

Original Research

Implementing ward based clinical pharmacy services in an Ethiopian University Hospital

Alemayehu B. MEKONNEN, Elias A. YESUF, Peggy S. ODEGARD, Sultan S. WEGA.

Received (first version): 25-Sep-2012

Accepted: 8-Mar-2013

ABSTRACT*

Background: Clinical pharmacy practice has developed internationally to expand the role of a pharmacist well beyond the traditional roles of compounding, dispensing and supplying drugs to roles more directly in caring for patients. Studies on the activities of the clinical pharmacist in an inpatient ward in resource constrained settings are scarce, however.

Objective: To assess ward based clinical pharmacy services in an internal medicine ward of Jimma University Specialized Hospital.

Methods: The study was carried out in the internal medicine ward from March to April, 2011 at Jimma University Specialized Hospital. The study design was a prospective observational study where pharmaceutical care services provided by clinical pharmacists for inpatients were documented over a period of two months. Interventions like optimization of rational drug use and physician acceptance of these recommendations were documented. Clinical significance of interventions was evaluated by an independent team (1 internist, 1 clinical pharmacist) using a standardized method for categorizing drug related problems (DRPs).

Results: A total of 149 drug related interventions conducted for 48 patients were documented; among which 133(89.3%) were clinical pharmacists initiated interventions and 16(10.7%) interventions were initiated by other health care professionals. The most frequent DRPs underlying interventions were unnecessary drug therapy, 36(24.2%); needs additional drug therapy, 34(22.8%) and noncompliance, 29(19.5%). The most frequent intervention type was change of dosage/instruction for use, 23(15.4%). Acceptance rate by physicians was 68.4%. Among the interventions that were rated as clinically significant, 46(48.9%) and 25(26.6%) had major and moderate clinical importance respectively.

Conclusion: Involving trained clinical pharmacists in the healthcare team leads to clinically relevant and well accepted optimization of medicine use in a resource limited settings. This approach can likely

be generalized to other health care settings in the country to improve medication outcomes.

Keywords: Medication Errors; Inpatients; Pharmaceutical Services; Professional Practice; Ethiopia

IMPLANTACIÓN DE SERVICIOS DE FARMACIA CLÍNICA EN LOS DEPARTAMENTOS DE UN HOSPITAL UNIVERSITARIO ETÍOPE

RESUMEN

Antecedentes: El ejercicio de la farmacia clínica se ha desarrollado internacionalmente para expandir el papel del farmacéutico más allá de los papeles tradicionales de formulación, dispensación y distribución de medicamentos a papeles más directamente relacionados con los cuidados de los pacientes. Sin embargo, son escasos los estudios de las actividades del farmacéutico clínico en los departamentos en establecimientos de recursos escasos.

Objetivo: Evaluar los servicios de farmacia clínica en un departamento de medicina interna del hospital universitario especializado de Jimma.

Métodos: El estudio fue realizado en el departamento de medicina interna desde marzo a abril de 2011 en el hospital Universitario especializado de Jimma. El diseño del estudio fue observacional prospectivo donde se documentaron los servicios de atención farmacéutica proporcionados por un farmacéutico clínico a pacientes internados durante un periodo de dos meses. Se documentaron intervenciones como la optimización del uso racional y la aceptación de los médicos de estas recomendaciones. Un equipo independiente (1 internista y 1 farmacólogo clínico) evaluó la significación clínica de estas intervenciones usando un método estandarizado de clasificar los problemas relacionados con medicamentos (PRM).

Resultados: Se realizó un total de 149 intervenciones para 48 pacientes.; de ellos, 133 (83,9%) fueron intervenciones iniciadas por el farmacéutico clínico y 16 (10,7%) fueron iniciadas por otros profesionales de la salud. Los PRM más frecuentes subyacentes a cada intervención fueron medicación innecesaria 36 (24,2%); necesidad de medicación adicional 34 (22,8%); e incumplimiento 29 (19,5%). El tipo de intervención más frecuente fue el cambio de dosis/instrucciones de uso 23(15,4%). La tasa de aceptación por médicos fue del 68,4%. Entre las intervenciones que fueron calificadas de clínicamente significativas, 46

* **Alemayehu B. MEKONNEN.** BPharm, MSc. Lecturer of Pharmacotherapy. School of Pharmacy, University of Gondar. Gondar (Ethiopia).

