Assessment on the burden of drug-related problems among ambulatory patients with type 2 diabetes on follow-up at selected hospitals of Southwest Ethiopia

Muktar Sano Kedir[1,3] Mohammed Salahuddin[2,3] Teshome Gebissa[1] Wondeson Gadisa Gobena[1] Abdurazak Jemal Tura[1] Mohammednur Hussein Tufa[1] Kaveripakkam Mohammed Ali Noorulla[1]

[1]Department of Pharmacy, College of Health Sciences, Arsi University, Asella, Oromia, Ethiopia
[2]Pharmacology Division, Department of BioMolecular Sciences, University of Mississippi, Mississippi, United States of America
[3]Department of Pharmacy, College of Health Sciences, Mizan-Tepi University, Mizan Teferi, Ethiopia
Correspondence: Dr Kaveripakkam Mohammed Ali Noorulla.
Department of Pharmacy, College of Health Sciences, Arsi University,
P.O. Box 04 or 396, Asella, Oromia, Ethiopia.
Phone numbers: +251-904447889.
E-mail address: nooruas@gmail.com, kmnoorulla@arsiun.edu.et

ABSTRACT

Background: *The emergence of drug-related problems might contribute to poor control of blood glucose levels, increased health care costs and poor health-related quality of life. Hence, the present study was designed to assess the burden of drug-related problems among patients with type 2 diabetes on treatment follow-up at the selected hospitals in Southwest Ethiopia.*

Methods: *Hospital-based cross-sectional study was conducted on ambulatory type 2 diabetic patients on treatment follow-up at Mizan Tepi University Teaching Hospital and Gebretsedik Shawo General Hospital from November 2017 to September 2018. A pre-tested semi-structured questionnaire and data abstraction format were used to collect relevant information from patients and their medical records, respectively. Data were analyzed using STATA version 13.0 software.*

Result: *This study included 260 patients, 251 (96.5%) of whom experienced at least one drug-related problem. A total of 472 drug-related problems which accounted for an average of 1.82 ± 0.59 (mean ± SD) problems per patient was identified. The participants with one, two and more drug-related problems were accounted for 16.9%, 73.4% and 6.2% respectively. The common problems were related to the need for additional drug therapy (84.6%) for either lipid-lowering and/or antiplatelet effect, dose too low (anti-diabetic medication dose escalation was not optimal) (84.2%) and non-adherence to medication (31.2%). Adverse drug reaction (3.4%) was the least prevalent type of the identified problem.*

Conclusion: *There was a high burden of drug-related problems among ambulatory type 2 diabetic patients on treatment follow-up. Hence, great emphasis should be given in improving the quality of their care.*

Keywords: Type 2 Diabetes mellitus, drug-related problem, ambulatory, Ethiopia.

INTRODUCTION

Globally diabetes mellitus is the most common endocrine disorder affecting people of both developed and developing countries. Co-morbid illnesses such as hypertension in diabetics made, use of multiple drugs inevitable. Particularly patients living with type 2 diabetes commonly need multiple medications for the treatment of diabetes or concurrent co-morbidities. A disruption in insulin secretion and action causes type 2 diabetes mellitus to have an increase in blood glucose levels, which disturbs the metabolism of carbohydrates, fats, and proteins.[1–4] Over the past few decades, diabetes has been rapidly increasing in both number of cases and prevalence.[5]

Various medications with different mechanisms of action are used to treat type 2 diabetes mellitus in order to keep blood sugar levels under control.[6] The use of multiple medications, in turn, might increase the probability of facing different types of drug-related problems (DRPs). On the other hand, the occurrence of DRPs might contribute to poor glycemic control, adverse drug reactions, increased healthcare costs as well as bad humanistic outcomes such as poor health-related quality of life.[4,7]

