Clinical Pharmacy Services in a Neurosurgical Intensive Care Unit in Iran: A Focus on a Comprehensive Medication Management Model

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Abstract

Background: Critically ill patients treated in the intensive care unit (ICU) are at risk of drug-related problems (DRPs), clinical pharmacists are specifically trained in pharmacotherapy evaluations with the abilities to identify and manage drug-related complications. This study aims to identify areas where clinical pharmacists can be effective in the ICU. The primary outcomes of this study were determining the clinical aspect of clinical pharmacists in the ICU, type, and number of clinical pharmacist interventions.

Methods: This was a prospective, interventional study in a teaching hospital in Iran. A clinical pharmacist was dedicated to implement comprehensive medication management (CMM); All Pharmacotherapy Problems were categorized.

Results: During the monitoring of 162 patients by the clinical pharmacist, 1524 interventions were conducted. The most frequent pharmacotherapy-related problems identified were drug selection (33.3%), dose adjustment (17.3%), and fluid and electrolyte management (12.9%).

Conclusion: Clinical pharmacists' interventions could reduce the rate of DRPs by pharmacotherapy evaluation and may have important role in many aspects of patient's management.

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Keywords: Clinical Pharmacy; Intensive Care Unit; Drug Related Problems

Introduction

Critically ill patients treated in the intensive care unit (ICU) are at risk of drug-related injuries caused by adverse events and serious errors which might become life-threatening. Clinical pharmacists are specifically trained in the context of pharmacotherapy evaluations with capabilities to identify drug-related problems (DRPs) and have cooperation with other healthcare providers in order to improve quality and safety of medication therapy (1).

During the past few decades clinical pharmacy services have developed around the worlds, According to the American College of Clinical Pharmacy (ACCP), clinical pharmacy is defined as the area of pharmacy concerned with the science and practice of rational medication use (2).

In Iran clinical pharmacists mostly work in hospitals, but their role is increasingly spreading in all areas of health care system for both ambulatory and in-patient care settings (3).

The actions of clinical pharmacists can improve the rational use of drugs so they can reduce the rate of medication side effects , drug costs and optimize patient outcome by selecting the most appropriate drug, dosage forms ,route of administration and drug monitoring consequently, They are a primary source of scientifically valid information on the safe, appropriate, and cost-effective use of medications (4,5).

Many studies have described the high rate of inappropriate

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prescribing and potential adverse drug reactions (ADRs) in different healthcare settings 6-9 An adverse drug reaction (ADR) is an unwanted, undesirable effect of a medication that occurs during usual clinical use. Adverse drug reactions occur almost daily in health care institutions and can impact a patient's quality of life, often causing significant morbidity and mortality (10).

A clinical pharmacist could find Drug related problems (DRPs) which is defined as an event or circumstance involving drug treatment that actually or potentially interferes with desired health outcomes, in addition to prevention of drug related errors in intensive care unit, medication errors are any preventable event that may cause or lead to inappropriate medication use or patient harm while medication is in the control of a health care professional, patient, or consumer (11).

Pharmacist participation on physician rounds, medication reconciliation at admission or discharge, and drug class-specific pharmacist services may reduce the frequency of adverse drug events (ADEs), medication errors and improved medication adherence.

CMM is defined as the standard of care that ensures each patient's medications are individually evaluated to determine that each medication is appropriate for the patient, safe and effective for medical condition given the comorbidities and other medications being taken, CMM includes an individualized care plan that achieves the intended goals of therapy with appropriate follow-up to determine actual patient outcomes (12).

Critical care patients are among the most vulnerable cases for medications related harms , because the acuity of their illness, multi-organ failure, polypharmacy and proportion of administration (13).

The impacts of the attendance of a clinical pharmacy service have not been fully evaluated, therefore this study aims to evaluate the clinical aspects of having a clinical pharmacist in a neurosurgery ICU with a focus on optimizing the quality of pharmacotherapy and patient safety.

Methods

This was a prospective study in a 6 months' period from October 2019 to April 2020 in neurosurgery intensive care unit of a university hospital in Tehran city. Neurosurgery intensive care unit had 8 beds. A dedicated clinical pharmacist visited all eligible patients 4 days per week. Ethics approval was obtained prior to the commencement of the research from the ethics committee of Tehran University of medical sciences Faculty of Pharmacy (Ethics Code: IR.TUMS.TIPS.REC.1398.159).

