Original Article

Clinical Pharmacist-Initiated Interventions for Medication-Related Problems in the Medical Intensive Care Unit of a Teaching University Hospital in South India: A Prospective Observational Study

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ABSTRACT

Background: Medical Intensive Care Unit (MICU) admitted patients have complex drug regimens, serious underlying diseases which increase the risks of Medication-Related Problems (MRP). The study aims to identify, characterize and determine the effect of clinical pharmacist proposed interventions on improving patient safety and cost of care by evaluating MRPs in MICU. **Materials and Methods:** The study was conducted for 8 months (April 2023 to November 2023) in the Department of MICU. Patients>24 hr of stay, consuming ≮ 4 drugs and patients >18 years of age were enrolled in the study. A self-designed validated data collection form was prepared to collect patient details. The detected MRPs were mapped using the "Pharmaceutical Care Network European (PCNE) version 9.1." **Results:** During the study period 705 patients were admitted to MICU out of them 382 were included. 489 MRPs were detected among 316 patients. MRP per patient was 1.54. The mean age was 62.78 years and disease per patient was 3.04. Most of the MRP were due to P1.1; No effect of drug treatment *n*=182 (37.22%). The major cause for the identified MRP was drug selection *n*=432 (34.28%). Majority of the interventions were planned at the drug level *n*=671 (50.93%), with an acceptance rate of 80.98%. Interventions accepted and fully implemented were 58.69%, Among these 74.64% of the problems had been resolved. **Conclusion:** Integrating clinical pharmacist in the MICU team reduces the incidence of MRP, length of MICU and hospital stay and improves the patient's health-related quality of life.

Keywords: Medical Intensive Care Unit, Pharmaceutical care, Clinical pharmacist, Drug related problems.

INTRODUCTION

Medical Intensive Care Unit (MICU) is a specialized department that provides comprehensive nursing and medical care, it has advanced equipment and offers various treatments to support vital organs.[1] Clinical pharmacist provides pharmaceutical care services to the MICU admitted patients. Medication Related Problems (MRP) tend to occur more frequently in patients with multiple organ failure, polypharmacy and side effects that can be fatal.[2] MRPs can significantly affect patient's quality of life and healthcare expenses, resulting in hospitalization and even death. Majority of MRPs were presumed and theoretically avoidable and their occurrence can be minimized through clinical pharmacist-led pharmaceutical care practices.[3]

According to a prior study, 1.3% to 41.3% of hospital admissions were connected to MRP and the majority of these MRP can be mitigated in patients who were hospitalized.[4] Pharmaceutical care services are patient-centered approaches to medication therapy that focus on improving patient outcomes. It is a collaborative process that involves clinical pharmacist working with other healthcare providers to identify, resolve and prevent MRP.[5]

The risk of serious adverse effects is increased among the patients in MICU, as they receive multiple drugs and may have complex drug regimens. Drug-Drug Interactions (DDIs), drug deposits in the body because of multiple organ malfunctions and susceptibility to medication reactions due to their labile status are more frequent among patients in MICU.[6] Changes in pharmacokinetic and pharmacodynamic properties of medications, the presence of many chronic diseases, polypharmacy and the MICU

environment are some of the elements that affect the complexity of the patient's medication regimens.[7] Pharmaceutical care practices and therapy efficacy must be evaluated in the MICU. Pharmaceutical Care Network Europe (PCNE) V9.1 classifies MRP into three broad domains: treatment efficacy problems, treatment safety issues and others.[8] Problems with drug therapy are the result of unfulfilled medication-related demands. They are essential to the practice of pharmacological care.[9] Clinical pharmacist in the MICU team may decrease the mortality and MICU stay, according to studies[9]. Clinical pharmacist services can help to improve the health-related quality of life associated with pharmaceutical care services.[10]

In recent years, due to aggressive treatment approaches, the survival duration has increased but still morbidity and mortality remain high due to complex treatment regimens and polypharmacy for a prolonged duration potentially increases the risk of MRP. Therefore, clinical pharmacist could be a crucial in the reduction of inherent risk associated with medication use and their safety. Collaborative care of clinical pharmacist with physicians may aid to become essential in enhancing the therapeutic efficacy and safety.