The term DRP is used to describe a circumstance involving the drug that actually or potentially interfere with the desired health outcomes. According to Cipolle and his colleagues, the types of DRPs are defined as “Adverse drug reaction - The drug causing an adverse reaction, Co-morbidity - Co-existence of one or more additional conditions in persons with a specified index medical condition, Dosage too low - Dosage too low to produce the desired response, Dosage too high - Dosage too high to produce the unpleasant symptoms, Drug-related problem - An event or circumstance involving drug therapy that actually or potentially interferes with desired health outcomes, Need for additional drug therapy - Additional drug therapy required to treat or prevent a medical condition or illness from developing, Non-compliance (non-adherence) - Patient not able or willing to take the drug therapy as intended”.[8,9]

A study conducted in the United States revealed 28% of all emergency department visits were due to DRPs, of which 70% of them could be preventable.[10] In one case report, the patient with diabetes had a preexisting vulnerable plaque and DRPs led to adverse drug reactions that decreased the patient's health-related quality of care.[11]

In Ethiopia, only few studies were conducted regarding the magnitude of DRPs that affected type 2 diabetic patients attending treatment follow-up.[12–15] Therefore, determining the magnitude of the commonly occurring DRPs is essential for preventing or resolving these problems. So, in the light of the above facts, the study was designed to assess the burden of DRPs on type 2 diabetic patients on treatment follow-up in Southwestern Ethiopia.

METHODS

A hospital-based cross-sectional study design was planned and conducted among the ambulatory type 2 diabetic patients of two hospitals in the Southwest part of Ethiopia, Mizan Tepi University Teaching Hospital and Gebretsedik Shawo general hospital. These two hospitals have more than 2,750,000 catchment populations.

The targeted department for the study was the diabetic clinic. All the 339 patients who had type 2 diabetic treatment follow-ups between November 2017 and September 2018 were initially considered for the study. The type 2 diabetic patients above 18 years of age and those on treatment follow-up at the diabetic clinic for at least 4 subsequent visits were included, whereas severely ill patients who cannot respond to the interview, the patients who were unwilling to participate and the patient's whose data was lost/not documented were excluded.

Two experienced clinical pharmacists and two clinical nurses used semi-structured data abstraction format to obtain information from the patient medical records. The information included were study participants' medical history, medication history, management of comorbidities, and fasting blood sugar values. The information related to socio-demographics, socio-economic status, and level of adherence were collected by face-to-face interviews and their medical records were reviewed. To assure the quality of data, the data collection questionnaire was pre-tested on 5% of type 2 diabetic patients attending treatment follow-ups, and the same was improved and validated by removing the contents that were not recorded in their medical records.
All the collected data were coded, checked for completeness and entered into Epi Info version 7.0. Then, it was screened, cleaned and exported to STATA version 13.0 for analysis. Descriptive analyses (frequency and percentage) were carried out to summarize data that were related to DRPs. The level of adherence measurement tool was adapted from the study by Van Roozendal B

and Krass I, 2009.[4] To identify particular DRPs, various guidelines such as the American diabetic association standards of medical care in diabetes, the International diabetic federation global guideline for type 2 diabetes, and Ethiopian standard treatment guideline for general hospitals 2014 were used explicitly.

RESULTS

Socio-demographic characteristics

From the total 339 patients on treatment follow-up, 260 of them were included in the study. On the other hand, 17 of them were used for conducting a pre-test of data collection tool while the rest 62 of them were excluded due to eligibility criteria. Of the respondents included in the study, two-thirds (66.2%) of them were male. Their mean age was about 50.41 ± 6.23 years, of which the majority (82.5%) of study participants were between 41 to 50 years. Based on the World Bank poverty line estimate since 2015, fifty-one (35%) of them had very low monthly income (less than 57 USD equivalent), which is under the poverty line of the specified year. The socio-demographic characteristics of ambulatory type 2 diabetes mellitus patients were shown in the **Table 1**.

