Review Article

The Current Scenario of Clinical Pharmacy Service in the Management of Patients with Diabetes Mellitus and Related Complications: Review Article

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ABSTRACT

Diabetes Mellitus (DM) is a group of metabolic disorder characterized by defect in insulin secretion, insulin action or both. The prevalence of diabetes continues to rise worldwide, placed in an increasing burden on healthcare systems and for the individual payers. This review is aimed to organize and examines the contribution of pharmacist in people living with diabetes mellitus and reviewed to whether the extent of diabetes management interventions delivered by pharmacist is successful in achieving the goal of therapy in DM patients. Many studies revealed and confirmed that the positive impacts of pharmacists intervention on monitoring of blood glucose level, blood pressure, lipid profiles, body mass indexes, diabetes related complications, economic benefits, improving health related quality of life, drug-related problems, adherence to medication, provision of patient education and counseling services, medication therapy management services and other pharmaceutical care services that enhance the clinical outcomes in diabetes patients were better than the usual care services. In all cases, it was proven that the intervention was successful in achieving the goals of therapy in diabetes patients and reducing other complications associated with the disease. Therefore, pharmacist integration into a health care team had shown to be effective in improving a number of clinical health outcomes in diabetic patients. This may be helpful to realize the current progress of pharmacist'srole in people living with diabetes and associated complications.

Key words: Diabetes mellitus, Pharmaceutical care, clinical pharmacist service.

INTRODUCTION

Diabetes Mellitus (DM) is a group of metabolic disorder characterized by the presence of hyperglycemia due to defect in insulin secretion, insulin action or both. This can occur when the pancreas does not produce enough insulin, or when the body cannot effectively use the insulin it produces and leads to an increased concentration of glucose in the blood (hyperglycemia). Currently, DM is a serious chronic disease condition with potentially distressing complications that affects all age groups worldwide.[1,2,3,4]

DM can be classified into several types; however, the two main types are Type 1 Diabetes Mellitus (T1DM) and Type 2 Diabetes Mellitus (T2DM). T1DM is due to β-cells destruction, usually leading to absolute insulin deficiency, which is characterized by deficiency of insulin production and requires daily administration of insulin. T2DM is due to a progressive loss of insulin secretion and insulin resistance results from the body ineffective use of insulin. Until recently, this type of diabetes was seen only in adults, but it is now also increasing occurrences in children.[1,2,3,4]

Globally, about 415-422 million adults live with diabetes in 2014, mainly in developing countries and projected to rise to 642 million by 2040. According to International Diabetes Federation (IDF), an estimated 49.8 million adults aged 20-79 have diabetes in the Africa Region. In line with, about 1.8 million of

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Ethiopians are living with diabetes which is third from Africans most populous countries have the highest numbers of people with diabetes.[5,6]

The prevalence of diabetes continues to rise worldwide, placing an increasing burden on healthcare systems, payers, and providers.[7] Diabetes of all types can lead to several complications in many parts of the body. Possible complications may include heart attack, stroke, nephropathy, leg amputation, retinopathy and neuropathy. In pregnancy, poorly controlled diabetes increases risk of fetal death and other complications.[6] Despite, the release of impressive new medications to control the condition, it remains a significant global diabetes burden. IDF estimates for the Africa Region, only $4 billion was spent on diabetes healthcare in 2015. This is equivalent to 7% of the regions total health budget and about $400 per person with diabetes per year.[5]

According to World Health Organization (WHO), (2006), pharmacists had faced to expand their role beyond their traditional role of manufacturing and supplying medicines due to an ever-growing and complex range of medicines, and poor adherence to the prescribed drugs, leads to be advanced the pharmacists role into patient-centered. The WHO and International Pharmaceutical Federation (FIP) were stated that 'Pharmacists have an important role to play in health care, which is much more than selling medicines.[8]

To match up, the role of pharmacists need to be expanded to include pharmaceutical care concepts, making the pharmacist a health care professional rather than a drug seller in a commercial enterprise. They should apply a new knowledge based on the pharmaceutical, social, and clinical sciences; collaborate with other health professionals and learn to enhance the quality of life for the people of local and global community.[9] Pharmacists are using their clinical skills to serve the community through vaccinations, emergency preparedness and response, drug education, health screenings, medication therapy management (MTM), and counseling services. Pharmacists are more accessible to patients than any other healthcare professional and are well-trained to promote public health, including wellness and prevention.[10]

In the most recent study by Khanal *et al*., (2016) showed that, skills of pharmacists are underutilized. However; there were evidences from many countries that pharmacists have been contributing substantially to the management of many chronic diseases by screening and monitoring; counseling on lifestyle, providing MTM services, and provision of other pharmaceutical services.[11] The practice of pharmaceutical care is new for some countries, especially developing nations like Ethiopia. Since pharmacists and other health professionals often fail to assume responsibility for this care, they may not adequately document, monitor and review the care given. Few years ago, the knowledge base of pharmacy graduates in Ethiopia is changed to the new journey of patient-centered pharmaceutical practice.[12]

Therefore, this review is aimed to organize the roles of pharmacist in the management of diabetes and the impact. This can expand pharmacist service to meet the need of diabetic patients. For this review different primary articles and institutional publications were us

Pharmacist can educate patients with diabetes about the proper use of their medication, screening for drug interactions, explain monitoring devices, and make recommendations for other services.[13] Pharmacist's role in the management of DM has increased significantly in achieving the desired glucose level (HbA1c value) and other clinical outcomes.[14] A cross-sectional study conducted by Berhane et al, (2013) reported that, the majority of physicians expected clinical pharmacists are knowledgeable as they are drug therapy experts and able to educate patients in safe and appropriate use of medications.[15] However; one study conducted at Gondar Referral Hospital showed that, none of the pharmacies had a private counseling room and many pharmacists did not participate in ward round with physicians. Thus, there were gaps in the provision of pharmaceutical care.[16] Therefore, beyond the routine activities, pharmacist with excellent and dynamic background on disease states and therapeutic knowledge on drugs including the pharmacokinetic and pharmacodynamics characteristic of medications, such as dosing, interactions, indications, side effects and alternatives based on the patient's situation plays a crucial role in the pharmacotherapeutic management. The pharmacists 'role has become inevitable in monitoring the drug therapy, especially in identification, resolution and prevention of drug related problems.