Clinical pharmacist services in the MICU regularly showed the possibility for a significant reduction of MRP and length of MICU stay.[11] The objective is to identify, characterize and determine the effect of clinical pharmacist-proposed interventions on improving patient safety and cost of care by evaluating MRP in the MICU.

MATERIALS AND METHODS

Study design

Hospital-based prospective interventional study, designed to evaluate MRP associated with the use of drug therapy. The study was conducted for 8 months from April 2023 to November 2023 in the Department of MICU of a teaching university hospital in South India. Pharmaceutical care services were provided to patients admitted to MICU by clinical pharmacist. The study involved implementing an intervention by a clinical pharmacist and evaluating its impact on MRPs. The current study provides evidence of the effectiveness of interventions provided by research pharmacists in reducing MRP.

Study site

The study was conducted at MICU of a University Hospital at Karnataka. It is an 1800 bed multi-specialty teaching hospital with 36 specialties serving for people in and around Mysore and adjoining districts.

Study Participants

Patients>24 hr of stay, consuming not less than four medications and patients>18 years of age were enrolled in the study. Patients with severe critical illness and life-threatening medical conditions were excluded from the study.

Statistical analysis and sample size calculation

Open-source public health statistics for the restricted population were used to determine the sample size. Based on the study, the effect of medication-related problems during pharmaceutical care practices delivered to the critical care unit[12] showed an average admission of 374 patients in the critical care unit, 80% power of the study. The estimated sample size was 311 at a 95% confidence level. Collected data were entered into Microsoft Excel 2019 and descriptive statistics were used to represent the data.

Ethical consideration

The study was accepted by the Institutional Ethics Committee of JSS Hospital, Karnataka, India.

Data Collection

Eligible patients in the MICU were interviewed before recording their clinical history. Study details were provided to the included patients and informed consent was obtained. To gather patient information, including demographics (gender, age, family type, area of residence, social behaviour, marital status and socioeconomic status using the Kuppuswamy scale), a self-designed verified data collection form was prepared and clinical; paraclinical data were recorded in individual case report forms. The data help to assess individual patient needs and potential MRP by using standard drug information databases such as UpToDate, Micromedex, Lexicomp and Clinical Key. Clinical pharmacists conducted a thorough review of all medications, including prescriptions and herbal supplements taken by patients admitted to the MICU.

Tool used to document MRP

An international organization that promotes the development and implementation of Pharmaceutical Care (PC) services is PCNE. The identified MRP were mapped using PCNE V 9.1. The detected MRPs were discussed by a physician for appropriate interventions. Clinical pharmacists' proposed interventions were discussed with the respective consultant and based on their experience and opinion and the interventions were implemented to solve the problem in MICU admitted patients.

RESULTS

Patients Demographics: A total of 705 patients were admitted in the MICU. Among them 382 were eligible, out of them 316 patients had 489 MRP and 66 patients were DAMA. Among them females were n=187 (59%) and the males were n=129 (41%). The mean age of patients enrolled in the study was found to be 62.78±16.95. Most of the patients in the current study were married n=198 (63%) and living in a joint family n=199 (63%). Many of the patients were found to be non-smokers and active alcoholics n=127 (40%) followed by active smokers and alcoholics n=86 (27%). According to Kuppuswamy socioeconomic scale, majority

of the patients mainly belongs to upper and lower middle class comprising *n*=127 (41%) and *n*=108 (34%) respectively as shown in Table 1.

Clinical characteristics: Among 316 patients 489 MRP were identified. The prevalence of medical conditions per patient was found to be 3.04. The most common diagnosis includes acute exacerbation of COPD *n*=184(58.22%), followed by acute febrile illness *n*=87(27.53%), etc. Several comorbidities were identified to be prevalent among study patients, among them the most frequently noticed comorbidity were hypertension *n*=110(34.1%) and subsequently type 2 diabetes mellitus *n*=86(27.21%), hypothyroidism *n*=59(18.67%), ischemic heart disease *n*=36(11.39%) and bronchopneumonia *n*=25(7.91%). The mean length of MICU stays and hospital stay was 4.74 and 3.56 days respectively. On average each in-patient receives 15.46 medications whereas 7.28 medications were prescribed at discharge. The mean medication cost per patient admitted to the MICU was 22406.28 in the Indian rupees as shown in the Table 2.

