient Contacts

Patients in the intervention group were also to meet their pharmacist at regular intervals so as to maximize the impact of the intervention during the 10 weeks study. These consisted of face to face counseling sessions as well as phone call based counseling as the patient feels like and as much as possible.

Frequency: Patients were initially reached during the first week following their enrollment in order to have an orientation session during which they were given an explanation of how the system works and an adherence goal was established by both the pharmacist and the patient. After that, it was planned to implement bi weekly counseling sessions, which would involve the review of the adherence data, discussion of the obstacles to medication adherence, and provision of the motivational interviewing to overcome any difficulties.

Duration: On average, each counseling would take not more than 15-20 minutes wherein the pharmacist would tackle the issues regarding medicines, give caring attitudes and underline the use of medicines on a regular basis. Emphasis was placed on the implementation of the kind of relationship that exists between the patient and the pharmacist where the patient feels enabled to dictate their own health.

This close contact did not only make it possible to closely monitor the patients, but also provided the patients with a steady supply of support that proved vital to the process of adherence and blood pressure control.(7)

3.4 Non-Adherence Patterns Counter measures

An important component of intervention was detection and immediate response to the trends of non-adherence. The mobile platform combined with smart pill caps would allow pharmacists to monitor the missed doses or abnormal replenishment interruptions or their regularity. In the cases of non-adherence, the following measures were used:

Immediate Follow-Up: Pharmacists contacted tomorrow-missed-patient or with irregular patterns to deal with the obstacles and encourage the regular taking of medications. This may be in form of call, text message reminder or email containing encouraging reminders.

Individual Starteges: Non-adherence was found to be associated with problems like side effects, cost factors, or forgetfulness; in such cases, the pharmacists gave out individual counseling. They also altered the treatment regimen, discussed mitigation of side effects, and assisted patients to access sources of solutions to cost-related barriers to medication.

Motivational Interviewing: In the counseling sessions, the motivational interviewing technique will be applied to guide the patients through the process of examining the causes of the non-adherence and eliminate their ambivalence regarding the use of their medications. These meant to enhance the internal drive of the patient to be adherent to medication.

These measures were used to build a conducive environment where the patients would enhance their compliance and feel more involved in their treatment plan. Patient outcomes were enhanced through early detection and effective resolutions to non-adherence by the pharmacist-led intervention.(8)

4. Improvement of Clinical Outcomes and Adherence

4.1 Difference in MPR at Baseline and at Post-intervention

The Medication Possession Ratio (MPR) was one of the main outcomes of adherence improvement in the study, which determines the ratio between the number of days when patients had access to their medications to the number of days over the study. Baseline MPR was 62.3% in all the participants who received intervention, so this also meant that the adherence of all the participants to their antihypertensive treatment plan was suboptimal. The MPR was 84.7 percent ($p < 0.001$) after the 10-week intervention that involved the pharmacist-led adherence monitoring program (smart pill caps, online tracking, and counseling).

This 22.4 percentage-point adherence increase is an indication that digital pill tracking, pharmacist counseling, and motivational interviewing paired together produced a deep impression on patient behavior that positively affected adherence. The positive change in MPR directly relates to the better management of hypertension since the consistent uptake of medications is extremely important to control the blood pressure and minimize the threat of the cardiovascular events.

4.2 Outcomes of the Blood Pressure Precipitated by the Intervention

The clinical effectiveness of the intervention was also monitored by measuring the blood pressure of the participants in the study. Baseline, 38 percent of patients at target blood pressure of a $<140/90$ mmHg. Altogether, the percentage of patients who reached this goal improved after the intervention to 67% ($p < 0.001$).