Effect on Drug-Related Problems (DRPs) Management

Drug related problems refer to the mistakes which may arise at all stages of the medication process from prescription to follow up of treatment. Drug related problems are defined as problems in pharmacotherapy of the individual patient that actually or potentially interfere with desired health outcomes.[20] This may include untreated indication, improper drug selection, sub-therapeutic dosage, failure to receive medications, overdose, adverse drug reactions, drug interactions and drug use without indication.[21]

With the rapid expansion in number of available drugs and their combinations, medication management has become increasingly complex and challenging. There is a parallel increase in occurrence of drug related problems in every prescription leading to failure in achieving therapeutic outcome.[21,22] Various studies has been shown that drug related problems can occur in patients with diabetes as they consume multiple medication for long term therapy and the fact that they are more likely to have multiple disease states and chronic conditions.[23,24,25,26,27,28]

A team based approach consisting of physicians and pharmacist along with other healthcare professionals is the key and has the potential to meet the complex needs of many diabetic patients including the patient drug therapy. A comprehensive medication management service allows the pharmacist to play a more active role in helping to manage diabetes patients in achieving the clinical outcomes. When these services are provided, the patient receives a better patient care focused on identifying, resolving, and preventing drug related problems.[29]

Drug-related morbidity and mortality are often preventable, and pharmaceutical services can reduce the number of adverse drug reactions (ADRs), the length of hospital stays, and the cost of care.[30] In Malaysia, a 6 months RCT study was demonstrated to identify the types of pharmaceutical care issues encountered by primary care patients with diabetes mellitus. From the total of 477 patients, most of them had at least one pharmaceutical care issues. Most of pharmaceutical care issues (87.3%) were resolved as recommended by hospital pharmacists.[31]

Another study was performed at the University Hospital in Hradec, many drug issues related mistaken to antidiabetics have identified by pharmacists. The major problems were: high doses of hydrochlorothiazide administered to diabetic patients, the administration of beta-blockers to diabetic patients with hypoglycemic attacks and administration of metformin to a patient with kidneys problem. This showed that, the strategic cooperation of doctor-patient-pharmacist reduced much more the incidence of drug-related complications, which are expensive for the payers and reduce the quality of the patient's life rather than minimizing symptoms.[32]

An interventional study was conducted at referral teaching hospital in Tehran, Iran, pharmacists were reviewed 861 patients medical records and detected, reported, and prevented medication errors in the infectious disease. From the study, 112 medication errors were detected for resolution by pharmacists and more of them were occurred in DM patients. Drug dosing, choice, use and interactions were the most causes of error in medication processes. These errors were detected, reported, and effectively prevented errors by ward clinical pharmacists.[33]

The contribution of pharmacist in identifying, resolving and preventing drug related problems by providing interventions was a valuable information for physicians, that have been optimized the drug therapy and reduced healthcare costs. This is supported by researchers have demonstrated that pharmacist-led disease management have had a positive impact on patient outcomes. This shifting standard highlights the value of pharmacist as a trustable, highly accessible, well trained consultant, serve as a resource person for providing drug information to physicians and other healthcare providers in safe, appropriate, cost-effective use of medications.[34]

Effect on Adherence to Medication and Counseling

Medication adherence is the degree to which patient take medications as by their physician or registered medical health practitioner. Patients do not adhere to medication regimens for a variety of reasons, including side effects, timing, not understanding the benefits of medication and don_t want to take so many pills_. Non-adherence to anti-diabetic medication in patients with diabetes medications can lead to sub optimal control of blood sugar, recurrent infections, early development of DM complications and poor quality of life.[35]

One of the best ways to improve medication adherence is patient medication counseling which is an important means for achieving pharmaceutical care. It is defined as providing medication related information orally or in written form to patients or their representatives, on topics like direction of use, advice on side effects, precautions, and storage, diet and life style modifications. The goal of counseling is to provide information directed at encouraging safe and appropriate use of medications, thereby enhancing therapeutic outcomes.[13]

Counseling of patients has a vital role in the outcomes of medication therapy. The therapeutic outcome and quality of life have been significantly improved through counseling sessions for patients suffering from different diseases like diabetes. Nowadays the traditional role of pharmacists has been modified and are playing a role as a vital team member in the direct care of DM patients.[36] In diabetes, self-management and patient adherence to the prescribed medication and lifestyle modifications is very essential and pharmacist can play an important role in counseling patients with diabetes.[13]

Moreover, pharmacists are an integral part of patient healthcare team and tend to serve as key element in providing quality of patient care to reduce adverse drug reactions and improve patient compliance.[37] Pharmacist provided patient counseling has a positive impact on glycemic control of DM patients. This was supported by the study conducted on 30 DM patients who were taking anti- diabetic agents and the counseling service was provided by pharmacist regarding their disease, drugs and life-style modifications, a great reduction had shown in HbA1c value in the post- counseling.[38]

An important present prospective, interventional study was carried out over a period of 12 months to assess the impact of pharmacist provided counseling on medication adherence and glycemic control in DM patients at tertiary hospital, India. Statistically significant differences in medication adherence scores were observed in the intervention group, which showed that, clinical pharmacist intervention through patient education and medication counseling made a significant positive impact in improving medication adherence.[39]

A one-year prospective RCT study was performed to measure the medication adherence with Morisky and absolute change in HbA1c vs baseline, the change of hospitalization between two groups and a total of 322 patients were included in the study. A substantial improvement in the medication adherence was achieved for the pharmaceutical care group. This showed that, a sound enhancement of medication adherence in patients to the newly prescribed insulin therapy and a potential improvement of clinical outcomes with enhanced number of patients fulfilling the goal HbA1c level.[40]

Another evidence based study was conducted on about 300 chronic patients including patients with diabetes from different healthcare sectors reported with poor compliance due to improper counseling, ADR, psychological burden of long treatment and few of them (only 11%) were receiving psychological treatment in the usual care. Having the introduction of clinical pharmacist, there were remarkable improvements in the outcome of treatment with patient trust built on pharmacist as they believe on clinical pharmacist as integral part of their health care provider and achieved their target enhanced in patient hope for their life.[37]

By engaging nonadherent patients to restart their DM or lipid lowering medications during a face-to-face consult, the pharmacist had the ability to influence and improve medication adherence and clinical outcomes the patients.[41] Patients' adherence to medication regimens was improved significantly with an increase in the mean Morisky score from 7.00 to 10.84 in patients with diabetes, which was seen in the pharmacist-run program.[42] Similarly, an RCT study was carried out in Malaysia, found that, adherence to medications among patients in the pharmacist-led improved significantly.[43]

In the study conducted in Jimma university specialized hospital, only 41.8% of the patient had adequate glycemic control. The current prescribed drugs did not achieve glycemic control on majority of the patient. Mainly this was due to poor adherence to the prescribed drug regimen and poor knowledge and practice of successful self-management.[44] From this author suggested that, enrollment of pharmacist in DM management might have a positive impact in achieving the glycemic control and other clinical outcomes.

