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A Study of Clinical Pharmacist Initiated Changes in Drug Therapy in a Teaching Hospital

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Abstract
This study was aimed to assess and quantify the pharmacist-initiated changes in drug therapy and its cost savings at a tertiary care South Indian Hospital. The medication details of all patients enrolled to the study was collected prospectively and reviewed independently by the intervening pharmacist to identify any Drug Related Problems (DRPs). Where an DRP was identified, it was discussed with physician and suitable suggestion was provided. Clinical significance of each intervention was graded based on the expected clinical outcome. An independent panel consisting of clinician and academic clinical pharmacists reviewed all the interventions made by the intervening pharmacist for potential cost savings relating to length of stay, readmission, drugs, medical procedures and laboratory monitoring. A total of 261 DRPs were identified from 189 patients. The incidence of DRPs was found to be 7.9 per 100 patients. The most common DRP was found to be drug use without indication (18%) followed by improper drug selection (14%). Seventeen percent of the DRPs observed were in patients suffering from cardiovascular disorders followed by respiratory disorders (15%). The average time spent for each intervention was 12.5 minutes. The most frequent change initiated by the intervening pharmacist was cessation of the drug (20%). The annualized cost savings incurred by the pharmacist-initiated changes in drug therapy was Rs: 46,686 /=.
In our study, pharmacist initiated change in drug therapy was well accepted by the physicians. The study demonstrates that routine clinical pharmacist review of in-patient drug therapy can improve patient outcome and reduce patients' healthcare cost.
Key words: *Pharmacist, Intervention, Drug therapy, Drug related problems, Cost.*

INTRODUCTION

Drug therapy enhances health related quality of life (QoL) for most of the diseases[1]. Despite excellent benefits and safety profile of most medications, drug related problems pose a significant risk to patients, which adversely affect quality of life, increases hospitalization and overall healthcare costs.[2,3] However, optimization of drug therapy may, by preventing Drug Related Problems (DRPs), influence health expenses, potentially save lives and enhance patient's quality of life.[1, 2, 3] Increased use of medication and availability of new drug therapies potentially increase the risks of patient for iatrogenic adverse drug events in hospitals.[4,5] Iatrogenic adverse events are important for consideration because it can not only prolong hospital stay but also increase the patient healthcare expenditure. Therefore, it is important that all drug related problems resulting in serious injury or death are evaluated to assess whether improvement in the healthcare delivery system can be made to reduce the likelihood of similar events occurring in the future .[4,5] In clinical medicine, a wide range of drug related problems might arise due to various causes.[3,6] Various factors encountered in medical practice lead to DRPs. Medical prescribing errors, improper dosage, improper drug selection, drug-drug interaction, drug without indication, untreated indication are the most commonly encountered DRPs.[6] The cause of DRPs also includes those that are iatrogenic and idiosyncratic in nature. In addition, factors like increased use of medications, polypharmacy and availability of new drug therapies will potentially increase the risk of drug-induced illness.[3,6]

Studies on the prevalence of DRPs in hospitals and a closer characterization of all DRPs are lacking and the bedside clinical approach evaluation of patients' DRPs is applied.[1] However, studies carried out to assess and minimize DRPs in hospitals are reported.[6] It is reported that medication errors occur in 3-6.9 % of in-patients and the error rate for in-patients' medication orders was reported to be 0.03-16.9 % with each hospital experienced a medication error every 22.7 hours.[7] An Indian study reported that the incidence of DRPs was

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found to be greater than quoted as an average in developed countries[3]. High incidence of inappropriate dosage and improper drug selection observed in the study was attributed to lack of standard treatment protocols or a formulary for hospital and the differing treatment patterns between the medical wards in each Indian hospital[3].

Drug therapy has become so difficult that no one professional is expected to optimize the drug therapy and control DRPs alone[7,8]. Today there exist a due problem in medical care that urgently requires expert attention namely that of preventable drug related morbidity and mortality[3,9]. These problems could be well preventable / minimized by initiating changes in drug therapy through clinical pharmacy services[3]. Also, reduction in healthcare cost and improved patient care may be attained through clinical pharmacy services by ensuring the rational use of medications, and improving patient compliance with medications[10].