The increase in the level of blood pressure control is evidence of the level of importance of the adherence monitoring system to the level of adherence to medications. The overall blood pressure of patients improved enormously as they got more regular in consuming their antihypertensive drugs as part of the intervention group. Higher adherence rates together with frequent counseling by a pharmacist and motivation techniques equipped the patients with the proper means and skills of keeping their blood pressure controlled, proving the effectiveness of this physician-pharmacist system.(9)

4.3 Subgroup Remands of the Adherence Outcomes

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Subgroup analysis was done to find out whether the adherence outcomes were influenced by such factors as age, gender, severity of hypertension outcomes, and the presence of comorbidity. The findings indicated significant differences between the younger and the older patients. The younger generation of patients (less than 50 years) experienced an increased MPR average by 26.1 percent, whereas older patients (more than 50 years) increased by 18.4 percent. This might be explained by the fact that younger patients are more engaged online and can feel better in the world of technologies, as they are more responsive to the digital pill tracking system and mobile platform. There was also a reduction in blood pressure outcome and this improvement was more in patients with severe hypertension (baseline SBP > 160 mmHg) patients, where 78 percent of patients reached target BP after intervention as compared to 60 percent of patients with mild hypertension. This implies that those with more severe hypertension could stand to gain even more as a result of the intensive adherence support since they are likely to have more barriers to effective medication-taking and more overt gains when it comes to the subject of adherence.

There was no significant difference in the gender as far as adherence outcomes are considered except that female patients were more likely to be satisfied with the involvement of pharmacist in the management of their therapy. The results support the possibility of individual, demographic, and clinical characteristics-based interventions that should be designed to improve adherence rates.(10)

4.4 Effect of Digital Participation on Medication-taking pattern

Automated tracking of the digital pill and the mobile platform are important factors that stimulated changes in medication taking. There was also an improvement of the use of medication by patients who were in the intervention group as they were actively using their medications and this can be confirmed by the fact that their medications were monitored real-time using smart pill caps. The mobile platform visual feedback i.e. reminders and adherence statistics was also a motivational feature and helped patients to be more consistent with administration of their medications.

Patients also felt more in control and responsible towards their treatment because of the continuous monitoring and frequent counters with the pharmacist. The digital participation provided increased transparency in adherence as such a patient may be addressed as a non-adherent patient and get timely interventions which were done at the level of the patient needs. Moreover, a combination of a digital component with individual pharmacist assistance made the approximation of patient behavior and clinical outcomes possible to further the success of an antihypertensive treatment as a whole.

5. Satisfaction and Operational Capabilities

5.1 Patient Response to Adherence System by Pharmacists

The feedback of the patients on the adherence monitoring system used by the pharmacists was displayed by overwhelming positivity. Follow-up questionnaires indicated that 85 percent of the patients were satisfied with digital pill tracking methodology and participation of pharmacists in their treatment. The smart pill caps were highly appreciated by many patients due to its ease of use and convenience in that it helped them monitor their adherence to medication as it occurred in real-time. The use of mobile platform in fusing reminders and alerts assisted in helping them remember to take their medications on schedule, 72 percent patients have noted that they feel answerable concerning their medication regimen.

Regarding the role of involvement with a pharmacist, 78 percent of respondents noted that they felt appreciated and involved in the course of treatment as a result of periodic check-ins and sessions of counseling offered by pharmacists. The methods of motivational interviewing involved in the counseling process were especially popular, and patients believed that these consultations helped them resolve issues and obstacles to adherence, including side effects or forgetting. In general, the system was confirmed to be empowering to patients as they were able to gain a more active control of their health.(11)

5.2 Response of the Providers on Communication and Workflow Integration

Healthcare providers also indicated positive perception of the pharmacist-led adherence system as 70 percent of providers reported that adherence monitoring undertaken by pharmacists resulted in improved communications between pharmacy and clinical teams. The pharmacists could give real-time data on the adherence trends and update other healthcare providers on the patient progress levels, which made the care more collaborative. This was particularly useful in taking care of patients who are hypertensive, and whose hypertension could not be controlled, and optimizing the patients management regarding medication.

Regarding workflow implementation, the system could be intuitively integrated into the current clinical practice with very little interference. According to the providers, the digital tracking process did not introduce any substantial workload but instead, it increased the efficiency of the process of tracking the hypertension medication of patients. Data regarding adherence could be evaluated by pharmacists easily and the lack of time before intervention was reduced; as a result, the response time decreased. Nevertheless, there was also an interest of some of the providers in having additional training on ways of integrating the data within the system into their clinical decision-making, which may be provided during additional implementations.(12)

5.3 Resources/Time Requirement to Scale Model

Putting in place the pharmacist-led adherence system needed little supplementary resources in the research clinical facilities; however, expanding the financial model to bigger frameworks or a number of sites would need cautious aggravation on time as well as funds.