Medication related problems

489 problems were identified in 316 patients. Majority of the problems were occurred due to P1.1: No effect of drug treatment despite right use *n*=182(37.22%), followed by P1.2: Effect of drug treatment not optimal *n*=138(28.22%), P2.1: Adverse drug responses *n*=89(18.2%), P1.3: Untreated indications *n*=46(9.41%) and P3.1: Unnecessary drug therapy *n*=34(6.95%), as shown in Figure 1. Causes for MRP were common due to drug selection *n*=432(34.28%), followed by drug use process *n*=240(19.05%), dose selection *n*=163(12.94%), dispensing *n*=156(12.38%), treatment duration *n*=141(11.19%), others *n*=89(7.06%) and drug form *n*=39(3.09) as shown in Table 3.

Planned Intervention: Majority of the interventions were planned at drug level *n*=671(51%), which made changes in the drug formulation, dosage etc. followed by prescriber level *n*=436(33%) and patient level *n*=215(16%) as shown in Figure 2.

Acceptance of Interventional proposals: A total of 489 interventions were proposed at various levels. The acceptance rate of proposed interventions was *n*=396(80.98%) however the fully implemented intervention were *n*=287(58.69%) as shown in

Table 1: Demographic details.

Number of the Patients=316		
Demographic characteristics		N (%)
Gender	Female	187(59)
	Male	129(41)
Age (years)	21-40	56(18)
	41-60	99(31)
	61-80	142(45)
	80	19(6)
Marital Status	Unmarried	38(12)
	Married	198(63)
	Widow	72(23)
	Divorce	8(2)
Family Type	Joint	199(63)
	Nuclear	117(37)
Area of Residence	Urban	132(42)
	Rural	184(58)
Social behavior	Active-Smoker and Alcoholic.	86(27)
	Non-Smoker and Alcoholic.	57(19)
	Active Smoker and Non-alcoholic.	46(14)
	Non-Smoker and Active alcoholic.	127(40)
Kuppuswamy Socio-economic Scale	Upper	16(5)
	Upper middle	127(41)
	Lower middle	108(34)
	Upper lower	58(18)
	Lower	7(2)
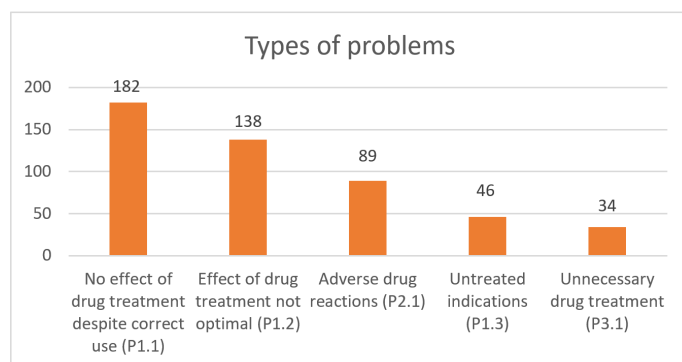
Figure 1: Types of problems identified by PCNE V9.1.
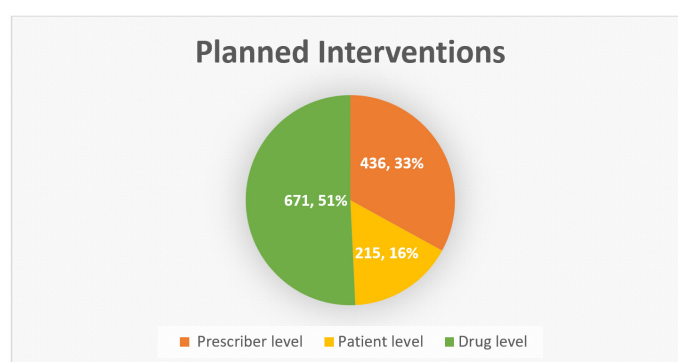
Figure 2: Planned Interventions.

Table 4. Outcomes of clinical pharmacist proposed interventions were presented in Figure 3.

DISCUSSION

The study recorded 489 MRP in 316 patients. Drug selection was the most prevalent MRP were often due to inappropriate drug combinations *n*=137(31.71%). These findings align with studies by Chiang *et al*. and Martins *et al*. who reported similar

Table 2: Clinical features of the MICU admitted patient.