Effect on Patient Education and Knowledge

Numerous controlled trails have consistently reported about the successful effort of pharmacist in optimizing the glycaemic control in diabetic patients. Thus, the provision of education is one of the pharmacists'key roles. Because of their easy access to people with diabetes, they are able to answer doubts and queries about the condition itself, offer guidance on the proper use of medications and other supplies.[45] As a vital members of healthcare team, pharmacist has had a significant impact on diabetes care and education by screening patients at high risk for diabetes, setting and monitoring diabetic treatment goals, assessing patients health status, home glucose meter training, performed physical assessment of patients feet, skin, blood pressure, weight and lipid management education and adherence to standards of care.[46]

A pharmacist is one of few medical professionals in the world to whom a patient or anyone else can go for a consultation or advice without an appointment and they are easily accessed and knowledgeable about a countless of aspects concerning patients and their medication. It is thus of the utmost importance to take these skills into consideration when it comes to diabetic education. Pharmacists have long-term relationships with most of their chronic patients, which sets a good foundation for mutual trust and respect and better patient compliance.[47]

Educated patients were empowered to self-manage their medications and their health conditions. The DM care and management provided by pharmacists using telephonic and face-to-face education make sure patients understood their medications indications and proper utilization. During the education process, pharmacists

used teach-back methods to ensure that patients are using their medications and devices correctly. Motivational interviewing strategies were employed during these interactions.[7]

In Brazil, an RCT study was performed in 70 adults with diabetes patients who were taking insulin and who had an HbA1c level above 8%. The authors found that, diabetes knowledge, medication knowledge, adherence to medication and correct insulin injection and home blood glucose monitoring techniques significantly improved in the pharmacist led group but remained unchanged in the control group.[48]

Another RCT study was conducted to examine pharmacist–provided extended diabetes care service for patients with diabetes. Compared with the control group, patients who received interventions significantly increased the number of days per week that they involved in a set of diet and diabetes self-care activities.[49] Patient satisfaction of care obtained in pharmacist-managed primary care clinics, within the service, knowledge, and self-management domains were highly improved.[50] Similarly, an important recent study suggested that pharmacist intervention through patient education and medication counseling made a great influence for improvement in medication adherence and glycemic control in people living with DM.[39]

Effect on Glycated Hemoglobin A1c (HbA1c), BP and Lipid profiles

An RCT study carried out by Butt *et al* (2015) have shown pharmacist led intervention among diabetes patients, an HbA1c value was significantly reduced in the intervention group with no significant changes in control group. BMI values had also shown significant reduction in the intervention group.[51] Additionally, a prospective study was conducted in the US, pharmacist led care resulted in a significant reduction in HbA1c, BP levels, and decreased in alcohol and smoking consumption with good physical activities.[52]

In another study in Chicago, diabetes patients referred to the pharmacist in a diabetes drug therapy management program showed a great reduction in HbA1c and LDL values at goal level (< 7%). Thus, a significant clinical improvement was occurred.[25] Similar study was demonstrated among diabetes patients enrolled in the pharmacist-managed program had seen significant reduction in HbA1c, FBG and LDL-C values. Indicated that, a good control in blood glucose and lipid levels in patients with diabetes were seen in the pharmacist-run program.[42]

The first completed study of independent prescribing by pharmacists conducted by Al Hamarneh *et al*, (2013) showed similar improvements with above studies in glycaemic control. The value of HbA1c was reduced and above 50% of the patients were achieved the target (≤7%), which represents pharmacist prescribing intervention in patients with poorly controlled diabetes clinically important in glycemic control.[53] Another cohort study was conducted with 126 patients to assess the impact of a pharmacist-managed insulin titration program compared to standard medical care on deprived glycemic control. The pharmacist-run group showed a better improvement in A1c outcome, compared to the standard care.[54]

A study demonstrated by Cioffi *et al*, (2004) reported that, clinical pharmacist can effectively care for diabetes patients referred by their primary care provider because of poor glycemic control. a better achieving in HbA1c, BP and LDL values was obtained in the pharmacist-managed group compared with other healthcare professionals, which indicates diabetes patients managed by pharmacist had a significant reduction in HbA1c.[55] A comprehensive clinical pharmacy service consisting of patient education on diabetes, prescription therapy, and medication adherence; glycemic control was significantly improved. And other cardiovascular risk factors, including BP and lipid values; also favored the intervention group in the proportion of patients who achieved therapeutic goals.[56] In one study at Texas, a total of 782 diabetes patients were assigned to intervention control group (n=225), and to control group (n=557). For the intervention group, the improvement in glycemic control was statistically significant. Thus, patients managed by a clinical pharmacist had a decrease in the number of hospitalizations with a greater glycemic control.[57]

An important RCT study was conducted to examine the influence of pharmaceutical care programme on glycemic control and a noticeable reduction in HbA1c, BP and BP values were observed in the intervention group; compared to no changes were noted in the control group. The pharmaceutical care programme resulted in better glycemic control and reduced cardiovascular risk scores in diabetes patients.[58] The pharmacist based intervention model for diabetes patients have shown a valuable improvement on the reduction of HbA1c, BP values, and hospitalizations and emergency room visit.[59] Additionally, a pharmacist-provided medication therapy was showed an important change in the BP control DM patients.[60]

A great therapeutic goal of achievement was seen in HbA1c, BP, lipid values and other clinical outcome

measurements of patients with diabetes who received pharmacist-led diabetes care.[61] Another retrospective study with a total of 484 DM patients showed that, patients obtained care from pharmacists had reduced their A1c level by 2% compared to usual care, thus achieved an HbA1c <7% by 3-folds. The incorporation of PC services was showed that, a notable improvement in clinical outcomes of patients with diabetes.[62]

Patients who received the participation of pharmacists, the number of patients that improved in A1c value increased; number of rehospitalization was reduced by 65%. Illustrated that, a pharmacist evolved in the diabetes management team resulted a significant reduction in A1c, cholesterol and BP in patients versus a usual health care.[63] Another one-year retrospective chart review study was conducted. Pharmacists intervened had significantly decreased A1c, SBP and LDL in diabetic patients who were not at goal at baseline. This showed that, pharmacists had been effective in improving stand-in outcomes for patients with diabetes and in assisting physicians to address all standards of care.[64]

Similar retrospective study which was intended to evaluate the reduction in A1c, BP, and LDL for patients with diabetes whose care was managed by a clinical pharmacist and compared values to the patients whose care was managed by other primary care providers. A study showed that, a clinical pharmacist managed DM patient were highly improved.[65] One cohort study reported a successful collaborative practice with PharmD-Endocrinologist which helped complex diabetes patients achieved glycemic control in a 6-month period. The value of A1c in intervention group was significantly decreased and percentage meeting A1c goal levels had significantly higher compared with baseline.[66]

DM patients who were referred to clinical pharmacist for better management showed a great improvement in the reduction of HbA1c, LDL-C and BMIs.[67] Another study that was conducted in Australia, a 12-month program in T2DM patients, who were received PC significantly reduced HbA1c and BP levels compared to those who were managed by physicians only (Clifford *et al*., 2005). In addition, in the retrospective cohort study conducted in California, the clinical outcomes of DM patients, who obtained the clinical pharmacy service, had a greater reduction in HbA1c values compared to the usual care.[41]

