Impact of Clinical Pharmacy Interventions on Medication Error Nodes

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Introduction

A medication error (ME) is any preventable event that may cause or lead to inappropriate medication use or patient harm while the medication is within the control of the healthcare professional, patient, or consumer.[1,2] ME comprise any error in the medication use process, irrespective of whether an injury or the potential for an injury occurred.[3] Some MEs do not cause harm while others are caught before harm occurs ("near-misses"). MEs may originate at any stage of the drug-use process including prescribing, dispensing, administering, monitoring, and documenting.[4] Medication related problems (MRP) have been defined as negative consequences of medications that can harm or potentially harm patients.[5]

The involvement of pharmacists in the medication use process, as members of the healthcare team, improves the quality of patient care by preventing medication errors (MEs).[1,6] According to DW Bates (2007), pharmacists are competent in the monitoring of error frequencies and also near misses.[7] Pharmacy interventions can be defined as any recommendation to a healthcare provider by pharmacists that aim to change patient management or therapy. [8]Although the definition of intervention is well understood by pharmacist vernacular, its scope of interpretation may be ambiguous to other healthcare providers and hospital administrators.[8] Furthermore, it was assessed that documenting and quantifying pharmacy interventions in terms of medication error preventions might result in a greater appreciation of pharmacists by hospital administrators and risk management.

At the Lebanese American University School of Pharmacy (LAU SOP) in Lebanon, pharmacy students are involved in direct patient care during their introductory and advanced pharmacy practice experiences (IPPE, APPE) in compliance with the accreditation Standards of American

Colleges of Pharmacy Education (ACPE).[9] Students on APPE rotations round with clinical pharmacy faculty and are required to document their interventions after having discussed them with clinical pharmacy faculty on service. The documentation tool /intervention sheet **(**Appendix 1) used at LAU SOP was adopted in 2003 based upon published literature**.**[6] Interventions are aggregated and used to document pharmacy's contribution to patient care. It was hoped that presenting accepted interventions in terms of prevented medication related problems would strengthen the recognition of clinical pharmacy services by hospital administrators.

The need to develop reporting systems able to capture pharmacy interventions and report MEs has been previously recognized.[1] Recently, the American College of Clinical Pharmacy (ACCP) recognized that the pharmacy practice lacks a consistent process for direct patient care and discussed several options for a pharmaceutical care plan, essentially encompassing medication therapy assessment, development and implementation of a pharmaceutical care plan and finally evaluation of the outcome. [10] Therefore, as per the recommendations of ACCP, interventions were retrospectively analyzed by grouping them according to MRPs.

Aim of the study

The objective of this study is to show the impact of pharmacy interventions in reducing MRPs when medication error (ME) nodes are used as a mean of reporting.

Ethics approval

The study was approved by the LAU Institutional Review Board (IRB). The results were reported in aggregate. Neither physicians nor patients names were identified nor linked to identifiers. Due to the retrospective nature of the study, a consent form was not needed.

Methods

All interventions that were prospectively documented on infectious diseases and cardiology services during the inclusive period of September 2012 through May 2013 were retrospectively reviewed and analyzed. These two services were the first to be launched during this period. Prior to analyzing the data, a new pharmacy reporting sheet was developed by the authors to link interventions according to MRPs. The form was designed to prompt the user to focus on assessing the medication regimen for MRPs and then to road map a plan, via an intervention.

The new form was tailored to group pharmacy interventions within seven categories of MRPs. The MRP categories were based on the individualized medication assessment and planning tool (iMAP) process of a pharmaceutical care plan.[5] (Appendix 2). Furthermore, MRPs were classified into one of the five nodes of MEs based on where they originate in the drug-use process. (Table 1) Similar associations have been previously published, linking ME categories to reasons for MEs.[1,4] The authors classified overlapping MRPs such as suboptimal drug versus suboptimal duration, frequency or administration when related to the prescribing process such as a physician prescribed a suboptimal duration, frequency or administration, based upon text descriptions of the interventions in the database. If no text was provided, the aforementioned MRPs were classified as prescribing errors. The MRP, Fear of non-adherence was not classified into a ME node. Drug information questions were not considered as MRPs and were therefore not classified.