A study in the United States estimated that the cost of treating conditions caused by inappropriate medication was US $177.4 billion in 2000.[8] It is reported that due to high expenditure towards medical expense patients tend to skip the medication or nonadherence to the medication that will worsen the disease condition. Pharmacist can ensure appropriate drug use, decrease out of pocket expenditures, and improves access to needed drugs[11] by providing consultation at the point of care. In a recent study it is reported that the annualized cost savings relating to length of stay, readmission, drugs, medical procedures and laboratory monitoring as a result of clinical pharmacist initiated changes to hospitalized patient management or therapy was $ 4 444 794 for eight major acute care government funded teaching hospitals in Australia.[2] Studies exploring cost savings achieved through the provision of clinical pharmacy services to hospitalized patients in major acute care teaching hospital are limited. Moreover, in Indian setup, studies assessing the pharmacist interventions and its cost saving has not been well demonstrated. Hence, this study was intended to assess and quantify the clinical pharmacist-initiated changes to drug therapy and its cost savings at JSS Medical College Hospital, Mysore.

METHODS

This prospective study was conducted at a 1000 bed multispeciality tertiary care teaching hospital (JSS Medical College Hospital, Mysore) over a period of seven months. In-patients of either sex of any age undergoing treatment in medicine wards were included in our study. The exclusion criterion was patients receiving treatments on out-patient basis. The intervening pharmacist was a postgraduate pharmacy practice student. All the interventions made by the intervening pharmacist were preceded by consultation with the academic clinical pharmacist. The medication details of all those patients who were admitted to medical wards were collected and documented in a suitably designed data collection form. The intervening pharmacist, to identify the drug related problems, reviewed collected data independently. Nature of the drug related problem of each case that was identified was categorized based on categories described by Helper and Strand.[9]

Drug related problem identified was brought to the notice of the concerned physician for the remedial action and the primary reason(s) for initiating the intervention was recorded. In addition, appropriate suggestions were provided to the concerned physician at the earliest possible time. The clinical significance of each intervention was assessed by the intervening pharmacist, and later reviewed and verified by an academic clinical pharmacy practitioner for accuracy. The acceptance level of physician for the particular intervention was also recorded as either accepted or not accepted. Similarly, whether or not there was a change in drug therapy was noted. After the interventions, further details such as suggestions provided, its category and resources or references consulted were documented. In addition, the total time taken by the intervening pharmacist in preparing and undertaking the intervention was recorded. At the time of patient discharge, the intervening pharmacist documented the actual changes to drug therapy and patients' outcomes relating to the intervention. The involvement of pharmacist in therapeutic decision - making was rated according to Campagna's decision- making model, but for simplification.

An independent clinical panel was convened which consisted of a consultant physician, final year postgraduate medical student and an academic clinical pharmacist. All those interventions, which were accepted and changed by the physician, were assessed by the panel for any possible impact on the following: length of stay (LOS), readmission probability, medical procedures and laboratory monitoring. The independent clinical panel reviewed only those interventions perceived by the intervening pharmacist as having an impact on either length of stay, readmission probability, medical

procedures or laboratory monitoring. The panel then confirmed or rejected the intervening pharmacist's assessment and quantified the resultant changes. The criteria for assessment and quantification of these changes were based solely on review of the individual case and the collective decision of the panel. The panel did not assess the interventions perceived to result only in a change in drugs but instead intervening pharmacist calculated the impact on drugs-costs. Actual cost at the study site was considered for the purpose of analysis of impact on cost savings on length of stay, probability of readmission and evaluation of changes to lab monitoring.

Cost Evaluation of Probability of Readmission and Length of stay

The probabilities of readmission were estimated based on the probability (expressed as percentage likelihood) of a readmission event occurring without the intervention compared with the probability of a readmission after the intervention has occurred.[2] Costs were then calculated by multiplying this probability with the average cost of the treatment for specific disease costing at study site.

