

Evaluation of the Import of Medication Therapy Management (MTM) Intervention Services on Therapeutic Outcomes of Patients with Multiple Chronic Medical Conditions (MCMC)

Comfort O. Olurishe, Bilikisu Umar, Victor B. Irmiya, Abdullahi Musa, Suleiman Aliyu, Buhari Y. Isa, Umar Abubakar, Ibrahim Malam Baba Mbiza, Sami'a Y. Adebayo Ubaidullah Muhammad, Tahirah B. Salihu, Jibril Sa'idu, Abdullateef Abdulsalam

Department of Pharmaceutical Services, Ahmadu Bello University Teaching Hospital, Zaria, Nigeria

Corresponding Author: Comfort Olurishe

Email: comfortolurishe@yahoo.com **Phone:** +2347057372848

ABSTRACT

Background: As part of efforts to address the problem of medication-related morbidity and mortality, MTM is evolving as a prominent pharmaceutical care service targeting patients with MCMCs aimed at optimizing therapeutic outcomes through appropriate/improved medication use and monitoring.

Objectives: To evaluate the import of pharmacist led MTM intervention services on therapeutic outcomes in type 2 diabetic outpatients with other co-morbid medical conditions.

Methods: A prospective, longitudinal and interventional study conducted among forty Type 2 Diabetic Mellitus out-patients with co-morbid medical conditions in a pilot MTM clinic at ABUTH, using structured questionnaires, and face to face interview. Patients were managed using the five core components of MTM (medication reviews, medication action plan, interventions/referral, and follow-up). Management outcomes, knowledge on disease, medication adherence, and selfcare were evaluated and analyzed using Pearson Chi-square.

Results: There were significant decreases in 2-hours post prandial ($p < 0.05$) and in medication adherence level ($p = 0.002$) observed 3 months after MTM intervention. A decrease of 68%, 57% and 21% was recorded in the occurrence of drug interactions, drug identity problem and adverse drug reactions respectively. 5% of co-morbid obese and 9% of stage one hypertensive patients also moved to the class of overweight and pre-hypertension. Patient satisfaction assessment revealed that 90% were satisfied with the services received.

Conclusion: MTM intervention services resulted in significant improvements in overall management outcomes, boosted patient confidence and satisfaction in health care services. We recommended the establishment of MTM unit as an integral part of the Department of Pharmaceutical Services in health-care facilities.

Key Words: Medication therapy management; Type 2 Diabetes; Intervention; Therapeutic outcome

INTRODUCTION

Medication therapy management (MTM) is an outcome-oriented intervention service, provided typically by pharmacists to patients with chronic multiple medical conditions that aims to maximize their treatment goals by helping such patients to better understand their health conditions and the medications used to manage them¹. It is defined by the American Pharmacists Association as a “service or group of services that optimize therapeutic outcomes for individual patients”².

MTM service involves providing self-management education, addressing medication adherence issues, and considering preventative health strategies to optimize therapy and improve clinical outcomes³. It involves a comprehensive medication (prescribed/over the counter medications and dietary supplement) review to ascertain if patient's medication-related needs viz a viz the patients' medical conditions, comorbidities and complications have been met and all medications are appropriate, effective, safe, and convenient. At the end of the review, a care plan is developed and shared with the patient and the primary care provider to resolve and prevent any drug therapy problems (DTPs).

Studies have shown that MTM help improve medication adherence rates, improve medication safety, effectiveness, and reduce the occurrence of medication errors⁴, in addition to promoting the rational use of medicines. This service can be especially valuable for people who are older, have multiple chronic conditions, take multiple medications, or are seen by multiple doctors. The polypharmacy in this category of patients comes along with frequently undesirable consequences, such as increased risk of inappropriate drug use, under-use of effective treatments, medication errors, drug interactions, poor patient compliance, and adverse drug reactions⁵.

The centre for disease control and prevention in a 2020 report found that at least 51.8% of American adults had at least 1 of 10 selected diagnosed condition including diabetes, hypertension asthma, coronary heart disease e.t.c⁶. Diabetes Mellitus is the most common endocrine disorder associated with disabling and life-threatening complications and premature deaths. The global prevalence of diabetes in 20-79 years old in 2021

was estimated to be 10.5% (536.6 million people) with an estimated prevalence of 12.2% (783.2 million) people in 2045⁷. Fewer than one in ten of people living with diabetes in low or middle income countries receive coverage of guideline based diabetes treatment⁸. Medication Review (MR) and Medication Therapy Management (MTM) are evolving as the most prominent services in pharmaceutical care and have a strong potential to provide a large benefit for patients and society. MTMs can only be performed in an inter-professional, collaborative setting.

A pilot MTM study conducted in the United States on diabetic out patients showed 1.52% average reduction in HbA1c, average knowledge and medication adherence score increased as well as average score on the patient satisfaction⁹. Attaining optimum glycaemic control reduces the risk of microvascular (retinopathy, neuropathy & nephropathy) and macrovascular complications (CHD, stroke & PVD). Another research done in Florida on MTM interventions resulted in an average reduction of 1.3% in HbA1c goal in pharmacist group compared to usual care participant¹⁰. Furthermore, a randomized controlled trial recently found that patient education can reduce the risk to acquire diabetes¹¹, with other studies supporting the efficacy of patient counseling on drug-adherence¹² and patient skills in handling drug-devices¹³. Several other international studies have explored the benefit of MTM on the quality and costs of therapy^{14,15}.