Elias A. YESUF. MD. Department of Health Services Planning and Management, Jimma University. Jimma (Ethiopia).

Peggy S. ODEGARD. PharmD, CDE. Professor of Pharmacy. School of Pharmacy, University of Washington. Seattle, WA (United States).

Sultan S. WEGA. MSc, PhD fellow. School of Pharmacy, Jimma University. Jimma (Ethiopia).

(48,9%) y 25 (26,6%) tuvieron grande y moderada importancia clínica, respectivamente.

Conclusión: Envolver a un farmacéutico clínico en el equipo de salud lleva a la optimización clínicamente relevante y aceptada del uso de medicamentos en un establecimiento de recursos limitados. Este abordaje puede, probablemente, generalizarse a otros establecimientos en el país para mejorar los resultados de la medicación.

Palabras clave: Errores de Medicación; Pacientes Internos; Servicios Farmacéuticos; Práctica Profesional; Etiopia

INTRODUCTION

The role of pharmacists as members of the health care team has expanded beyond conventional medication dispensing. Recently, pharmacists entered doctor's clinics as clinical pharmacists to perform direct patient care services.¹ According to Barber², clinical pharmacy services (CPS) are patient oriented services developed to promote the rational use of medicines and more specifically to maximize therapeutic effect, minimize risk, minimize cost and respect patient choice.¹ To achieve this, clinical pharmacists are trained in therapeutics and provide comprehensive drug management to patients and health care providers (clinical pharmacists). Interacting with the health care team in patient rounds, interviewing patients and conducting medication histories; providing recommendations on drug selection and follow-up all resulted in improved outcomes^{2,3} Murray *et al.*⁴ reported the effect of pharmacist interventions in outpatients with cardiovascular disease reduced the risk of adverse drug events by 34% compared with the control group. The positive impact of CPS (or pharmaceutical care services) on clinical, economic and humanistic outcomes has been demonstrated in numerous studies in the North America and United Kingdom (UK).⁵⁻⁸ Despite this, there is much inter-country and intra-country variability in the practice and implementation of clinical pharmacy (CP) and CP is still in its early stages, even in most European countries.⁹ CP is new to many developing countries including Ethiopia.

The importance of pharmaceutical care services in saving lives and protecting public health is particularly relevant in resource-limited settings with a high prevalence of major medicine-treatable diseases.¹⁰ Ethiopia is an Eastern African country of approximately 80 million persons with a gross domestic product of USD900 per capita, classifying it as a low-income country.¹¹ In addition to policy and resource related challenges, the effect of limited number and quality of pharmacy personnel on the provision of health care in Ethiopia is prominent.^{12,13} To tackle these and similar problems in the country, the School of Pharmacy of Jimma University launched the country's first graduate program in clinical pharmacy with an objective of training patient centered pharmacy practitioners as well as training faculty members for the new undergraduate clinical pharmacy courses in the new

revised national curricula of the country in March 2009. Jimma University took the lead in clinical pharmacy in Ethiopia because of its unique experiential learning practice sites and its community-based approach to learning, which allows students to train in the university's teaching hospital and local training health centers. The graduate program is accompanied by a one year clinical internship program for which ward based clinical pharmacy services are the primary focus. Therefore, the purpose of this study was to assess the development, implementation and initial outcomes of ward based clinical pharmacy service in the internal medicine ward of Jimma University Specialized Hospital (JUSH).