The panel quantified the impact of each intervention on LOS by estimating the change in the number of days in either a general medical ward or high dependency wards (Incentive Care Unit, Coronary care unit, Emergency wards). The change in LOS was based on likelihood of changes in LOS occurring if the intervention was not done.[2] The local independent clinical panel decided as to sub-classification of the wards based on individual case. The cost impact of changes in LOS was then calculated based on average ward costs for the particular ward as existed at the study site.

Laboratory Monitoring Changes and Medical Procedures

The independent clinical panel examined the changes to laboratory monitoring or medical procedures and allocated a probability of the event being changed as a result of the intervention. The cost impact was then calculated by multiplying this probability by the study site's costs for the particular medical procedure or laboratory test.

Evaluation of Drug Cost

The impact of pharmacist intervention on drug cost was assessed by considering change in the medication orders that occurred during hospital stay. The discharge medications of the patient were not considered for cost evaluation.[2] For the analysis of drug costs, intervening pharmacist referred latest issue of Current Index of Medical Specialities (CIMS). If the drug costs for the particular drug was not available in CIMS, then cost mentioned in Indian Drug Review (IDR) was considered. All those changes made in drug therapy were noted from patients' medication administration records. The total drug cost was calculated by considering only the actual drug cost based on drug, dose administered, frequency and duration of therapy. Administration charges, syringes and reconstitution solutions, and discharge medications were excluded from the cost assessment procedure. Cost of injections was calculated as whole vials. If a dose range was prescribed, cost was based on the average dose administered.[2]

Annualized Cost Savings

Annualized cost savings were calculated by extrapolating the seven months' data and their associated cost saving over a year.

RESULTS

A total of 3315 cases were followed and reviewed in the medical ward over seven months period. Of the cases reviewed, 261 drug related problems were identified from 189 patients. The incidence of DRPs was found to be 7.9 per 100 patients followed. Average DRPs per prescription was 1.4 (range: 1 to 5). Majority [57.8 % (n≤109)] of patients were male. The average age of the patients was 49.8 ± 13 (Mean ±SD) years (range: 19 to 80 years). Majority (52.8%) of DRPs occurred in the age group of 41- 60 years. The demographic details of the study patients are summarized in Table 1.

The most common drug related problem was drug use without indication, which accounted for 18% (n≤47) of total DRPs followed by improper drug selection [14% (n≤36)] and subtherapeutic dose [14% (n≤36)].The types of drug related problems are summarized in Table 2.

Of the total interventions, the significance level 'moderate' was found to be high (60%) followed by significance level 'minor' (29%). The significance level of drug related problems is represented in Table 3.

The most frequent suggestion provided by the intervening pharmacist was cessation of drug [20 % (n≤53)] followed by addition of drug [14% (n≤37)]. Change in drug dose accounted for 13% (n≤33) of total suggestions provided. Suggestion related to pharmaceutical aid was found to be least [2% (n≤4)]. Various suggestions provided by the intervening pharmacist are summarized in Table 4.

The acceptance rate of intervening pharmacist's suggestions was found to be 87 % (n≤227). Of these, changes in drug therapy was observed in 81% (n≤183) of accepted suggestions. The total time spent by the intervening pharmacist in preparing, undertaking and documenting all interventions was 106 and 25 minutes

[average 12.5 minutes; range: 2 to 60 minutes].

Of the total interventions, 46% (n≤118) of interventions belonged to drug therapy decision-making level 1 (Corrective) followed by level 4 (Proactive) accounting to 30% (n≤79). The Pharmacist's involvement in drug therapy decision making is presented in Table 5.

A total of 128 interventions resulted in decrease in cost of therapy while 33 interventions incurred additional cost. The total net cost savings was Indian Rupees (INR) 27,233.55/≤. This included savings of INR 5590.50/≤ for reduction in length of stay, INR 9079.85/≤ for readmission reduction, INR 476.20/≤ for laboratory monitoring and INR 12,087.00/≤ for drugs. The impact of pharmacist-initiated changes to drug therapy and their associated cost savings is presented in Table 6.