Table 1: The socio-demographic characteristics of ambulatory type 2 diabetes mellitus patients attending selected hospitals of Southwestern Ethiopia, September 2017

Variable	Frequency (%), n=260
Sex	
Male	172 (66.2)
Female	88 (33.8)
Age	
≤ 40 Years	40 (15.4)
41-50 Years	215 (82.7)
> 50 Years	5 (1.9)
Marital Status	
Single	2 (0.8)
Married	234 (90.0)
Divorced	7 (2.7)
Widowed	17 (6.5)
Occupation	
Merchant/Trade	87 (33.5)
Government Employee	60 (23.1)
Retired	41 (15.8)
Farmer	34 (13.0)
Housewife	32 (12.3)
Daily Laborer	6 (2.3)
Educational Status	

Illiterate	87 (33.5)
Primary	88 (33.58)
Secondary and above	85 (32.7)
Monthly Family Income	
Below Poverty line (< 57 USD)	51 (35.0)
Above Poverty line (> 57 USD)	169 (65.0)

Disease Management Related Characteristics

The average duration of treatment follow-up on antidiabetic medication was 3.58 years (3.58 ± 3.22 years), ranging from 4 months to 25 years. Of the overall study participants, 105 (40.4%, n=260) of them had at least one co-morbid conditions; of which hypertension being the major one 89 (84.8%, n=105) followed by obesity 5 (4.8%, n=105). Ischemic heart disease accounted for 3.8% (4 patients) of the co-morbidities while dyslipidemia, HIV, asthma and kidney disease collectively responsible for the remaining 6.6% (7 patients) of the co-morbidities.

Of the medication used for controlling blood glucose level, combination of metformin and glibenclamide was the most commonly prescribed regimen to 175 patients (67.3%, n=260) followed by metformin alone 33 (12.7%, n=260) and glibenclamide alone 25 (9.6%, n=260) in descending order. On the other hand, about 9% (23 patients) of the study participants were treated with combination of triple drugs containing metformin, glibenclamide and insulin. Medications used for the treatment of ambulatory type 2 diabetic patients were shown in the **Table 2**.

Table 2: Medications used for treatment of ambulatory type 2 diabetic patients attending selected hospital of Southwestern Ethiopia, September 2017

Antidiabetic Medications	Frequency, (%)
Metformin alone	33, (12.7)
Glibenclamide alone	25, (9.6)
Insulin	4, (1.5)
Metformin and Glibenclamide	175, (67.3)
Metformin and Glibenclamide and Insulin	23, (8.8)

Level of Glycemic Control

In this study, the average fasting blood glucose (FBG) level was regarded as the surrogate indicator of blood glycemic control. In this regard, the achievement of FBG value less than or equal to 130mg/dl is used as a target glycemic control. Accordingly, the percent of patients that achieved adequate blood glycemic control (FBG ≤ 130mg/dl) on recent appointment, immediate last appointment, second last appointment, and first appointment following antidiabetic medication were found to be 26.2 %, 28.8 %, 17.7 % and 2.7 % respectively. The level of glycemic control among the ambulatory type 2 diabetic patients was shown in **Table 3**.

Table 3: The level of fasting blood glucose control among ambulatory type 2 diabetic patients attending selected hospital of southwestern Ethiopia, September 2017

Appointment schedule	**Frequency FBG control (%)**	
	FBG ≤ 130mg/dl (Adequate)	FBG >130 mg/dl (Inadequate)
Recent appointment	68 (26.2)	192 (73.8)
Immediate last appointment	73 (28.1)	187 (71.9)
Second last appointment	46 (17.7)	214 (82.3)
First appointment	7 (2.7)	253 (97.3)

Burden of DRPs

A total of 472 DRPs, which accounted for an average of 1.82 ± 0.59 per patient was identified. Of the total study participants, 251(96.5%, n=260) of them were faced one or more DRPs. Accordingly, 44 (16.9%, n-260) of them faced one type of DRP while the rest 191(73.4%, n=260) and 16 (6.2%, n=260) were faced two and more DRPs respectively.

About 85% of study participants were in need of additional drug therapy to treat or prevent the development of microvascular and macrovascular complications. Although these patients were the best candidate for lipid-lowering drugs and or antiplatelet medications, these drugs were not given for them. Similarly about 84% of study participants on the treatment follow-up were on dose too low (did not provided optimaly escalated dose of antidiabetic medications required for

controlling their FBG level). Besides, the level of non-adherence to antidiabetic medication was also high 81 (31.2%, n=260), this in turn responsible for the occurrence of 17.16% (81/472 of the total DRPs reported in this study. The type and frequency of DRPs among ambulatory type 2 diabetes mellitus patients were shown in **Table 4**.

