Towards patient safety: assessment of medication errors in the intensive care unit in a developing country's tertiary care teaching hospital

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ABSTRACT

Objectives To determine the incidence, causes, patterns and outcomes of medication errors (MEs) in the intensive care unit.

Methods The ME reporting system was established using the principles based on prospective, voluntary, open, anonymous and stand-alone surveillance in a tertiary care teaching hospital located in southern India. MEs involving patients of either sex were included in the study, and the reporters were given the choice to remain anonymous. The analysis was carried out to determine the patterns, causes and outcomes of the reported errors and was discussed with healthcare professionals (HCPs) to minimise the recurrence of MEs.

Results A total of 292 MEs were reported voluntarily among 5137 admitted patients and the incidence of MEs was 5.6%. Administration errors (n=143, 49%) were the most common type of MEs reported followed by prescription errors (n=56, 19%) and dispensing errors (n=43, 15%). Factors responsible for MEs were related to performance deficit of HCPs due to excessive workload, fatigue, unclear interpersonal communications and patient-related factors, which accounted for 37.6%, 13.1%, 9.6% and 7.7%, respectively. The majority of the reported MEs had an outcome of category C and A, based on the National Coordinating Council for ME Reporting and Prevention (NCC MERP) outcome category scale, amounting to 42.2% and 41.7%, respectively.

Conclusions Although the majority of MEs that reached the patients did not cause any harm, providing continuous education and awareness of MEs to HCPs and patients may minimise the scope of the factors that may contribute to MEs and improve overall patient safety.

INTRODUCTION

Medication errors (MEs) compromise patient safety. In the current work setting, multiple unavoidable factors such as workload, fatigue, work extended hours, sleep deprivation, environmental, professional sanctions and newly inducted staff may contribute knowingly or unknowingly towards MEs and thus jeopardise the patient's safety.^{1–3} The concern of stakeholders in the healthcare profession on the importance of patient safety started to increase with the advent of the 1999 Institute of Medicine's (IOM) report "To Err is Human: Building a Safer Health System". We have little evidence that patient safety has improved since then.^{3–5} Critically ill patients admitted to intensive care units (ICUs) receive twice as many

medications as patients admitted to other units.² This situation potentially increases the risk of iatrogenic injury. Evidence suggests that MEs account for 78% of severe outcomes, with an average estimate of 1.7 MEs each day per patient. Of those, many patients suffer potentially life-threatening errors during their stay in critical care units.^{6–9} Furthermore, there are as many as 80–200 steps involved in administering a single dose to a critically ill patient—encompassing domains of prescribing, transcribing, dispensing, administering, documenting, monitoring and storing—providing a sufficient window for MEs to occur.^{10 11}

It has been more than two decades since Leape highlighted the need to gather comprehensive patient information and restructure hospital data systems to minimise errors in healthcare; however, the use of Computerised Physician Order Entry (CPOE) systems is modest even today.^{12 13} Overall, ME rates in hospitals range from 4.4% to 59.1% worldwide. However, reporting of these errors is less than 5% around the globe. There are many reasons for under-reporting of these errors, including the punitive course of actions, fragile systems of patient safety and financial constraints. It is estimated that North America spends 37.6 billion dollars each year on managing MEs and another 17 billion dollars on preventing medication mistakes.¹⁴ Researchers across the world have proposed specialised programmes such as the Systems Engineering Initiative for Patient Safety model, CPOE systems and Healthcare Information Technology for Economic and Clinical Health (HITECH) to reduce MEs. As mentioned earlier, the information on efficient utilisation of systems in preventing MEs is currently limited,^{13–15} which could be due primarily to a lack of nationalised ME reporting programmes. In 2006 only 12 countries had signed the Salamanca Declaration intended to promote safe medication practices globally, and by 2007 there were 11 nations either with national or local ME reporting systems. However, India is not one of them.^{16 17}

The most common risk factors for MEs in developing countries are inefficient communication systems in hospitals and illegible prescriptions.¹⁸ An ME reporting programme was initiated in the ICU of the study healthcare setting to understand and assess the pattern, risk factors and outcomes of reported MEs.