Interventions were reviewed by the authors who are specialists in Infectious diseases and cardiology and the therapeutic class as per American Hospital Formulary Service (AHFS)

recommendations was added into the database[11]. During the prospective reporting of interventions, students did not always document whether the MRP had reached the patient or not. Therefore, it was not possible to classify the corresponding medication error nodes as ME according to the National Coordinating Council for Medication Error Reporting and Prevention (NCC-MERP©).[12]

Data analysis

Data were entered on an excel spread sheet. Records for entry with incomplete data were excluded. The statistical analysis was carried out using IBM-SPSS version 22 software for Windows Release (IBM Corp. Released 2013. IBM SPSS Statistics for Windows, Version 22.0. Armonk, NY: IBM Corp.). Descriptive statistics, such as percentages, were used to summarize the data and report the frequency distribution of intervention categories, MRPs, respective drug classes as well as other expressive results. All results are reported utilizing the new reporting; 6 intervention major categories, 22 subcategories, 7 MRPs and 5 ME nodes**.**

Results

During this one year period, a total of n=1174 interventions were made, which consisted of n=83 drug information questions. The remaining n=1091 interventions were classified as MRPs. These interventions were documented on n=3217 patient days. Analyzing the interventions and MRPs per 1000 patient days resulted in 360 intervention/1000 patient days and 340 medication related problem/1000 patient days, respectively. Out of the n=1174 interventions, 72% were accepted. This translates into approximately 72% prospective reduction in MRP across ME nodes related to prescribing, monitoring and documenting. (Figure 1) The majority of interventions were cardiology related interventions 508(43.3%) while 453(38.6%) were infectious disease related and 213(18.1%) were miscellaneous. When classifying the medication according to AHFS drug class, the anti-infective agents were the most intervened on drug class capturing a total of 448 (38.2%) followed by cardiovascular drugs, and blood formation and coagulation with 245 (20.9%) and 204 (17.4%) respectively.

The top five medications associated with pharmacist interventions in terms of cardiology were atorvastatin, aspirin, bisoprolol, enoxaparin, furosemide and clopidogrel. In Infectious Diseases, the top five medications were vancomycin, amoxicillin- clavulanate, meropenem, imipenem and fluconazole.

Out of n=1174 interventions most of the recommendations were reported under the major intervention categories of pharmacotherapeutic recommendation followed by patient care. Table 2 summarizes the findings of major intervention categories. In terms of subcategories, the most common pharmacist interventions were focused on dosing, addition and discontinuation of medications. The intervention subcategories pin point the overall efforts of where pharmacist

interventions took place as well as per specialty. In both specialties, the interventions were mostly pertaining to prescribing. (Table 3)

As for the MRPs, the most common were suboptimal dosing followed by suboptimal drug and suboptimal duration, frequency or administration. (Table 4) The total n=1091 MRPs were considered for classification into ME nodes. We excluded all n=77 fear of non-adherence MRPs, because it is not a well-established medication related problem. This resulted in a total of n=1014 classifiable MRPs. (Table 1) The origin of the errors showed 834 (82.2%) of the MRPs were related to the prescribing node, 126 (12.4 %) to the documentation node and 54 (5.3%) to the monitoring node. No MRPs originated from the dispensing or administration nodes. Furthermore, when interventions were analyzed per ME nodes, a high percentage of intervention acceptance was noted across the nodes, 570 (68.30%) in prescribing, 42 (77.77%) in monitoring and 100 (79.36%) in documenting errors. (Figure 1)

Discussion

The majority of the interventions were secondary to MRPs originating from prescribing, documenting and monitoring error nodes. The most common MRPs in cardiology were suboptimal dosing and drug therapy needed which prompted pharmacists to recommend the initiation of venous thromboembolism (VTE) prophylaxis, early initiation of beta blocker and angiotensin converting enzyme (ACE) inhibitors in patients post-acute coronary syndromes, optimization of bridge therapy in VTE treatment and modification of statin doses according to indication and patient specific characteristics. In regards to dose adjustments, enoxaparin was the most common drug intervened on according to renal function and indication, followed by statins dose modification. Sequentially, the interventions that predominately corresponded to drug therapy needed were the addition of ACE inhibitors/angiotensin receptor blocker for indications such as post-acute coronary syndrome, secondary prevention for coronary artery disease and others. In infectious disease, the most common MRPs were suboptimal dosing and suboptimal drug which led to dose adjustments and de-escalation of therapy. Examples of the interventions were mostly related to the dosing adjustments of both carbapenems and vancomycin. As for the MRP suboptimal drug, the most common interventions were discontinuation of both fluoroquinolones and carbapenems.

