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Prospective interventional study: Home-Based Medication Review of Polypharmacy Reduction in Patients with Chronic Kidney Disease

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Abstract:
Chronic kidney disease (CKD) patients have common polypharmacy, which exposes individuals to a risk of adverse drug events and hospitalizations. This is a longitudinal interventional study that examined the efficacy of pharmacist home-based medication reviews to limit the number of inappropriate medications in CKD patients. Eighty-five adult (stage 3 5), patients consuming 8 or more medical drugs were recruited. During home visits, pharmacists were carrying out full medication reviews and found drug duplications, drugs that were contraindicated, and multiple opportunities in deprescribing medications. During a 12 week follow-up period it reduced the average number of medications per patient of 10.4 at baseline to 7.8 at follow-up ($p < 0.01$), the number of clinically significant drug-drug interactions declined by 43 percent, and medication adherence went up by 21 percent. Emergency visits due to adverse drug events were also reduced as a result of the intervention. These findings suggest the critical role of pharmacist-led interventions in the maximization of pharmacotherapeutic regimens and enhancing the safety of CKD patients.

Keywords: ***Chronic kidney disease, polypharmacy, pharmacist-led medication review, medication review, deprescribing, drug interaction, poor adherence to medications.***

1. Introduction

The world health problem characterized by chronic kidney disease (CKD) is a developing global health concern with a rising trend across the developed and developing countries. With the increase in age of the population along with high rates of chronic diseases, CKD has become a major public health problem. CKD is commonly related to many comorbidities like hypertension, diabetes, and cardiovascular diseases, which make the process of treatment complicated and predisposed to negative health outcomes. Treating CKD alongside other comorbidities frequently causes polypharmacy, a case where prescriptions of a substantial number of drugs to patients occurs. Although polypharmacy is understandable to manage such comorbidities, it also serves as a source of concern regarding drug safety, especially when CKD patients are already at a high risk of encountering complications brought about by drugs.

1.1 Through What Proposals do We Approach to the Burden of Chronic Kidney Disease (CKD) Worldwide Together with its Comorbidities?

The global menace of CKD is alarming as it affects about 10 percent of the entire global population. CKD is characterized by a gradual loss of kidney functioning, which is usually indicated by using glomerular filtration rate (GFR) or albuminuria. Cases of CKD at an advanced stage (stage 3-5) may develop end-stage renal disease (ESRD) necessitating dialysis or transplantation of kidney. Cases of CKD are worsened by the fact that it is linked to other common chronic diseases like hypertension, diabetes, and cardiovascular diseases. These comorbidities do not only make managing CKD difficult but also increase the presence of kidneys dysfunction, costing a lot in terms of health care expenses and degrading the quality of life of the affected persons.

Treatment of CKD usually necessitates drugs to regulate blood pressure, regulated diabetes processes and cardiac problems. With the progression of this disease, CKD patients tend to acquire other comorbidities, which necessitate additional pharmacologic therapy. The complexity of the treatment routines increases with the probability of polypharmacy, in which patients are prescribed many medicines to cope with their health state. The presence of different medications, some of which might interact with each other, is associated with much concern as to the safety and efficacy of treatment.(1)

1.2 Polypharmacy is High and Risks in Patients with CKD

Polypharmacy is especially common in CKD patients and especially in stage 3 or above. Since the CKD patients frequently need various medications in order to alleviate a wide array of conditions, they are more prone to

polypharmacy as compared to the general population. It is also not impractical that CKD patients take up to eight or more medications at a time which predisposes them to possible medication errors, drug interactions and adverse events. Polypharmacy is also a strain to both patients and medical staffs since it involves the administration of many drugs which need close monitoring, particularly in patients with diminished renal functions.

CKD patients are at increased risk of an adverse drug event (ADE) because of drug clearance by the kidneys impairment. Normal excretion drugs by the kidney may accumulate in the body resulting into drug toxicity. Also, certain drugs often seen as making up part of the treatment plan to address CKD-related comorbidities, including angiotensin-converting enzyme (ACE) inhibitors, diuretics, and antidiabetic drugs, may include nephrotoxic effects, which can negatively affect kidney functioning. Pharmacological management of CKD has become more complex requiring close monitoring of the medication, due to the increased complexity and polypharmacy.

1.3 Adverse Outcomes of Ineffective Polypharmacy: Drug-Related morbidity, toxicity, hospitalization

Unsuitable polypharmacy may cause the development of drug related problems (DRPs), a wide category of problems that include drug interaction, overuse and underuse, erring, and adverse reaction. DRPs are of particular concern in CKD patients, which may result in worsening of the kidney functioning, hospitalization, or emergency health visits caused by the complications related to the utilization of particular drugs. Medication nonadherence is also possible due to inappropriate use of the medications, which is common among patients with numerous chronic conditions, which further undermines control of the diseases.