Table 4: The type of DRPs among ambulatory type 2 diabetes mellitus patients attending selected hospital of southwestern Ethiopia, September 2017

Type of DRPs	**Patient with DRPs Frequency (%), n=251**	**DRP Frequency %, n=472**
Need additional drug therapy	220, (84.6)	46.61
Dose too low	219, (84.2)	46.39
Non-adherence	81, (31.2)	17.16
Adverse drug reaction	9, (3.4)	1.90

Based on the patient medical records, the study participants were treated with different combinations of antidiabetic drugs. Metformin and glibenclamide combination had been given to 175 patients, of which 169 (96.6%) patients reported with DRPs. All of the study paticipants (27 patients) on treatment with insulin alone or combination of insulin with metformin and glbenclamide had atleast one DRP. Among 25 patients who were treated with glbenclamide alone, 23 (92%) were identified with DRP. Percentage of DRPs by diabetic medications used were shown in **Table 5**.

Table 5: Percentage of DRPs by diabetic medications used for ambulatory diabetic patients attending selected hospital of southwestern Ethiopia, September 2017

Type of Antidiabetic Medications	DRPs Occurrence Frequency (%), n
Metformin alone	32 (97.0), n=33
Glibenclamide alone	23 (92.0), n=25
Insulin	4 (100), n=4
Metformin and Glibenclamide	169 (96.6), n=175
Metformin and Glibenclamide and Insulin	23 (100), n=100

DISCUSSION

In the current study, a total of 260 type 2 daibetic patients on treatment follow up for an average of 3.58 years were included. The current syudy revealed a total of 472 DRPs, which accounted for an average of 1.82 ± 0.59 per patient. This result is lower than the 11.2 DRPs per patient found in a study of Jordanian ambulatory patients[16] and the 4.1 DRPs per patient found in a Danish study.[17] The considerable range in DRPs size seen in Jordan's study could be attributed to varied classifications of system used to define DRPs and the circumstances in which DRPs were assessed, as well as differences in study protocol the Danish study used was Problem Intervention Documcntation (PI-Doc).

Another finding from the Malaysian study was that average DRPs per patient were higher (2.37) than in the current study.[18] This difference could be due to a difference in study population, as the Malaysian study only includes type 2 diabetes mellitus patients with dyslipidemia, as well as a difference in study protocol, as the Malaysian study used Pharmaceutical Core Network Europe (PCNE). Regardless of the difference seen in magnitude of DRPs, the outcome in our study displays the necessity to make interventions on the DRPs therefore that the patients rally success

of treatment outcomes. Furthermore we recommend future studies to use similar DRPs classification system to generate comparable eveidences.

The burden of DRPs identified in the study was almost in line with the findings of the another Malaysian study.[19] However, the burden of DRPs in present study was higher than the prevalence reported in other similar studies conducted in Norway,[20] Lebanon,[21] Ethiopia,[22] Belgium,[23] Southwest Ethiopia.[24] The higher rate of DRPs in this study as compared to other studies might be partly related to the presence of clinical subspecialities/superspecialities in the study setting of those studies. In addition to the above reason the difference might be due to variation in setting of data collection, in those studies data was collecxted from patients admitted to medical wards where patients were strictlly followed and corrective measures might be given before the occurance of DRP.

About 96.5 percent of the study participants were subjected to one or more DRPs. This result is higher than the one obtained in Malaysia, where 90.5 percent of the participants had at least one DRP,[19] the one obtained in India, where 71 percent of patients had at least one DRP,[3] and the one obtained in Southwest Ethiopia, where 82 percent of the participants had at least one DRP.[13] This discrepancy can be explained by the fact that the study populations in Malaysia, India, and Southwest Ethiopia are type 2 diabetes mellitus patients with hypertension, which differs from the current study population. The dissimilarity in DRP recognized might also be owing to the diverse study methods used by these studies.