Other MTM outcomes relate to intermediate health outcomes measured typically by laboratory or other biometric tests for common chronic conditions; these may include haemoglobin A1c, blood pressure, cholesterol (e.g., total, low-density lipoprotein, and high-density lipoprotein cholesterol), and cardiac or pulmonary function (e.g., left ventricular ejection fraction, spirometry). Other MTM services that relate to patient-centered outcomes are morbidity, mortality, adverse drug events, missed days of work or school, patient satisfaction with care and health-related quality of life¹⁶.

Through their extensive training in medication therapy, pharmacists are ideally suited to interpret the patient's physical, clinical and laboratory data relative to therapeutic guidelines, assess the

effectiveness and safety of each individual patient's medicine regimen and offer recommendations to prescribers^{17,18}. MTM has gained significant attention as an important type of pharmaceutical care designed to improve patient outcomes with more appropriate medication use and monitoring¹⁹

As part of the effort to effectively address the urgent public health issue of medication-related morbidity and mortality, MTM services should be considered for any patient with actual or potential medication-related problems, regardless of the number of medications they use, their specific disease states, or their health plan coverage. MTM services will enhance patients' understanding of appropriate drug use, increase adherence to medication therapy, and improve detection of adverse drug events.

In the light of the aforementioned benefits of MTM services. We evaluated the import of MTM intervention services on therapeutic outcomes of diabetic patients with other co-morbid medical conditions.

1). Our goal was to establish and maintain the following clinical diabetes control indices

(a). A glycaemic control of fasting blood glucose: 4.0 – 6.2mmol/L, and 2hrs Post prandial:<10 mmol/l

(b). To Target Blood pressure to <130/80mmHg in patients

(c). In depth patient's education on disease condition and use of medication

2). To identify and resolve the following drug therapy problems (DTPs)

(a). To determine whether the drugs prescribed to patients are safe and appropriately indicated/justified

(b). To determine medication adherence levels

3). To Assess Patient's satisfaction and show reduction in expenses associated with physician visits, urgent and emergency care visits and hospitalization.

METHOD

A pilot MTM clinic was set up using 40 Type 2 Diabetic Mellitus out-patients at the polyclinic area, Ahmadu Bello University Teaching Hospital Zaria, Kaduna state.

Inclusion criteria

Type 2 diabetic mellitus patients (age: 40years and above) with other co-morbid medical conditions including cardiovascular disease, asthma,

arthritis, e.t.c **having a complete medical record** in addition to not meeting target diabetic goals despite been regular for clinic visits over a period of the last one year (i.e. three to four clinic visits) were recruited for the study.

Study population

All ambulatory Type 2 Diabetes Mellitus patients attending the medical out-patient clinic during the study time frame formed the study population and those who fully met the criteria of the study were taken as study participants. Patients who could not stand the interview (e.g, too sick to be interviewed), those with cognitive impairment and all that were not regular or changed follow-up site were excluded.

Study design

Patients' medication and medical profile was reviewed using their folders before their appointment date by qualified pharmacists trained to offer MTM services. Eligible patients were then approached and verbal consent obtained to participate in the study. The patients knowledge of diabetes and its management, adherence to medication, patients satisfaction, and selfcare approaches were assessed using designed proformas.

Their baseline parameters such as blood glucose and pressure values, heights and weights, knowledge about their disease state, roles on selfcare, adherence to medication, were assessed and documented in the MTM documentation forms before the patients proceeded to see the physician for the review. Thereafter, the Medication therapy management was carried out by the pharmacists and it involved a one to one in-depth patient education on diabetes and its management, self care approaches, counselling, procurement and use of point of care devices and other resources to enhance patients' understanding regarding the use of their medication in order to improve adherence.

The following MTM core elements were employed:

Medication therapy review (MTR): A systematic process of collecting the patient specific information, assessing medication therapy to identify medication related problems, and creating a plan to resolve them. A medication therapy review was conducted between the patient and the pharmacist as the patient presented all

current medications to the pharmacist, including all prescription and non-prescription medications, herbal products, and other dietary supplements. Pharmacists provided interventions to patients, including cautions regarding over-the-counter product use, education on dietary modifications, physical activity, self-monitoring, the benefit of proper medication use, and the advantage of medication adherence.

Personal medication record (PMR): The pharmacists provided the patient with a personal medication record containing a comprehensive list of medicines, information to assist the patient in his or her overall medication therapy self-management.

Medication-related action plan (MAP): The Pharmacists also developed an action plan, which is a list of actions for the patient to use in tracking progress for self-management and to achieve specific health goals.

Intervention and/or referral: Some patients required interventions which needed collaborating with physicians to resolve existing or potential medication-related problems identified during the course of running the MTM clinic.

Documentation and follow up: MTM services were documented and a follow up MTM visit was scheduled which was either based on the patient medication related needs, or the next appointed visit to the physician.

Patients were followed up on two phone interviews, one and two months after the first MTM clinic visit, and education and interventions on their medication action plans were further re-emphasized. On the next follow up i.e. three months, a second MTM was carried out and the intervention parameters as discussed in the study designed were re-assessed. Post intervention DTPs were also identified from study participants who had undergone the previous stages of the data collection process and phone call intervention services.

