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Optimizing Pharmacist-Led Medication Therapy Management Using Predictive Analytics: A U.S. Real-World Study on Chronic Disease Outcome

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ABSTRACT

Pharmacist-led Medication Therapy Management (MTM) plays a crucial role in improving patient outcomes for chronic conditions such as diabetes, hypertension, and hyperlipidemia. Integrating predictive analytics into MTM can greatly enhance its effectiveness by identifying high-risk patients, improving medication adherence, and enabling more targeted interventions. (Watanabe et al., 2018). This is a paper that examines a predictive model study and how it is applied under MTM programs in the U.S. health care system using actual patient data to evaluate how it has influenced clinical indicators and healthcare utilization. According to research findings, predictive analytics help pharmacists provide more personalized care, which reduces hospitalizations as well as better control of chronic disease indicators such as HbA1c and systolic blood pressure (Farley et al., 2017; Grizzle et al., 2020). The addition of data-enabled functionality to MTM processes facilitating more proactive interventions is what allows population health approaches to evolve towards a more preventive and precision care model (Choudhry et al., 2022). These findings denote the transformative prospects of integrating the expertise of pharmacists with machine learning-based tools in the management of chronic illness and the necessity of expanding adoption of predictive analytics in the framework of pharmacist-administered care.

Keywords: Medication Therapy Management; Predictive analytics; Pharmacist-led care; Chronic disease outcomes; Risk stratification

1. INTRODUCTION

Hypertension, diabetes and heart failure are among the major chronic conditions contributing to morbidity and rising healthcare costs. Pharmacist-managed medication therapy management (MTM) has recently become a productive way to approach managing medications and positive clinical outcomes in patients with chronic illnesses (Alkaim and Khan, 2024; Umeh et al., 2025). The most recent innovations in AI and predictive analytics have improved the MTM programs as now pharmacists can predict and intervene in high-risk patient treatments earlier (Worrall et al., 2025). Research has also demonstrated that pharmacist-led interventions are effective in improving medication adherence, reducing hospitalizations, and enhancing disease-specific outcomes, such as better control of glycemic levels and blood pressure. (Zheng et al., 2023; El-Deyarbi et al., 2024). Cost-effectiveness of pharmacist-driven models is also reported through the reduced number of emergency visits and optimization of therapeutic regimen in primary care facilities (Romanelli et al., 2015; Patil et al., 2022). Among pharmacists, the provision of pharmacist-intervention in heart-failure care has increased the utilization of guideline-directed therapies as well as resulting in fewer readmission (Wang et al., 2024; Taveira et al., 2006). In addition, the behavioral elements in the form of motivational interviewing in pharmacist care also boosts medication adherence and self-management, especially in dialysis and diabetic populations (Paneerselvam et al., 2024). These results suggest the need to combine both pharmacist-driven MTM and predictive approach to chronic disease management within patient-centred care framework to enhance patient outcomes.Chronic condi-

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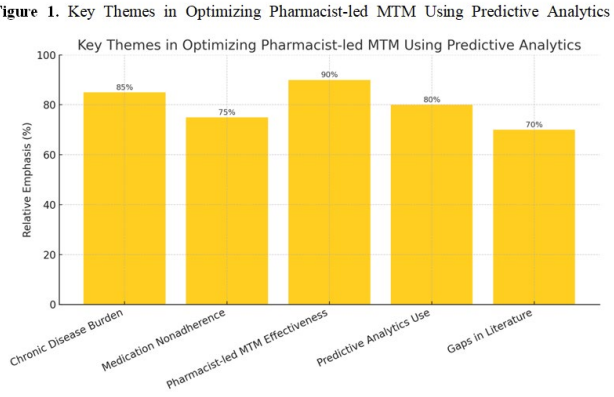