The percentage of DRPs increased as the drugs necessary to manage fasting blood glucose (FBG) levels increased, or when treatment with insulin alone was required. In this regard, every single trial participant (100%) who received insulin alone or in combination with metformin and glibenclamide experienced at least one DRP. As a result, more patients receiving insulin alone or in conjunction with oral hypoglycemic medicine will require strict supervision to avoid the occurrence of DRPs.

The current study found that the most common DRPs were the need for additional drug treatment (46.6 percent), a dose that was too low (46.39 percent), and non-adherence (17.16 percent). This

differs with a study conducted in Malaysia, where the two most common DRP classifications observed were potential interaction (18%) and drug not taken or delivered (14%).[18] In a Danish study,[17] DRP were regularly reported in appropriate use of medicine (26.9 percent) and appropriate choice of medicine (9.1 percent). The current study's discrepancy in the frequency of various DRPs could be attributable to differences in methodology (such as a medical review or interview technique) and the types of DRP classifications employed (such as Cipolle, PCNE, or PI-Doc system).

In this study, out of 260 type 2 diabetic patients on follow up about 220 of them had identified with dose too low and or need of additional drug therapy. This finding was inconsistent with other studies that reported drug interaction and medication error as the most frequently encountered types of DRPs.[21,23,25,26] This difference might be due to difference in study population, study design and level of vigilance in patient management (monitoring) at various study setting, being outpatient or in-patient (wars) might also impacted on the extent of identification and prevention of DRPs.

In the current study, dosage too low DRPs accounted for 46.39 percent of all DRPs. The report was higher than the 7.3 percent[5] study done in Indonesia, the 26.75 percent[2] study done in Wolait Sodda, Ethiopia, and the 15.8 percent study done in Southwest Ethiopia (hospital in Jimma).[13] In the current investigation, a significant prevalence of dosage too low DRP was related with a higher percentage of type 2 diabetes mellitus patients failing to achieve the desired fasting blood glucose (FBG) level. This disparity could be attributed to differences in the study populations between the current study and the studies conducted in Indonesia and Southwest Ethiopia. On the otherhand, about 84.6% of patients included in the study required additional drug therapy fro lipid lowering and or antiplatelet effects in order to reduce the risk of developing cardiovascular problems. To be noted, similar number of study participants were also on regimens containing dose too low. This finding was higher than the finding reported in other study conducted in Australia.[4] The variation might be due to stricter management provided for study participants included in the other study compared to the present one.

The current study's patients also had a significant rate of non-adherence to diabetes medication (31.1 percent). DRPs, particularly non-adherence, could have a significant role in this study population. This could be linked to forgetfulness, refusal to take medication, pharmaceutical expense, and unavailability.[19,27] This findings from the current study was also higher than the studies conducted in other areas.[15,18] The difference might be related to variation in the level of adherance support provided for admitted patients compared to that provided for the patients on follow-up at outpatient department. Furthermore, the level of adherence of patients on follow-up may not be strictly assessed. As a result, health care practitioners should consider medication adherence as an important component of managing type 2 diabetes patients.

Among the common DRPs observed in this investigation (1.9 percent), adverse drug reactions were the least reported concern. Hypoglycemia is a common side effect found in people using oral diabetes medications or insulin.[28] In this study, 9 out of 260 hypoglycemic instances were found, and patients should be taught on the signs and symptoms of hypoglycemia as well as its management. This finding from the current study was lower than prior studies conducted in Australia[4] and New York State.[29] The discrepancy could be attributed to the level of diligent monitoring of ADR among patients admitted to wards versus outpatient services, when adverse drug reactions may not be evaluated on a regular basis or are only found during follow up based on patient complaints.