Study variables:

Blood glucose: Blood glucose control levels were categorised using the guidelines of the American Diabetes Association (ADA)²⁰ on glycaemic control levels for Fasting plasma glucose control

levels and post prandial plasma glucose as shown below:

Fasting plasma glucose: Optimal (4.0-5.5 mmol/l), Acceptable (5.6-6.9 mmol/l), Poor (>7.0 mmol/l). 2 hours post prandial plasma glucose: Acceptable (<10 mmol/l), Poor (>10mmol/l)

Blood pressure: The study participants blood pressure was categorised into four, using the JNC 7 classification of hypertension²¹ in mmHg as Normal (<120/80), Prehypertension (>120-139/80-89), Stage 1(>140-159/90-99), Stage 2(>160/100).

Body mass index: The body mass index of study participants was categorised according to World Health Organization²² recommendations in kg/m² as underweight (<18) normal (18.5-24.9) overweight (25.0-29.9), class 1 obesity (30-34.9), class 2 obesity (35.0-39.9) and class 3 obesity (≥ 40).

Patient knowledge was assessed using the standard proforma as designed in a previous USA MTM study⁹.

Ethical consideration

Ethical approval was obtained from the ABUTH Scientific and Health Research Ethics Committee before commencement of this study. The study was approved on the 4th September, 2019 by the Health Research Ethics Committee of ABUTH under the D-U-N-5 with clearance number 954524802.

Data Analysis

Data analysis was carried out after careful compilation of data and recorded appropriately using microsoft excel. The data was categorized, coded and analysed by descriptive and analytical statistics using statistical package for social sciences (SPSS) VERSION 20, California INC. Data on clinical characteristics was analysed by descriptive statistics and presented as a table. Categorical variables were also analysed using chi-square test and represented as tables and charts.

RESULTS

Outcome of medication therapy management (MTM) intervention services on fasting plasma glucose in patients

A significant difference $p=0.001$ (Chi-square test) comparing the patients with poor glycaemic control before intervention with their control

status post-MTM intervention. However, no significant difference in status of patients with acceptable glycaemic control pre and post-MTM, but 37% of patients with FPG assessment as acceptable control at the beginning remained at that control level post intervention, while another 37% attained optimal levels, and the remaining 26% had poor glycaemic control post intervention (Table 1).

Table 1: Outcome of Medication Therapy Management (MTM) Intervention Services on Fasting Plasma Glucose in Patients

Baseline category of glycaemic control	Percentage level at end of study			P value (Chi square)
	Poor	Acceptable	Optimal	
Poor	70	13	17	0.001
Acceptable	26	37	37	

Values are presented as percentage frequencies. A significant difference $P=0.001$ (Chi square test) comparing the patients with poor glycaemic control before intervention with their control status post-MTM intervention.

Key: Fasting plasma glucose: Optimal (4.0-5.5 mmol/l), Acceptable (5.6-6.9 mmol/l), Poor (>7.0 mmol/l).

Import of MTM intervention services on FPG and 2HPP of patients post MTM intervention compared to values at previous clinic visits.

There was no significant difference in the number of patients with poor and acceptable glycaemic control (FPG) post MTM, compared to values at the three previous clinic visits before intervention

(Figure 1). However, there was a significant difference at $p=0.002$ (Chi-square test) comparing the number of patients with poor and acceptable glycaemic control (2hPP) values at the three previous clinic visits before intervention with their number 3 months after initiation of MTM Services (Figure 2).

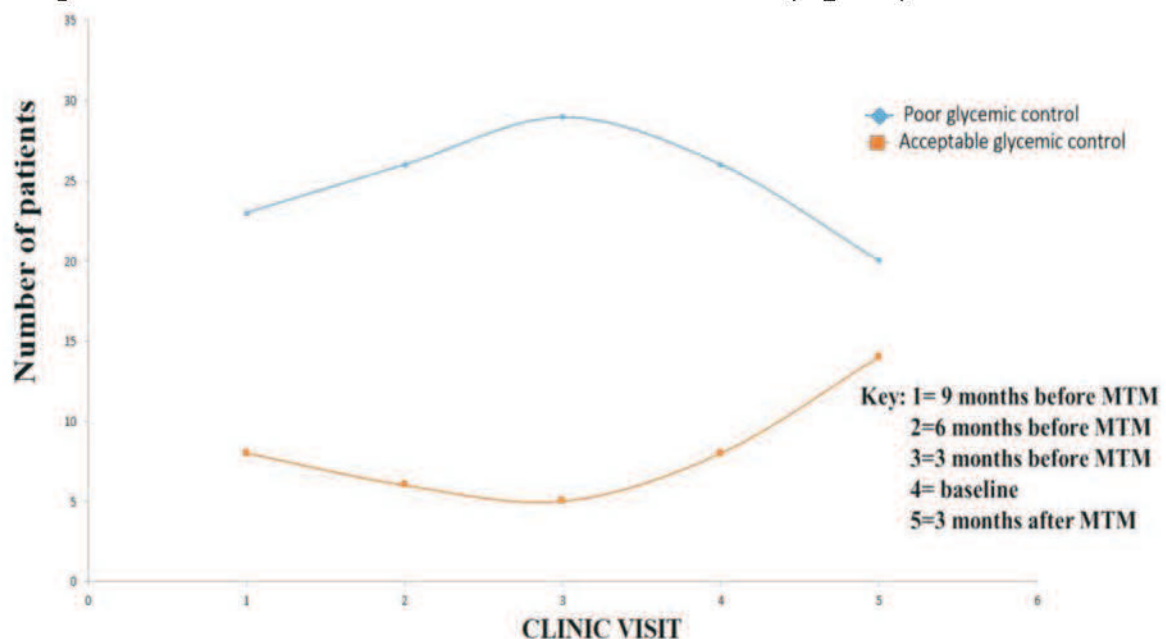


Figure 1: Effect of Medication Therapy Management Intervention Services on Fasting Plasma Glucose Three Months After Initiation of MTM

Values are presented as frequencies. No significant difference $P>0.05$ (Chi square test) comparing the number of patients with poor or acceptable glycaemic control values at the three previous clinic visits before intervention with their number 3 months after initiation of MTM Services.