A major consideration in the CKD patients is adverse drug effects, which could affect the metabolism and elimination of drugs. As an illustration, the drugs that might have elevated effects in CKD patients or have a prolonged impact on them include sedatives, analgesics, antibiotics, which augment the risk of overdose or toxicity. Also, certain medications interfere with renal functioning of patients with antecedent kidney diseases, like nonsteroidal anti-inflammatory drugs (NSAIDs), triggering the development of CKD. Such risks make it all the more crucial to engage in a regular medication review to uncover and eliminate the possible inappropriate treatment, thus decreasing the likelihood of developing ADEs and enhance general health levels.(2)

1.4 The work of Clinical Pharmacists in Best Medication Regimens

Clinical pharmacists can be of significant help in coping with polypharmacy, especially in CKD. Pharmacists are educated to perform comprehensive medication review and to detect possible drug-related issues as well as to recommend them to maximize medication plans. Pharmacists will be able to determine the appropriateness of a drug dose, whether there is a potential drug-drug interaction, and which drugs should not be used because of the renal and renal replacement activities of the patient. The knowledge of pharmacology, interactions between drugs, and change of dosing based on kidney functioning make pharmacists a vital part of the healthcare team in the management of CKD.

Pharmacist involvement in deprescribing process, i.e., withdrawing or reducing unnecessary drugs, is particularly beneficial in patients with CKD. Home-based medication reviews offer pharmacists a chance to discover areas of deprescribing unnecessary or inappropriate drugs and hence reduce the nature of the risks of polypharmacy and enhance patient safety. Pharmacists, in collaboration with nephrologists and primary care providers, therefore, become capable of ensuring that each patient receives the most appropriate and effective treatment, which correctly adapts to his or her needs.

1.5 Study Objective: Assess the effect of home-based pharmacist-led medication reviews on reduction of polypharmacy in CKD

This field research will examine how home-based medication review by a pharmacist would help decrease the prevalence of polypharmacy in CKD patients. In particular, it will evaluate the possibility of reducing the number of medications to be potentially achieved through comprehensive medication reviews provided by pharmacists and eliminating drug inappropriateness and optimizing of medication regimens. Further, the research will also focus on the impacts of such interventions to medicine compliance, drug interactions, and the patient in general as far as their safety is concerned. This proposed study can address this need by engaging pharmacists in managing medications in CKD, thus leading to vulnerable patient groups and precipitating the healthcare burden of inappropriate polypharmacy.

The results of the research could potentially act as strong proofs of the idea of involving pharmacists in multidisciplinary care teams of CKD patients focusing on the importance of home-based medication reviews to address polypharmacy, optimize treatments and treatment plans, and enhance care delivery to the CKD population, alongside safety and quality of care.(3)

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2. Home-Based Pharmacist-Led Medication Review Treatment

The type of intervention developed was given as home-based pharmacist-led medication review meant to combat the poly-pharmacy in the chronic kidney disease (CKD) patients. The intervention consisted in proper medication reviews, possible drug-related problems (DRP) detection, and deprescribing indications with nephrologists and primary care physicians. The goal of this approach was to avoid inappropriate polypharmacy, enhance the safety of patients, and make medication regimens among CKD patients, especially high-risk patients, more optimal. The intervention consisted of a structured home visit during which pharmacists could directly interact with patients, address problem areas related to medications and could offer their practical solutions to the whole medical care team.

2.1 Inclusion Criteria on Patients: CKD Stage 3 5, 8 Medications

Inclusion criteria were laid out to make sure that the intervention focused on the patients who had the highest likelihood of benefiting by having their medicine optimized. The participants had to comply with the following requirements:

CKD Stage 3-5: The subjects were recruited when they experienced a chronic kidney disease (stage 3 or higher) since these individuals are more prone to drug related issues because of the poor renal functions. Stages 3 to 5 involve moderate to severe CKD, and a patient with stage 5 needs dialysis or a kidney transplantation.

Polypharmacy: The patients were required to be undergoing eight or more medications. This criterion helped ascertain that the intervention targeted the easier-to-control complex medication regimens patients who were at increased risk of adverse drug reactions, drug-drug interaction, and medication nonadherence.

The study attempted to limit polypharmacy and enhance the safety and efficacy of medications that contribute to coping with complex diseases such as CKD, placing a high medication burden among the CKD patients.

2.2 Home visit Structure: Detailed Medication Review, Drug Reconciliation, Evaluation of Contraindications

The intervention itself was provided by the means of home-based pharmacist visits to ensure that pharmacists are able to directly communicate with the patients in a comfortable and familiar setting. Every household visit was structured in the following way:

Medication Review: In the course of the visit, the pharmacists performed a detailed evaluation of the patient medications as an incorporation of prescribed medication, over-the-counter medications, and supplements. The goal of the review was to find redundant or adjustable medications in order to reduce risks.