Recommendation

One method of lowering DRPs is to involve a clinical pharmacist, who can examine DRPs in a variety of settings, including hospital multidisciplinary teams, nursing homes, and primary care.[30] Clinical pharmacists' involvement as members of the health care team aids in the diagnosis and prevention of DRPs, which helps to rationalize drug therapy, obtain better therapeutic outcomes, and improve the quality of patient care.[3]

Limitation *of study*

The limitation of the present study was related to its inability in showing the overall prevalence of DRPs related to ineffective drug, drug interaction, unnecessary of drug therapy, dose too high;

since these type of DRPs were not easily identified by cross-sectional study conducted at outpatient department.

CONCLUSION

In the present study, high prevalence of DRPs was identified among patients with type 2 diabetes mellitus upon follow ups. Need additional drug therapy, dose too low, non-adherance and adverse drug reactions were the most frequent categories of DRPs identified. The current findings emphasizes the necessity of promoting pharmaceutical care at all phases of healthcare practices, particularly in patients with chronic conditions, in order to reduce potential DRPs and to enhance clinical outcomes. In order to limit DRPs, clinical pharmacists must be engaged in chronic follow-up departments, and they must collaborate with other medical professionals.

Ethical Consideration

This study was approved by the Mizan-Tepi University research standing committee (MTU/CHS/RSC50/17). Official permission was obtained from the two hospitals before the commencement of data collection. After explaining the purpose and procedures of the study, informed verbal consent was obtained from every study participant. The right not to participate or to withdraw from the study was kept for all respondents. Confidentiality of all respondents was maintained by recording their responses anonymously. Respondents were also informed that the service they need would not be affected whether they were involved in the study or not. The DRPs identified during the data collection process were reported to the concerned health provider.

Availability of Data

The datasets used and analyzed during the study are available on reasonable request.

Acknowledgement

We would like to thank health professional working in chronic care unit of Mizan Tepi University Teaching Hospital and Gebretsedik Shawo General Hospital for their cooperation during data collection.

Authors' Contribution

All authors made significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis, and interpretation, or in all these areas; took part in drafting, revising, or critically reviewing the article; gave final approval of the version published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

Funding

Mizan-Tepi University Research Office, Mizan Teferi, Ethiopia financially supported our study. The funders had no role in study design, data collection and analysis, decision to publish, or manuscript preparation.

Disclosure

All authors declare that they have no competing interest pertaining to this study.

REFERENCES

Association AD. Standards of medical care in diabetes—2019. *Diabetes Care*. 2019;42(Supplement_1):S13-S28.

Koyra HC, Tuka SB, Tufa EG. Epidemiology and predictors of drug therapy problems among type 2 diabetic patients at Wolaita Soddo University Teaching Hospital, Southern Ethiopia. *Am J Pharmacol Sci*. 2017;5(2):40-48.

Shareef J, Fernandes J, Samaga LN. Clinical pharmacist interventions in drug therapy in patients with diabetes mellitus and hypertension in a university teaching hospital. *International Journal of Pharmaceutical Sciences and Research*. 2015;6(10):4424.

van Roozendaal BW, Krass I. Development of an evidence-based checklist for the detection of drug related problems in type 2 diabetes. *Pharmacy World and Science*. 2009;31(5):580-595. doi:10.1007/s11096-009-9312-1

Zazuli Z, Rohaya A, Adnyana IK. Drug-related problems in type 2 diabetic patients with hypertension: a prospective study. *Journal of Basic and Clinical Pharmacy*. 2017;8(4):251-254.

Brahmbhatt SV, Sattigeri BM, Nil AK, Parikh DP, Shah HS. A prospective study on drug utilization pattern & rationality in the treatment of type II diabetes mellitus: a population-based analysis. *Int J Res Med Sci*. 2014;2(3):983-987.

Haugbølle LS, Sørensen EW. Drug-related problems in patients with angina pectoris, type 2 diabetes and asthma - Interviewing patients at home. *Pharmacy World and Science*. 2006;28(4):239-247. doi:10.1007/s11096-006-9023-9

Cipolle RJ, Strand L, Morley PC, Morley P. *Pharmaceutical Care Practice: The Clinician's Guide: The Clinician's Guide*. McGraw-Hill Medical; 2004.