DISCUSSION

In India, clinical pharmacy service is an emerging discipline[3]. Clinical pharmacy service is to optimize patient outcomes by working to achieve the best possiblequality use of medicines.[12] It has been shown that the clinical pharmacy activities reduce the drug related problems related hospitalization, probability of readmission and total cost of drug therapy.[2,3] This prospective study was carried out to assess and quantify the pharmacist-initiated changes in drug therapy of in-patients of a tertiary care teaching hospital.

In our study, DRPs were high (52.8%) in patients aged between 41and 60 years. Of the 189 patients, DRPs commonly observed in male patients (57.8%). This finding might be due to increased medication use owing to their multiple co-morbidities. Majority (71.4%) of patients received more than six drugs per day and hence increased risk of occurrence of drug related problems. Regular review of patients' medication use may potentially decrease the drug related problem.[13]

Drug use without indication [18% (n≤47)] was the most common DRP observed followed by improper drug selection [14% (n≤36)]. This observation is in contrast with the study carried out by Gurumurthi Parthasarthi et al[3], in which inappropriate dosing accounted for highest (31%) followed by improper drug selection (17%). Few drugs often used without indication included Rabeprazole, Paracetamol and Ranitidine. Although anti secretory agents often used as prophylaxis, especially in patients with previous history of acid peptic ulcer disease, the agents were prescribed while there was no such indication. A study conducted by David L. Whaley et al[14] reported that gastrointestinal agents were the major class of drug prescribed in a hospital. In our study, the use of proton pump inhibitor was to prevent the possible gastritis associated with use of antibiotics and NSAIDs. However, where appropriate, after intervening pharmacist's intervention rabeprazole was withdrawn from the patient's therapy.

Improper drug selection [14%] was the second most common DRP observed. This finding coincides with the study conducted by Gurumurthy Parthasarthi et al[3] wherein, it reported improper drug selection [17%] as the second most common DRP that occurs in medicine wards. The high incidence of improper drug selection may be attributed to lack of standard treatment protocol in the hospital, poor history taking etc. In one incidence, hypertensive patient with a history of diabetes was administrated with Beta-blocker owing to lack of documentation of patient's medical history. Later, when intervening pharmacist reviewed the case, it was observed that the patient was also diabetic and appropriate intervention was made as beta blockers may mask the hypoglycemic side effect of anti-diabetics. Failure to receive drug was accounted for 5% (n≤14) of the total DRPs. In few cases, it was due to economic constraints of the patients that led to non-procurement of prescribed medicines while in few other cases it was due to shift change of nursing staff and reluctance of patients to take the medications for unknown reasons. Other types of DRPs including drug duplication and class duplication were majority due to availability of more than 80,000 formulations of drugs in Indian market with different brand names leading to confusion.[3] This error can be minimized by prescribing generic names and also by reviewing and re-checking of medication order regularly prior to drug administration.

Of the 261 DRPs, 29% (n≤75) were rated to be 'minor', 60% (n≤157) were 'moderate' and 11% (n≤29) were 'major' significance of interventions. This finding correlates with a study[3] that reported 49% of interventions as 'moderate' significance. The 'moderate' significance level is the level of problems requiring adjustments, which are expected to enhance effectiveness of drug therapy producing minor reduction in patient morbidity or treatment costs. In our study, for example, patient experienced severe diarrhea [presence of signs of dehydration with abdominal pain and cramps] after receiving Clindamycin. After having assessed the ADR, the intervening pharmacist informed physician about the possible Clindamycin induced diarrhoea and sought for the cessation of drug. Thus the timely intervention by intervening pharmacist might have resulted in reduction in hospital stay and hence the cost

involved in the management of adverse drug reaction.