METHODS

This prospective observational study was conducted at JUSH, located in Jimma city of Oromia regional state which is located at a distance of 350 Km southwest of Addis Ababa. It provides specialized health services through its 9 medical and other clinical and diagnostic departments for approximately 9000 inpatients and 80,000 outpatients each year with bed capacity of 450 and a total of more than 550 staff. The study was carried out at the internal medicine ward of JUSH over a period of 2 months from March 1 to April 30, 2011. The internal medicine ward has three subsections: medical A, B, and C with total bed occupancy of 60. Three hundred patients were admitted during the study observation period. All in-patients in the internal medicine ward whose medicine chart or prescription led to an intervention were enrolled in the study based on their consent. Critically ill patients requiring intensive care unit (ICU) admission and patients with length of stay less than 48 hours were excluded from the study.

Data Collection Procedure

Normally, patients are under the care of one attending physician and two internal medicine residents in each ward of internal medicine, JUSH. Standard practice at the ward includes daily medical rounds by the resident in charge. Students and interns also participate in daily clinical rounds. The internist/resident assessed the patients and made recommendations and the resident/intern would make changes to the prescriptions respectively.

In this study, the graduate level clinical pharmacists completing their one year internship and training of trainers pharmaceutical care course were involved in ward rounds in the internal medicine inpatient settings to give pharmaceutical care services according to the standards of practice. This practice process involves three major steps including assessment, development of a care plan and follow-up evaluation. Specifically, eight clinical pharmacists, two for two weeks, were assigned in the internal medicine ward for 2 months and participated in medical and multidisciplinary team two days per week. Ward rounds usually took place from 10:00 am to 12:00 am. At each visit, the clinical pharmacist used all relevant information about each patient which was systematically

collected in the medical record: the results of examinations and laboratory results, the medical history, clinical factors, diseases, symptoms and medication history. We recognized that undertaking this activity for as many patients as possible represents a significant use of time and needs commitment. Likewise, recording all interventions to treatment takes time. So, for the sake of this study; pharmaceutical care interventions were documented in only those patients with DRPs. Participation with a multidisciplinary team was part of the project. Interventions made were communicated with the concerned health care professionals. All clinical pharmacists' interventions were documented in the pharmaceutical care patient record, which was already incorporated as patient care in the patient chart. With the data collected, the pharmacist evaluated appropriateness of medical therapy, identified any other DRPs and communicated interventions to the internist/resident. Written information to support the need for the intervention was then provided by the clinical pharmacist to the provider and the intervention documented. At discharge, the clinical pharmacists provided treatment update information to the patient or caregiver and the general practitioner for continuity of care and communication. A written plan (including names of drugs, indications, dosages and forms, frequency and time of administration, modalities of administration, list of drugs discontinued and reason) was given to the patient or caregiver, together with oral explanations. The further follow-up of the decisions on subsequent days or after the patient's discharge from the hospital was not a part of the study.

Drug related problems (DRPs) identified, resolved and prevented were recorded through DRP registration format. A drug-related problem is defined by Strand *et al.*¹⁴ as 'an undesirable patient experience that involves drug therapy and that actually or potentially interferes with the desired patient outcome'. Different pharmaceutical care researchers have employed different kinds of DRP classification categories. However, many of the DRP categories are adapted from the Cipolle-Morley-Strand classification.¹⁵⁻¹⁷ In our study, DRPs were categorized according to this classification scheme.¹⁸ It consisted of seven DRP categories: unnecessary drug therapy, needs additional drug therapy, ineffective drug therapy, dosage too low, adverse drug reaction, dosage too high and noncompliance. A definition for each DRP is available which is adapted from Cipolle *et al.*¹⁸ Thus, clinical pharmacists identified and documented DRPs accordingly. DRPs documented were validated by a senior pharmacist. Types of interventions made and their acceptance were recorded from the pharmaceutical care patient record. To judge the relevance of interventions, an independent panel comprised of one internist and one clinical pharmacologist rated DRPs according to their significance. Disagreements between the ratings were provided for discussion to the clinical pharmacist adjudication team for deliberation and confirmation of the DRP. Data collection was completed by junior pharmacists that were properly trained on the extraction of data from

pharmaceutical care patient record. Data were checked for completeness daily with appropriate follow-up and editing if needed. Data were then cleaned and analyzed, using SPSS version-16. The data were summarized and described using cross tabulation. Descriptive statistics was used to characterize interventions, drug related problems and physicians acceptance of interventions.