Drug Reconciliation: The list of drugs prescribed to the patient was reconciled by the pharmacists in order to identify whether they were properly recorded. This was done through cross-referencing of the medication with the medical records of the patient, assuring the right dosages, and also checking the disharmony of duplicating the prescription.(4)

Contraindications: Pharmacists also made sure that no medication that is prescribed does not have a contraindication to the renal status of the patient or any other comorbidities. To give an example, some them, including NSAIDs, ACE inhibitors, or potassium-sparing diuretics have to be considered for dose adjustment or discontinuation in CKD patients because of possible renal damage.

This multidimensional assessment strategy made it possible to enable the pharmacist to give a more detailed analysis of medication regimen of the patient to guide his recommendations.

2.3 Identification /Classification of drug-related problems (duplication, interactions, inappropriate dosing)

DRP identification and classification formed part of the essential elements of the intervention. Pharmacists employed a methodical way of recognizing the following DRPs:

Drug-Duplication: This is a challenge that occurs when the patients receive a variety of medications that have similar therapeutic outcomes. As an example, we can take two medicines both used to treat those with hypertension or diabetes. Pharmacists discovered these duplications in order to simplify the regimen, only taking away the unnecessary medications, as well as lowering the vulnerabilities of side effects.

Drug benefits: Drug-to-drug interactions: Also of particular concern in CKD patients is drug-to-drug interaction, since a compromised renal function may affect the potential pharmacokinetics of some drug. In this case, the possible extent of clinically significant drug interaction taking place- e.g. one which may augment the action of the anticlotting drugs or another that may otherwise cause hyperkalemia was determined by pharmacists and appropriate recommendations were given to adjust drugs, or change them.

Unsuitable Dosing: CKD may occur in relation to the capacity of body to process and excrete drugs. Pharmacists found cases where medications were not dosed as per the renal status of the patient as in situations where the doses of medication are supposed to be reduced or even at shorter intervals in patients with lower GFR. They advised to change doses according to the presently existing renal functioning.(5)

Through such an approach to identifying these DRPs, pharmacists may have a chance to offer specific recommendations to the patient and refine his/her medication plan, along with reducing the associated threats.

2.4 Deprescribing Programmes with Nephrologists and Primary Care Physicians

Deprescribing which entails the withdrawal of unnecessary or potentially harmful drugs is an important intervention to control polypharmacy among patients with CKD. Pharmacists cooperated with nephrologists and primary care doctors to recognize potential opportunities concerning deprescribing, especially in the event of any inefficiency in drugs or prohibitions.

Collaborative Decision-Making: Pharmacists discussed each medication with the healthcare providers of the patient in depth to determine how acceptable this medication is to the current status of the patient, renal function, comorbidities and other health conditions. Collectively, they would talk about the risks and advantages of staying or quitting drugs and come up with common choices as far as medication regime is concerned.

Withdrawal of Medications: Where possible based on the assessment provided by individuals with chronic kidney disease, pharmacists followed a gradual process of restriction of their medications including gradually stopping the drugs, adjusting the dosages, or substituting them with alternatives to prevent protests associated with withdrawal or developing other side effects.

Deprescribing was aimed at reducing complexity in medications and enhancing medication adherence and minimizing adverse drug events.

2.5 Pharmacist Recommendations Communication and Documentation

The clarity of pharmacist recommendations was also an important part of the intervention:

Prescriptions to Healthcare Professionals: At the end of the medication review, the pharmacists concluded the report of their findings and suggestions on the case and shared them with the primary care physicians and nephrologists. This report contained the recommendations regarding the change of dosing, discontinuation of medication, and alternative treatment.

Patient Education: Another intervention that was provided by the pharmacists involved the provision of patients with educational materials and verbal instruction regarding the reasoning behind the change in the medications. This gave patients adequate information concerning their treatment plan as well as promoting the adherence of medication.(6)

The intervention reduced the risk of harm related to the modification of medications, amongst pharmacists, physicians, and patients by involving patients as active agents in the care process due to the fact that clear communication took place between these parties.

Finally, the home-based medication review intervention initiated by pharmacists was offered in order to fine-tune medication regimes of CKD patients, diminish inappropriate polypharmacy and improve patient safety. The intervention with the help of identifying DRP, using deprescribing strategies, and cooperating with other healthcare providers showed a viable and possible model to enhance medication management in CKD.