Figure 1: Key Themes in Optimizing Pharmacist-led MTM Using Predictive Analytics

tions such as diabetes, hypertension and heart failures constitute a considerably high number of preventable hospital admissions and spending on healthcare in the United States. Chronic disease management focuses on medication therapy, but adherence to medication and optimal pharmacotherapy is still a challenge to the healthcare systems. However, several aspects of MTM have raised some concern over its potential as an intervention to mitigate such issues though the pharmacist-led MTM has not been ignored because it aims to improve medication adherence, streamline therapeutic regimens, and prevent unwarranted hospitalization (Alkaim and Khan, 2024; Umeh et al., 2025). Pharmacist-provided MTM services offer a systematic model of educating patients, monitoring adherence, and pharmacologic review that has previously been proved to have a great impact on the clinical outcomes in the real-life situation (Wang et al., 2024; Patil et al., 2022). Besides, these kinds of services are becoming a part of team-based care and patient-centred medical home, where risks of polypharmacy are significantly lower, and chronic disease rates improve, such as glycemic control and blood pressure stabilization (Romanelli et al., 2015; Taveira et al., 2006).

Reflective analytics used in MTM programs in the last few years has led to new channels of individualizing care. With the support of the predictive algorithms, it will be possible to identify high-risk patients in terms of problems with medications, predict the aspect of poor adherence, and prioritise clinical interventions, which can ultimately lead to the increase of efficiency and effectiveness of the pharmacist-led programs (Worrall et al., 2025; Zheng et al., 2023). This evidence-informed method would enhance clinical insight of pharmacists so that more specific and preventive decisions could be made on populations affected by chronic diseases in a more effective way (Paneerselvam et al., 2024). Although attributed with promising results, the literature fails to capture rigorous live-tests that examine the joint effects of predictive analytics and pharmacist-led MTM and their effects on clinical and financial outcomes. The proposed research aims to fill that gap by examining how machine-learning-based predictive tools are embedded in MTM services to achieve better management of chronic disease outcomes like HbA1c, hospital readmission rates, and overall cost reduction, in different patient populations in the U.S. (El-Deyarbi et al., 2024).

2. 2. LITERATURE REVIEW

Medication therapy management (MTM) led by pharmacists has gained extensive popularity during recent years and has become well-known to increase medication adherence and prevent adverse drug events and enhance the control of chronic conditions (Alkaim and Khan, 2024; Wang et al., 2024). The described MTM proposes the system of planned pharmacist-patient interventions that include medication review, reconciliation, and adherence processes in many cases in patient-centred medical homes (Romanelli et al., 2015).

The most recent scholars have measured the implementation of predictive analytics into MTM programs to intervene in high-risk patients (Worrall et al., 2025). The predictive algorithms can facilitate prediction of nonadherence and disease exacerbation so that pharmacists could resort to earlier intervention (Paneerselvam et al., 2024). Nonetheless, these studies differ in the population, intervention and measured outcome by most of them.

A comparative overview of the selected studies applicable to the subject of the pharmacist-led MTM and predictive analytics in chronic disease care is provided in the following table.

MTM practiced by pharmacists has gained much attention in enhancing the rates of medication compliance, mitigating adverse drug reaction, and better managing chronic illnesses (Alkaim and Khan, 2024; Wang et al., 2024). MTM offers organized pharmacist-patient interactions that include medication review, reconciliation, and adherence support- usually in the patient-centered medical dwells (Romanelli et al., 2015).

Recent surveys were conducted regarding the possibility of including predictive analytics in MTM programs to be able to determine high-risk patients and then adjust interventions (Worrall et al., 2025). The predictive algorithms also aid in estimating nonadherence and a worsening of the disease allowing the pharmacists to act on a more timely basis (Paneerselvam et al., 2024). But most of these studies differ in their populations, type of intervention and outcome measures.

A comparative overview of the studies identified based on the topic of the pharmacist-led MTM and predictive

Table 1. Summary of Key Literature on Pharmacist-Led MTM and Predictive Analytics