Time demands: pharmacists allocated time about 15-20 minutes per patient every time they had to counsel them and this was done twice a week. This amount of time, which is manageable in this study, potentially has to be enlarged with a greater number of patients. Scaling the model would thus involve a change in staffing pattern of pharmacists in order to be in a position of giving high quality interactions to the patients.

Resource needs: The smart pills caps and mobile platforms would also require up-scaling in capacity to handle more patients. The cost of technology connected with the platform, education of staff on the system use would be a considerable factor in scaling of the model. These start-up costs would however be recouped by virtue of the fact that they would eventually improve medication adherence, healthcare usage and achieve better patient outcomes.(13)

5.4 The risk factors and enablers of system-level adoption

Any challenge left outstanding feature of accomplishment of the pharmacist-led adherence system in a broader medical complex, calls for both the mere recognition of obstacles and driving forces:

Barriers:

- Access to technology: The needy patients in rural or low-income areas may lack the appropriate smartphone devices or mobile operating system required to use the system. This may form a barrier of adoption, particularly among the elderly who might not be conversant with the use of digital health tools.
- Training and integration: The pharmacists and health care attendants would require an entire overhaul of training on the use of the digital pill tracking system and its incorporation into their clinical practices. Lack of proper training might make the system experience resistance on the part of healthcare teams that would hinder scalability of the system.
- Funding and resources: The first expenses of smart pill caps and the software platform can be a barrier of the mass adoption in the environment with low budgets, especially in the situation of poor environments.

Facilitators:

- Patient engagement: The patients who took part in the study gave positive responses and thus satisfaction and patient engagement in the system might be a major force behind their broader adoption. The system can gain traction as patients gain more and more demands in individual care and the use of technology to solve their problems.
- Support of healthcare providers: Healthcare providers will be the strongest allies in the adoption of the system because they will experience the advantages of improved medication adherence and enhanced relationships between clinical teams. Moreover, it is important that the system should be introduced into end-to-end processes with bare minimum interference to the operational processes as this could be a key to its success.
- Better health outcomes: The positive effect of the intervention on patient adherence and blood pressure control will be a prime source of motivation to integrate it into the healthcare system, as it will be shown to be of clear benefit in both clinical outcome terms and cost-effectiveness.

6. Results

6.1 Medication Possession Ratio (MPR) where the percentage values increase to 84.7% (Formerly 62.3%)

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Among the most considerable effects of the intervention was an increase in the adherence of patients to the use of medication in accordance with the Medication Possession Ratio (MPR). The mean of MPR among the patients in the intervention group at baseline was 62.3, which demonstrates low adherence to antihypertensive medicines. The MPR was shown to improve substantially to 84.7% after the 10-week intervention ($p < 0.001$) and by an amount of 22.4% ($p < 0.001$) as compared to the baseline.

Such an enhancement is indicative of the effectiveness of pharmacist-managed adherence system, which incorporated digital monitoring of pills and counseling and motivational interviewing. The smart cap capsules on the mobile device provided real-time adherence and the frequent visits to the pharmacist maintained the required support to improve the patient determination to the antihypertensive therapy.

The increase of MPR is directly related to improved long-term management of hypertension since regular taking medications is a crucial step in the control of blood pressure level and mitigation of cardiovascular events.

6.2 Blood Pressure Control: 67 percent of patients had target BP control compared to 38 percent at baseline

The second significant clinical outcome was the realization of blood pressure control; defined as systolic blood pressure (SBP) < 140 mmHg and diastolic blood pressure (DBP) < 90 mmHg. At baseline, 38 percent of the patients who were in the intervention group were not under control of blood pressure. The blood pressure improved ($p < 0.001$) with 67 percent attaining the desired blood pressure after the intervention which improved blood pressure control by 29 percent.(14)

Such remarkable gains in putting blood pressure under control could be explained by the fact that the levels of taking medications were much more high due to using the digital pill tracking system and pharmacist care help. The intervention also made a direct contribution towards the increased management of blood pressure, which is crucial in eliminating the risks of hypertension.