Antibiotics (21%) was the most commonly implicated drug class in DRPs. This observation was coinciding with observations made by different studies.[15,16] Ahuva Lusting[15] found antibiotics (38.7%) as the most prevalent class of drugs prescribed in hospital. Inappropriate antibiotic usage may provoke the emergence of bacterial resistance and increased healthcare cost. Similar finding was reported in a study conducted by Carlos Bantar et al[16]. In our study, patients were either receiving high dose of antibiotics or antibiotics were prescribed without any valid indication. Of the 261 DRPs, 17% and 15% of the DRPs were found in patients treated for cardiovascular disorders and respiratory disorders respectively. These observations correlated with the Michael J. Dooley et al[2] study conducted in Australia. In our study, it may be perhaps due to high occupancy rate of patients with cardiovascular disorders and respiratory disorder in medical ward resulting in use of more medication in these patients, thus leading to potential DRPs.

Cessation of drug (20%) and addition of drug (14%) were the suggestions most frequently provided. This finding differs from observation made in an Indian study[2] wherein change in drug dose was reported as the most common suggestion made. Other suggestions made in our study included change in drug dose, duration of therapy, frequency of administration and substitution of drug etc. Addition of drug was suggested in case of untreated indications that required treatment. Few of the untreated conditions included anemia, cough and cold. In most cases, the change in drug dose was sought in patients with renal/hepatic impairment requiring dosage reduction. In our study, the major reasons for cessation of drug were due to drug use without indication and improper drug selection. Few examples that warranted the cessation of drugs in our study included use of beta-blockers in asthma patient, steroids in diabetes and paracetamol in afebrile condition. These findings of our study indicate that there is a scope for pharmacist to suggest issues related to rational drug therapy and emphasise the importance of involvement of pharmacist in healthcare delivery.

The acceptance rate of intervening pharmacist's suggestions was found to be high (87%). This observation correlates with other published studies[3,10]. Of the 87% of interventions accepted, 81% of interventions led to the changes in drug therapy. The remaining 19% of interventions that did not lead to changes in drug therapy might perhaps be due to lack of information to strengthen the suggestions provided. In few cases, experienced physician did not change their routine prescribing pattern despite the presence of DRP, especially, DRP of 'minor' significance. For example, a suggestion for use of domperidone instead of ondansetron for vomiting was rejected.

The total time spent by the pharmacist in preparing, undertaking and documenting all interventions was 106 hours and 25 minutes. The average time spent for each intervention was 12.5 minutes (range: 2 to 60 minutes). This observation is in contrast to Michael J. Dooley et al[2] study wherein 9.6 minutes (range: 0-60 minutes) was spent for each intervention. This difference may be attributed to the fact that unlike India, drug information services and patient medication history were available online in developed countries like Australia[17]. In addition, unlike our study, involvement of experienced clinical pharmacist would have led to the high acceptance rate and also reduction in time spent for each intervention.

Textbooks were found to be the most frequently (56%) consulted references followed by the personal knowledge of the intervening pharmacist in providing various suggestions. As majority of DRPs were of 'minor' significance, most of DRPs were managed with the amount of information available in various textbooks. The information available in textbooks is very comprehensive and also covers wide ranges of diseases and their treatment aspect. Also, since the department of clinical pharmacy located at JSS hospital is well equipped with drug information resources including the latest resources of textbooks, it was possible to obtain latest information required to address the DRPs.

All the 183 interventions which were accepted and changed by the physicians were allocated for cost analysis. Of these, 163 interventions had impact on the cost and the remaining interventions did not have any impact on cost savings. Of the 163 interventions, 126 interventions had impact on drug cost alone and hence only 37 interventions were assessed by the independent panel for quantification of length of stay, readmission, medical procedures and laboratory monitoring. As decided by the clinical panel, 33 interventions had resulted in cost-savings but two interventions resulted in increase in cost of therapy. However, two interventions were excluded as there was no impact on cost savings.