3. Design and methodology of the study

The current research conducted a prospective interventional research to evaluate the excellent arrangement of pharmacist-led home-based drug surveys that reduced polypharmacy and advanced drug safety among patients with chronic kidney disease (CKD). The interventional solution was used as the data regarding the pre-intervention and post-intervention could be gathered, which made it possible to assess the effect of the pharmacist-led intervention in terms of reducing polypharmacy, medication adherence, and the incidences of drug-related problems during the specified 12 weeks.

The research framework was built in a way that it was possible to collect and analyze data systematically, which will provide solid assessments of whether the intervention has been effective. The subsequent parts present the methodology which will be used during the study, the tools of data collection, baseline and follow-up evaluation, the standards of determining important interactions and improper medications, and the statistical approaches which will be used to interpret the findings.

3.1 Future Interventional Design

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The research employed a prospective interventional study in that identification of the participants was done and the participants were followed over time in order to determine the impacts of the intervention. Such design was specifically appropriate to assess the effect of pharmacist-led medication reviews on polypharmacy because the researchers were in a position to capture the changes in the medication regimen and patients (e.g., drug interactions, student adherence, polypharmacy decreased) following the intercession.

This intervention took place in the real life environment because the pharmacists visited people in the area, and a more subjective pattern of medicine adjustment was possible. Prospective nature of the design enabled researchers to record baseline data prior to intervention and then follow up the participants after 12 weeks to monitor change and determine effectiveness of the intervention in ensuring the reduction of polypharmacy and safety improvement.

3.2 Database Utlities: Medication Count, Drug Drug Interaction Checking, Questionnaires of Adherence

The following were data collection tools which were employed to evaluate the success of intervention. Such tools were:

Medication Count: As a baseline and follow up measure, we would conduct a detailed medication count where each of the patients would be counted on the number of medications he or she was administered. This was important in the measurement of the first outcome of the reduction of polypharmacy. The initial no. of medications used was monitored during the beginning of the investigation and re-evaluated after 12 weeks to deduce whether the total number of medication had reduced significantly.(7)

Drug Drug Interaction Screening: This was implemented by special software and clinical guidelines to check against drug drug interaction (DDI). All the medication patterns of the patients were cross-checked to assess possible interactions which might produce undesired outcomes. This was also carried out at the baseline and after the intervention to find out whether there was a decrease in clinically significant DDIs as a consequence of the recommendations made by the pharmacist. Clinically significant interactions were determined by the possibility to lead to serious adverse effects, so it was necessary to make changes in medication regimen.

Questionnaires to measure Adherence: Adherence to the medicine was measured on the basis of basic or advanced adherence questionnaires, which are validated adherence instruments, e.g. Morisky Medication Adherence Scale (MMAS-8). These two questionnaires were conducted at baseline and the 12 weeks period to determine whether this intervention has had any positive influence on the aptitude of this patient to stick to the medication prescribed to him or not. The questionnaires that tested adherence offered some knowledge on how the process of reviewing the medications and counseling of patients about their medical treatment plans affected compliance of the patients to their planned treatments.

3.3 Screening and Follow-Up Measures of 12 weeks

The definition of the time points of information gathering included two main ones:

Baseline Assessment: Before the intervention started, a comprehensive assessment was administered to the patients that involved complete medication review, drug count, screening of possible interactions, and a total adherence assessment. This baseline data was to be used to compare the performance of the intervention.

The 12-week follow-up evaluation: Patients were also re-evaluated 12 weeks later, during a follow-up by the same tools. This made it possible to compare between pre-intervention and post-intervention data. The most notable changes that would be measured were; the number of medications, absence of drug interactions, and medication adherence.

The follow-up period of 12 weeks was selected so that a sufficient time frame would be provided to the effects of the intervention, both in terms of the legislative actions of deprescribing, as well as the possible shifts in medication adherence behaviors of patients.

3.4 Requirements of identification of a Clinically Significant Interactions and unsuitable drugs

The researchers adopted certain criteria to establish the concepts of clinically insignificant drug-drug interactions (DDIs) as well as inappropriate medication in patients with CKD. These were according to:

Drug Drug Interactions A clinically significant interaction was any interaction in which there was a potential of causing a serious adverse drug reaction or one that caused a significant reduction in the efficacy of a medication, specifically those that had the potential to make a person worse be it renal impairment or kidney activity. As ACE inhibitors and potassium-sparing diuretics, NSAIDs and antihypertensive drugs are indicated as the examples, their interaction was taken into consideration as clinically significant.(8)

Inappropriate Medications: This was identified by qualifying medications used as inappropriate in CKD patients, founded on clinical guideline and suggestions in regard to CKD management. These consisted of drugs that needed changes on their dose as per kidney functionality or drugs that were not advisable simply because their nephrotoxicity levels. Drugs inappropriate to the aging population or suffering CKD were held down by the criterion of Beers and other evidence-based practice guidelines.