Clinical characteristics		Frequency (*n*=316)
No. of DRPs		489
Primary admission diagnosis	Acute exacerbation of COPD	184(58.22)
	Acute febrile illness with sepsis	87(27.53)
	Seizures	43(13.61)
	Gastroenteritis	39(12.34)
	Acute kidney injury	37(11.71)
	Lower respiratory tract infection	34(10.76)
	Pyelonephritis	29(9.17)
No. of comorbidities	Hypertension Type 2 diabetes mellitus Hypothyroidism Ischemic heart disease Bronchopneumonia	110(34.81) 86(27.21) 59(18.67) 36(11.39) 25(7.91)
Length of MICU stay	1-3 days 4-6 days Avg + SD	129(40.82) 187(59.18) 4.74+0.92
Length of Hospital stay	0-3 days 4-7 days Avg+SD	140(44.31) 176(55.69) 3.56+0.91
No. of drug prescribed to in patient	1-10 11-20 >21 Avg+SD	89(28.16) 163(51.58) 64(20.35) 15.46+2.7
No. of drugs prescribed on discharge	1-10 11-20 Avg+SD	228(72.15) 88(27.84) 7.28+1.69
Medication cost	Avg. medication cost Avg. Total cost (Bed charges, Nursing fee, Lab charges, consultation fee.	22406.28+12668.3 IQR*(16993.26 to 122871.6) 149403.35+136191.8 IQR*(89081.96 to 1088137)
	IQR*- Interquartile range	

trends in MICU settings.[13] Inappropriate combinations can arise from factors like potential interactions and contraindications due to a patient's specific condition or existing medications. Clinical pharmacist plays a crucial role in mitigating these risks. Their expertise in medication review allows them to identify potentially problematic drug combinations and recommend safer alternatives.[14] This can involve considering a patient's individual needs, potential for adverse effects and known drug interactions. By proactively addressing all these issues clinical pharmacists can prevent complications and ensure patients receive the most appropriate medication. Inappropriate outcome monitoring *n*=89(20.60%) similar findings were matched by Chiang *et al*.[13] These findings emphasize the need for clear communication protocols, standardized procedures and double-checking mechanisms to minimize errors during medication dispensing and administration.[15] The presence of MRPs related to dose selection *n*=163(12.94%) and treatment duration *n*=141(11.19%) underscore the importance of vigilant medication review. Previous research by Martins *et al*. identified incorrect dosing as a frequent MRP in MICU. Clinical pharmacist involvement in medication order review and the use of standardized dosing guidelines can significantly reduce these errors. Similarly ensuring appropriate treatment duration, especially for antibiotics, in cases like UTIs is crucial to prevent antibiotic resistance. This study identifies patient with type-2 diabetes taking a high dose of metformin (1000 mg twice daily) with gastrointestinal side effects.[16] This finding aligns with established knowledge about metformin dose-related side effects. Metformin works by reducing hepatic production and improving insulin sensitivity however, a well-known side effect particularly at higher doses.[17] The study identified a concerning case of inappropriate outcome monitoring in MICU patients with heart failure and pneumonia. while respiratory status (oxygen saturation, breathing rate) was monitored, weight was a crucial indicator of fluid overload in heart failure.[18] The dominance reflects the complexity of medication use in the MICU, where clinical pharmacist is expertise in drug selection, dosing and interactions. Common interventions were dose adjustment, drug selection and formulation adjustments.[11,19] Drug-level interventions have direct impact on medication safety and effectiveness for MICU patients.[20] A large portion is dedicated to
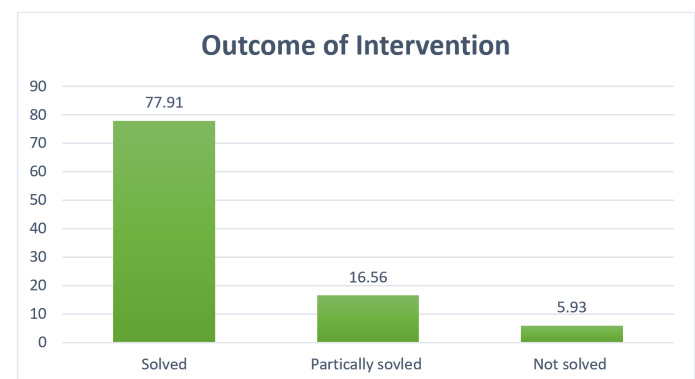
Figure 3: Outcome of Interventions.