The net cost savings made through interventions was Indian Rupees (INR): 27,233/≤. In our study, the

Table No.1 - Demographic details of the study patients

Characteristics		Number (%) (n= 189)
Age (years)	18-29	10 (5.3)
	30-40	31(16.4)
	41-50	50 (26.4)
	51-60	50 (26.4)
	61-70	42 (22.2)
	71-80	6 (3.2)
Sex	Male	109 (57.8)
	Female	80 (42.3)
Number of drugs received per patient	1-5 drugs	54 (28.6)
	6-10 drugs	116 (61.4)
	>10 drugs	19 (10)
Co-morbidities	Nil	56 (30)
	1-2	95 (50)
	3-4	31 (16)
	>4	7 (4)

Table No.2 - Types of drug related problems

Drug related problems	Number (%) (n=261)
Drug use without indication	47 (18)
Improper drug selection	36 (14)
Sub therapeutic dose	36 (14)
Drug interaction	31 (12)
Over dose	28 (11)
Adverse drug reaction	21 (8)
Untreated indication	19 (7)
Failure to receive drug	14 (5)
Others*	29 (11)

* Class duplication (n≤12), Drug duplication (n≤9), Dispensing errors (n≤6) and Drug use without prescription (n≤2).

Table No.3 - Significance level of drug related problems

Significance level*	Number (%) (n=261)
Minor	75 (29)
Moderate	157 (60)
Major	29 (11)

*** Minor:** Problems requiring small adjustments and optimization to therapy, which are not expected to significantly alter hospital stay, resource utilization or clinical outcome.

Moderate: Problems requiring adjustments, which are expected to enhance effectiveness of drug therapy producing minor reductions in patient morbidity or treatment costs.

Major: Problems requiring intervention, expected to prevent or address very serious drug related problems, with a minimum estimated effect on reducing hospital stay by no less than 24 hours.

Table No. 4 - Suggestions provided by the intervening pharmacist

Suggestion provided	Number (%) (n=261)
Cessation of drug	53 (20)
Addition of drug	37 (14)
Change in drug dose	33 (13)
Change in duration of therapy	31 (12)
Change in frequency of administration	23 (9)
Substitution of drug	22 (8)
Change in cost of therapy	18 (7)
Change in route of administration	13 (5)
Change in dosage form	12 (5)
Pharmaceutical aid	4 (2)
Others*	15 (6)

* Need for laboratory investigation (n≤1), need for patient counseling (n≤6), annotation changes (n≤7) and availability of drugs (n≤1).

Table No.5 - Pharmacist's involvement in drug therapy decision making

Decision making level*	Total (%) (n=261)
Level 1	42 (16)
Level 2	118 (46)
Level 3	22 (8)
Level 4	79 (30)

* Level 1 (Annotative): The pharmacist is clarifying a prescription and/or the interventions of a prescriber. The prescriber makes no changes.
* Level 2 (Corrective): The pharmacist is actively questioning a prescription to try to get it changed or corrected. His advice may be accepted or rejected. The prescription may or may not be changed.
* Level 3 (Consultative): The pharmacist is making an active contribution to a discussion. He is asked for or offers his advice before a decision is made. His advice may be accepted or rejected. The prescription may or may not be written or changed.
* Level 4 (Proactive): The pharmacist suggests something, which has not been previously considered. He may also initiate and/ or start a discussion. His advice may be accepted or rejected. The prescription may or may not be written or changed.

Table No.6 - The impact of pharmacist initiated changes to drug therapy and their associated cost savings.

	Number of intervention		Cost incurred (INR)	
	Increase in Cost of Therapy	Decrease in Cost of Therapy	Increase in Cost of Therapy	Decrease in Cost of Therapy
Length of Stay				
• **General ward bed**	2	12	315.00	3176.05
• **High dependency bed**	0	4	0	2729.45
Readmission	0	13	0	9079.85
Laboratory Monitoring	0	4	0	476.20
Medical Procedures	0	0	0	0
Drugs	31	95	1621.75	13708.75
Total	33	128	1936.75	29170.30
Overall Savings (net savings)				27233.55
Annualized Savings				46686.08