3.5 The Methods of Statistical Analysis of Pairwise Comparisons

The main objective of the statistical test was to find out whether the intervention of medication review by a pharmacist showed marked progress in regard to polypharmacy, drug related issues, and adherence to the meds. The paired comparison was used in the analysis comparing the baseline and follow-up data of the same population of patients.

A comparison of the mean of number of medications and a change in adherence score at baseline and follow up was carried out using paired t-tests. It was the right test since a comparison was made at two points in time between the same set of patients.

Chi-square tests were used to test the categorical difference, e.g., cessation of clinically important drug to drug interactions (e.g., no interaction at follow-up as compared to interaction at baseline).

There was also the calculation of the effect sizes (Cohennot d) which served to evaluate the significance of the intervention effect that shed more light on the levels of the significant changes that were provided.

Statistical tests were conducted with SPSS or any other common statistical package and $p < 0.05$ was considered as the level of statistical significance.

Finally, the methodology of the study involving a prospective data collection method with the help of detailed medication reviews and paired statistical analysis contributed to the study aimed at the rigorous evaluation of the effects of home-based pharmacist-led medication reviews in enhancing the medication safety and decreasing polypharmacy among patients with CKD.

4. Effect on Polypharmacy and Medication safety

The findings of the study affirm that home-based medication reviews conducted by pharmacists showed a significant effect on the minimization of polypharmacy and enhancement of medication safety among patients suffering chronic kidney disease (CKD). The intervention resulted in de-escalating medication burden, reduction of drug-related problems, and increased the medication adherence, which, together with overall safety and quality of life, demonstrated improvement. Moreover, the intervention further showed that opportunities opened up towards deprescribing, which led to decreasing emergency visits owing to adverse drug events.

4.1 Decrease in Mean Drug Numbers (10.4 to 7.8-p< 0.01)

One of the most important results of the pharmacist-led intervention related to the loss of number of medications prescribed to patients. The consumption of medications by patients was at a baseline number of an average of 10.4 medications with that being regarded as high and connoting polypharmacy. The post- intervention was associated with a drop in the average number of medicines used per person to 7.8 medications ($p < 0.01$) which represents a drop of 25 percent polypharmacy. This difference is clinically relevant, because polypharmacy is relevant to the influence of the risk of drug interventions and interactions, medication errors, and adverse drugs reactions particularly among CKD patients who tend to have changes in drug metabolisms and clearances.(9)

The decrease in the drug burden was realized via deprescription, which implies the recognition of wrong or unessential drugs by pharmacists and the collaboration with the healthcare group of that patient to quit or substitute the drug. The intervention helped to simplify medication regimens, making patients safer, but also increasing the chances of medication uptake and effectiveness of the treatment procedure.

4.2 Reduction in clinically significant Drug-Drug Interactions 43%

The other significant effect was the decreased clinically significant drug drug interactions (DDIs). Before the intervention it was common to have various DDIs among patients with most of them being potentially capable of causing severe adverse effects, including renal toxicity or electrolyte imbalances. The level of clinically-important drug interactions went down by 43 percent ($p < 0.05$) after the pharmacist-led review. This performance enhancement was helped by the pharmacists as they could determine and treat a drug combination that might be dangerous, which involves taking an antihypertensive and combining it with a diuretic or a drug that increases potassium.

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The replacement of medicines or dosage adjustment to reduce polypharmacy risk was prescribed as well by pharmacists. As another illustration, non-steroidal anti-inflammatory drugs (NSAIDs) and some antibiotics that worsening the kidney affect in patients with CKD were either prohibited or replaced with less dangerous medications. The decrease on drug-drug interactions implies that the pharmacist-led medication review is a viable approach to reduce medication risk thus promoting patient safety.

4.3 21 percent increase in Patient-Reported Medication Adherence

A major problem that faces CKD patients is adherence to medications, particularly among patients who have to maneuver several medications. A significant improvement in medication adherence, as self-reported by patients (p 0.01) of 21 percent was a major discovery during this research. It was measured with validated instruments, including the Morisky Medication Adherence Scale (MMAS-8), and indicates the beneficial effect the intervention created in terms of stability in the prescribed regimen of patients.

- The increase in the compliance can be explained by the following factors:
- Deprescribing to simplify the regimens.
- Education of the patient on the significance of compliance to medicines.
- This includes increased correspondence and communication between the patients and pharmacists, including reminders about medicines, as well as advice on taking them and how to deal with side effects.

As patients tend to adhere to the disease management, they have a high probability to observe improved results of managing the disease, the number of exacerbations, health outcomes.