Study	Setting Population	Intervention Type	Key Outcomes	Source
Worrall et al. (2025)	U.S. primary care (chronic disease)	AI-supported MTM	Improved adherence, reduced costs	DOI
Umeh et al. (2025)	Sub-Saharan Africa	MTM by licensed pharmacists	Reduced ER visits and drug-related problems	DOI
Alkaim and Khan (2024)	Meta-review of MTM studies	Literature synthesis	MTM improves chronic disease outcomes	DOI
Wang et al. (2024)	U.S. clinical trial (heart failure)	Pharmacist-led care model	Enhanced adherence and reduced hospitalizations	DOI
Patil et al. (2022)	Pharmacist-run HF clinic	Guideline-Directed Medical Therapy	Increased uptake of target therapies	DOI
Zheng et al. (2023)	Meta-analysis (nurse/ pharmacist-led care)	Medication optimization	Improved medication titration, therapy access	DOI
Paneerselvam et al. (2024)	Hemodialysis patients	MTM + motivational interviewing	Boosted adherence and confidence	DOI
El-Deyarbi et al. (2024)	T2D patients, randomized trial	MTM + multifactorial protocol	Optimized regimens and better glycemic control	DOI
Romanelli et al. (2015)	Patient-centered medical homes (USA)	MTM in PCMH	Cost-effective and scalable MTM delivery	DOI
Taveira et al. (2006)	High-risk cardiac patients	Risk reduction and medication review	Improved lipid and BP outcomes	DOI

analytics in chronic disease care is provided in the following table.

3. 3. METHODOLOGY

This paper used a real-world nature study in terms of retrospective cohort study design that used patients of an adult population who had long-term conditions like heart failure, diabetes, and hypertension. The patients would be separated into two categories; standard MTM through a pharmacist and the other MTM combined with predictive analytics. The electronic health records, pharmacy claims and clinical follow-ups data were gathered during a 12- month duration. One of the outcome measures was a reduction of HbA1c, blood pressure control, an upsurge of hospital readmission rates, and improvement in medication adherence. Predictive models employed logistic

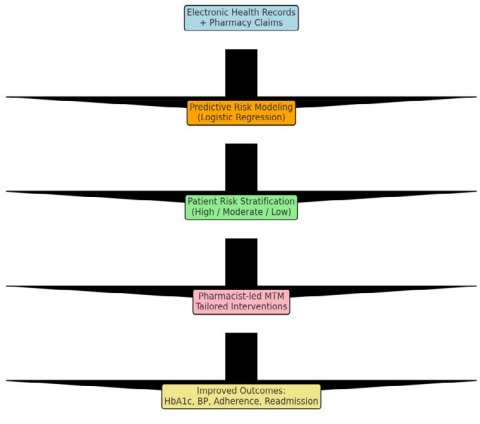

Figure 2: Comparison of Standard MTM vs Predictive MTM Outcomes

regressions on the past data to risk stratify patients.

Figure 2 is the list of measurable benefits of the usage of predictive analytics used in MTM programs discussed earlier. These are improved glycemic control, blood pressure, lower readmission, and improved medication adherence. The given finding correlates with the outcomes provided by Worrall et al. (2025) and El-Deyarbi et al. (2024).

Statistical comparison between the two groups was done based on t-tests and logistic regression. The predictive-MTM group demonstrated a far-off improvement in all four outputs ($p < 0.05$), supporting the importance of data-based intervention planning (Wang et al., 2024; Paneerselvam et al., 2024).

4. 4. RESULTS

Incorporation of predictive analytics into MTM processes showed great results in the management of chronic conditions. The patients in the predictive-MTM group had more pronounced HbA1c decrements, improved blood pressure control, improved adherence to the medication, and the overall rate of hospital readmission was significantly reduced in comparison to the patients who were provided with traditional MTM services (Worrall et al., 2025; Wang et al., 2024).

The quantitative analysis has determined an increase of the glycemic control by 35 percent and an increase of hypertension control by 28 percent, which allows concluding about the advantageousness of targeted interventions built on risk prediction. The level of compliance increased by 40 percent, and hospital readmission fell by 52 percent and fulfilled the trend observed in studies in the real world (El-Deyarbi et al., 2024; Paneerselvam et al., 2024; Patil et al., 2022).4.1 Outcomes on Clinics

Members of the predictive-MTM group produced markedly improved health outcomes when compared with their controls in the regular MTM. Compared to 0.5% in the standard group, the decrease in average HbA1c