Mourão AOM, Ferreira WR, Martins MAP, et al. Pharmaceutical care program for type 2 diabetes patients in Brazil: a randomised controlled trial. *Int J Clin Pharm*. 2013;35(1):79-86. doi:10.1007/S11096-012-9710-7

Patel P, Zed P. Drug Related Visits to the Emergency Department: How Big Is the Problem? *Pharmacotherapy*. 2002;22(7):915-923. doi:10.1592/phco.22.11.915.33630

Mehrpooya M, Vaseghi G, Eshraghi A, Eslami N. Delayed Myocardial Infarction Associated with Rituximab Infusion: A Case Report and Literature Review. *American Journal of Therapeutics*. 2016;23(1):e283-e287. doi:10.1097/MJT.0000000000000214

Tigabu BM, Daba D, Habte B. Drug-related problems among medical ward patients in Jimma university specialized hospital, Southwest Ethiopia. *Journal of Research in Pharmacy Practice*. Published online 2014. doi:10.4103/2279-042X.132702

Yimama M, Jarso H, Desse TA. Determinants of drug-related problems among ambulatory type 2 diabetes patients with hypertension comorbidity in Southwest Ethiopia: A prospective cross sectional study 11 Medical and Health Sciences 1103 Clinical Sciences. *BMC Research Notes*. 2018;11(1):679. doi:10.1186/s13104-018-3785-8

Demoz GT, Berha AB, Woldu MA, Yifter H, Shibeshi W, Engidawork E. Drug therapy problems, medication adherence and treatment satisfaction among diabetic patients on follow-up care at Tikur Anbessa Specialized Hospital, Addis Ababa, Ethiopia. *PLoS ONE*. 2019;14(10). doi:10.1371/journal.pone.0222985

Teklay G, Hussien J, Tesfaye D. Non-adherence and associated factors among type 2 diabetic patients at Jimma University Specialized Hospital, Southwest Ethiopia. *Journal of Medical Sciences (Faisalabad)*. 2013;13(7):578-584. doi:10.3923/JMS.2013.578.584

Al-Azzam SI, Alzoubi KH, Aburuz S, Alefan Q. Drug-related problems in a sample of outpatients with chronic diseases: a cross-sectional study from Jordan. *Ther Clin Risk Manag*. 2016;12:233-239. doi:10.2147/TCRM.S98165

Haugbølle LS, Sørensen EW. Drug-related problems in patients with angina pectoris, type 2 diabetes and asthma - Interviewing patients at home. *Pharmacy World and Science*. 2006;28(4):239-247. doi:10.1007/S11096-006-9023-9

Zaman Huri H, Chai Ling L. Drug-related problems in type 2 diabetes mellitus patients with dyslipidemia. *BMC Public Health*. 2013;13(1):1192. doi:10.1186/1471-2458-13-1192

Zaman Huri H, Fun Wee H. Drug related problems in type 2 diabetes patients with hypertension: a cross-sectional retrospective study. *BMC Endocrine Disorders*. 2013;13:2. doi:10.1186/1472-6823-13-2

Blix H. Drug-related problems in hospitalised patients: a prospective bedside study of an issue needing particular attention. Published online 2007. https://www.duo.uio.no/handle/10852/28078

Al-Hajje AH, Atoui F, Awada S, Rachidi S, Zein S, Salameh P. Drug-related problems identified by clinical pharmacist's students and pharmacist's interventions. *Annales pharmaceutiques francaises*. 2012;70(3):169-176. doi:10.1016/J.PHARMA.2012.02.004

Mekonnen AB, Yesuf EA, Odegard PS, Wega SS. Implementing ward based clinical pharmacy services in an Ethiopian University Hospital. *Pharm Pract (Granada)*. 2013;11(1):51-57. doi:10.4321/S1886-36552013000100009

Somers A, Robays H, de Paepe P, van Maele G, Perehudoff K, Petrovic M. Evaluation of clinical pharmacist recommendations in the geriatric ward of a Belgian university hospital. *Clinical Interventions in Aging*. 2013;8:703. doi:10.2147/CIA.S42162