The following operational definitions were used:

- Acceptance of pharmaceutical care interventions: the doctor approves the proposal made by the pharmacist for the prevention or resolution of the DRP.
- Clinical importance of interventions: a rating of the intervention's significance or impact with regard to patient's outcomes. Significance was classified as extreme - life saving, deleterious; major - intervention may prevent serious morbidity, including readmission, serious organ dysfunction, serious adverse drug event; moderate - no benefit or minor benefit, depending on professional interpretation; mild - recommendation that brings care to a more acceptable and appropriate level of practice or that may prevent an adverse drug event of moderate importance.

Ethical Consideration

Letter of ethical clearance was obtained from the Ethical Review Board of Jimma University. Privacy and confidentiality was ensured during the pharmaceutical care services. Thus, name and address of the patient was not recorded in the DRP data collection format. From the pharmaceutical care service, DRPs were identified and resolved/prevented so that health and economic outcome was ensured.

RESULTS

Clinical pharmacists were present in the internal medicine ward for 16 days during the study period. A total of 149 drug related interventions were documented for 48 of the 300 patients admitted during the study period. Among them, 133 (89.3%) interventions were initiated by the clinical pharmacists and 16 (10.7%) by another health care professional (i.e. interventions were already handled by another health care professional). Mean average age of the patients was 38 (SD=17.6) (range 18-80), majority of patients 32 (66.7%) were females and mean average DRPs identified per patient was 3.83 (SD=2.43).

Medication use for all patients was evaluated for potential DRPs. DRPs identified were documented. These are summarized in Table 1. Unnecessary drug therapy was the most common drug related problem identified accounting for a quarter of all documented drug related interventions. Of the 36 DRPs classified as unnecessary, 18 (50%) were because there was no valid medical indication at that time, 9 (25%) were due to alcohol use or smoking and 7 (19.4%) were due to duplication of therapy. "Needs additional drug therapy" was also a

Table 1. Characteristics of interventions documented by clinical pharmacists, JUSH, Ethiopia, March-April 2011.

Drug related problem category*	Interventions, n (%)
Unnecessary drug therapy	36(24.2%)
Additional drug therapy	34(22.8%)
Ineffective drug	4(2.7%)
Dosage too low	18(12.1%)
Adverse drug reaction	16(10.7%)
Dosage too high	12(8%)
Noncompliance	29(19.5%)
Total	149(100%)

*A classification scheme by Cipolle *et al*, 2004

common problem identified 34 (22.8%). For 17 (50%) of the subjects, a medical condition indicated the need for initiation of drug therapy, with 12 (35.3%) requiring preventive drug therapy to prevent development of a new condition. The third most frequently identified drug related problem was noncompliance, 29 (19.5%) including unavailability of drug product 18 (62.1%) and the patient prefers not to take the medications 9 (31%).

Analysis of drug classes involved in interventions of all types showed iron, calcium, vitamins and other supplements, 30 (20.1%), were the most frequent classes involved in DRPs, followed by antibiotics, 22 (14.8%) (Table 2). The frequencies of classes of drugs with each particular drug therapy problem demonstrated; - the most predominant were antibiotics as 'unnecessary drug therapy' and 'adverse drug reaction' categories; digoxin from the 'ineffective drug therapy' category; iron, calcium, vitamins and other supplements from the 'needs additional drug therapy' and 'dosage too low' categories and anticoagulants, antihyperlipidemics from the 'dosage too high' and 'noncompliance' categories.

Clinical pharmacists working in an internal medicine ward during the study period were providers of pharmaceutical care resulting in 133 initiated interventions. Among those interventions they acted up on, dosage/instruction for use changed and consulting the health care professionals each accounting for 23 (17.3%) were the most common interventions made followed by new drug started 19

Table 2. Classes of drugs involved in interventions of all types, JUSH, Ethiopia, March – April 2011.