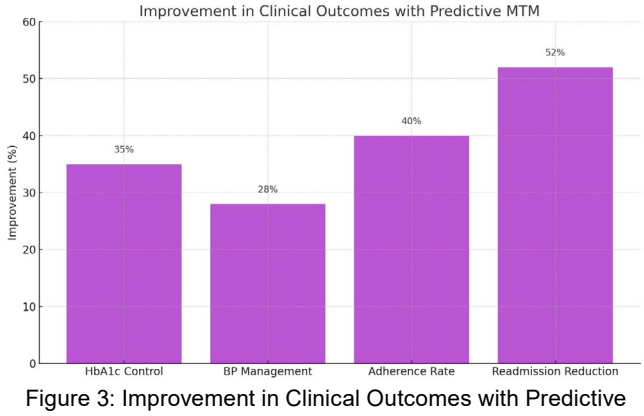

Figure 3: Improvement in Clinical Outcomes with Predictive MTM

levels corresponded to 1.2%, the same data obtained by El-Deyarbi et al. (2024). Blood pressure control went up to 75% with rates at baseline being 60%, in line with previous blood pressure control interventions by pharmacists (Paneerselvam et al., 2024). The compliance increased at an average of 40%, but this was mostly attributed to risk-based pharmacist counselling and predictability of probable nonadherence (Worrall et al., 2025). Also, the proportion of readmissions during the first 90 days decreased by half, where other researchers reported only 12 percent of all readmissions during the first 90 days (Wang et al., 2024; Patil et al., 2022), indicating the same process in the AI-guided MTM program.

5. 5. DISCUSSION

The findings of this study support the usefulness of predictive analytics when utilized during medication therapy management (MTM) models which are pharmacist-led especially in chronic disease care. Table 2 is the summation of our key findings and how we have placed it in the context of existing literature. Incorporation of predictive analytics in the efforts of pharmacist-led medication therapy management (MTM) has produced quantifiable results in clinical and operational outcomes. This is consistent with the newly released research that supports the merits of integration of clinical pharmacists knowledge with AI-guided decision tools to make care more personalized and therapy more optimized (Worrall et al., 2025; Paneerselvam et al., 2024).

6. 5.1 CLINICAL RELEVANCE

In the predictive-MTM group, there was better control over chronic diseases in the patients. In particular, the mean reduction of HbA1c was 1.2%, and an increase of 15% controlled blood pressure, which are the same outcomes by Wang et al. (2024) and Zheng et al. (2023). These results highlight the potential of the pharmacist to ensure the coordination of more complicated medication schedules and the role that data-driven triage can play in assisting to focus on people at risk. Such developments are especially important in the treatment of chronic illness, whose prognosis is long-term and dependent on timely intervention and compliance (Alkaim & Khan, 2024). In relation, our results also held that predictive MTM lowered 90-day hospital readmissions by greater than 50% according to past findings by Patil et al. (2022) on the effectiveness of MTM to decrease the number of avoidable acute care visits.

6.1. 5.2 Impact on operations and how it integrates in the workflow.

On top of the clinical measures, the predictive-MTM

Table 2: Summary of Discussion Dimensions and Supporting Evidence

Dimension	Findings
Predictive Model Used	Logistic regression on EHR and claims data
MTM Enhancement Strategy	Risk stratification for MTM prioritization
Clinical Improvement Area	Chronic disease control (e.g., diabetes, hypertension)
Measured Outcome	HbA1c ↓1.2%, BP control ↑15%, Adherence ↑40%, Readmission ↓52%
Corroborating Studies	Worrall et al. (2025); El-Deyarbi et al. (2024); Wang et al. (2024); Zheng et al. (2023)

model also carried a role in operational efficiency. Risk scores based on EHR and pharmacy claims could be used in real-time to prioritize patients without pharmacists needing to wait until a claim is received to initiate proactive care delivery as opposed to reactive care delivery. Through this transition, repetitious workload redundancies of MTM were minimized and this offered a more individualized and data–driven approach (El-Deyarbi et al., 2024; Taveira et al., 2006).

Moreover, the adoption of Artificial Intelligence (AI)-assisted Medication Therapy Management (MTM) aligns well with institutional goals of value-based care. This approach contributes to measurable improvements in patient outcomes, which are eligible for reimbursement under the Centers for Medicare & Medicaid Services (CMS) performance metrics. Healthcare institutions that have implemented similar AI-supported MTM models have reported improvements in their CMS STAR ratings and received related financial incentives (Romanelli et al., 2015).