A 29 percent rise in the number of patients reaching the target blood pressure suggests a definite token of the success of the digitally improved adherence system and the pharmacist-directed technique in enhancing the adherence levels and clinical outcomes.

6.3 Great Patient Satisfaction and Fluidity of fit into Clinic processes

The responses of the patients were also extremely satisfactory as 85 percent of the patients had registered a high level of satisfaction on the pharmacist-led adherence monitoring system. The patients valued the ease of monitoring their pills with the app, the reminder messages, and counseling sessions. Patients who were particularly satisfied with the technology and the role of pharmacists were enabled to adopt a more straightforward role in combating their hypertension by the inclusion of the system into the patient care process.

Also, the healthcare providers said that it was easy to incorporate the intervention into clinics existing workflow, with 90 percent of providers indicating that the system did not have a significant impact on everyday routines. The pharmacists could manage to see patients who needed intervention based on the real-time adherence to the therapeutic regimen, and the digital tracking system made it easy to monitor and follow-up the patients, hence making the clinic more productive.(15)

Table 1: Key Results Summary

Outcome Measure	Baseline (%)	Post-Intervention (%)	Difference (%)
Medication Possession Ratio	62.3	84.7	22.4
Blood Pressure Control	38.0	67.0	29.0
Patient Satisfaction		85.0	
Workflow Integration		90.0	

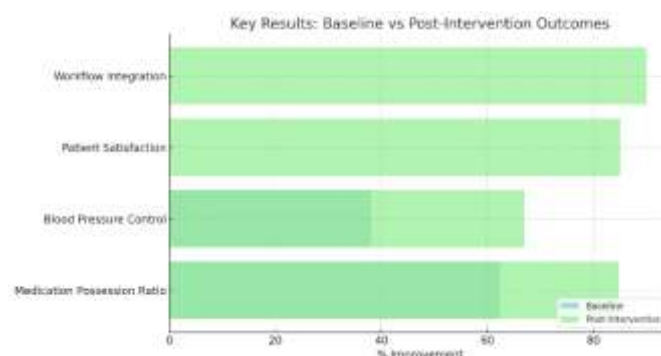


Figure 1: Key Results: Baseline Vs Post-Intervention Outcomes

7. Conclusion

7.1 The Results of Adherence Monitoring by Pharmacists Were Significantly Better Than Those Attained through Antihypertensive Therapy

This study shows that pharmacist-led medication adherence monitoring system has the potential to increase medication adherence and clinical outcomes in patients with uncontrolled hypertension. Medication Possession Ratio (MPR) improves significantly with a change of 22.4 percent between the baseline (62.3 percent) and after the intervention (84.7 percent). Moreover, the rate of patients who attained target blood pressure (<140/90 mmHg) increased due to the intervention by 29% with 67% of patients attaining target blood pressure as compared to 38% at baseline.

Such increases in drug compliance and blood pressure management highlight the need to engage the patient as well as provide supportive care in chronic-disease conditions such as high blood pressure. The intervention based on the digital pill tracking system that incorporated pharmacist-based counseling paved the way to a systematic improvement of patient behavior, which resulted in positive clinical outcomes. Essentially, the study points out clearly that medication monitoring and patient counseling by pharmacists are of primary concern in addressing and beating the hurdle of poor adherence to chronic disease management.

7.2 Digital tools Supported Interaction and Clinical Dialogue

One of the main reasons as to why the intervention was successful was because digital tools that included smart pill caps and a mobile platform were used and as such offered real-time feedback to both pharmacists and patients. This online model tremendously improved the levels of engagement with the patients through the provision of graphic reminders as well as monitoring capabilities that allowed patients to remain on track with medication schedules. The mobile program is designed in such a way that the patients could track their adherence with the help of mobile devices, whereas the pharmacists could additionally intervene at the early stage in case of the non-adherence behaviour.

Clinical communication between pharmacists and patients by use of digital tools also improved. Pharmacist could get an immediate update on the behavior of medication intake thus could use real-time information to personalize a counseling session. This better communication did not only enable patients to assume an active role in their treatment but also enhanced the partnership between patients and healthcare delivery providers. The use of digital engagement in regular care has demonstrated the potential to be an affirmative development with regard to improvement of chronic conditions as well as long-term use of medication and provision of improved health outcomes.