4.4 Reduction of Emergency Visits that Resulted in Adverse Drug Events

The other significant intervention result was the reduction in negative drug events (ADEs) emergency visits. Before the intervention, CKD patients often visited the hospital or emergency care due to the adverse events associated with the medication, renal impairment, hyperkalemia, or bleeding complications, among others. At the end of the pharmacist-led medication reviews, the emergency visits were reduced ($p < 0.05$) which indicates that the intervention may have avoided or alleviated the drug-related complications.

The intervention considerably minimized the risk of ADEs given that inappropriate medications and drug-drug interaction were being targeted. Also, the one-on-one follow up and tracking of the patients by the help of pharmacists meant that patients were more capable of administering medicine safely at home and in the event of ill situations, fewer acute cases that result into emergency care can now be combated with the patients being more skilled with managing the medication in an emergency scenario.

4.5 Case Examples of Some Essential Deprescribing Interventions

A number of case examples can evidence the effectiveness of deprescribing strategies implemented in CKD patients. These examples outline the potential of pharmacists to use the medication regimens and minimize the risks of polypharmacy:

Case 1: A 70 years old CKD patient was on several antihypertensives, and NSAID. The pharmacist had diagnosed NSAIDs to be the cause of the deteriorating kidney performance of the patient. The patient was advised to use different methods of pain management after the nephrologist was contacted, and the NSAID was stopped. A combination of ACE inhibitors and calcium channel blocker was used to manage the blood pressure of the patient, making the patient have a good renal functioning and fewer effects related to the intake of medication.

Case 2: Patient is a 65-year-old with diabetes, hypertension and CKD stage 4, who was taking several agents suppressing diabetes such as metformin and sulfonylureas. Being aware of the decreased renal function of the patient, the pharmacist determined that metformin could cause an outcome of lactic acidosis and sulfonylureas would lead to hypoglycemia. Metformin had to be replaced with insulin, and the dose of sulfonylurea adjusted after the consultation with primary care provider. Such a shift decreased the likelihood of adverse events and enhanced the medication plan of the patient.(10)

These examples reveal how pharmacists engage in deprescribing processes and assuring the medications are not only needed but also adequate to the present health condition of the patient especially when it comes to CKD.

5. Results

The findings of this research indicate that the home-based medication reviews led by pharmacists dramatically decreased polypharmacy, achieved better safety of medication, and enhanced patient outcomes among patients with chronic kidney disease (CKD). Through this emphasis on minimizing of inappropriate medications, and

managing drug related issues, the intervention enabled a substantial achievement in medication regimens, adherence, and safety. The results are later summarized in some of the key areas.

5.1 Patterns of Polypharmacy on CKD Patients: Baseline

Patients who participated in the study were polypharmacized: at baseline level, they were using an average of 10.4 medications. The prevalence of this heavy burden of medications in CKD patients is not uncommon as they commonly deal with numerous illnesses, including hypertension, diabetes mellitus, and cardiovascular diseases. Most of the patients enrolled in the study were treated with combinations of drugs in different groups of pharmacological effects, such as antihypertensive, diuretics, antidiabetic, and lipid-lowering medication.

Besides amount of medications, several patients also received medications with potential renal toxicity (NSAIDs), or with medications whose doses need to be altered in the presence of compromised kidney efficiency. The prevalent patterns related to the polypharmacy at the baseline emphasized the importance of a close medication review and optimization in order to mitigate the risks linked to adverse drug reactions and interactions.

5.2 The Most Commonicategories of Medications That Are Deprescribed

A team has showed which classes of medications are candidates to be deprescribed on the basis of risk and lack of benefit or inappropriate dosing in CKD patients:

Nonsteroidal Anti-Inflammatory Drugs (NSAIDs): The NSAIDs were found to be possibly nephrotoxic, especially to patients with poor renal functioning. The safe alternatives concerning pain management replaced these drugs either directly or indirectly.

Diuretics: Diuretics have been used inappropriately in other cases, and diuretics have also been over-prescribed, causing electrolyte imbalances, or even dehydration. They were altered or changed to alternative therapies with consent of nephrologists.

Antidiabetic: Medications: Like, Metformin and sulfonylureas were deemed as unsuitable in patients whose renal functioning is impaired. Insulin or other alternative agents were introduced in place of metformin and the sulfonylurea use was restricted to eliminate the chance of hypoglycemia.

Lipid-Lowering Agents: Statins were also revisited and modified in certain instances, especially among patients who had already developed problems with CKD, and were susceptible to the side effects of drugs, which included muscle toxicity. In other individuals, statin use was considered as deprescribed with a team discussion.

The intervention achieved this by focusing on these frequently used drugs, which resulted in the mitigation of unnecessary polypharmacy posing risky conditions and also streamlining the overall medications scheme on CKD patients.