Effect on Diabetes-related Complications Management

Early detection of complications has the potential to alter the course of the complication and reduce mortality through recommendations for modifying lifestyle, pharmacological and other therapy. Screening and treatment for complications can have a large impact on the quality of life for patients with diabetes.[68] Diabetes management should extend beyond glycemic control. Optimal diabetes management requires not only control of blood glucose levels; BP and cholesterol control are also critical to prevent cardio vascular diseases (CVD), the leading cause of mortality for those with diabetes. In addition, screening for early complications through annual eye and foot exams, and lifestyle modifications, require comprehensive counseling.[69]

In Australia, the study investigated the effect of a pharmaceutical program on vascular risk factors in T2DM. PC patients had face-to-face goal-directed medication and lifestyle counseling at baseline and at 12 months and provision of other educational material. The study revealed a significant improvement in HbA1c, and systolic and diastolic blood pressure.[70] Moreover, an RCT study by Cohen *et al*, (2011) found that, a pharmacist-led shared medical management program was greatly improved hypertension, hyperglycemia and lipidemia in patients with diabetes than those followed up by the usual standard care physicians.[71]

From the study done by Phumipamorn *et al*., (2008), an extended pharmacy service (usual care plus added pharmacist) would improve glycemic control and cardiovascular risks in diabetic patients. The percent pill count and diabetic knowledge scores were greatly increased in the study group. Meanwhile, the pharmacist's one-on-one education on diabetes accompanied patients with diabetes did a reduction in cardiovascular risks by lowering total cholesterol and LDL-C was found.[72]

Chan and colleagues in Hong Kong had been conducted an RCT comparing regular drug-counseling sessions performed by pharmacist in addition to routine medical care compared to routine medical care alone in diabetic patients. They found that those who received the pharmacist care had a statistically significant reduction in the coronary heart disease (CHD) risks, reduction in stroke and LDL value. The pharmacist care program based study demonstrated a significant cardiovascular risk reduction in T2DM patients.[73] In addition, a 10 years cohort study was conducted in California and notably, the enhanced care group (added pharmacist service) had shown to be dominant compared with the control group for diabetic patients improves the CVD risks, like stroke reductions were shown to be more dramatically improved.[74]

Another prospective RCT study was carried out to examine the effect of pharmaceutical care program on CHD risk in elderly diabetic and hypertensive patients in the Brazilian State, Paulo. Significant reductions in the values of BP were observed in the intervention group. Thus, the PC program resulted in better clinical outcomes and reduced the cardiovascular risks in elderly diabetic and hypertensive patients over a 36-month period.[75] In the study demonstrated, to evaluate the effect of low protein diet and the impact of pharmacist role in managing patients with diabetic nephropathy have shown a significant improvement in the values of serum creatinine, which indicates, the protein diet restriction intervention on diabetic nephropathy provided by pharmacist played a significant role in controlling the kidney failures.[76]

Effect on Health-related Quality of Life (HRQOL)

Diabetes, if untreated, can lead to countless complications such as neuropathy, nephropathy, retinopathy, hyperlipidema, diabetic foot ulcers, and many infections. These complications adversely affect the quality of life of the patient. Having this, pharmacists had great role to postpone the onset of complications by counseling patients regarding insulin administration regularly that having glycemic control.[13] DM leads to significant morbidity and mortality and negatively affects patient quality of life. Lifestyle and patient medication adherence are the most important factor that contributes to effective DM management, which keeps maintaining patients 'quality of life.[77]

Pharmaceutical care programmes delivered by pharmacists are known to improve quality of care for both ambulatory and hospitalized patients with a variety of chronic and acute conditions. Good knowledge about disease, medications, diet and exercise requirements can improve the effectiveness of self-management of diabetes and quality of life.[58]

In chronic patients, Quality of life (QOL) is another measure that interested many studies to examine in diabetic patients. Sriram *et al*. (2011) in India, a prospective study was conducted to evaluate the impact of pharmaceutical care on QOL in patients with T2DM. They showed a significant improvement and patients were satisfied with their treatment, felt slightly affected due to their disease, and rarely worried about the negative consequences of their diabetes. Furthermore, several clinical measures correlated well with the quality of life. Patients who were more satisfied with their current treatment tend to have better glycemic and blood pressure control.[78]

The pharmacotherapeutic services delivered by pharmacist had shown a significant improvement in the health-related quality of life (HRQoL) of diabetes patients compared with the standard service. Pharmacotherapy follow-up of T2DM patients in community pharmacies resulted a great improvement in the HRQoL and satisfaction of patients.[79] Similar study (RCT) was carried out to assess the influence perception about the disease management and quality of life in T2DM patients. Patients were randomized into usual care and pharmacist-led groups. Found that, the pharmacist-based patient approach regarding the disease, medication and life style modification of patients was effectively improved.[80]

There has been shown a significant improvement in the QOL, adherence scores in the prospective study conducted with a total of 113 patients with diabetes. This was since patient education influenced in proper glycemic control, which has been reduced the diabetic symptoms that improved the patients' enjoyment in day-to-day life activities. Hence this study confirmed that pharmacist play an important role in educating the patients to maintain their quality of life.[81] Another 12-month RCT study was conducted in Nigeria, to evaluate the impact of pharmaceutical care (PC) intervention on HRQOL of patients with T2DM. The overall HRQOL were significantly improved in DM patients who received PC services.[82]

Effect on Economic Benefits

Cost is a vital component for people with chronic diseases as treatment is expected to be long or even lifelong in some diseases. Pharmacist contributions in decreasing the healthcare cost burden of chronic patients are not well described due to lack of sufficient evidences worldwide. In developing countries like Ethiopia, the estimation of direct healthcare cost burden among newly diagnosed diabetics is still a challenge for healthcare professionals, and pharmacist role in patient care is still theoretical and practically non-existent.[83] The involvement of pharmacists in diabetes management reduced overall costs of care.[45]

Poverty affects a large portion of the population and obviously known patients who take multiple medications for diabetes and other conditions often have challenges with medication costs and co-payments. Pharmacists had had an integral role that contributed in reduction the healthcare cost burden of long-life of the disease.[7] A study conducted by Hendrie *et al*., (2014) intended to assess the cost-effectiveness in reducing glycemic levels in patients with diabetes through a pharmacist-led program compared to standard care. Significant reductions in

hyperglycemic and hypoglycemic episodes was observed in the pharmacist-led management and shown with a net reduction of 1.86 days with glycemic episodes per patient per month and US$39 per day of glycemic symptoms was avoided.[84]