MATERIALS AND METHODS

The study was conducted using a newly established ME reporting centre in the ICU of a tertiary care

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teaching hospital providing healthcare facilities to people residing in and around the Mysuru district of southern India. The ME reporting system was designed to be a voluntary, open, stand-alone and anonymous reporting system and data were collected for 6 months (April–September 2015). Patients of either sex aged ≥ 18 years admitted to the ICU were included. All the relevant information was documented on a suitably designed ME reporting form (see online supplementary file 1).

Identification and assessment of MEs

The case records of inpatients were reviewed on a daily basis to identify medication mistakes which the ME review committee later quantified.

Upon reporting an error, data about the incident including (but not limited to) the description of the suspected medicine involved, date the problem was identified and type of formulation were collected. Information on the personnel involved (optional) and contributing human factors leading to the ME were obtained from the personnel and various data sources such as case notes, medication treatment charts, prescriptions and further documented in a suitably designed ME assessment form.

The patterns of identified MEs were categorised as a prescription error, transcription error, dispensing error, administration error, nursing staff notes documentation error, medication storage error, medication monitoring error and procurement error. The outcomes were categorised based on the severity according to the National Coordinating Council for ME Reporting and Prevention (NCC MERP)¹⁹ (figure 1).

RESULTS

During the study period 5137 patients were admitted to the ICU. A total of 292 MEs were voluntarily identified and

reported by various medical professionals. Of the 292 MEs, 194 (66.4%) were recognised and communicated by the healthcare professionals (HCPs) and 98 (33.5%) were reported through intensive follow-up with other HCPs (table 1).

As shown in table 2, drug administration errors were the most common, accounting for 105 (35.9%) of the 292 errors, followed by prescribing and dispensing errors.

The detailed distributions of the reported MEs are shown in table 3; medication administration errors were the most frequent (48.9%).

Of the 292 errors reported, 201 (68.8%) and 91 (31.1%) errors were found in the intensive care ward and attached pharmacy, respectively (table 4).

In most cases, workload ($n=117$, 37.6%) was the prime reason or contributing factor for the medication incident to occur. Fatigue and lack of communication were the second and third most common contributing factors (table 5).

DISCUSSION

The investigation of MEs in the current framework of the healthcare system across the world is not well perceived and widely accepted. Great caution was exercised at the study site to deliver this programme, with emphasis on the virtues of voluntary, non-punitive, stand-alone and anonymous reporting and not to fault-find with any individual involved in the error. Although the rate of reporting in the initial stages was slow, it has gradually improved. HCPs voluntarily reported 292 errors among the 5137 admitted patients. Of the reported 292 errors, 194 (66.4%) were identified and communicated by HCPs other than a clinical pharmacist and 98 (33.5%) through intensive

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Figure 1 National Coordinating Council for Medication Error Reporting and Prevention's index for categorising medication errors.

Table 1 Overall distribution of medication errors identified and reported by healthcare professionals (HCPs)

Sl. no	Category of HCP	No (%) medication errors reported
1	Doctors	72 (24.6)
2	Nurses	122 (41.7)
3	Research pharmacists	98 (33.5)
Total		292 (100)

Sl. No., serial number.