Key: Fasting plasma glucose: Optimal (4.0-5.5 mmol/l), Acceptable (5.6-6.9 mmol/l), Poor (>7.0 mmol/l).

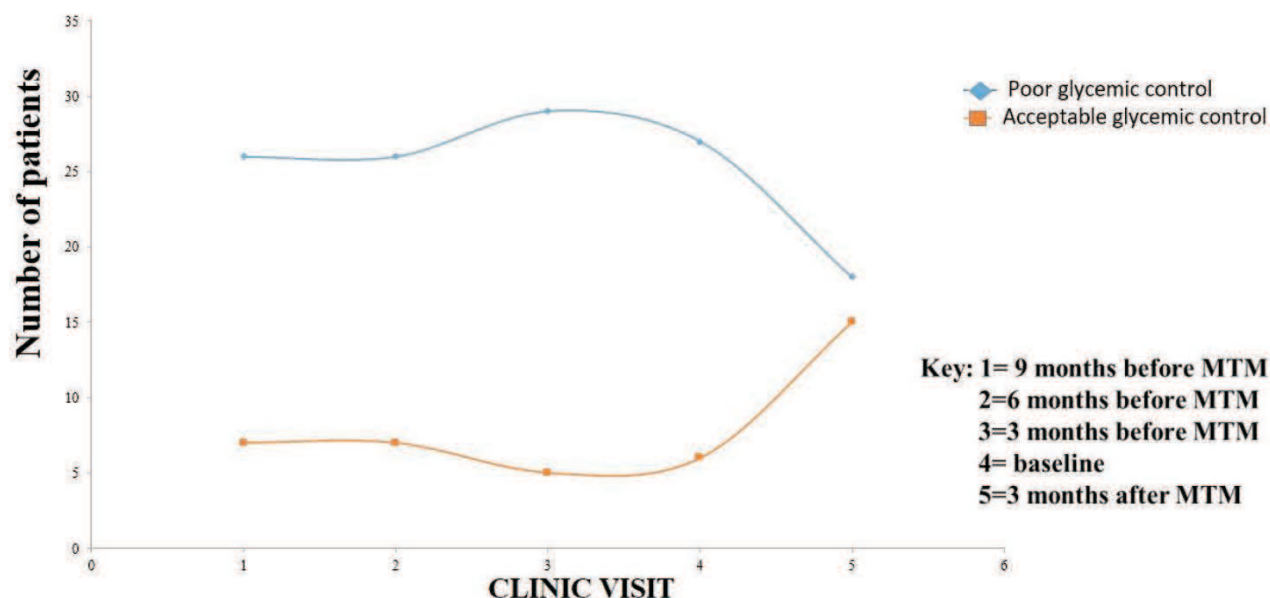


Figure 2: Effect of Medication Therapy Management (MTM) Intervention Services on 2 Hours Post Prandial (2HPP) Three Months After Initiation of MTM

Values are presented as frequencies. A significant decrease at $p=0.002$ (Chi square test) comparing the number of patients with poor or acceptable glycaemic control values at the three previous clinic visits before intervention with their number 3 months after initiation of MTM Services.

Key: 2 hours post prandial plasma glucose: Acceptable (<10 mmol/l), Poor (>10 mmol/l)

Outcome of MTM services on patient blood pressure 3 months post intervention

The percentage of patients with blood pressure in the normal range before MTN were 11% and the percentage remained as such post MTM, on the other hand, the percentage of patients in the

prehypertensive category increased from 15% at baseline to 31%, after intervention because of the patients in stage 1 and Stage 2 hypertension who had reduced from 42% and 31% at baseline to 31% and 27%, post intervention respectively (Figure 3).