Analyzing the data as MRPs allows the pharmacist to highlight the potential medication errors that require corrective actions within the institution, whereas data as interventions allows the identification of corrective actions that were recommended by a pharmacist to implement a care plan. It is also worth mentioning that one MRP may have necessitated the implementation of multiple interventions within the pharmacist's care plan, and this is reflected within the results of

340 MRP/1000 patient days that necessitated a total of 360 interventions/1000 patient days to be recommended

As expected, given that the pharmacists were rounding on the specialty services of cardiology and infectious diseases, the most commonly intervened on medications were anti-infective agents, cardiovascular drugs, and blood formation and coagulation, which is in line with previous reports showing that these drug classes were mostly associated with MEs. For instance, the Medication Error Detection, Amelioration and Prevention (MEDAP) Study reported that the most common drug classes associated with MEs were systemic anti-infective followed by hematologic and cardiovascular drugs.[4,13,14,15,16]

The most common origins for error were prescribing, followed by documentation errors, then monitoring errors. This is also in line with the MEDAP study where prescribing administering and monitoring were in the top three common origins for error.[4]However, unlike the MEDAP study, no errors originated at the level of dispensing or administration which is due to the fact that the MRPs and subsequent interventions were made during interdisciplinary rounds with physicians, focusing on prescribing errors, rather than being at the bedside during nursing rounds or during the dispensing process in main pharmacy. In previous studies, prescribing errors were reported and mostly associated with anti-infectives in the inpatient setting and with cardiovascular medications in the outpatient setting. [13,17] Similar to our findings other studies reported that dosing errors were more frequent than wrong drug selection.[14-21]

Classifying MRPs within 7 categories segregates problematic processes within an institution. (Table 4) Pharmacy leaders can utilize MRP and ME nodes quantification to highlight issues within the medication use process. Furthermore, presenting MRPs may be helpful to identify targets for quality initiatives within the institution.

Strengths

This paper reflects interventions as the number of prevented MRPs per medication error node. Since MRPs can be classified into ME nodes, it becomes easier for the pharmacist to identify performance improvement projects and advocate for optimal patient care. It may also serve as an educational tool train IPPEs and APPEs student pharmacists on how to use a stepwise approach in identifying MRPs, developing care plans and quantifying medication error nodes to target improvement projects.

Limitations

Although the study does not report on the severity of the interventions or the associated cost, the most common problems led the pharmacists to intervene on medications associated with important, well documented clinical outcome measures related to antibiotic stewardship and anticoagulation dosing [22]. Furthermore, the retrospective nature of the study hindered the ability to classify ME according to NCCMERP. Despite the limitation of not being able to quantify MEs it was still possible to highlight the role of a pharmacist in providing patient centered care by intervening on frequent medication error nodes. Another limitation is that no MRPs were categorized in the dispensing or administering ME nodes which shows bias due to the reporter. These results further emphasize the need to promote documentation and analysis of interventions according to this process by students on IPPE rotations in hospital pharmacy and staff pharmacists as well. Furthermore, it identifies that more effort should be allocated towards interdisciplinary collaboration between pharmacy and nursing to recognize and prevent medication related problems pertaining to administration. These results further support the recommendation by the institute of medicine (IOM) which calls for interdisciplinary collaboration to prevent MEs. [2,4,23, 24]

Furthermore, we believe that these results in addition to previously published literature supporting the presence of a clinical pharmacist on rounds to decrease medication errors, should further decrease the reluctance of hospital administrators to recruit clinical pharmacists.[25]

Conclusion

Analyzing pharmacy interventions according to corresponding MRPs facilitated the recognition of pharmacy's role in reducing preventable MRPs across the medication error nodes of prescribing, documenting, and monitoring.

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298 **TABLES**

299 **Table 1**

TABLE 1 Medication Related Problems grouped into Medication Error Nodes

Medication Error Node (Where the initial error occurred)	**Medication Related Problems** (reasons for the medication error)
Prescribing	• Drug therapy needed including prescription omissions • Suboptimal dosing • Suboptimal drug, • Suboptimal duration, frequency or administration when related to the prescribing process such as a physician prescribed a suboptimal duration, frequency or administration.
Administration	• Suboptimal duration, frequency or administration when related to the administering process such as a nurse administered the medication with a suboptimal duration, frequency or administration despite having an appropriate physician prescription.
Monitoring	• Medication monitoring needed
Documenting	• Documentation error including incomplete orders, medication discrepancy due to lack of reconciliation and transcription errors
Dispensing	• Suboptimal drug,
Note: Drug information and medication counseling were not classified into medication error nodes	

