

# A quality assurance study on the administration of medication by nurses in a neonatal intensive care unit

Raja Lope R J, Boo N Y, Rohana J, Cheah F C

## ABSTRACT

**Introduction:** This study aimed to determine the rates of non-adherence to standard steps of medication administration and medication administration errors committed by registered nurses in a neonatal intensive care unit before and after intervention.

**Methods:** A baseline assessment of compliance with ten standard medication administration steps by neonatal intensive care unit nurses was carried out over a two-week period. Following this, a re-education programme was launched. Three months later, they were re-assessed similarly.

**Results:** The baseline assessment showed that the nurses did not carry out at least one of the ten standard administrative steps during the administration of 188 medication doses. The most common steps omitted were having another nurse to witness drug administration (95 percent); labelling of individual medication prepared prior to administration (88 percent), checking prescription charts against patients' identification prior to administration (85 percent) and visually inspecting a patient's identification tag (71 percent). Medication administration errors occurred in 31 percent (59/188) of doses administered, all due to imprecise timing of medication administration. There were no resultant adverse outcomes. Following implementation of remedial measures, there was a significant reduction in non-adherence of seven of the ten medication administration steps and the rate of medication administration errors (p-value is less than 0.001). However, in 94 percent of doses administered, the nurses still did not get a witness to countercheck calculations of drug dosages before administration.

**Conclusion:** Non-compliance with the standard practice of medication administration by nurses is common but can be improved by continuing re-education and monitoring, plus the implementation of a standard operating procedure.

**Keywords:** medication administration errors, medication errors, neonatal intensive care unit, quality assurance, standard operating procedure

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## INTRODUCTION

Medication errors are common occurrences, particularly in the neonatal intensive care unit (NICU). Potential adverse drug events due to medication errors occur up to three times more frequently in NICUs than in adult wards.<sup>(1)</sup> This is of concern as neonates are more vulnerable to adverse effects of medication errors because of their relatively less efficient metabolism and excretion of drugs compared to adults. Medication errors may result in morbidity, mortality, increased monitoring and cost of care, and delayed hospital discharge. Nurses are the key participants in the preparation and administration of medication. During their training, nurses are taught the Six Rights of medication administration, which are: giving the right medication in the right dose at the right time via the right route to the right patient with the right documentation.<sup>(2)</sup> This serves as a useful framework for standard operating procedures (SOP). However, one-off education alone is insufficient to prevent medication errors, as up to 60% of medication errors may be committed by registered nurses.<sup>(3,4)</sup>

The term, medication administration errors, refers to medication errors that occur during the process usually involving nursing actions in which the patient receives or is supposed to receive a medication. Medication administration errors include errors of commission and omission.<sup>(5)</sup> The former occurs when one or more of the Six Rights of medication administration are violated, whereas the latter occurs when a prescribed medication is not given.

Department of Paediatrics, Universiti Kebangsaan Malaysia, Jalan Yaacob Latif, Kuala Lumpur 56000, Malaysia

Raja Lope RJ, MBBS, MRCP  
Senior Lecturer

Rohana J, MD, MMed  
Associate Professor

Cheah FC, MD, PhD, FRACP  
Associate Professor

Clinical School, International Medical University of Malaysia, Jalan Rasah, Seremban 70300, Malaysia

Boo NY, MBBS, MRCP, FRCP  
Professor

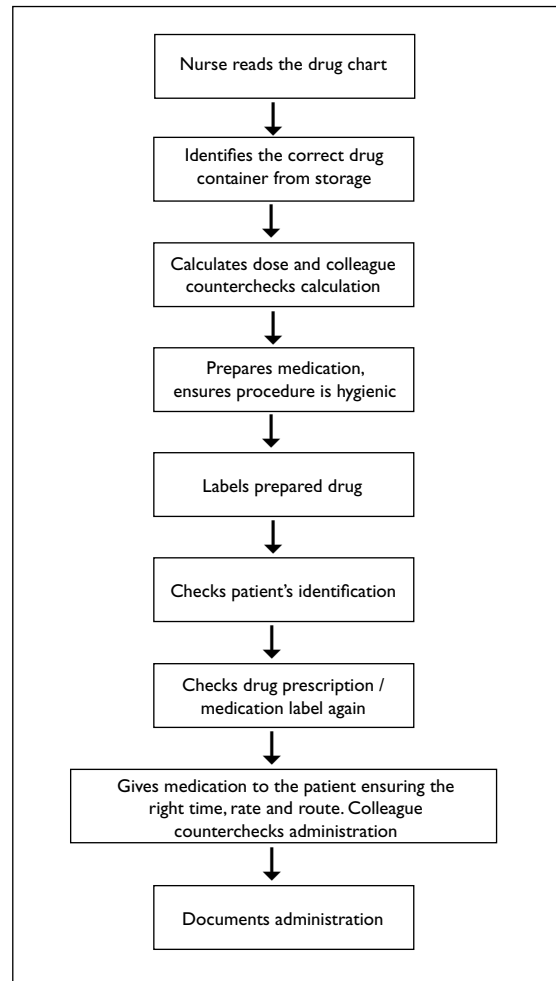
Correspondence to:  
Dr Raja Juanita  
Raja Lope  
Tel: (60) 3 9145 7888  
Fax: (60) 3 917 37827  
Email: juanita@mail.hukm.ukm.my