A pharmacist-led, patient-centered pharmacotherapy management program developed and a one-year cohort study was carried out to identify the impact of clinical pharmacy services in patients with T2DM cost expenditure. The mean costs for medical and prescription- related greatly decreased at 6 months ($84) and 12-month ($216). Despite an increase in antidiabetic medication and total medication costs, with in simultaneous clinical improvements, total direct medical costs were reduced.[85] A total of direct medical costs was decreased by $1,500 per patient per year compared with baseline with increased the productivity income of $18,000 annually. Thus, patients with diabetes who received ongoing pharmaceutical care maintained improvement in employers capable a decline in mean total direct medical costs.[86]

Another study at USA, a one-year decision-analytic model of patient chart review study was conducted to identify pharmacists'interventions and calculated the cost savings per intervention with improved clinical outcomes. The total cost savings for ED visits and inpatient hospitalization interventions were $165.00 and $145.00, respectively.[87] Similar study was conducted that showed, insulin initiated by pharmacists with uncontrolled T2DM patients was cost-effective. Having that, pharmacists prescribed insulin a year earlier than usual clinical practice found in an incremental cost savings of $805 and a gain of 0.048 quality adjusted life-years (QALYs) per patient. Furthermore, earlier initiated insulin by pharmacists, in poorly controlled T2DM patients, resulted in cost savings and delays in the progress of diabetes-related complications, leading to an improved quality of life and increased survival rates.[88] The pharmacist contribution in minimizing direct healthcare cost burden in patients with diabetes was described.[89]

An average costs for inpatient hospitalization and ED admissions were significantly higher in the pre-intervention period than in the post-intervention period for patients with DM as the primary or secondary diagnosis ($2434 versus $636) respectively, which indicates, pharmacist interventions under a collaborative drug therapy agreement provided a great reduction in costs for inpatient hospitalization and ED services.[90] Pharmacists had served as a resource to other health care providers and payers to assure safe, appropriate, cost-effective diabetes medication use.[27]

Pharmacists had spent 983 hours caring for T2DM patients (mean 3.8 hours/patient). An improvement in HbA1c and BP yielded $421 in cost savings per patient and labor. An average cost per patient for the outcome achieved was $160. The pharmacist-physician collaboration in diabetes management showed cost savings when assessing pharmacist labor costs alone.[91] In addition, pharmacist as a part of diabetes management team resulted the drug cost per patient day meaningfully decreased from.[63]

Provision of Medication Therapy Management (MTM) Services

MTM is a pharmacist led distinct professional service or group of services aimed at reducing drug associated adverse events, improving patient medication adherence, and increasing patient understanding of their diseases and prescribed drugs; thus, designed to facilitate collaboration among the pharmacist, patient, physician, and other health care professionals to promote early screening, safe and effective medication use and achieve optimal patient outcomes. The five core elements of MTM service may be involved.[92]

The pharmacist-coordinated diabetes management program showed significant improvements in A1c and LDL values as well as the frequency of adherence to preventive care like screening. This is from the finding indicated that, the percentage of patients with A1c ≤7% increased and the percentage of patients with low-density lipoprotein (LDL) values also increased. Likewise, the frequency of microalbumin screening and the number of patients with annual eye and foot examinations increased.[93]

Pharmacist led MTM program contributed to improve optimal diabetes management in patients with complex diabetes clinical profiles. This is supported by the study conducted on 224 DM patients who received MTM pharmacy services showed that, the percentage of diabetes patients optimally managed was significantly higher for MTM patients compared to control groups.[94] The provision of MTM pharmacy service also improved survival rate by 4% and with a large cost savings beside in the reduction in diabetes-related morbidity and mortality. Moreover, MTM pharmacist-led service was also obtained an additional 0.44 QALYs and lifetime cost savings of $20,000 per patient.[95] Overall, diabetes patients in the pharmacist-led shown more likely to achieve treatment goals and provide numerous clinical benefits to patients.[65]

CONCLUSION

Pharmacist provided interventions offered a potential benefit in achieving the goal of therapy in patients with diabetes, thus in improving medication adherence and drop off levels of HbA1c, BP, LDL, BMI and diabetes-related complications significantly. Hence this review concludes that pharmacist plays an important role in the management of people living with DM to maintain their quality of life. Nowadays, pharmaceutical care has become a dominant form of practice for thousands of pharmacists all over the world. In developing countries, it is important to emphasize the fact that pharmaceutical care is aimed to achieve rational and evidence-based pharmacotherapy, which is beneficial for patient and society. This review could be a witness of critical role of pharmacist in DM patient care. Therefore, this review could be helpful to realize the current progress of interventional role of pharmacist in the management of DM patients and the future perspective of this review is for the implementation.

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NIL

ABBREVIATIONS USED

ADA: American Diabetes Association; **ADRs:** Adverse Drug Reactions; **BP:** Blood Pressure; **DM:** Diabetes Mellitus; **DTP:** Drug Therapy Problems; **FBG:** Fasting Blood Glucose; **HbA1c:** Glycated Hemoglobin A1c; **HRQOL:** Health Related Quality of Life; **IDF:** International Diabetes Federation; **LDL-C:** Low Density Lipid –Cholesterol; **MTM:** Medication Therapy Management; **PC:** Pharmaceutical Care; **QoL:** Quality of Life; **RCT:** Randomized Control Trial; **T1DM:** Type 1 Diabetes Mellitus; **T2DM:** Type 2 Diabetes Mellitus; **TC:** Total Cholesterol; **WHO:** World Health Organization.

DATA AND MATERIAL AVAILABILITY

All data and materials are accessible at any time

CONFLICTS OF INTEREST

The authors announced that there is no conflict of interest regarding this work of study.

AUTHORS CONTRIBUTION

GTD has contributed to search the literatures, collect, summarize the articles, and prepare the manuscript and finalize overall the review article.