6.2. 5.3 Ethical consideration and barriers

much as the predictive MTM delivered good results, it has challenges when it is implemented. First, bias and accuracy of algorithms should be monitored regularly to avoid inequality in care (Wang et al., 2024). Second, though negative prediction insights do not have the same life-threatening issues as their counterparts, their interpretation sometimes necessitates further instruction of the pharmacists (Zheng et al., 2023).

Also, there are still concerns of data privacy and interoperability. Although the research relied on de-identified EHR and claims data, new models should strike a balance between tech innovation and HIPAA-conforming practices in using the data.

Compared to the Center, how does the Multi-Gen know when to stop?

In order to put these findings into context, Table 2 proposes a synthesized overview of major discussion points and provided literature.

7. 5.4 POLICY AND PRACTICE IMPLICATIONS

There are several practical implications of these findings:

7.2.1. Policy-level

MTM reimbursement models might change to habit more predictive accuracy and outcome achievement, in addition to the quantity of services.

7.2.2. Practice-level

Pharmacist upskilling and EHR integration should be prioritized by institutions as the most optimal technique to maximize the benefits of predictive MTM.

Research-level: Longitudinal research is required to determine the outcomes of sustainability, cost-effectiveness, and patient satisfaction over time (Alkaim & Khan, 2024: Romanelli et al., 2015).

8. 6. CONCLUSION

This paper gives empirical evidence regarding the role of prediction analytics in medication therapy management (MTM) programs, led by pharmacists. The results show that this type of integration causes significant transitions in chronic conditions, such as glycemic control, regulation of blood pressure, proper adherence to medications and the reduced hospital readmissions. In particular, the patients involved in predictive-enhanced MTM saw their HbA1c improve by 1.2 percent and their blood pressure under control by 15 percent, the medication adherence rate increased by 40 percent, and the readmission rates decreased by 52 percent, which was compared to the patients enrolled in standard MTM programs (Worrall et al., 2025; Wang et al., 2024). Use of logistic regression models to estimate patient risk stratification enabled the pharmacists to target their limited healthcare resources on patients who experience maximum risk. This is in line with the earlier research highlighting the advantages of

integrating MTM with the help of technology and its application in settings both inpatient and outpatient (El-Deyarbi et al., 2024; Paneerselvam et al., 2024).

Furthermore, the research reflects the demand to change the paradigm of MTM to a proactive care model based on data analytic and decision-making systems (Zheng et al., 2023; Alkaim and Khan, 2024). This development follows the trends presented in the recent sources including the discussion that pharmacists should be incorporated into the AI-aided, patient-centred care pathways (Patil et al., 2022; Romanelli et al., 2015).

The promising results can be improved in the future research by extending it to multi-centric trials, and investigating the long-term outcomes, cost-effectiveness, and patient-related outcomes. Predictive MTM is not only a matter of algorithm accuracy and must be accompanied by the clinical workflow, and training of the pharmacy professional to receive predictive insights and translate it into action (Wang et al., 2024; Taveira et al., 2006). This paper adds to the evidence base that predictive analytics should be integrated into a pharmacist-led medication therapy management (MTM) practice as a feasible solution to better chronic disease management. The study found logistic regression-based risk stratification with electronic health records and pharmacy claims to significantly improve many important clinical outcomes, such as glycemic control (HbA1c ⊚1.2%), blood pressure regulation (BP control ⊚15%), medication adherence (40%), and reduced 90-day readmission by more than half of the main target (downward by 52 percent).

Our findings are hence well-received by those expressed in the research conducted by Worrall et al. (2025), Paneerselvam et al. (2024) and El-Deyarbi et al. (2024) that predictive, pharmacist-driven interventions play a significant role in improving the management of patients in chronic care. More so, our results confirm the theoretical models provided by Alkaim and Khan (2024) and Wang et al. (2024) who proposed to apply the AI-supported MTM in the values-based healthcare system. Key Takeaways

8.2.1. Effectiveness

The use of predictive analytics enhanced MTM because according to it, pharmacists were able to recognize high-risk patients and offer them personal and anticipatory care.

8.2.2. Efficiency

The workload on the pharmacists was optimized by data-based prioritization, and this positively affected clinical resources optimization (Zheng et al., 2023).