At the time of the present study, it was not known how common medication administration errors were in NICUs in Malaysia. The objectives of this study were to determine the rates of non-adherence to standard steps of medication administration and rates of medication administration errors by registered nurses in an NICU before and after the implementation of remedial measures.

## METHODS

This was an observational study carried out in NICU, Hospital Universiti Kebangsaan Malaysia during two two-week phases in 2005 and 2006. This NICU has 34 beds, of which ten are intensive care cots. Prescriptions charts were kept in the bay of each individual cot. Nurses working in this NICU prepared medications at a counter where the central medication storage cabinet was located. The medications for each baby were drawn up in separate syringes and placed on individual trays. Medication for several babies under the care of one nurse may be prepared at the same time by that individual.

During the study period (February 2005 – phase 1 and February 2006 – phase 2), the nurses were monitored by third-year medical students on their adherence to the Six Rights doctrine of medication administration. The study was carried out in February as this was when the medical students were scheduled to carry out a quality assurance project. The nurses were not aware that they were being monitored. The medical students were taught how to use a standard format to document the performance of the nurses in an inconspicuous manner. The format consisted of easily observable physical manoeuvres of the expected steps of drug administration based on the Six Rights doctrine taught in nursing school. The students were divided into small groups rostered to observe the nurses over a 24-hour period. The main researcher was informed of medical errors at the end of the observation period, and the nurses as a group were notified of the type and frequency of errors made during the re-education programme. Ethical approval was not required by the university for quality assurance studies of this design at the time of this study and therefore not obtained. Quality assurance projects were a compulsory component of the third-year undergraduate medical curriculum. Based on the findings of the first phase of the study, a re-education programme (consisting of feedback, lectures and the use of education posters) was launched and a SOP (Fig. 1) was implemented seven months after phase 1. Three months after completion of the education programme, these nurses were re-monitored over another two-week period in a similar manner but by a different batch of medical students.



**Fig. 1** Flow chart shows the standard operating procedure of the expected steps in medication administration.

The American Society of Hospital Pharmacists (ASHP) categorises medication errors into errors due to incorrect prescription, administration or supply. Based on the ASHP definition, medication administration errors were defined to be present whenever there was an omission error, an extra dose given, wrong preparation of a medication, incorrect dose given, incorrect drug given, deteriorated drug given or if a drug was given via the wrong route, wrong rate or at the wrong time.<sup>(6)</sup> In this study, a drug was defined as given at the wrong time if it was administered 30 minutes earlier or later than the actual time prescribed. The medication administration error rate was calculated as follows: (number of errors)/(number of doses given + number of omissions) × 100. Bed occupancy rate (BOR) was calculated as: (number of inpatient days/number of days in a month) × number of beds × 100. The latter is a standard calculation used to show the actual utilisation of an inpatient health facility for a given time period. Data was analysed using the Statistical Package for Social Sciences software version 12.0 (SPSS Inc,

**Table I. Non-adherence rates of the standard steps of medication administration by nurses before and after a re-education programme.**

Steps in medication administration	No. (%) of non-adherences per step		p-value
	Before (n = 188)	After (n = 169)	
Read prescription chart	31 (16.5)	0 (0)	< 0.001*
Check drug label (storage)	3 (1.6)	0 (0)	0.50
Countercheck calculation of drugs	39 (20.7)	161 (95.3)	< 0.001*
Label medication	166 (88.3)	81 (47.9)	< 0.001*
Check patient's identification	133 (70.7)	34 (20.1)	< 0.001*
Check drug prescription / medication label again	159 (84.6)	61 (36.1)	< 0.001*
Administration at right time	59 (31)	26 (15.4)	< 0.001*
Given via right route	0 (0)	0 (0)	–
Witness for drug administration	178 (94.7)	158 (93.5)	0.90
Correct documentation	81 (43.1)	1 (0.6)	< 0.001*

\* denotes statistical significance.