potential cost savings quantified arose only from the intervening pharmacist-initiated interventions. The potential cost savings arose from other activities carried out by the intervening pharmacist such as drug information, patient medication counseling, monitoring and managing adverse drug events were not considered and quantified. In addition, the total time spent by the intervening clinical pharmacist to address the DRPs was 106 hours and 25 minutes. If the intervening clinical pharmacist had spent more time in reviewing patients' drug therapy, it would have resulted increased potential cost savings. Moreover, the cost savings due to intervention quantified in our study were a direct link to utilization of specific health resources. Although some patients experienced other health outcome benefits from the interventions done by the intervening clinical pharmacist, these outcomes were not quantified in economic terms. Reduction in drug cost accounted for the majority of the cost-benefit measured. It is obvious that increased number of drug use without indication and improper drug selection increases the unnecessary drug cost. Therefore, by intervening in these types of DRPs clinical pharmacist can contribute to reduction in unnecessary healthcare expenditure arising due to use of unnecessary medications. The total drug cost saved due to clinical pharmacist interventions was INR: 13,708.75 while increase in drug cost accounted for Rs: 1621.75. This increased drug cost observed in our study was majority due to untreated indication such as anemia, cough and vomiting. Although, addition of drug in these cases led to increase in treatment cost, patient would have benefited in terms of therapeutic outcome. However, the net drug cost savings was INR: 12,087. Savings of drug cost was also observed in Michael J. Dooley et al[2] study wherein the cost savings accounted for $8 279 while the increased drug cost accounted for $ 7964. Our study findings reveal that the clinical pharmacist's intervention is one of the effective cost saving measures, and clinical pharmacists should enforce their attitude towards cost effective patient management.

Increased length of stay has been consistently associated with drug related problems like inappropriate drug selection and subtherapeutic dose. Interventions of these DRPs would certainly result in reduction in the patients' healthcare expenditure. In our study, the reduction of treatment cost due to reduction in length of stay was estimated to be INR: 5905.50 while two of the interventions had increased the length of stay thereby increasing the healthcare expenditure by INR: 315.00. This findings correlates with the multicentre prospective study[2] conducted in Australia which showed a reduction of $1 50 307 due to decrease in length of stay as a result of their intervention in eight major acute care hospitals. The difference in the magnitude of reduction in healthcare expenditure due to reduced length of stay may be explained by the fact that their study was conducted on a large-scale population in eight acute care government funded hospitals.

The potential for probability of readmission was prevented in 13 cases and that resulted in cost savings of INR: 9079.85. This finding differs with the Michael J. Dooley et al[2] study wherein the cost saving was found to be $111848. There were no interventions on medical procedures that resulted in cost savings and only four interventions had impact on laboratory monitoring that resulted in cost savings amounting to INR: 476.20. In Michael J. Dooley et al[2] study the expenditure on laboratory monitoring was $ 4558 and cost savings on laboratory monitoring was accounted for $ 4 213.

In our study, the annualized cost savings due to clinical pharmacist-initiated changes to drug therapy was found to be Rs: 46,686.08. In Michael J. Dooley et al[2] study, the reported annualized saving was $ 4 444 794. The difference in the annualized cost savings between these two studies is due to fact that variation in the study population and number of hospitals included in the study. Michael J. Dooley et al[2] study was conducted at eight major acute care hospital with well trained and experienced pharmacist. But, our study was conduced in a single tertiary care teaching hospital and also the intervening pharmacist was a postgraduate clinical pharmacy student with minimal experience on drug therapy reviewing and managing DRPs. Other reasons might be due to differences in the cost of drugs, laboratory tests, hospital stay charges etc between the study sites.

Nevertheless, clinical pharmacist initiated changes to drug therapy resulted not only the cost savings but also associated with improved patient outcome. The overall observation made from this study was that pharmacists have greater responsibility in healthcare team in minimizing and/or preventing drug related problems and thereby can potentially reduce the unnecessary hospital stay, readmission, laboratory monitoring and drug cost.

CONCLUSION

Our study demonstrates that the physicians' acceptance rate of pharmacist-initiated changes in drug therapy is high. Clinical pharmacist's review of in-patients drug therapy can positively influence the patient outcomes and reduce healthcare costs. This proves the fact that clinical pharmacist has an enormous role to play in the healthcare management through quality use of medicines.

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