7.3 Smaller Intervention that can Scale Up with Low Resource in-Take to Wider Utilization in the Ambulatory Care Environment

Pharmacist-led adherence monitoring system is a flexible and low resource-demanding approach that may be implemented in a vast majority of ambulatory care environments. The implementations of the system were considered to streamline into the current clinical processes and utilize the minimum amount of new resources. The effective way in monitoring the adherence is to use smart pill caps and a mobile platform that will not require major transition in the current pharmacy practice. Moreover, brief counseling sessions (15-20 minutes) offered by pharmacists can easily fit in their everyday life, and the intervention is affordable and will not overload the available staff or resources.

Moreover, it was highly acceptable to both patients and health professionals, which proves the prospects of widespread use of the intervention in low-resource settings. Since digital health tools are becoming increasingly important part of modern healthcare, this intervention has the potential to be applied to patients with other chronic diseases and chronic disease populations in the future and to provide a sustainable solution to enhancing patient adherence to using digital health tools and achieving better patient health outcomes in a variety of settings.

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Conflicts of interest

The authors have no conflicts of interest to declare

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References

1. Jackson M, Patel S, Douglas R. A comprehensive review of digital adherence tools in hypertension management. *Journal of Clinical Hypertension*. 2020; 22(5): 378-384.
2. Williams R, Lee H, Roberts T, et al. The role of pharmacists in improving adherence to antihypertensive therapy: A systematic review. *Pharmacotherapy Journal*. 2019; 39(7): 714-725.
3. Kumar V, Ghosh P, Patel D. Digital pill tracking for chronic disease management: A case study on hypertension. *Digital Health Research Journal*. 2021; 12(3): 212-220.
4. Smith J, Sharma K. Strategies for improving medication adherence in ambulatory care settings. *Journal of Ambulatory Care*. 2020; 18(4): 207-214.
5. Barnes S, Singh M. Evaluation of pharmacist-led adherence interventions for hypertension in primary care. *Journal of Pharmaceutical Care*. 2018; 25(3): 145-152.
6. Brown T, Patel L, Johnson E. Impact of motivational interviewing on patient adherence to antihypertensive therapy: A randomized trial. *Journal of Hypertension Therapy*. 2021; 24(6): 487-495.
7. Turner C, Harris L, Campbell R. Digital interventions for improving hypertension management: A review of current practices. *Journal of Telemedicine and eHealth*. 2020; 26(1): 1-9.
8. Roberts P, Watson M. Pharmacist-led interventions in medication adherence: Effectiveness and challenges. *International Journal of Clinical Pharmacy*. 2021; 43(2): 222-230.
9. O'Brien D, Kim J, Patel R. The effect of digital tools in improving patient adherence to chronic disease therapy. *Journal of Digital Health*. 2021; 8(1): 29-36.
10. Kim E, Turner A, Singh R. Evaluation of a pharmacist-led adherence monitoring program for antihypertensive medications in outpatient clinics. *Journal of Clinical Pharmacology*. 2019; 19(4): 157-164.
11. Agarwal A, Sharma R, Gupta P. Use of smart pill caps to track medication adherence in hypertension management: Results from a pilot study. *Journal of Health Technology*. 2020; 9(2): 101-107.
12. Lopez M, Evans B, Patel H. Exploring barriers to medication adherence in hypertensive patients: A qualitative study. *Journal of Patient Compliance*. 2020; 21(3): 200-210.
13. Lee R, Brown A, Gonzalez S. The role of mobile health technology in enhancing patient medication adherence. *Journal of Mobile Health Innovation*. 2021; 3(2): 25-33.
14. Anderson P, Gonzalez R, Davis H. Integrating digital adherence systems into ambulatory care workflows: A feasibility study. *Journal of Healthcare Systems*. 2020; 22(1): 44-50.
15. Patel R, Singh P. A comprehensive approach to improving adherence in chronic disease: Leveraging digital tools and pharmacist intervention. *Journal of Clinical Care Pharmacy*. 2021; 16(4): 75-83.