Convenience sampling was employed in this study to include all eligible patients who met the inclusion criteria during the study period.

All individuals, irrespective of gender and age, who stayed in the Neurosurgery ICU for a minimum duration of 24 hours were included into the study.

Neurosurgery intensive care unit patients routinely visited by a clinical pharmacist. Interventions recorded on a Pharmacotherapy form which was qualified by two expert clinical pharmacists. Demographic characteristic such as age, gender, past medical history, past drug history, past allergic history obtains from patient's documents, family interview, and in some cases from the patients. Patients' medications are reviewed according to Comprehensive Medication Management (CMM) program which is introduced by American college of clinical pharmacy (ACCP).

Clinical pharmacists work in collaboration with other providers to deliver CMM that optimizes patient outcomes. Through team-based pharmacotherapy assessment, all of patients who remain at least for 24 hours in neurosurgery intensive care visited by a clinical pharmacist.

All clinical pharmacist's interventions and recommendations recorded in the patient's document. A pharmacist intervention is a recommendation initiated by the pharmacist in response to a DRP (drug related problem) occurring at any phase of the medication process, such as addition a medication, stopping a medication, suggesting an alternative therapy, management of adverse drug effects, drug interaction identification, modifying the administration route, performing therapeutic monitoring, optimizing the administration technique or suggesting a dose adjustment, This recommendation is accepted or not by the physician in charge of the patient. Our interventions categorized in 10 Categories as demonstrated in Table 2. In addition to the routine Pharmacotherapy evaluation, clinical pharmacist was also available for providing drug information for health care staffs outside of the hospital. The clinical pharmacist visited every other day with a detailed review of patient's file focusing on the patient's past medical and drug history, current diagnosis and medication therapy and laboratory results.

Results

The research is an intervention study that involves 162 participants, and their profiles are depicted in Table 1. The majority of the enrolled individuals were male (57.4%), primarily falling within the age range of 36 to 55 years. Moreover, the prevalent diagnosis among the participants was brain tumor.

As indicated in Table 2, the study involved patients under clinical pharmacist follow-up, with 1524 interventions conducted. Importantly, primary pharmacotherapy-related problems included drug selection (33.3%), dose adjustment (17.3%), and fluid and electrolyte management (12.9%), as highlighted in Figure 1. Furthermore, medication reconciliation was performed for 67.9% of patients, and at least one nutritional recommendation was given to 38.8% of patients. In this study a substantial majority of patients underwent medication consultations, accounting for 94.4% of the total participants. Remarkably, 96.5% of the clinical pharmacist's interventions gained acceptance from the medical team.