Table 2 Categories of medication errors reported by various healthcare professionals

Sl. no	Category of error	Category of reporter			Total no (%) of errors
		Doctor	Nurse	Clinical pharmacist	
1	Prescription	2	2	52	56 (19.1)
2	Transcription	6	5	6	17 (5.8)
3	Dispensing	11	19	13	43 (14.7)
4	Administration	33	58	14	105 (35.9)
5	Documentation	7	9	1	17 (5.8)
6	Procurement	4	17	12	33 (11.3)
7	Monitoring	8	11	0	19 (6.5)
8	Storage	1	1	0	2 (0.6)
Total (%)		72 (24.6)	122 (41.7)	98 (33.5)	292 (100)

Sl. No., serial number.

follow-up. The yardstick of the programme's success would be HCPs voluntarily adopting the open reporting system rather than anonymously by coming forward to discuss reported errors openly within the healthcare system. Although an electronic format of reporting was made available to report MEs through a voluntary ME reporting system under the Hospital Information Systems (HIS), HCPs have preferred to communicate through the paper-based system.

Medication administration errors were the most commonly reported MEs ($n=105$, 35.9%), and these results were in contrast to the results of a study conducted by Raju *et al*²⁰ where medication administration errors comprised 60% of all reported MEs. This situation warrants arrangements for continuous education programmes on prevention of MEs for nursing staff as they spend 40% of their time on drug administration, and the evidence suggests that one in three MEs were due to the nursing staff's medication administration.^{21–23}

The number of prescription errors ($n=56$, 19.1%) was lower than in other published studies. In a systematic review, Reckmann *et al* proposed the reduction of MEs on similar lines with the use of the CPOE system. Although CPOE reduces the incidence of prescription and dispensing errors, the design used in developing the CPOE algorithm may affect the outcomes in preventing MEs—that is, when an algorithm is not programmed robustly to adopt CPOE dynamically, there would be a minimal impact on the reduction of MEs.²⁴

We observed similar findings to those of Radley *et al*¹⁴ who found that CPOE reduced MEs by 48%. However, the use of the existing CPOE system was modest at the study site. Although an electronic system was made available for prescribing medicines and reporting MEs at the study site, the use of the system was minimal. Of the total 72 MEs reported by

Table 3 Detailed distribution of medication errors under each category

Sl. no	Category	Subcategory of errors	No (%) of errors
1	Prescription	Incompleteness	54 (18.4)
		Illegible	2 (0.6)
Total			56 (19.1)
2	Transcription	Incompleteness	2 (0.6)
		Illegible	15 (5.1)
Total			17 (5.8)
3	Dispensing	Wrong drug	11 (3.7)
		Wrong strength	0
		Wrong dosage form	0
		Wrong quantity	
		Fewer	5 (1.7)
		More	1 (0.3)
		Other brand	12 (4.1)
		Delayed dispensing	14 (4.7)
Total			43 (14.7)
4	Administration	Wrong drug	1 (0.3)
		Wrong strength	5 (1.7)
		Wrong dosage form	0
		Wrong time	
		Prolonged >1 hour	81 (27.7)
		Administered before 1 hour	3 (1)
		Wrong administration technique	8 (2.7)
		Wrong patient	0
		Dose missed	7 (2.3)
		Documentation	
		Incomplete documentation	15 (5.1)
		Delayed documentation	2 (0.6)
		Monitoring	19 (6.5)
		Storage	2 (0.6)
Total			143 (48.9)
5	Procurement	Failure to bring	23 (7.8)
		Insufficient quantities	4 (1.3)
		Substituted with other brands	3 (1)
		Time taken to procure >12 hours	3 (1)
Total			33 (11.3)
Grand total			292 (100)

Sl. No., serial number.

Table 4 Distribution of outcome of medication errors according to the National Coordinating Council for Medication Error Reporting and Prevention

Sl. no.	Place where errors originated	Place where errors originated			
		Category A n (%)	Category B n (%)	Category C n (%)	Category D n (%)
1	Pharmacy	74 (25.3)	6 (2)	11 (3.7)	0 (0)
2	Wards	48 (16.4)	14 (4.7)	113 (38.6)	26 (8.9)
Total		122 (41.7)	20 (6.8)	124 (42.4)	26 (8.9)
Grand total		292 (100)			

Sl. No., serial number.