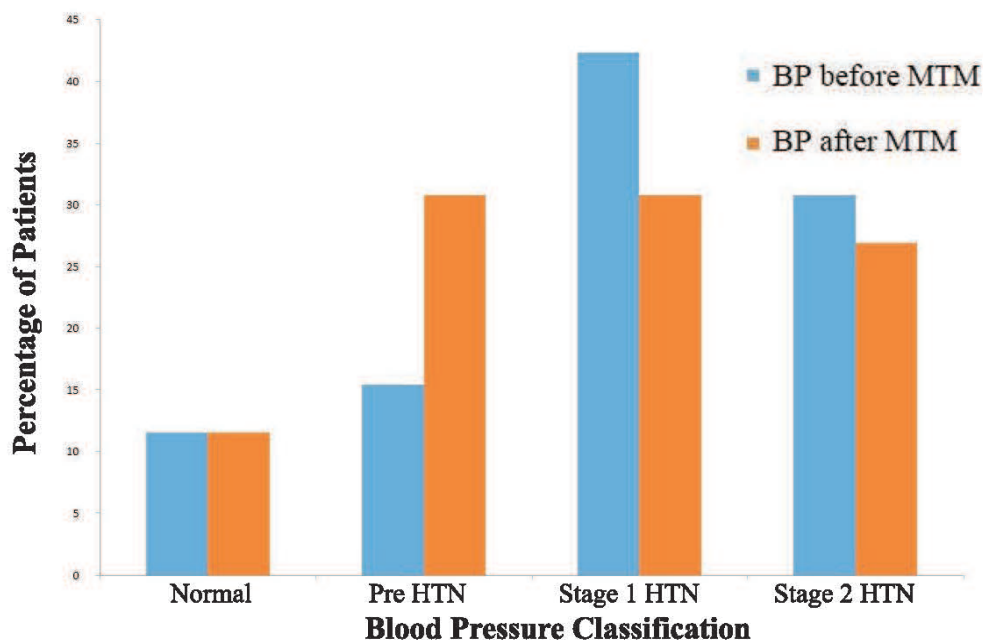


Figure 3: Outcome of MTM Services on Patient Blood Pressure 3 Months Post Intervention

Values are presented as percentage frequencies. No significant difference ($P>0.05$) Chi-Square Test, comparing the Patients BP pre and post MTM intervention.

Key: Blood pressure classification is presented as Systole/Diastole in (mmHg)- Normal ($<120/80$), Prehypertension ($>120-139/80-89$), Stage 1 ($>140-159/90-99$), Stage 2 ($>160/100$).

Effect of MTM services on patients body mass index (BMI) 3 months post intervention

The baseline body mass index of the patients studied were 5% in the normal range, 31% with Class 1 obesity and 10% with Class 3 Obesity and this was maintained throughout the study.

However, the patients that were overweight (26%) pre-MTM intervention had increased (31%) because of the reduction to 21% in the number of patients with Class 2 obesity from the initial 26% at the onset (Figure 4).

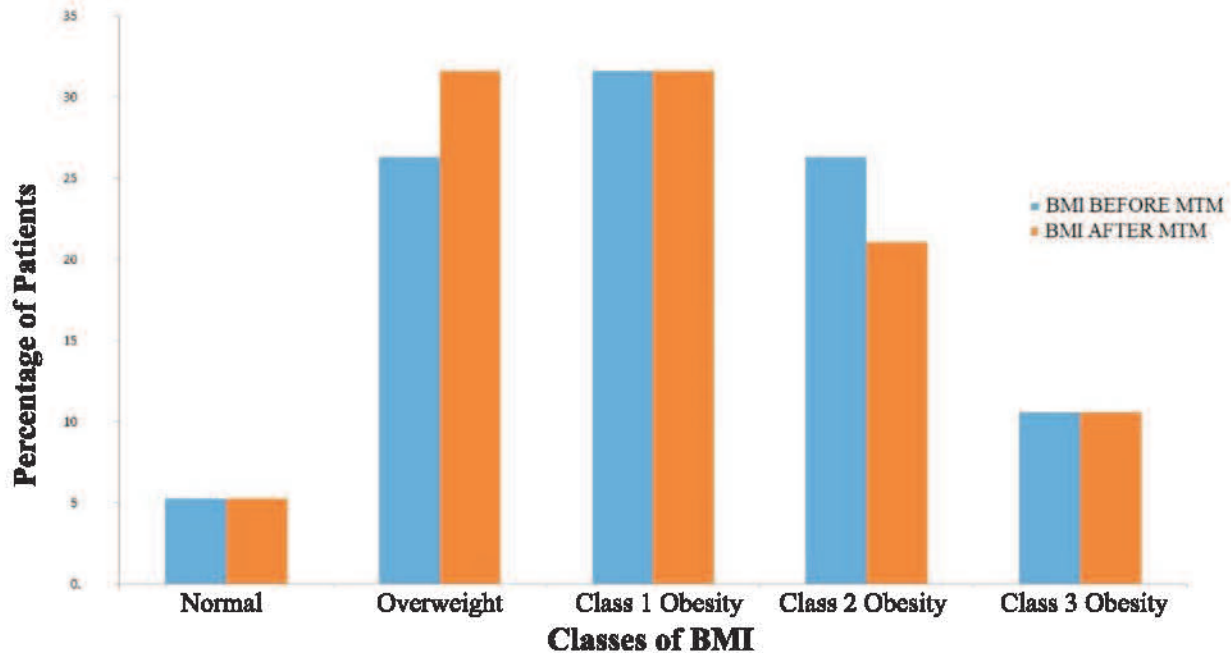


Figure 4: Outcome of MTM Services on Patients Body Mass Index (BMI) 3 Months post intervention

Values are presented as percentage frequencies. No significant difference ($P > 0.05$) Chi-Square Test, comparing the Patients BMI pre and post MTM intervention.

Key: Classification of body mass index in kg/m^2 as: underweight (< 18), normal (18.5-24.9), overweight (25.0-29.9), class 1 obesity (30-34.9), class 2 obesity (35.0-39.9) and class 3 obesity (≥ 40)

Level of resolved drug therapy problems following MTM intervention service

The most frequent drug therapy problem observed pre-intervention, was drug interactions as seen in previous prescriptions of 89% of the study participants and 64% with drug identity problems. However, there were significant reductions to 21% and 7% post-MTM respectively. In addition, adverse drug reactions and overdose were observed in 25% and 4% of the patients with a reduction to 4% and 0% respectively post-intervention. Underdosed patients before MTM intervention was (11%) while (7%) of patients had prescriptions of medicines contraindicated due to other co-morbid conditions (Figure 5).