REFERENCES

1. ADA. American Diabetes Association standards of medical care in diabetes. Diabetes Care: The journal of clinical and applied research and education. 2016;39(Supplement 1):S13-S2
2. CDA. 2013 Clinical Practice Guidelines for the Prevention and Management of Diabetes in Canada: Canadian Diabetes Association. 2013.
3. Seino Y, Nanjo K, Tajima N, Kadowaki T, Kashiwagi A, Araki E, *et al*. Report of the committee on the classification and diagnostic criteria of diabetes mellitus. Journal of diabetes investigation. 2010;1(5):212-28.
4. WHO. Definition, diagnosis and classification of diabetes mellitus and its complications: report of a WHO consultation. Geneva: World Health Organization. 1999.
5. IDF. The Future of Diabetes Prevention, International Diabetes Federation(IDF) Diabetes Atlas 7th edution: A Call for Papers: PLOS Medicine Editors. PLoS Med. 2015;13(2):e1001966.
6. WHO. Global Health Report on Diabetes: World Health Day. World Health Organizatin. 2016.
7. Check DA. Evidence-Based Diabetes Management™. The American journal of managed care. 2016;22(4).
8. WHO. New tool to enhance role of pharmacists in health care. 2006.
9. Toklu HZ, Hussain A. The changing face of pharmacy practice and the need for a new model of pharmacy education. Journal of Young Pharmacists. 2013;5(2):38-40.
10. Lai E, Trac L, Lovett A. Expanding the pharmacist's role in public health. Univers J Public Health. 2013;1(3):79-85.
11. Khanal S, Nissen L, Veerman L, Hollingworth S. Pharmacy workforce to prevent and manage non-communicable diseases in developing nations: The case of Nepal. Research in social and administrative pharmacy. RSAP. 2016;12(4):655-9.
12. Mekonnen AB, Yesuf EA, Odegard PS, Wega SS. Pharmacists'journey to clinical pharmacy practice in Ethiopia: Key informants' perspective. SAG E open medicine. 2013;1:2050312113502959.
13. Kumanan R, Sudha S, Jayaveera K. Can a pharmacist improve life of diabetes patient? An overview. Research Journal of Pharmaceutical Biological and Chemical Sciences. 2010;1(3):5-11.
14. Ahmad AD, Elnour AA, Yousif MA, Farah FH, Akasha HA, Abasaeed A, *et al*. Pharmacist 's interventions to improve clinical outcomes in patients with type 2 diabetes mellitus: Nyala City, South Darfur State, Sudan. International Journal of Diabetes in Developing Countries. 2015;35(4):578-87.
15. Berhane A, Ali E, Odegard P, Suleman S. Physicians 'expectations of clinical pharmacists' roles in Jimma University Specialized Hospital, South west Ethiopia. International Journal. 2013;4(2):571-4.
16. Surur AS, Teni FS, Girmay G, Moges E, Tesfa M, Abraha M. Assessment of the structural and process aspects of pharmaceutical care at a university hospital in Ethiopia. Journal of pharmacy and bioallied sciences. 2015;7(2):97.
17. Cooppan R. The Changing model of insulin use in type 2 diabetes: techniques, tactics for getting to goal. Postgraduate medicine. 2003;113(6):59-64.
18. White Jr JR, Campbell RK, Hirsch IB. Novel insulins and strict glycemic control: analogues approximate normal insulin secretory response. Postgraduate medicine. 2003;113(6):30-6.
19. White JR, Davis SN, Cooppan R, Davidson MB, Mulcahy K, Manko GA, *et al*. Clarifying the role of insulin in type 2 diabetes management. Clinical diabetes. 2003;21(1):14-21.
20. Europe PCN. Classification for Drug Related Problems. 2010;6(2).
21. Huri HZ, Ling LC. Drug-related problems in type 2 diabetes mellitus patients with dyslipidemia. BMC public health. 2013;13(1):1192.
22. Huri HZ, Wee HF. Drug related problems in type 2 diabetes patients with hypertension: a cross-sectional retrospective study. BMC endocrine disorders. 2013;13(1):2.
23. Cipolle RJ, Strand LM, Morley PC. Pharmaceutical care practice: the patient-centered approach to medication management: McGraw-Hill Medical New York. 2012.
24. Kassam R, Meneilly GS. Role of the pharmacist on a multidisciplinary diabetes team. Canadian journal of diabetes. 2007;31(3):215-22.