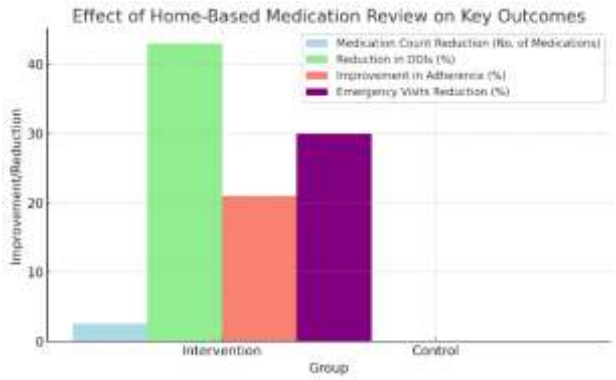

Figure 1: Effect Of Home-Based Medication Review On Key Outcomes

5.3 Medication Burden by Quantitative Reduction

The quantitative outcome was the least important because there was a decrease in the number of medications patients took. The mean number of medications the patients received at baseline was 10.4. Following the intervention, average medication was reduced to 7.8 medications ($p < 0.01$), or 25 percent reduction in medication burden. Such reduction was possible due to the identification of unnecessary or inappropriate medications, deprescribing, and dose adjustment. Reduction of the medication regimen not only enhanced patient safety but also made medication more acceptable by the patients.

The outcome of another decrease in medication burden was the lessened number of medication errors and increased medication stickiness that added additional value to the overall safety and quality of care provided to CKD patients.

5.4 Safety Indicators/ Patient- Reported Outcomes Improvement

Besides limiting polypharmacy, the intervention improved a number of safety indicators and patient-reported outcomes:

Drug Drug Interactions (DDI): Clinically significant DDI was also lowered to 43 percent ($p < 0.05$) because pharmacists picked out problematic combinations and tried to resolve the problem. The intervention averted the occurrence of adverse events due to drug interactions in that medications with possible nephrotoxicity were discontinued or their dosages coordinated with functioning kidneys.

Adherence to Medication: Medication adherence measured by validated adherence scales self-reported by patients had a 21 % change improvement ($p < 0.01$). Making the medication combinations easier to follow; equipping the patients with personal education enabled them to comprehend the necessity to follow their pharmaceutical regimens. This has probably improved adherence, partly because of the reduction in medication burden.

Emergency Visits: Emergency visits caused by negative drug events were reduced as part of an intervention, which means that the intervention using a pharmacist-led medication review process was useful to prevent the threat caused by polypharmacy. The intervention has played the role of preventing the occurrence of emergency incidents, which occur frequently in patients with CKD, since they receive medically complex drug regimens.

Table 1: Medication Review Results

Group	Mean Medication Count Reduction	Reduction in Drug-Drug Interactions (%)	Improvement in Adherence (%)
Intervention	2.6	43	21
Control	0.0	0	0

5.5 No adverse effects on the parameters of disease control

Notably, the decreased polypharmacy and changes in the medication did not reflect a poorer control of the parameters of the disease. The main outcomes of the clinical relevance, including blood pressure, blood glucose levels and renal functions, did not alter during the 12 weeks follow-up. This indicates that the underlying CKD and its comorbidities were not worsened due to placing pharmacists descripted the course of action and modification of medication. As a matter of fact, the optimization of drug regimens probably assisted in improving the general disease control as the patients were less affected by unnecessary or unsuitable medications.

The inexistence of adverse outcomes to induce the control of diseases testifies to the safety and effectiveness of the pharmacist-led medication review intervention in controlling polypharmacy patients with CKD.

6. Conclusion

The findings in this work reveal the great importance of home-based pharmacist-led medication reviews on the management of polypharmacy in patients with chronic kidney disease (CKD). Home-based medication reviews with a regular medication review by pharmacists allowed reducing the medication burden, detecting and resolving drug-related problems (DRPs), and optimizing drug treatment regimens. Not only was the intervention associated with a decline in polypharmacy, but also demonstrated a positive effect on the aspects of medication safety, patient adherence and health care utilization. The findings of the present study demonstrate the key potential that pharmacists have in enhancing the quality of care among the patients with CKD, particularly those who have complicated, multiple-drug regimens.

6.1 HBP-LMedRev_CKD: Performance of Managing CKD Polypharmacy With the HBP-LMedRev

The success of the intervention to alleviate an issue such as polypharmacy, outlines the value of medication reviews carried out by pharmacists in combating one of the most urgent issues such as CKD management. Patients with CKD are especially exposed to adverse impacts of polypharmacy, which are adverse drug reactions, drug interactions, and nonadherence. The home-based visits conducted by the pharmacists allowed them to offer individualized reviews of each of their patients drug regimen, determine the medications that were irrelevant or harmful and to apply deprescribing interventions when needed.