Drug class	N (%)
Iron, calcium, vitamins and other supplements *	30 (20.1%)
Antibiotics	22 (14.8%)
Anticoagulants, antihyperlipidemics	17 (11.4%)
Diuretics	16 (10.7%)
Antacids, antiulcers	11 (7.4%)
Analgesics	10 (6.7%)
Antiretrovirals	7 (4.7%)
ACEIs	6 (4.0%)
Digoxine	6 (4.0%)
Antifungals	5 (3.4%)
Antituberculars	4 (2.7%)
BBs	3 (2.0%)
Bronchodilators	2 (1.3%)
others†	9 (6.7%)
Total	149 (100%)

ACEIs=angiotensin converting enzyme inhibitors; BBs=beta-blockers
 *other supplements include potassium, multivitamins
 †antihelminthics, antiviral, sedative hypnotics

(14.3%) and drug discontinuation 16 (12%) (Table 3).

A total of 68.4% of the interventions were fully accepted and 2.3% were partially accepted by physicians. All of the health education interventions that were made were accepted by the patients and implemented by the multidisciplinary team. An independent clinical panel assessed the clinical significance of 94 interventions made by clinical pharmacists. The panel reviewed only those interventions which were considered fully and partially accepted. The panel and the intervening pharmacist were deemed to be in agreement if both assessed the same change (increase/decrease) and the same magnitude of change. Individual ratings were different for some of the interventions and level of agreement was determined between the independent panels and the intervening clinical pharmacists after discussion and consensus was reached. On the basis of clinical importance, 46 (48.9%); 25 (26.6%); 18 (19.2%) and 5 (5.3%) interventions were rated as major, moderate, mild, and extreme respectively.

DISCUSSION

The clinical pharmacist contributes to the general health outcomes by improvement of the drug therapy. This study provided evidence for the benefit of a patient to a more appropriate (effective and safe) medication use as a result of clinical pharmacist initiated interventions. A number of studies reported that involvement of clinical pharmacists in patient care in the inpatient hospital settings resulted in safer and more effective medication use through identification, resolution and prevention of drug therapy problems.¹⁹⁻²⁴ To our knowledge, this is the first study to report results of the ward based clinical pharmacy services in an African hospital setting. We found that clinical pharmacists through the provision of pharmaceutical care were able to propose a lot of interventions to a wide variety of DRPs and drugs. The most common drug related problem in our patients was unnecessary drug therapy (24%) with the most common reason being no valid medical indication (50%) and much of the share was to antibiotics. A study in Indonesia showed antibiotics are the third most common agents involved in unnecessary drug therapy²⁵ but the cost incurred on them is the highest. . Unnecessary drug use has two implications according to this result. On the one hand, antibiotic use without indication and over prescription has its own effect on the emergency of resistance to particular bacterial strains. On the other hand, in this era of inflation drug therapy costs are on the rise. This is cumbersome for developing nations. Prevention of unnecessary drug therapy will contribute in cost saving among hospitalized patients. Numerous US studies have demonstrated cost reductions when pharmaceutical care is provided.^{23,24} In Australia the value of clinical pharmacists in reducing costs of treatment and shortened hospital stays has been reported.²⁶ A study done in Sweden has showed the addition of pharmacists to health care teams would lead to

Interventions Type	Frequency (%)
Non accepted interventions *	39(29.3%)
Drug stopped	16(12%)
New drug started	19(14.3%)
Dosage/instruction for use changed†	23(17.3%)
Switch to other drug(s)	3(2.3%)
Consult the health care professional‡	23(17.3%)
Patient/medication counseling§	10(7.5%)
Total	133(100%)

*interventions from a clinical pharmacist to concerned health care professionals but not acted upon it
 †DRPs classified as dosage too high or dosage too low and acted up on were classified in this group
 ‡Consultations to health care professionals about potential and actual DRPs like laboratory monitoring, availing drugs
 §Advice intended to resolve the DRP.

major reductions in morbidity and health care costs.²⁷ Though we were not able to assess the specific cost-effectiveness of this intervention; services must have a financial impact that demonstrates evidence as scientifically robust, ethically justifiable⁶, and beneficial so that outcomes can be communicated to policy makers.