Chicago, IL, USA). The proportions of nurses not adhering to the various steps of medication practice before and after the remedial programme were compared. Pearson's chi-squared test (with Yates' correction for expected values of < 5) was used for analysis of categorical variables. A p-value of < 0.05 was considered to be statistically significant.

## RESULTS

There was a significant difference ( $p < 0.001$ ) in the BOR during phase 1 (BOR 60.2%) and phase 2 (BOR 52.1%) of the study. 50 nurses were observed during phase 1, while 51 nurses were observed in phase 2. 94% of the nurses observed in phase 2 were the same nurses as those observed in phase 1. There was no significant difference ( $p < 0.001$ ) between the mean number of nurses per shift during phase 1 ( $n = 9.18$ ) and phase 2 ( $n = 9.78$ ). 92% of the phase 1 nurses participated in the re-education programme.

An initial baseline assessment showed that the nurses omitted at least one of the ten standard administration steps during the administration of 188 medication doses (Table I). The most common steps omitted were: having a witness during drug administration (94.7%), labelling of medication (88.3%), checking prescription charts against patients' identification immediately before medication administration (84.6%) and visually inspecting a patient's identification tag (70.7%). Based on the ASHP definition, medication administration errors occurred in 31% (59/188) of the observed doses administered. Of these errors, 100% ( $n = 59$ ) were due to medication given at the wrong time.

Following implementation of remedial measures, there was a significant reduction in the rates of medication administration errors and non-adherence to six of the medication administration steps ( $p < 0.001$ ) (Table I). These steps were: checking prescription charts, labelling of medication, checking patient's identification, re-checking drug prescription and medication label against patient's

identification, giving medication at the precise time and documentation after giving medications. The rate of medication administration error was halved (from 31% to 15.4%;  $p \leq 0.001$ ) and this was due entirely to imprecise timing of drug administration. However, the incidence of nurses failing to get a witness to countercheck their calculation of drug dosages increased (20.7% vs. 95.3%); while the incidence of nurses not having a witness during the administration of medication remained unchanged (94.7% vs. 93.5%) (Table I).

## DISCUSSION

Traditional prevention strategies against medication errors have been based mainly on incident reporting and chart review. These do not address many weaknesses of the system that results in medication errors. Here, direct observation was used to monitor medication administration as it provided information on the actual rates of adherence to each of the major steps of medication administration by the nurses. This method has been shown to be the gold standard in determining the rate of medication administration errors and has helped us to identify the steps commonly omitted by the staff so that remedial actions targeted in overcoming them could be formulated.<sup>(7)</sup> As this method is very labour intensive, there are few reported studies using this method of monitoring.<sup>(8)</sup> With the advent of new technology, one other method used in quality assurance studies is the use of close circuit television recordings to monitor clinical practice.<sup>(9)</sup>

The first phase of this study showed that failure to adhere to proper practice of medication administration by nurses was a common occurrence. Observers documented 31 occasions in which the drug chart was not inspected prior to drawing up the medication. These cases, however, involved the administration of oral multivitamins and minerals only. We suspect that the drug charts may have been

read at the bedside, the details memorised, but the charts were not physically taken to the central preparation area. This may arise in recall inaccuracies. After re-education, there were no documented cases of non-adherence to this step. Labelling medication was a commonly missed step. Although not defined as a medication administration error, we considered this to be an important practice procedure not to be omitted in order to avoid the problem of a mix-up of medication between babies, particularly when drugs were prepared centrally and simultaneously for different babies.

The baseline incidence of medication administration errors was 31%. It is difficult to directly compare medication error rates between different studies due to variations in definitions and methodology. However, Barker et al reported a medication administration error rate of 19% in a similar study involving mainly adult wards.<sup>(7)</sup> Medication errors occur more frequently in NICUs than adult wards,<sup>(1)</sup> which is probably why our medication administration error rate was higher. The most common medication administration error detected in this study was administering medication at the wrong time, which is a similar finding as reports from other studies.<sup>(6,7)</sup> The possible reasons for this include a busy intensive care unit, understaffing as well as nurses' inexperience and failure to appreciate the importance of the precise timing of medication administration.<sup>(5,10)</sup> However, following re-education, the issue of wrong timing was reduced significantly from 31% to 15.4%. Possible confounding factors such as the staffing level and BOR (as a measure of workload) were not likely contributors to the lower medication error rate after re-education. There was no significant difference in the staffing level during phases 1 and 2 of the study. Although there was a significantly higher BOR during phase 1 of the study (60.2%), it is unlikely that there would have been a major increase in workload as the NICU was operating well below full capacity. There was no reported adverse outcome consequent to the imprecise timing of medication. In 2007, we implemented standardised times for drug administration; this may have further reduced the incidence of medical errors due to wrong timing.