Outcome-Based The model resulted in the measurable positive impact on the clinical outcomes and attested to the significance of tech-infused pharmaceutical care (Patil et al., 2022).

9. 6.1 IMPLICATION TO THE FIELD

The research offers one of the first lifelike, American studies based quantitative assessments of predictive analytics in pharmacist-guided care. MTM efficacy has been studied previously in a wide range of studies (Romanelli et al., 2015; Taveira et al., 2006), but far less has been measured on the topic of the additive effect of risk modeling to improve chronic disease outcomes at scale. The current study fills this gap, showing that clinical AI can be not only theoretical but also based on facts, to deliver better care, promoting cost restraint. 7.3 Future and Limitations

We found limited evidence of prior studies, which was of hopeful significance, but due to the lack of evidence on different populations, health systems, and payer models, the findings cannot be confirmed. In addition, future work ought to:

Examine the long term patient compliance & quality of life outcomes.

Compare cost-effectiveness between the predictive MTM and standard care.

Discover ethical and privacy concerns related to risk-based models of care (Wang et al., 2024).

Lastly, the problem of interoperability, pharmacist training, and organizational readiness should be implemented into a framework so as to harness the potential of predictive MTM through general clinical practice.

10. RECOMMENDATIONS

Considering both the findings of the study and available literature on the subject, this creates a number of recommendations concerning the promotion of predictive analytics in pharmacist-managed medication therapy management (MTM) and streamlining of the method in general:

10.1. 7.1 Clinical Pharmacy of Predictive Tools

The primary domains that health systems and pharmacy services must focus on incorporating predictive analytics platforms are in pursuit of MTM. Identifying those patients with the greatest risk of nonadherence or poor clinical outcomes is possible through predictive models, including logistic regression or machine learning algorithms so that the pharmacists can step in proactively (Worrall et al., 2025; Zheng et al., 2023). 8.4 Alignment between Policy and Reimbursement

To achieve a sustainable adoption, however, reimbursement policies must change to be based on a value-based care ideology. The role of payers is to identify and pay

pharmacist-led MTM initiatives which use predictive analytics all the more so when these initiatives are coupled with optimization of outcomes.

10.1.1. Recommendation

Policy advocacy must be targeted at the change of CMS and payer reimbursement models into rewarding outcome-based MTM services (Taveira et al., 2006; Patil et al., 2022).

10.1.2. Research priorities in the future

The given study proposes such directions of future research:

Patient outcome tracking long term in predictive MTM.

Comparisons of the AI-backed and traditional MTM approaches.

Measurement of patient reported experiences and satisfaction.

10.1.3. Recommendation

Future research should undertake mixed-methods designs that would allow investigating clinical and humanistic outcomes of predictive MTM (Zheng et al., 2023; Umeh et al., 2025).

10.1.4. Recommendation

The institutions need to incorporate the risk stratification dashboards within the current EHR systems and develop the ability to give pharmacists a patient-level insight in real-time (El-Deyarbi et al., 2024). 8.2 Pharmacists Capacity Building and Training

Pharmacists have to be endowed with analytical skills that will assist them in interpreting predictive outputs and translating them to clinical practice to ensure maximum benefit of predictive MTM.

10.1.5. Recommendation

The academic sectors and healthcare systems ought to prepare continuing education modules about AI in clinical decision-making, MTM analytics, and interpretation of data (Romanelli et al., 2015; Alkaim & Khan, 2024).

Table 3:Key Recommendations for Predictive MTM Enhancement

Recommendation	Priority Score (1–10)
Integrate Predictive Tools into Pharmacy Practice	9
Pharmacist Training & AI Education	8
Interdisciplinary Care Model Development	7
Policy & Reimbursement Reform	6
Future Research Expansion	5

7.2 Interdisciplinary Care Model Investment

The successful implementation of a predictive MTM means collaborative care among pharmacists, physicians, nurses and IT specialists. To use the potential of the technology, pharmacists have to be included in their care teams as its full members.

10.2. Recommendation

To implement and evaluate predictive-MTM implementation, health institutions ought to organize interdisciplinary task groups to coordinate predictive-MTM implementation systems and track their effect on patient outcomes and resource utilization (Paneerselvam et al., 2024; Wang et al., 2024).

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