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302 **Table 2**

Table 2. Intervention (major categories)				
	Cardiology N(%)	Infectious diseases N(%)	Other N(%)	Total N(%)
Categories				
Allergy/disease state contraindication	5(1%)	3(0.7%)	7(3.3%)	15(1.3%)
Alternate route	10(2%)	26(5.7%)	49(23%)	85(7.2%)
Drug information	47(9.3%)	20(4.4%)	16(7.5%)	83(7.1%)
Interactions/incompatibility	10(2%)	10(2.2%)	7(3.3%)	27(2.3%)
Order clarification	36(7.1%)	5(1.1%)	19(8.9%)	60(5.1%)
Patient care	84(16.5%)	29(6.4%)	23(10.8%)	136(11.6%)
Pharmacotherapeutic recommendation	316(62.2%)	360(79.5%)	92(43.2%)	768(65.4%)
Total	508(100%)	453(100%)	213 (100%)	1174 (100%)

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305 **Table 3**

Table 3: Interventions (subcategories)				
	Cardiology N(%)	Infectious disease N(%)	Other N(%)	Total N(%)
Subcategories				
Adjust frequency and duration	11(2.2%)	52(11.5%)	7(3.3%)	70 (6%)
Change to more effective drug	15(3%)	23(5.1%)	6(2.8%)	44 (3.7%)
Change to a more effective route	0	1(0.2%)	1(0.5%)	2(0.2%)
Check Labs	13(2.6%)	33(7.3%)	6(2.8%)	52 (4.4%)
Clarified type of allergic reaction	3(0.6%)	3(0.7%)	3(1.4%)	9(0.8%)
Dose	115(22.6%)	143(31.6%)	18(8.5%)	276 (23.5%)
Drug addition	109(21.5%)	25(5.5%)	18(8.5%)	152(12.9%)
Drug discontinuation	35(6.9%)	69(15.2%)	33(15.5%)	137(11.7%)
Drug information	47(9.3%)	20(4.4%)	16(7.5%)	83(7.1%)
Drug interaction	10(2%)	10(2.2%)	7(3.3%)	27(2.3%)
Enforced the documentation of allergy in the	2(0.4%)	0	1(0.5%)	3(0.3%)

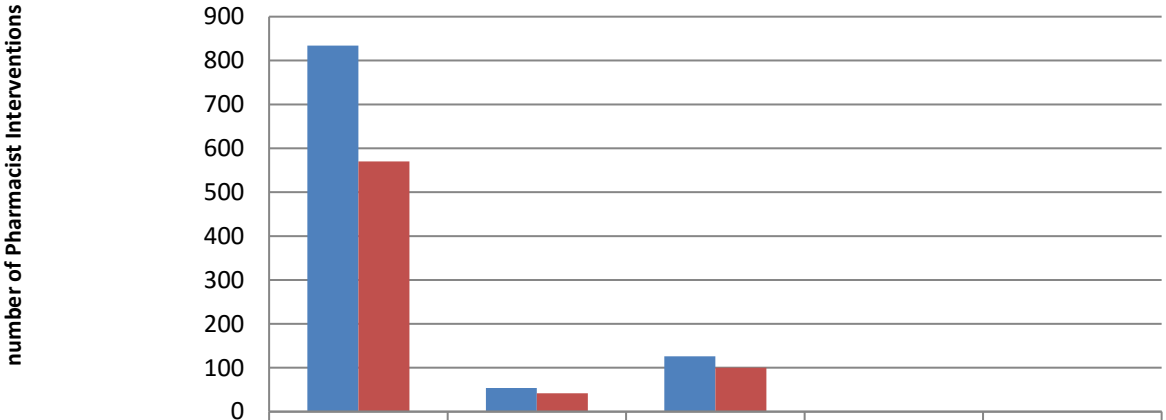
medical record				
Formulary conversion	2(0.4%)	2(0.4%)	1(0.5%)	5(0.4%)
Identified a drug induced ADR	14(2.8%)	10(2.2%)	1(0.5%)	25(2.1%)
Incomplete order	36(7.1%)	5(1.1%)	19(8.9%)	60(5.1%)
IV to po	10(2%)	26(5.7%)	48(22.5%)	84(7.2%)
Medication counseling	54 (10.6%)	19(4.2%)	4(1.9%)	77(6.6%)
Medication reconciliation	28(5.5%)	5 (1.1%)	18(8.5%)	51(4.3%)
Other	0	0	4	4(0.3%)
Pharmacokinetic consult	1(0.2%)	0	0	1(0.1%)
Recommend a pharmacoeconomic alternative	0	3(0.7%)	0	3(0.3%)
Warned about a pertinent ADR	3(0.6%)	4(0.9%)	2(0.9%)	9(0.8%)
Total	508(100%)	453	213	1174(100%)