Effect of MTM intervention services on medication adherence

There was a significant reduction ($p = 0.001$) Chi Square test, comparing the percentage of patients with a baseline poor adherence status with their status post intervention (Table 2).

DISCUSSION

In this study, pharmacists as members of the health care team added value to the multidisciplinary approach to outpatient care, evident in the significant reductions in glycaemic indices recorded. A systematic review similarly documented improvements in both fasting and post prandial glucose levels following pharmacists intervention through medication therapy management²³. Other studies using glycosylated haemoglobin also recorded improvements after instituting pharmacists led MTM services^{9,24,25}. The study similarly recorded an increase in percentage of patients achieving set blood pressure goals similar to a study where pharmacist intervention led to decreases in average systolic and diastolic blood pressure by 6.0 and 4.2 mmHg, respectively²⁶. Attaining set blood pressure goals is of importance in type 2 diabetic patient because of the increased risk of cardiovascular and renal complications associated with the comorbid states. The patients' average

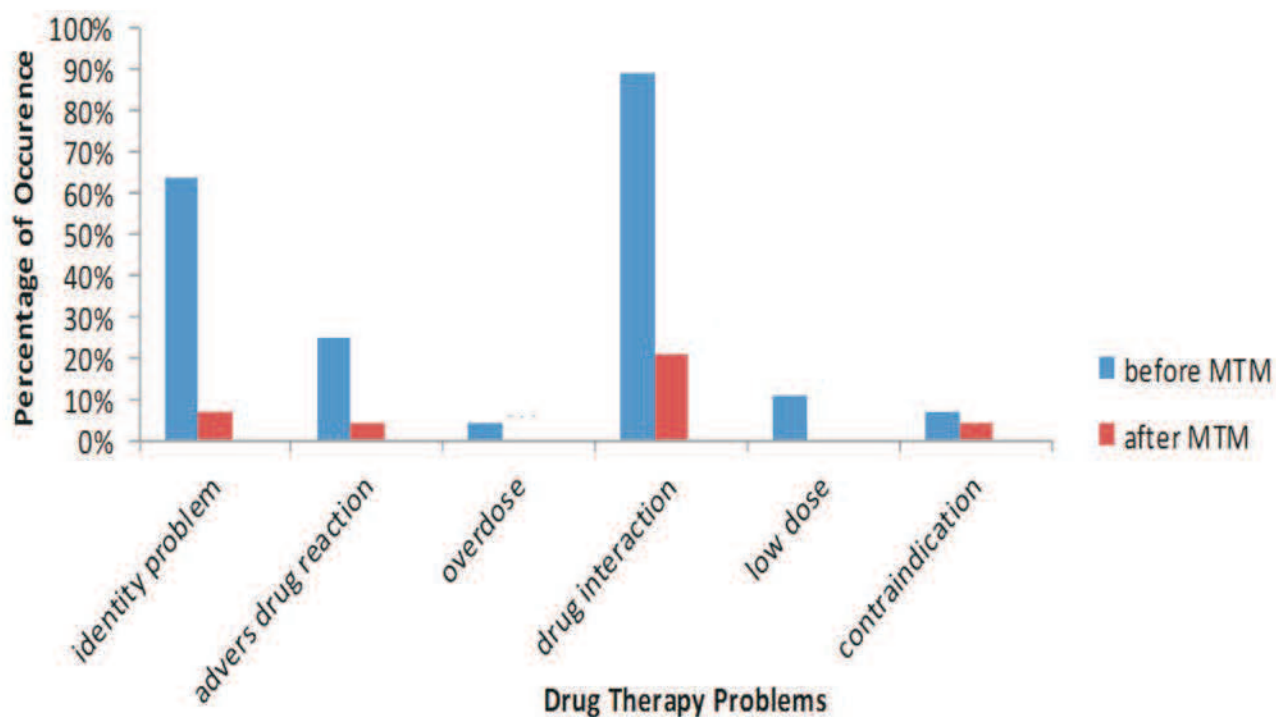


Figure 5: Level of Resolved Drug Therapy Problems Following MTM Intervention Service

Table 2: Outcome of MTM Intervention Services on Medication Adherence

Baseline level of medication adherence	Percentage level at end of study				P value (Chi-square)
	Poor	Fair	Good	Very good	
Poor	9	58	33	0	0.001
Fair	0	0	63	37	
Good	0	0	37	63	

Values are presented as percentage frequencies. Significance difference (P=0.001) Chi Square Test, comparing patients with a baseline poor adherence status with their status post intervention

knowledge also increased and this is consistent with a study carried out in USA, that showed increase in the average knowledge score after 16 weeks of instituting MTM intervention service in a qualified health center⁹. The results of our study clearly indicate that diabetic education on various selfcare approaches, and increased patient participation in their disease management led to increased diabetes knowledge and invariably, improved management outcomes. Self-blood glucose monitoring was of major emphasis in our study, alongside dietary modifications, medication adherence and exercise. These are key counselling points in patients receiving a diabetes education, and were reported as rating high, the quality of information provided to them by pharmacists²⁷.