The most significant improvement in the adherence to the Six Rights of medication administration was in the documentation of the medication being provided (43.1% vs. 0.6% post re-education). However, nurses still did not get a witness to countercheck drug dosing calculations and the administration of drugs. The main reason cited by the nurses was a lack of staff and the nurses did not want to trouble their fellow colleagues who were already too busy with other duties. Double-checking dispensed drugs and drug doses has been identified as an effective way of intercepting potential errors,<sup>(3)</sup> and is recommended in many institutional guidelines.<sup>(11,12)</sup> Increasing the nurse to patient

ratio, employing the service of a clinical pharmacist and continuing nursing education emphasising the importance of a witness are several measures that could help overcome this problem.<sup>(12)</sup>

In this study, re-educating the nurses, improving staff awareness of the correct steps in medication administration, implementation of an SOP and continuing monitoring through quality assurance studies were measures taken that successfully reduced the problem of medication administration errors. Other methods that are known to reduce medication administration errors include computerised medication administration records,<sup>(13)</sup> bar-coding of patients and medications<sup>(13)</sup> and automated drug dispensing systems.<sup>(14)</sup> These are additional helpful measures that may help to minimise medication administration errors in this NICU. The disadvantage of these measures for developing countries is the higher operational costs involved.

The main limitation of this study was that inter-rater reliability testing was not done on the observers. Efforts to minimise inter-observer errors consisted of using a standard record format of easily observable physical manoeuvres of the expected steps of drug administration based on the Six Rights doctrine. In conclusion, this study has shown that medication administration errors in the NICU are common. A continuous quality improvement approach with a staff re-education programme, enforcing SOPs and periodic monitoring, was successful in alleviating the problem.

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## REFERENCES

1. Kaushal R, Bates DW, Landrigan C, et al. Medication errors and adverse drug events in pediatric inpatients. *JAMA* 2001; 285:2114-20.
2. Potter AP, Perry AG. *Basic Nursing - Essentials For Practice*. 5th ed. New Jersey: Mosby, 2003: 294-6.
3. Ross LM, Wallace M, Paton JY, Stephenson T. Medication errors in a paediatric teaching hospital in the UK: five years operational experience. *Arch Dis Child* 2000; 83:492-7.

4. Raju TN, Kecskes S, Thornton JP, et al. Medication errors in neonatal and paediatric intensive-care units. *Lancet* 1989; 2:374-6.
5. Carlton G, Blegen MA. Medication-related errors: A literature review of incidence and antecedents. *Annu Rev Nurs Res* 2006; 24:19-40.
6. Wilson DG, McCartney RG, Newcombe RG, et al. Medication errors in paediatric practice: insights from a continuous quality improvement approach. *Eur J Pediatr* 1998; 157:769-74.
7. Barker KN, Flynn EA, Pepper GA, et al. Medication errors observed in 36 health care facilities. *Arch Intern Med* 2002; 162:1897-903.
8. Walsh KE, Kaushal R, Chessare JB. How to avoid paediatric medication errors: a user's guide to the literature. *Arch Dis Child* 2005; 90:698-702.
9. Carbine DN, Finer NN, Knodel E, Rich W. Video recording as a means of evaluating neonatal resuscitation performance. *Pediatrics* 2000; 106:654-8.
10. O'Shea E. Factors contributing to medication errors: a literature review. *J Clin Nurs* 1999; 8:496-504.
11. Simpson JH, Lynch R, Grant J, Alroomi L. Reducing medication errors in the neonatal intensive care unit. *Arch Dis Child Fetal Neonatal Ed* 2004; 89:F840-2.
12. American Academy of Pediatrics. Prevention of medication errors in the pediatric inpatient setting. *Pediatrics* 2003; 112:431-6.
13. Fortescue EB, Kaushal R, Landringan CP, et al. Prioritizing strategies for preventing medication errors and adverse drug events in pediatric inpatients. *Pediatrics* 2003; 111:722-9.
14. Schwarz HO, Brodowy BA. Implementation and evaluation of an automated dispensing system. *Am J Health Syst Pharm* 1995; 52:823-8.

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