Table 4: Medication related problems (MRPs)

	Cardiology	Infectious disease	Others	Total
Drug therapy needed	109(23.6%)	25(5.8%)	18(9.1%)	152 (13.9%)
Suboptimal dosing	115(24.9%)	143(33%)	18(9.1%)	276(25.3%)
Medication monitoring needed	17(3.7%)	37(8.5%)	8(4.1%)	62(5.3%)
Suboptimal drug	76(16.5%)	117(27%)	48(24.4%)	241(22.1%)
Documentation problems	69(15%)	13(3%)	44(22.3%)	126(11.5%)
Suboptimal duration, frequency, or administration	21(4.6%)	79(18.2%)	57(28.9%)	157(14.4%)
Fear of non-adherence	54(11.7%)	19(4.4%)	4(2%)	77(7.1%)
Total	461 (100%)	433(100%)	197(100%)	1091(100%)

Figures

Figure 1. Pharmacy Interventions classified according to Medication Error (ME) Nodes



	Prescribing	Monitoring	Documenting	Dispensing	Administering
total number of iterventions	834	54	126	0	0
number of accepted Interventions	570	42	100	0	0

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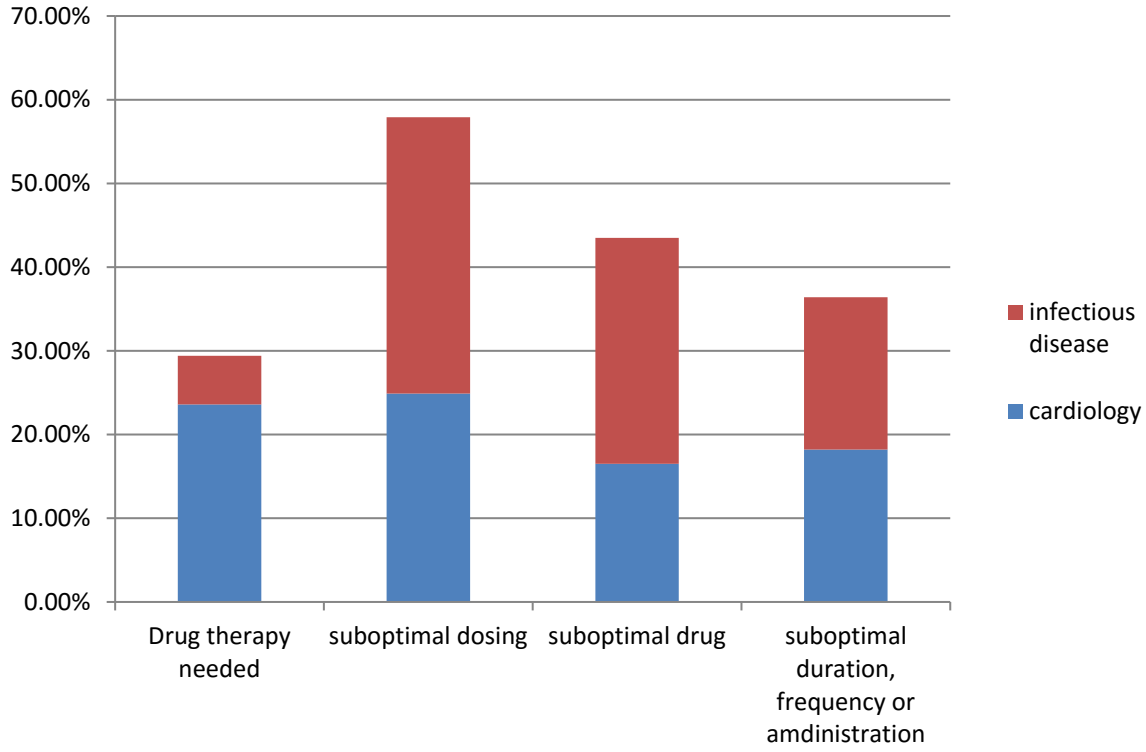
Figure2. Common MRPs in infectious disease and cardiology services



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