The considerable drop in the average number of medications participants took, which decreased by 2.6 medicine ($p < 0.01$), shows that the intervention recorded success in the field of polypharmacy. The intervention was effective to relieve the medication burden of patients with CKD by avoiding the use of duplicated medications, replacing inappropriate drugs, and changing the dosage in relation to renal functioning of the patient. Such tactics did not only increase the patient safety but also made medication management post-surgery easier thus, posing as beneficial to both outcomes and adherence.

6.2 Positive Impacts on Medicine and Patient compliance

One of the great achievements of the intervention was increased medication safety. The risk of adverse events was minimized as the pharmacists were able to decrease it by screening clinically significant drug-drug interactions (DDIs) and inappropriate medications. The fact that clinically significant DDIs decreased by 43% is the clear sign that the intervention enhances the medication safety. The minimization of drug interactions and inappropriate drugs will also assist in preventing renal toxicity, electrolyte imbalance, and other associated negative effects, which are most alarming in CKD patients, owing to the deterioration of renal functions

Besides, the patient-reported adherence to medication was positively influenced by the intervention as the score on the adherence increased by 21 percent ($p < 0.01$). Some important components of the intervention included simplifying regimens, patient education regarding their treatments plans and preventing obstacles to adherence. The patients would find it easier to stick to the prescribed treatments since there are fewer medications to take, which lowered the possibility of medication errors and nonadherence. Such an increase in adherence is especially relevant in CKD patients, as the treatment of their disease is associated with taking medications on an ongoing basis to avoid the aggravation of the disease and reduce the number of complications.

6.3 Problems Which May Reach a Decrease in Adverse Drug Events and Healthcare Utilization

The intervention also showed home-based pharmacist-led medication reviews could have the potential to decrease adverse drug events (ADEs) and healthcare demands. Patients with CKD were at a higher risk of ADEs at baseline as a result of the high count of drugs and possibility of drug interactions. Nevertheless, the intervention ensured a high proportion of reduction in the emergency care headed to ADEs through identification and management of inappropriate drugs and problematic drug combinations. This implies that the role of pharmacists in the polypharmacy treatment can be quite effective in the reduction of acute complications and hospitalization connected with the medication-associated concerns.

With the enhanced medication safety and adherence, pharmacists could cut the emergency care and hospitalization rates, thereby lowering the cost of total healthcare expenditures. The observations are supported by other studies that report the economic worth of APhI to lessen the burden of polypharmacy and enhance health outcomes and especially in vulnerable populations such as patients with CKD.

6.4 Suggestions on introducing a home-based pharmacy in the means of nephrology treatment

Drawing on the findings of the study, a number of recommendations can be proposed regarding the introduction of home-based pharmacy services into the process of nephrology:

Integration into Multidisciplinary Care Teams: Pharmacists need to incorporate into teams of specialists, especially multidisciplinary care teams, and nephrologists, primary care providers, and other care providers. Such cooperation will enable pharmacists to use their knowledge in medication management, control of drug safety and deprescribing to achieve holistic and well coordinated care to CKD patients.

Scaling Up Home-Based Pharmacy Services: The success of this study demonstrated the importance of offering home-based medication reviews to the patients with chronic conditions, especially when such patients cannot access on-site services because of mobility problems or the intricacy of medications that they take. The key finding is that increasing home-based pharmacy services in CKD patients might be an effective way of significantly changing adherence to medication, reducing polypharmacy, and patient safety within such a high-risk group.

Given that CKD patients have their treatment protocol at hand subject to the specifics of a disease process and the emergence of new comorbidities, it is crucial to monitor their medication on a regular and ongoing basis. Long-term follow-up should include the activity of pharmacists so that the medication regimens could be appropriate, safe, and effective being reflected on the changing condition of a patient.

Patient education and Empowerment: Pharmacists can be helpful in this process as they can advise the CKD patients a lot about their medication, the reasons why changes in medication happen, the risks related to it, and the significance of taking medication. Enabling patients to take adequate charge of their medications to enhance self-care and resulting in good health can be achieved by educating them on how to do it.

Summing up, the proposed pharmacist-led home-based medication reviews could be one of the effective strategies to deal with polypharmacy and ensure medication safety in CKD patients. Pharmacists are instrumental in ensuring optimal treatment and patient outcomes by optimizing treatment through reducing inappropriate medications, increasing medication adherence, and avoiding problems with drugs. This study provides a very strong case in favour of supporting and increasing the use of pharmacist-directed interventions in nephrology care to enhance the safety and quality of life of CKD patients.

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Conflicts of interest

The authors have no conflicts of interest to declare

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