The second most common drug related problem that lead to intervention was needs additional drug therapy (22.8%). The majority of these (50%) were medical conditions requiring initiation of drug therapy and 35.2 % of them were indicated to prevent the onset of a new medical condition. A study in Minnesota has reported additional drug therapy is the most identified drug related problem accounting for 32% of DRPs.¹⁵ MacKinnon *et al.* found untreated indications (43.5%) were the most common.²⁸

The drug classes most frequently involved in drug related problems and interventions were iron, calcium, and vitamins supplements (20.1%). This is somewhat a higher value with intervention study by Rasmussen *et al.* which also found that vitamins and minerals were the most common drugs involved in the intervention (5.5%).¹⁹ This might be due to the

overall perception of prescribing iron gluconate in the same dose as iron sulphate and adult onset malnutrition were common. Antibiotics were the class of medications second most frequently implicated in DRPs in the intervention. As mentioned above, problems with antibiotics were so vast that guidelines were not likely followed. The majority of interventions was accepted and was viewed as clinically important. Moderate higher acceptance rate was found in this study. Spinewine *et al.* described acceptance rate of as low as 67% can be consider as a higher value.²² It is not surprising to get this value. Physicians acted as preceptors in some of the sessions. This is further supported by the clinical significance of interventions made (Table 4). Studies reported the impact of this service method was demonstrated by the number and clinical importance of the interventions made.^{22,29} It was the responsibility of an independent review panel to assess the significance of interventions. This method of evaluation of clinical pharmacists' interventions by a multidisciplinary panel is an approach utilized by other investigators.^{22,26,29} The higher value of major clinically important interventions strengthens our findings. This might be due to the fact that as

<p>Interventions of moderate clinical importance</p> <ul style="list-style-type: none"> Drug related problem: lactating mother taking doxycycline for her pneumonia Intervention: doxycycline is contraindicated in breast feeding mothers. So, a safer drug product is required due to risk factors. doxycycline was discontinued and substituted with safer drugs Drug related problem: a patient taking salbutamol 5 mg po TID and salbutamol puff QID for his moderate persistent asthma Intervention: Salbutamol puff was made PRN basis Drug related problem: two analgesics (paracetamol and diclofenac) prescribed by an intern for mild intermittent fever Intervention: duplication of treatment, little benefit but increased risks of adverse effects. diclofenac was discontinued. Drug related problem: two antimalarials (coartem and chloroquine) for mixed malarial infection (p.vivx and p.falciparum) Intervention: duplication of therapy, little benefit. Coartem can cover both infections. chloroquine was discontinued Drug related problem: Fluconazole cimetidine drug interaction Intervention: fluconazole was administered before 2 hrs of cimetidine administration <p>Interventions of Major clinical importance</p> <ul style="list-style-type: none"> Drug related problem: nephrotoxicity 2° to gentamycin was noticed Intervention: gentamycine dose was changed from TID basis to daily basis Drug related problem: iron gluconate 300 mg po TID in the same dose as that of iron sulphate was prescribed for most patients to treat anemia Intervention: the stated dose is too low to produce a desire effect. so, iron gluconate 600 mg po TID was initiated for all cases Drug related problem: a patient with CHF 2° to ischemic cardiomyopathy and hypertriglycermia Intervention: fibrates were recommended but due to unavailability replaced with lovastatin Drug related problem: warfarine induced hemorrhage that results in hypovolemic shock Intervention: start Vit. K 5 mg IM stat Drug related problem: a 41 kg female patient on antiTB (RHZE) taking 2 tabs po/day Intervention: dose of antiTB was increased to 3 tabs po/day
--

clinical pharmacists documentation was strictly adhered to time and they would likely to document interventions of major clinical importance. A prospective multicenter study by Dooley *et al.* showed a quarter of interventions were of major clinical importance.²⁶ Spinewine *et al.* described the same result in elderly population.²² The limitation of the study, however, is the interventions made by other health care professionals were not assessed for clinical importance and compared with pharmacists' intervention.