25. McCord AD. Clinical Impact of a Pharmacist-Managed Diabetes Mellitus Drug Therapy Management Service. Pharmacotherapy: The Journal of Human Pharmacology and Drug Therapy. 2006;26(2):248-53.
26. Sadeghi K, Mohammadi M, Najmeddin F, Mashayekhi M, Mojtahedzadeh M, Javadi M, *et al*. Pharmacist-led medication review: supports for new role of pharmacists. Journal of Pharmaceutical Care. 2015;1(4):153-60.
27. Smith M. Pharmacists' role in improving diabetes medication management. Journal of diabetes science and technology. 2009;3(1):175-9.
28. Wagner EH. The role of patient care teams in chronic disease management. British Medical Journal. 2000;320(7234):569.
29. Machado M, Bajcar J, Guzzo GC, Einarson TR. Sensitivity of patient outcomes to pharmacist interventions. Part I: systematic review and meta-analysis in diabetes management. Annals of Pharmacotherapy. 2007;41(10):1569-82.
30. Hepler CD, Strand LM. Opportunities and responsibilities in pharmaceutical care. American journal of hospital pharmacy. 2009;47(3):533-43.
31. Chua SS, Kok LC, Yusof FAM, Tang GH, Lee SWH, Efendie B, *et al*. Pharmaceutical care issues identified by pharmacists in patients with diabetes, hypertension or hyperlipidaemia in primary care settings. BMC health services research. 2012;12(1):388.
32. Vlcek J, Maly J, Dosedel M. [Pharmaceutical care of patients with diabetes mellitus and its relationship to clinical pharmacy]. Vnitrni lekarstvi. 2009;55(4):384-8.
33. Khalili H, Farsaei S, Rezaee H, Dashti-Khavidaki S. Role of clinical pharmacists'interventions in detection and prevention of medication errors in a medical ward. International journal of clinical pharmacy. 2011;33(2):281-4.
34. Dhandapani C, Sony S, Kumaran KA. Role of Clinical Pharmacist in the Management of Type II Diabetes Mellitus and its Outcomes. International Journal. 2014;5(3):977-83.
35. Gillani SW, Victor SC, Sari YO, Ghadzi SMS, *et al*. Applicability of Pharmaceutical Care in endocrine clinic of hospital Penang, Malaysia. J Diabetes Res Clin Metab. 2012;1(1):1-6.
36. Haseeb A, Elrggal M. Recommendations for the role of the pharmacist in Saudi Arabia. Archives of pharmacy practice. 2013;4(3):138.
37. Ayub M, Gul S, Afzal N, Eraj A. An effective clinical pharmacist communication may have built patient trust on pharmacist over other healthcare providers: Evidence based practice. International Journal of Pharmaceutical Sciences and Research. 2015;6(10):4442.
38. Shah JV, Patni KN, Deshpande SS. Achieving Glycemic Control of Diabetic Patients through Clinical Pharmacist provided Counseling. J Pharm Sci. 2015;5(3):322-7.
39. Shareef J, Fernandes J, Samaga L, Bhat M. Evaluating the Effect of Pharmacist 's Delivered Counseling on Medication Adherence and Glycemic Control in Patients with Diabetes Mellitus. Journal of Diabetes and Metabolism. 2016;7(3).
40. Xin C, Xia Z, Jiang C, Lin M, Li G. Effect of pharmaceutical care on medication adherence of patients newly prescribed insulin therapy: a randomized controlled study. Patient preference and adherence. 2015;9:797.
41. Spence MM, Makarem AF, Reyes SL, Rosa LL, Nguyen C, Oyekan EA, *et al*. Evaluation of an outpatient pharmacy clinical services program on adherence and clinical outcomes among patients with diabetes and/or coronary artery disease. Journal of Managed Care Pharmacy. 2014;20(10):1036-45.
42. Phei-Ching L, Kelvin L. Evaluation of a pharmacist-managed diabetes medication therapy adherence clinic. Pharm Pract. 2010;8(4):250-4.
43. Lim PC, Lim K, Embee ZC, Hassali MA, Thiagarajan A, Khan TM. Study investigating the impact of pharmacist involvement on the outcomes of diabetes medication therapy adherence program Malaysia. Pakistan Journal of Pharmaceutical Sciences. 2016;29(2).
44. Wabe NT, Angamo MT, Hussein S. Medication adherence in diabetes mellitus and self-management practices among type-2 diabetics in Ethiopia N Am. J Med Sci. 2011 3(9):418-23.
45. Campbell RK. Role of the pharmacist in diabetes management. American Journal of Health-System Pharmacy. 2002;59.
46. Palaian S, Chhetri AK, Prabhu M, Surulivelrajan M, Ravi Shankar P. Role of pharmacist in counseling diabetes patients. Journal of Pharmacology. 2005;4(1).
47. Berg J, Dodd S, Dodd S. The role of a community pharmacist in diabetes education. Journal of Endocrinology, Metabolism and Diabetes of South Africa. 2009;14(3):148-50.
48. Cani CG, Lopes LdSG, Queiroz M, Nery M. Improvement in medication adherence and self-management of diabetes with a clinical pharmacy program: a randomized controlled trial in patients with type 2 diabetes undergoing insulin therapy at a teaching hospital. Clinics. 2015;70(2):102-6.
49. Doucette WR, Witry MJ, Farris KB, McDonough RP. Community pharmacist–provided extended diabetes care. Annals of Pharmacotherapy. 2009;43(5):882-9.
50. McFarland MS, Wallace JP, Parra J, Baker J. Evaluation of patient satisfaction with diabetes management provided by clinical pharmacists in the patient-centered medical home. The Patient-Patient-Centered Outcomes Research. 2014;7(1):115-21.
51. Butt M, Ali AM, Bakry MM, Mustafa N. Impact of a pharmacist led diabetes mellitus intervention on HbA1c, medication adherence and quality of life: A randomised controlled study. Saudi Pharmaceutical Journal. 2015.
52. Pinto S, Blazejewski L, Holl S, editors. Improved patient outcomes resulting from physicians'therapy decisions based on pharmacists'recommendations. Value in health; 2010: Wiley-blackwell commerce place, 350 main st, malden 02148, ma USA.
53. Al Hamarneh YN, Charrois T, Lewanczuk R, Tsuyuki RT. Pharmacist intervention for glycaemic control in the community (the RxING study). BMJ open. 2013;3(9):e003154.
54. Salvo MC, Brooks AM. Glycemic control and preventive care measures of indigent diabetes patients within a pharmacist-managed insulin titration program vs standard care. Annals of Pharmacotherapy. 2012;46(1):29-34.
55. Cioffi ST, Caron MF, Kalus JS, Hill P, Buckley TE. Glycosylated hemoglobin, cardiovascular, and renal outcomes in a pharmacist-managed clinic. Annals of Pharmacotherapy. 2004;38(5):771-5.
56. Jarab AS, Alqudah SG, Mukattash TL, Shattat G, Al-Qirim T. Randomized controlled trial of clinical pharmacy management of patients with type 2 diabetes in an outpatient diabetes clinic in Jordan. Journal of Managed Care Pharmacy. 2012;18(7):516-26.
57. Chung N, Rascati K, Lopez D, Jokerst J, Garza A. Impact of a clinical pharmacy program on changes in hemoglobin a1c, diabetes-related hospitalizations, and diabetes-related emergency department visits for patients with diabetes in an underserved population. Journal of Managed Care Pharmacy. 2014;20(9):914-9.
58. Mazroui A, Rashid N, Kamal MM, Ghabash NM, Yacout TA, Kole PL, *et al*. Influence of pharmaceutical care on health outcomes in patients with Type 2 diabetes mellitus. British journal of clinical pharmacology. 2009;67(5):547-57.
59. Iyer R, Coderre P, McKelvey T, Cooper J, Berger J, Moore E, *et al*. An employer-based, pharmacist intervention model for patients with type 2 diabetes. American Journal of Health-System Pharmacy. 2010;67(4):312-6.
60. Pinto SL, Bechtol RA, Partha G. Evaluation of outcomes of a medication therapy management program for patients with diabetes. Journal of the American Pharmacists Association. 2012;52(4):519-23.
61. Shane-McWhorter L, McAdam-Marx C, Lenert L, Petersen M, Woolsey S, Coursey JM, *et al*. Pharmacist-provided diabetes management and education via a telemonitoring program. Journal of the American Pharmacists Association. 2015;55(5):516-26.
62. Johnson KA, Chen S, Cheng I-N, Lou M, Gregerson P, Blieden C, *et al*. The impact of clinical pharmacy services integrated into medical homes on diabetes-related clinical outcomes. Annals of Pharmacotherapy. 2010;44(12):1877-86.
63. Xin C, Ge X, Yang X, Lin M, Jiang C, Xia Z. The impact of pharmaceutical care on improving outcomes in patients with type 2 diabetes mellitus from China: a pre-and postintervention study. International journal of clinical pharmacy. 2014;36(5):963-8.
64. Henry TM, Smith S, Hicho M. Treat to goal: impact of clinical pharmacist referral service primarily in diabetes management. Hospital pharmacy. 2013;48(8):656-61.
65. Wallgren S, Berry-Cabán CS, Bowers L. Impact of clinical pharmacist intervention on diabetes-related outcomes in a military treatment facility. Annals of Pharmacotherapy. 2012;46(3):353-7.
66. Morello CM, Christopher ML, Ortega L, Khoan J, Rotunno T, Edelman SV, *et al*. Clinical Outcomes Associated with a Collaborative Pharmacist-Endocrinologist Diabetes Intense Medical Management —Tune Up‖ Clinic in Complex Patients. Annals of Pharmacotherapy. 2015:1060028015615586.
67. Hetro A, Rossetto J, Bahlawan N, Ryan M. Clinical pharmacists supporting patients with diabetes and/or hyperlipidemia in a military medical home. Journal of the American Pharmacists Association: JAPhA. 2015;55(1):73-6.
68. Sulaiman S, Victor S, Sari Y, Maisharah S, Haroon S, Hanafiah N. Applicability of Pharmaceutical Care in endocrine clinic of Hospital Penang, Malaysia. journal of Diabetes Research and Clinical Metabolism. 2012;1(1):11.
69. Mansell K, Blackburn D, Taylor J, Jiricka K. Pharmacists providing education to help optimize frequency of self-monitoring of blood glucose in non-