Table 3: Causes for medication related problems.

Primary Domain	Causes	*n*=1260(%)
Drug selection		
C1.1	Inappropriate drug according to guidelines.	89(20.60)
C1.2	No indication for drug.	76(17.59)
C1.3	Inappropriate combination of drugs.	137(31.71)
C1.4	Inappropriate duplication of therapeutic group.	48(11.11)
C1.5	No or incomplete drug treatment in spite existing indication.	28(6.48)
C1.6	Too many different drugs/active ingredients prescribed for indication.	54(12.51)
Total 432		
Drug form		
C2.1	Inappropriate drug form	39(100)
Total 39		
Dose selection		
C3.1	Drug dose too low.	41(25.15)
C3.2	Drug dose of a single active ingredient too high.	69(42.33)
C3.5	Dose timing instructions unclear or missing.	53(32.52)
Total 163		
Treatment duration		
C4.1	Duration of treatment too short.	74(52.48)
C4.2	Duration of treatment too long.	67(47.52)
Total 141		
Dispensing		
C5.1	Prescribed drug not available	64(41.02)
C5.2	Necessary information not provided or incorrect information provided	38(24.36)
C5.3	Wrong drug, strength or dosage advised	54(34.62)
Total 156		
Drug use process		
C6.1	Inappropriate timing of administration or dosing intervals by health professionals.	68(28.33)
C6.4	Drug not administered at all by health professional.	86(35.83)
C6.5	Wrong drug administered by health professional.	47(19.58)
C6.6	Drug administered via wrong route by health professionals.	39(16.25)
Total 240		
Other		
C9.1	No or inappropriate outcome monitoring.	89(100)
Total 89		

simply informing prescribers and suggesting alternative therapies to move beyond information sharing towards more collaborative decision making. Pharmacist participation in the healthcare team and joint review of medication regimens could enhance communication and lead to more effective treatment plans. The presence of patient counseling interventions *n*=29(16.34%), is crucial for long-term medication adherence and improved clinical outcomes. Pharmacist-led patient education empowers patients with knowledge about their medication.[21] The high acceptance rate of clinical pharmacist proposed interventions *n*=396(80.98%) aligns with recent research by Albayrak A *et al* who also reported high acceptance rate for pharmacist recommendations in critical care settings.[22] The greater percentage of solved MRP were 77.91% who reported substantial improvement in medication

Table 4: Acceptance of Interventional proposals.

Primary Domain	Intervention	N (%)
Intervention accepted		
A1.1	Accepted and fully implemented.	287(58.69)
A1.2	Accepted partially implemented.	65(13.29)
A1.3	Accepted but not implemented.	28(5.72)
A1.4	Accepted implementation unknown.	16(3.27)
Total 396(80.98)		
Intervention not accepted		
A2.1	Not accepted, not feasible.	29(5.93)
Other		
A3.1	Intervention proposed acceptance unknown.	38(7.77)
A3.2	Intervention not proposed.	26(5.33)
Total 64(13.09)		
Grand Total 489(100)		

safety following clinical pharmacist interventions in the medical intensive care settings.

CONCLUSION

This study highlights the critical functions of clinical pharmacist interventions were performed to solve MRP and optimize pharmacotherapy by implementing appropriate interventions. Majority of the planned interventions were at prescriber level and pertained to dosage adjustment. Clincial pharmacist interventions significantly improve safety by solving MRP. Moving forward focusing on strategies to address partially resolved cases and fostering collaboration will further enhance the effectiveness of clinical pharmacist contributions to improved patient outcomes in MICU.

ACKNOWLEDGEMENT

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

Ethical approval was obtained from the Institutional review board of JSS hospital with reference no. JSSMC/IEC/05012022/21NCT/22021-22. The study was conducted in the medical intensive care unit. Purpose and objectives of the study was explained to the patient and written inform consent was obtained from the patients > 18years of old.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

ABBREVIATIONS

MICU: Medical intensive care unit; **MRP:** Medication related problems; **PCNE:** Pharmaceutical care network European; **DDIs:** Drug-drug interactions; **PC:** Pharmaceutical care; **DAMA:** Discharge against medical advice; **COPD:** Chronic obstructive pulmonary disease; **UTIs:** Urinary tract infections.

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