CONCLUSIONS

Patient centered clinical pharmacy services promote rational use of medications and this is of paramount importance in a resource limited settings. Our study revealed that involvement of trained clinical pharmacists in a health care delivery team leads to well documented and improved optimization of medication use; and further assures that implementation of ward-based clinical pharmacy services is possible in Ethiopia. The provision of pharmaceutical care can result in improved identification of drug related problems in admitted

patients. A clinical pharmacist contributes to a more correct medication of inpatients, even with the modest contribution in the pre-round meeting and the ward round twice per week. Analyses such as those presented here provide information to better focus the training of practitioners based on the most frequently encountered drug related problems in the inpatient hospital setting. If clinical pharmacists become familiar with these common drug related problems, they will become adept and competent in managing these conditions. The provision of clinical pharmacy services in JUSH internal medicine wards has resulted in improved documentation, increased understanding of range of drug related problems confronting patients, and expanded the health professional team.

CONFLICT OF INTEREST

All the authors declare that there is no conflict of interest and contributed equally to this work.

Funding: The authors wish to express their sincere appreciation to Jimma University of Ethiopia for the financial support.

References

1. Chisholm-Burns MA, Kim Lee J, Spivey CA, Slack M, Herrier RN, Hall-Lipsy E, Graff Zivin J, Abraham I, Palmer J, Martin JR, Kramer SS, Wunz T. US pharmacists' effect as team members on patient care: systematic review and meta-analyses. *Med Care*. 2010;48(10):923-33. doi: 10.1097/MLR.0b013e3181e57962.
2. Barber N. Towards a philosophy of clinical pharmacy. *Pharm J*. 1996;257:289-91.
3. Kaboli PJ, Hoth AB, McClimon BJ, Schnipper JL. Clinical pharmacists and inpatient medical care: a systematic review. *Arch Intern Med*. 2006;166(9):955-64.
4. Murray MD, Ritchey ME, Wu J, Tu W. Effect of a Pharmacist on Adverse Drug Events and Medication Errors in Outpatients With Cardiovascular Disease. *Arch Intern Med*. 2009;169(8):757-63. doi: 10.1001/archinternmed.2009.59.
5. Chisholm-Burns MA, Graff Zivin JS, Lee JK, Spivey CA, Slack M, Herrier RN, Hall-Lipsy E, Abraham I, Palmer J. Economic effects of pharmacists on health outcomes in the United States: A systematic review. *Am J Health Syst Pharm*. 2010;67(19):1624-34. doi: 10.2146/ajhp100077.
6. Matsoso MP. Future vision and challenges for hospital pharmacy. *Am J Health Syst Pharm*. 2009;66(5 Suppl 3):S9-12. doi: 10.2146/ajhp080628.
7. Hatoum HT, Catizone C, Hutchinson RA, Purohit A. An eleven year review of the pharmacy literature: documentation of the value and acceptance of clinical pharmacy. *Drug Intell Clin Pharm*. 1986;20(1):33-48.
8. Child D, Camtro JA, Cooke J. Effectiveness of hospital pharmacy: where is the evidence? Guild of Health care pharmacists, 2001. Available at: <http://www.ghp.org.uk/login.aspx?reason=notauthenticated> (Accessed 23/03/2012).
9. LeBlanc JM, Dasta JF. Scope of international hospital pharmacy practice. *Ann Pharmacother*. 2005;39(1):183-91.
10. King RC, Fomundam HN. Remodeling pharmaceutical care in Sub-Saharan Africa (SSA) amidst human resources challenges and the HIV/AIDS pandemic. *Int J Health Plann Manage*. 2010;25(1):30-48. doi: 10.1002/hpm.982.
11. Ethiopia. The World Fact Book. Central Intelligence Agency: USA. Available at: <https://www.cia.gov/library/publications/the-world-factbook/geos/et.html> (Accessed June 13, 2011).
12. Suleman S, Ketsela A, Mekonnen Z. Assessment of self medication practices in Assendabo town, Jimma zone, southwestern Ethiopia. *Res Social Adm Pharm*. 2009;5(1):76-81. doi: 10.1016/j.sapharm.2008.04.002.
13. Makonnen E, Yoseph M, Berhane Y. Quality of prescription at a tertiary care pharmacy in Addis Ababa. *Ethiop Med J*. 2002;40(3):233-9.
14. Strand LM, Morley PC, Cipolle RJ, Ramsey R, Lamsam GD. Drug-related problems: their structure and function. *DICP*. 1990;24(11):1093-7.
15. Rao D, Gilbert A, Strand LM, Cipolle RJ. Drug therapy problems found in ambulatory patient populations in Minnesota and South Australia. *Pharm World Sci*. 2007;29(6):647-54.
16. Isetts BJ, Brown LM, Schondelmeyer SW, Lenarz LA. Quality assessment of a collaborative approach for decreasing drug-related morbidity and achieving therapeutic goals. *Arch Intern Med*. 2003;163(15):1813-20.
17. Becker C, Bjornson DC, Kuhle JW. Pharmacist care plans and documentation of follow-up before Iowa Pharmaceutical Case Management Program. *J Am Pharm Assoc* (2003). 2004;44(3):350-7.
18. Cipolle RJ, Strand LM, Morley PC. *Pharmaceutical Care Practice: The Clinician's Guide*. 2nd ed. New York: McGraw Hill; 2004.
19. Struck P, Pedersen KH, Moodley P, Rasmussen M. A pilot study of pharmacist-initiated interventions in drug therapy in an Australian pediatric hospital. *EJHP Science*. 2007;13(4):105-12.