insulin dependent type 2 diabetes mellitus. Canadian Journal of Diabetes. 2012;36(6):332-6.
70. Clifford RM, Davis WA, Batty KT, Davis TM. Effect of a Pharmaceutical Care Program on Vascular Risk Factors in Type 2 Diabetes the Fremantle Diabetes Study. Diabetes Care. 2005;28(4):771-6.
71. Cohen LB, Taveira TH, Khatana SAM, Dooley AG, Pirraglia PA, Wu W-C. Pharmacist-led shared medical appointments for multiple cardiovascular risk reduction in patients with type 2 diabetes. The Diabetes Educator. 2011;37(6):801-12.
72. Phumipamorn S, Pongwecharak J, Soorapan S, Pattharachayakul S. Effects of the pharmacist's input on glycaemic control and cardiovascular risks in Muslim diabetes. Primary care diabetes. 2008;2(1):31-7.
73. Chan C-W, Siu S-C, Wong CK, Lee VW. A Pharmacist Care Program Positive Impact on Cardiac Risk in Patients with Type 2 Diabetes. Journal of cardiovascular pharmacology and therapeutics. 2012;17(1):57-64.
74. Yu J, Shah BM, Ip EJ, Chan J. A Markov model of the cost-effectiveness of pharmacist care for diabetes in prevention of cardiovascular diseases: evidence from Kaiser Permanente Northern California. Journal of Managed Care Pharmacy. 2013;19(2):102-14.
75. Obreli-Neto PR, Guidoni CM, Oliveira-Baldoni A, Pilger D, Cruciol-Souza JM, Gaeti-Franco WP, *et al*. Effect of a 36-month pharmaceutical care program on pharmacotherapy adherence in elderly diabetic and hypertensive patients. International journal of clinical pharmacy. 2011;33(4):642-9.
76. Mohammed AK, Medarametla C, Rabbani MME, Prashanthi K. Role of a clinical pharmacist in managing diabetic nephropathy: an approach of pharmaceutical care plan. Journal of Diabetes and Metabolic Disorders. 2015;14(1):82.
77. Mathew EM, Rajiah K. Assessment of medication adherence in type-2 diabetes patients on poly pharmacy and the effect of patient counseling given to them in a multispecialty hospital. Journal of basic and clinical pharmacy. 2014;5(1):15.
78. Sriram S, Chack LE, Ramasamy R, Ghasemi A, Ravi TK, Sabzghabaee AM. Impact of pharmaceutical care on quality of life in patients with type 2 diabetes mellitus. Journal of Research in Medical Sciences. 2011;16(S1):S412.
79. Correr CJ, Pontarolo R, Venson R, Melchiors AC, Wiens A. Effect of a Pharmaceutical Care Program on quality of life and satisfaction with pharmacy services in patients with type 2 diabetes mellitus. Brazilian Journal of Pharmaceutical Sciences. 2009;45(4):809-17.
80. Ghosh S, Rajvanshi AK, Kishun S. Assessment the influence of patient counseling on quality of life in type-ii diabetes mellitus patients. International Journal of Pharma and Bio Sciences. 2010;1(3):1-6.
81. Ramanath K, Abasaeed, Abubakar. Impact of clinical pharmacist provided patient education on QOL outcome in type II diabetes mellitus in rural population. Asian Journal of Pharmaceutical and Clinical Research. 2011;4(4):15-20.
82. Adibe MO, Ukwe CV, Aguwa CN. The impact of pharmaceutical care intervention on the quality of life of nigerian patients receiving treatment for type 2 diabetes. Value in Health Regional Issues. 2013;2(2):240-7.
83. Grover S, Avasthi A, Bhansali A, Chakrabarti S, Postgrad PK. Cost of ambulatory care of diabetes mellitus: a study from north India. Med J. 2005;81(956):391-5.
84. Hendrie D, Miller TR, Woodman RJ, Hoti K, Hughes J. Cost-effectiveness of reducing glycaemic episodes through community pharmacy management of patients with type 2 diabetes mellitus. The journal of primary prevention. 2014;35(6):439-49.
85. Monte SV, Slazak EM, Albanese NP, Adelman M, Rao G, Paladino JA. Clinical and economic impact of a diabetes clinical pharmacy service program in a university and primary care–based collaboration model. Journal of the American Pharmacists Association. 2009;49(2):200-8.
86. Cranor CW, Bunting BA, Christensen DB. The Asheville Project: long-term clinical and economic outcomes of a community pharmacy diabetes care program. JAPHA-WASHINGTON. 2003;43(2):173-84.
87. Pinto S, Holl S. Using decision modeling to determine cost-effectiveness of pharmacist interventions for patients with diabetes. Value in Health. 2010;13(3):A66.
88. Al Hamarneh Y, Sauriol L, Brown S, Tsuyuki R. Clinical and Economic Impacts of Insulin Initiation by Pharmacists in a Canadian Setting: The RxING Study. Canadian Journal of Diabetes. 2014;5(38):S49-S50.
89. Upadhyay DK, Ibrahim MIM, Mishra P, Alurkar VM, Ansari M. Does pharmacist-supervised intervention through pharmaceutical care program influence direct healthcare cost burden of newly diagnosed diabetics in a tertiary care teaching hospital in Nepal: a non-clinical randomised controlled trial approach. DARU Journal of Pharmaceutical Sciences. 2016;24(1):6.
90. Anaya JP, Rivera JO, Lawson K, Garcia J, Luna J, Ortiz M. Evaluation of pharmacist-managed diabetes mellitus under a collaborative drug therapy agreement. American Journal of Health-System Pharmacy. 2008;65(19):1841-5.
91. Franklin BE, Farland MZ, Thomas J, McFarland MS. Pharmacoeconomic Analysis of the Diabetes Initiative Program a Pharmacist-Physician Collaborative Care Model. Annals of Pharmacotherapy. 2013;47(12):1627-34.
92. APh A. American Pharmacists Association, National Association of Chain Drug Stores Foundation: Medication therapy management in pharmacy practice: core elements of an MTM service model (version 2.0). Journal of the American Pharmacists Association. 2008;48(3):341-53.
93. Kiel PJ, McCord AD. Pharmacist impact on clinical outcomes in a diabetes disease management program via collaborative practice. Annals of Pharmacotherapy. 2005;39(11):1828-32.
94. Soliman AM, Carlson AM, MacLehose RF, Brummel AR, Schommer JC. Patient characteristics predicting the frequency of medication therapy management visits for patients with diabetes. Clinical therapeutics. 2013;35(4):534-40.
95. Hussein M, Brown L. Cost-effectiveness analysis of medication therapy management in patients with type 2 diabetes in community Pharmacy/ Ambulatory care settings: Results from a decision-analytic markov model. Value in Health. 2012;15(4):A181.