The BMI in a patient with DM is a cornerstone of therapeutic efficacy, monitoring and subsequent decision-making, as it assesses obesity status and cardiovascular risk factors. A deteriorating BMI impedes treatment efficacy because lifestyle interventions are not adequate²⁸. Our study clearly demonstrated reductions in patients BMI following MTM interventions.

Due to coexistence of comorbidities and complications, diabetes management is challenged by the occurrence of drug therapy problems (DTPs). They can occur at different stages of medication use starting from prescriber to patients and are especially pronounced among older adults as they are often diagnosed with multiple chronic medical conditions²⁹. Drug-drug interactions were the most identified DTPs in the pre-intervention phase of our study as similarly reported by³⁰. Significant drug interactions are known to compromise efficacy of therapy in patients coupled with increase in exposure to side effects. The MTM intervention, however recorded a reduction in incidence of drug interactions following effective counselling on medication spacing. Adverse drug reactions (ADR) were also observed in our study. A Pharmacists led MTM study in Ethiopia recorded ADR as most frequent type of DTP, contrary to drug interactions been the most occurring in our study³¹. This was probably due to difference in recruitment criteria, pharmacist clinical skills and tools used for DTP assessment. A study in Sao Palo had demonstrated that advanced age was positively associated with a higher number of DTPs because the

pharmacokinetic and pharmacodynamic changes intrinsic to the aging process favoured the occurrence of adverse events related to the use of medications³².

Our study found that 43% of study participants had poor medication adherence in the preintervention phase similar to greater than 39% observed in a similar study³⁰. The study in Sao Palo recorded non-adherence as being the most frequent DTPs amongst older patients with MCMC in a primary health care centre and associated it to difficulty in accessing medications³². The location of our study site is a semi urban area and some patients could not afford the cost of their medication due to polypharmacy often attributed to the presence of other comorbid conditions like hypertension. This implies that prescribing medications is often challenging in people with multiple chronic diseases. Forgetfulness was also another factor and inability to identify the medications correctly which was the second most occurring DTPs. Patients face barriers in managing their disease state, specifically in understanding how to take their medications appropriately and becoming actively engaged in self-management of their diabetes⁹. In our study, the identification of specific barriers for each patient and appropriate counselling led to improvement in patience adherence as observed post intervention. A systematic review and meta-analysis, though amongst patient with heart failure reported that pharmacist intervention had significant effects in improve medication adherence among patients³³. The satisfaction score of our study participants' was relatively high (90%) and was consistent with rates (80% and above) reported in other MTM studies^{30,34}.

CONCLUSION

The outcome of our study revealed that pharmacists led MTM program has potential to improve optimal diabetes management by a more comprehensive one to one in-depth patient education/counselling and disease monitoring. The findings also demonstrate that pharmacists, can assist a multidisciplinary team in identifying, intervening and preventing DTPs and thus delaying the onset and progression of complications.

REFERENCES

1. The United States Agency for Healthcare Research and Quality (AHRQ). Health care innovations exchange (2016). Pharmacists-led medication therapy management innovations. <http://www.ahrq.gov/innovations/ihdex.html>
2. Blumi BM (2003). Definition of Medication Therapy Management: development of a profession-wide consensus. *JAPA* 45(3):566-572.
3. Ogallo W, Kanter AS (2017). Using Natural Language Processing and Network Analysis to Develop a Conceptual Framework for Medication Therapy Management Research. *AMIA Annu Symp Proc* 984–993.
4. Liao Y, Xu C (2018). Exploration of the mode of medical treatment management (MTM) applied in clinical pharmacist training. *China Mod Doctor* 56(1):141–144.
5. Ghandi TK, Weingart SN, Bolus J et al (2003). Adverse drug event in ambulatory care. *N Engl J Med* 348(10): 556-564
6. Boersma P, Black LI, Wars BW (2020). Prevalence of multiple chronic conditions among US adults, 2018. *Prev Chronic Dis* 17:200130: DOI:[http://dx. doi. org/10.5888/pcd17200130](http://dx.doi.org/10.5888/pcd17200130)
7. Sun H, Saeedl P, Karuranga S, Pinkepank M, Ogurtsova k, Duncan BB, Stein C, Basit A, et al (2021). IDF. Diabetes atlas. Global, regional and country-level diabetes prevalence estimate for 2021 and projections for 2045. *Diabetes Res. Clin. Pract.* 183:109119:DOI:10.1016/i.diabres.
8. Flood D, Seiglei JA, Dunn M, Tschida S, Thellimann N, Marcus M, (2021). The state of diabetes treatment coverage in 55 low and middle income countries: a cross sectional study of nationally representative, individual-level data in 680102 adults. *The Lancet* 2(6):340-351.
9. Ndefo UA, Moultry AM, Davus PN, Askew R (2017). Provision of medication therapy management by pharmacist to patients with type 2 diabetes mellitus in a federally qualified health centre. *Pharmacy and Therapeutics (P&T)* 42(10):632-637
10. Johnson KA, Chen S, Gheng IN et al (2010). The impact of clinical pharmacy practices integrated into medical homes on diabetes related clinical outcomes. *Ann Pharmacother* 44(12):1877-1846.
11. Schmiedel K, Mayr A, Fiebler C, Schalger H, Friedland K (2015). Effects of the lifestyle intervention programme in people at risk of type 2 diabetes: a cluster randomised control trial. *Diabetes Care* 38(5). 637-939.
12. Lee JK, Grace KA, Taylor AJ (2006). Effect of a pharmacy care program on medication adherence and persistence, blood pressure, and low-density lipoprotein cholesterol: a randomized controlled trial. *JAMA* 296(21): 2563–2571.
13. Hammerlein A, Muller U, Schulz M (2011). Pharmacist-led intervention study to improve inhalation technique in asthma and COPD patients. *J Eval Clin Pract* 17(1):61–70.
14. Barnett MJ, Frank J, Wehring H, Newland B, VonMuester S, Kumbera R, Hulterman T, Perry PJ (2009). Analysis of pharmacist provided medication therapy management (MTM) provided services in community pharmacies over 7 years *J Manage Care* 15(1):18-39.
15. Schultz BG, Tilton J, Jun J, Scott-Horton I, Quach D, Touchette DR, Cost effectiveness analysis of a pharmacist led medication therapy management programme: Hypertension management. *Value Health* 24(4):522-529.
16. Hassol A, Shoemaker SJ. Exploratory Research on Medication Therapy Management. (Prepared by Abt Associates under Contract #HHSM-500-2005-00181/TO#3.) Baltimore, MD: Centres for Medicare & Medicaid Services; July 8, 2008
17. Ells AW, Sherman JJ (2013). Community and clinical pharmacy services: A step-by-step approach. In: Westberg SM, Reidt SL, Sorensen TD, eds. *Medication Therapy Management*. 1st ed. New York: McGraw-Hill Education:49-61.
18. Cipolle RJ, Strand LM, Morley PC (2012). *Pharmaceutical Care Practice: The Patient-Centered Approach to Medication Management*. 3rd ed. New York: McGraw Hill Professional.
19. Jeong, E. Deguzman L, Fredericks D *et al.*, (2012). Comprehensive medication reviews improve hospitalization and emergency department outcomes. *Kaiser Permanente*.