doctors, most errors were observed to have occurred during medication administration ($n=33$, 11.3%), followed by dispensing ($n=11$, 3.7%), monitoring ($n=8$, 2.7%) and transcription ($n=6$, 2%). Of the 122 (4.7%) errors reported by nurses, most occurred during administration ($n=58$, 19.8%), followed by dispensing ($n=19$, 6.5%), procurement ($n=17$, 5.8%), monitoring ($n=11$, 3.7%), and the rest during documentation ($n=9$, 3%), transcription ($n=5$, 1.7%), prescription ($n=2$, 0.6%) and storage ($n=1$, 0.3%).

Table 5 Distribution of contributing factors towards reported medication errors

No	Contributing factors	No of errors
1	Communications	30
2	Distractions	20
3	Workload	117
4	Peak hours	14
5	Fatigue	41
6	Documentation	2
7	Inadequate monitoring	14
8	Patient-related factors	24
9	Calculation errors	4
10	Illegible prescriptions	16
11	New staff	6
12	Knowledge deficient	17
13	Emergency situation	6
Total		311

A significant proportion of MEs occurred during medication administration (n=143, 48.9%), most of which occurred due to administration at the wrong time (n=84, 28.7%). The study by Kirmani²⁵ reported similar results to those of our study, with 13% of MEs caused by delayed dose administrations of medications regarding drug administration at the wrong time, followed by insufficient monitoring of high alert medications (n=19, 6.5%), incomplete documentation (n=17, 5.8%), wrong administration rate (n=8, 2.7%), missed dose (n=7, 2.3%) and inappropriate storage (n=2, 0.6%). Prescription errors contributed to 56 errors (19.1%), which included errors due to incompleteness (n=54, 18.4%) and illegibility (n=2, 0.6%). Errors in dispensing contributed to 43 (14.7%) of the 292 errors reported, which included delayed dispensing of medications (n=14, 4.7%), inappropriate medication brand substitution (n=12, 4.1%), wrong drug dispensing (n=11, 3.7%) and dispensing the wrong quantity (n=6, 2%). Medication procurement errors accounted for 11.3% of the total MEs. These errors included failure to bring the drugs to the patient by their caregivers (n=23, 7.8%), delivery of insufficient quantities of

medicines (n=4, 1.3%), substitution with other brands (n=3, 1%) and delay in the procurement of medicines due to economic considerations (n=3, 1%). Medications purchased from outside the hospital might contribute to the occurrence of MEs.²⁶ The National President of the Pharmaceutical Society of Australia has suggested that brand substitution may lead to MEs.²⁷

Transcription errors were observed in 17 MEs (5.8%), which included errors due to illegibility (n=15, 5.1%) and incompleteness of prescriptions (n=2, 0.6%). These results were in contrast to a study conducted by Fahimi *et al*²⁸ where transcriptional errors accounted for 52% of MEs.

Most reports indicate that workload is a prime reason for the occurrence of MEs (n=117, 37.6%). Of the listed contributing factors, workload, fatigue, sleep deprivation and peak hours are considered to be factors that contribute towards MEs.

CONCLUSION

The voluntary reporting of MEs was slow and most of the errors identified in the study did not cause any harm. To minimise these MEs, reporting systems should be designed to encourage HCPs by conducting awareness and education programmes, assuring a non-punitive and reward-based system, thus promoting patient safety.

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What this paper adds

What is already known on this subject

- Medication errors occur at every stage of healthcare and jeopardise patient safety.
- Under-reporting of medication errors is prevalent and only a few countries have medication error reporting programmes.
- In developing countries the prevalence of medication errors is unknown.

What this study adds

- A culture of voluntary medication error reporting can be fostered among healthcare workforces in developing countries through non-punitive policies.
- Dynamic work ratio of healthcare professionals (HCPs) can increase the rate of medication errors.
- Clinical pharmacists can assist HCPs to promote patient safety.

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