20. Stuchbery P, Kong DCM, DeSantis GN, Lo SK. Identification by observation of clinical pharmacists' activities in a hospital inpatient setting. *Pharm Pract.* 2007;5(1):10-6.
21. Veggeland T, Dyb S. The contribution of a clinical pharmacist to the improvement of medication at a geriatric hospital unit in Norway. *Pharm Pract.* 2008;6(1):20-4.
22. Spinewine A, Dhillon S, Mallet L, Tulkens PM, Wilmotte L, Swine C. Implementation of ward-based clinical pharmacy services in Belgium - description of the impact on a geriatric unit. *Ann Pharmacother.* 2006;40(4):720-8.
23. Connor SE, Snyder ME, Snyder ZJ, Steinmetzpater K. Provision of clinical pharmacy services in two safety net provider settings. *Pharm Pract.* 2009;7(2):94-9.
24. Altavela JL, Jones MK, Ritter M. A prospective trial of a clinical pharmacy intervention in a primary care practice in a capitated payment system. *J Manag Care Pharm.* 2008;14(9):831-43.
25. Rahmawati F, Pramantara IP, Rohmah W, Sulaiman SA. Polypharmacy and unnecessary drug therapy on geriatric hospitalized patients in yogyakarta hospitals, Indonesia. *Int J Pharm Pharm Sci*2009;1(1):6-11.
26. Dooley MJ, Allen KM, Doecke CJ, Galbraith KJ, Taylor GR, Bright J, Carey DL. A prospective multicentre study of pharmacist initiated changes to drug therapy and patient management in acute care government funded hospitals. *Br J Clin Pharmacol.* 2004;57(4):513-21.
27. Gillespie U, Alassaad A, Henrohn D, Garmo H, Hammerlund-Udenaes M, Toss H, Kesttis-Lindblad A, Melhus H, Morlin C. A comprehensive pharmacist intervention to reduce morbidity in patients 80 years or older: A randomized controlled trial. *Arch Intern Med.* 2009;169(9):894-900. doi: 10.1001/archinternmed.2009.71.
28. MacKinnon NJ, Morais C, Rose T. Drug-related problems identified in a workplace asthma self-management program. *Can Pharm J.* 2007;140 (2):110-5.
29. Bosma L, Jansman FG, Franken AM, Harting JW, Van den Bemt PM. Evaluation of pharmacist clinical interventions in a Dutch hospital setting. *Pharm World Sci.* 2008;30(1):31-8.