20. American Diabetes Association, Standards of Medical Care in Diabetes-2019 Abridged for Primary Care Providers. *Clin Diabetes* 37 (1):11-34.
21. The Seventh Report of the Joint National Committee (JNC) on Prevention Detection Evaluation and Treatment of High Blood Pressure. US department of Health and Human Services. National Institute of Health. <http://www.nhibi.nih.gov>
22. Obesity: preventing and managing the global epidemic (2000). Report of a WHO consultation. World Health Organ Tech Rep Ser 894:i-xii, 1-253.
23. Crosby C, Qian J, Ngorsuraches S, Garza KB (2019). The Impact of pharmacist-delivered medication therapy management (MTM) on outcomes for Patients with diabetes: A Systematic Review. *Value in Health. in health.com*
24. Tilton JJ, Edakkhunnathu MG, Moran KM, Vaysman AN, DaPisa AL, Goen BM, Touchette DR (2019). Impact of a medication Therapy Clinic on glycosylated haemoglobin, blood pressure and resource utilization. *Annals of Pharmacotherapy* 53(1):13-20.
25. Skinner JS, Wilkins CH (2015). Assessing the effectiveness of pharmacists directed medication therapy management in improving diabetes outcomes in Patients with poorly controlled diabetes. *The Science of Diabetes Self Management and Care* 41(4) <https://doi.org/10.1177/0145721715587563>
26. Pinto SL, Kumar J, Partha G, Bechtol RA (2014). Pharmacist-provided medication therapy management (MTM) program impacts outcomes for employees with diabetes. *Popul Health Manag* 17(1): 21–27.
27. Shawn McFarland M, Wallace JP, Parra J, Baker J (2014). Evaluation of patient satisfaction with diabetes management provided by clinical pharmacists in the patient-centered medical home. *Patient* 7(1):115-121.
28. Galicia-Garcia U, Benito-Vicente A, Jebari S *et al.* (2020). Pathophysiology of type 2 DM. *Int J Mol Sci* 21(17):6275. <https://doi.org/10.3390/ijms21176275>
29. Gurwitz JH, Rochon P (2002). Food and Drug Administration. Improving the quality of medication use in elderly patients: a not-so-simple prescription. *Arch Intern Med* 162(15):1670-1672.
30. Wondesen A, Berha AB, Woldu M, *et al* (2022). Impact of medication therapy management interventions on drug therapy problems, medication adherence and treatment satisfaction among ambulatory heart failure patients. *BMJ Open* 12: e054913. doi:10.1136/bmjopen-2021-054913
31. Negash Z, Berha AB, Shibeshi W, Ahmed A, Woldu MA, Engidawork E (2021). Impact of medication therapy management service on selected clinical and humanistic outcomes in the ambulatory diabetes patients of Tikur Anbessa specialist
32. Dias BM, Ramalho-de-Oliveira D, Santos BD, Neves CM, Oliveira GC, Silva DA *et al* (2022). Factors associated with the identification of drug therapy problems among older patients in Primary Health Care 20:1-7.
33. Ruppar TM, Cooper PS, Mehr DR *et al* (2016). Medication adherence interventions improve heart failure mortality and readmission rates: systematic review and meta- analysis of controlled trials. *J Am Heart Assoc*; 5: e002606.
34. Moczygemba LR, Barner JC, Brown CM, *et al* (2010). Patient satisfaction with a pharmacist- provided telephone medication therapy management program. *Res Social Adm Pharm* 6:143–54.