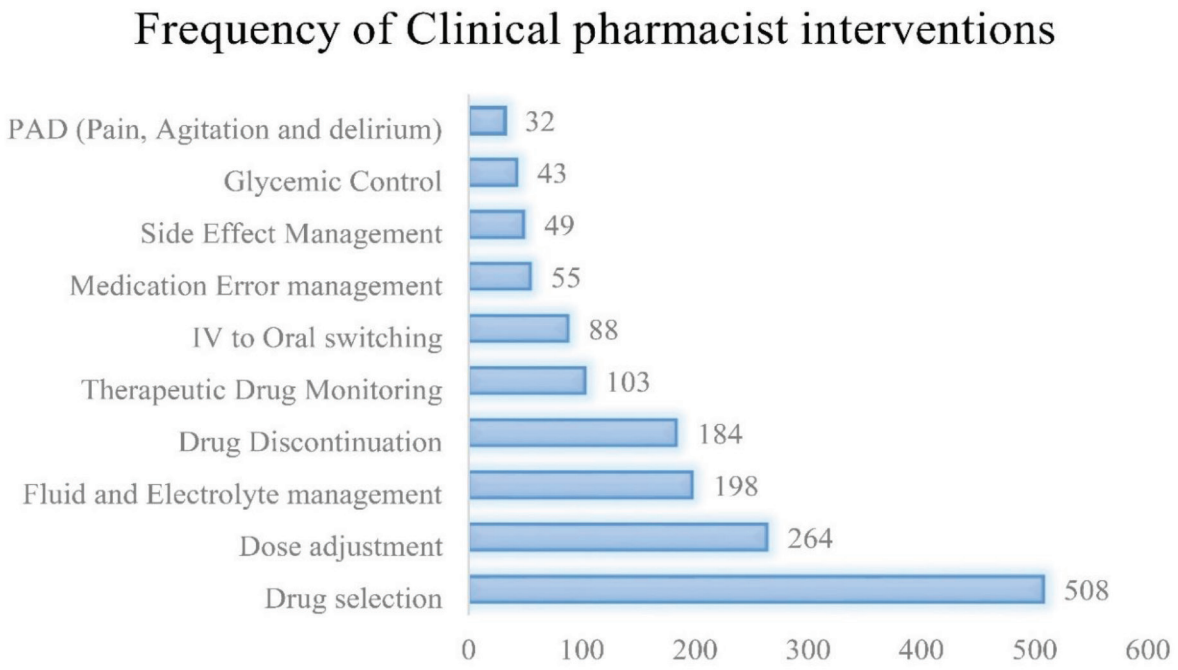

Figure 1. Frequency of clinical pharmacist interventions.

Table.1 Characteristics of Neurosurgery site patients.

Demographic		percent
Gender	Female	69 (42.59%)
	Male	93 (57.40%)
	Total	162 (100%)
Age	1-15	2 (1.23%)
	16-35	27 (16.66%)
	36-55	73 (45.06%)
	56-75	51 (31.48%)
	>75	9 (5.55%)
Diagnosis	Brain Tumor	71 (43.82%)
	ICH*	33 (20.37%)
	Discopathy	27 (16.66%)
	CNS** infection	9 (5.55%)
	Others	22 (13.58%)

*ICH: Intracerebral Hemorrhage

**CNS; Central Nervous System

Table 2. Type and frequency of clinical pharmacist interventions.

Type of clinical Pharmacist interventions	Number (Percent)
1. Drug selection	508 (33.33%)
2. Dose adjustment	264 (17.32%)
3. Fluid and Electrolyte management	198 (12.99%)
4. Drug Discontinuation	184 (12.07%)
5. TDM*	103 (6.75%)
6. IV** to Oral switching	88 (5.77%)
7. Medication Error management	55 (3.6%)
(Including drug interaction, Prescription Errors, etc.)	
8. Side Effect Management	49 (3.21%)
9. Glycemic Control	43 (2.82%)
10. PAD***	32 (2.09%)
Total	1524 (100%)
Acceptance Rate	1472 (96.58%)

* TDM: Therapeutic Drug Monitoring

** IV : Intravenous

*** PAD : Pain, Agitation and delirium

Discussion

The result of this study demonstrated that attendance of a clinical pharmacist could decrease drug related problems in the neurosurgery intensive care unit. A total of 1524 intervention in 162 patients. Most of the patients received at least one medication consultation (94.4% (, it is reflecting the high prevalence of DRPs in the setting.

The willingness of the physicians regarding the clinical pharmacist's integration into the intensive care unit was reflected in the high (96.5%) acceptance rate of the pharmacist's recommendations. In this study we attempted to find out areas which clinical pharmacists can make effective interventions in the ICUs.

According to our study clinical pharmacists are important for: drug selection, dose adjustment, medication reconciliation, PAD (pain, agitation and delirium), glycemic control, fluid and electrolyte management, nutrition, therapeutic drug monitoring, side effects management.

Medication reconciliation

Medication reconciliation is an important aspect of care for any patient admitted to the hospital, it involves reviewing medications that the patient was receiving before admission and deciding which drugs need to be restarted to be sure about continuation of care. For many patients, medications taken before admission are not restarted because acute medical conditions preclude their use. Another important issue is withdrawal symptoms from some medicines (e.g., benzodiazepines, opioids and selective serotonin reuptake inhibitors). Typically, these medications should be restarted as soon as possible to reduce complications (14,15).

In our study we performed medication reconciliation for patients. Medication errors frequently occur in the intensive care unit (ICU); pharmacists have significant role to perform it in the ICU. In Bosm et al., study implementation of medication reconciliation reduced medication transfer errors from 45.1% to 14.6% and resulted in a potential net cost–benefit of € 103 per patient (16)

Pharmacotherapy Evaluation (Including Drug selection, Dose adjustment, drug discontinuation)

Pharmacotherapy evaluation by clinical pharmacists reduces medication errors and promote drug safety and efficacy. They should review all patients' drugs including regularly scheduled and as-needed medications to ensure that each has an appropriate indication and unnecessary medicines should be discontinued, to reduce the risk of side

effects, drug interactions, medication errors, and cost (1,14). In our study we performed pharmacotherapy evaluation for neurosurgery ICU patients, as a result interventions were drug selection (n = 508), Dose adjustment (n = 264) and Drug discontinuation (n = 184), pharmacotherapy evaluation can consider as an integral part of medication therapy as demonstrated in previous research can improve drug safety and unnecessary use of medicine (1,3).

Nutrition

Patients in the ICU may receive nutrition by different methods, such as tube feeding, parenteral nutrition, normal diet as tolerated, and no oral intake. We assess patient's nutrition routinely in pharmacotherapy evaluation, sixty-three patients received at least one nutritional intervention (including Nutrition initiation, modification and monitoring). Clinical Pharmacists can have important role in collaboration with other medical staff for daily assessment of nutrition, route of drug administration and recommendation for preparation of solid drugs through tube feeding (14)

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Pain, agitation and delirium

Pain, agitation, and delirium (PAD) are commonly observed in critically ill patients, most critically ill patients experience some form of delirium during their ICU stay. Untreated delirium can lead to an increased length of stay in the ICU.

In Marshall et al., study, the institution of a daily pharmacist-enforced intervention directed at improving sedation guideline adherence resulted in a significant decrease in the duration of mechanical ventilation in patients receiving continuous sedation (17).

We recommended 32 interventions for management of PAD in 21 patients which all accepted by patients' physician, critical care pharmacists play an integral role in the multidisciplinary ICU team for assessment of PAD by selection of appropriate drugs, dose assessment and management of analgesic, Antipsychotic and another drug which can be used for PAD (14).

Glycemic Control

Blood glucose control is an important aspect of patient care in the ICU, clinical pharmacists can assist to select the most appropriate pharmacological regimen such as oral hypoglycemic agents and insulin regimens, they also help to titrate the doses of these agents and reassess for efficacy and safety to maintain blood glucose within the patient's target range (14,18). In one study implementation of a pharmacist team for management of glycemic control in hospitalized, postoperative patients led to safer and improved glycemic control and lower rates of hypoglycemia.19 In our study we did 43 interventions for 24 patients in aim of glycemic control, It seems clinical pharmacist could play important role for better glycemic control in collaboration with medical team.

Therapeutic Drug monitoring (TDM)

In our practice we performed 103 TDM interventions for 41 patients (25.3%) mostly for vancomycin, Aminoglycoside and Anticonvulsants. TDM is used mainly for monitoring of drugs with narrow therapeutic ranges, drugs with marked pharmacokinetic variability, medications for which target concentrations are difficult to monitor, and drugs known to cause therapeutic and adverse effects, it helps blood drug concentrations maintain within a targeted therapeutic range (20).

Clinical pharmacists by knowledge of pharmacokinetic principles could assess TDM interpretations and can improve appropriateness of TDM use, and substantially reduced drug toxicity and unnecessary costs (21).

Side effect management

According to the Centers for Disease Control and Prevention Adverse drug events (ADEs) are responsible for 1.3 million physician visits, 350,000 hospitalizations, and an estimated cost of $3.5 billion per year in the US. It is estimated that more than 40% of these costs are due to medication errors that are potentially preventable (22).

Poly pharmacy and altered organ function contribute to Adverse drug events (ADEs) in patients requiring intensive medical care (23). having clinical pharmacist could prevent ADEs and subsequently decrease medication cost in the ICU.

FASTHUG-MAIDENS mnemonic

Since 2005 FASTHUG mnemonic used to standardize and clarify the areas which a pharmacist can help ICU physicians in order to maintain more appropriate care for critically ill patients. In 2011 a modified version of FASTHUG named as FASTHUG-MAIDENS created in order to include drug related-problem approaches into this standard structure (14).

Conclusion and Relevance

This study demonstrated that clinical pharmacists could

have important role in managing Drug related problems by pharmacotherapy evaluation and may have important role in: drug selection, dose adjustment, Medication reconciliation, Nutrition assessment, Glycemic control, PAD (Pain, Agitation, and Delirium) assessment, Fluid and electrolyte management, TDM (Therapeutic Drug Monitoring), side effect management, and staff education. In addition, this study is highlighting the benefits of physician's cooperation with pharmacist's in making decision for patients which is showed by 96.6% acceptance rate of the clinical pharmacist's interventions by physicians.

Conflict of interest

The authors declare no conflict of interest, financial or otherwise.

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