Military Antimicrobial Stewardship: Improving Parenteral Antibiotics Medication Administration in a Malaysian Military Hospital

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ABSTRACT

INTRODUCTION. Medication Administration Errors (MAEs) are possible and may cause potentially serious or fatal effect. Parenteral antibiotics medication has particularly been associated with serious and life threatening errors. Objective: The objective of this study was to determine the common types of Medication Administration Errors (MAE) and to improve the rate of Correct Medication Administration (CMA) for parenteral antibiotics. METHODS. The standard set was 100% CMA rate. The indicator was an improvement in the CMA rate (CMA rate = 100% - MAE rate). The undisguised direct observation was used to evaluate medication administration at two medical wards in a military hospital. One observer who is a pharmacist followed the medication serving rounds and documented the parenteral antibiotics drug preparation and administration. Observation information was collected at pre and post intervention. During baseline data collection, the perceived contributing factors were documented when there were intervention strategies. RESULTS. At the pre-intervention stage, 284 out of 559 drug administrations observed had at least an error (MAE rate 50.8%, CMA rate 49.2%). The most common error was incorrect drug preparation (32.7%), incorrect administration technique (23.2%), incorrect rate error (19.7%), deteriorated drug error (11.6%) and omission error (3.8%). The common contributing factors were inadequate knowledge (46.0%), failure to adhere to guidelines (22.4%) and incomplete guidelines (19.7%). Quick reference guide for parenteral antibiotics was developed. Pharmacist-led educational sessions were conducted to educate nursing staffs on medication safety and the use of the reference guide. At post-intervention-stage, 152 out of 468 drug administration observed had at least an error (MAE rate 32.5%, CMA rate 67.5%). DISCUSSION. Post remedial analysis demonstrated a marked improvement of CMA rate from 49.2% to 67.5%. Substantial improvements were seen across all types of parenteral antibiotics administration errors. CONCLUSION. Future strategies should be implemented to further reduce MAEs for all class of medications. This includes regular updates of reference guides, continuing joint education programs between prescribers, pharmacists and nurses on medication safety besides conducting periodic audits on medication administration to identify areas that require remedial actions.

Keywords: Medication Administration Error, Correct Medication Administration, Parenteral Antibiotics, Malaysian Military Hospital.

INTRODUCTION

The National Coordinating Council for Medication Error Reporting and Prevention (NCC MERP) defines a medication error as "any preventable event that may cause or lead to inappropriate medication use or patient harm while the medication is in the control of the health care professional, patient or consumer" [1]. The Institute of Medicine's (IOM) first Quality Chasm report, To Err Is Human: Building a Safer Health System, stated that medication-related errors statistically were a significant cause of morbidity and mortality; they accounted "for one out of every 131 outpatient deaths, and one out of 854 inpatient deaths" [2,3]. Medication errors were estimated to account for more than 7,000 deaths annually. This means almost one in five medication doses administered in hospitals is given in error causing at least 1 death occurrence per day and 1.3 million people are injured each year due to medication errors globally. Malaysian Patient Safety Goal (MPSG) number seven is to ensure medication safety. However, since 2013, there has been a steady rise of approximately 20% in actual errors and near misses errors nationally.

Drug delivery processes can be categorized as prescribing, transcribing, dispensing and administration. Each stage of these processes involves a specific role of Health Care Provider's (HCP), either doctor or nurse [2]. However, pharmacist duty is to overlook, coordinate and prevent any medication error occurrence throughout any of these stages. It has been reported that medication errors occurred most frequently at the prescribing stage, followed by administration, transcription and dispensing. However, prescribing errors were often intercepted, unlike drug administration errors [1,2]. Statistically, 48% of prescribing errors were intercepted compared with 2% or less of administration errors. This means that drug administration errors are more likely to reach the patients and has a higher potential for causing patient harm. Drug administration is an activity that is prone to many types of errors, partly attributed to the rapid development in medical technology, leading to a tremendous increase in types and complexity of medical devices as well as the vast pharmacology of medications being introduced into the market [2,3,4]. In addition, there are various routes of administration, different dosages, dosage forms and dosing regimens which are often changed according to the patient's clinical conditions and diagnostic test results available. Hence, it is always crucial for HCP's to be vigilant and practice the five rights of medication administration. Which are; right patient, right medication, right dose, right time and right route [2,3].

When compared, parenteral drugs pose particular risks causing

higher incidence of administration errors compared to enteral or topical drugs because of their greater complexity and the multiple steps required in their preparation, storage requirements and shelf life upon reconstitution and administration technique. This is proven by several studies on drug administration errors that used observational method reported administration error rates varied from 3 to 44%. However, higher error rate (44%) has been observed in as patients who were usually on parenteral drugs and polypharmacy [2,3,4].

Based on the 2014 Malaysian protocol on Antimicrobial Stewardship Program in healthcare facilities, the second core objective is to optimize antimicrobial therapy by promoting judicious use of antimicrobials, optimizing antimicrobial selection, dosing, route and duration of therapy in order to maximize clinical cure or prevent infections. Dosing and route of therapy is an integral part of drug administration stage in drug delivery [2,3]. Hence, medication administration errors concerning parenteral antibiotics should be viewed as a hindrance in curbing inappropriate antimicrobial use which supposedly minimizes patient's harm and healthcare cost [5]. Appropriate parenteral antibiotics administration is also essential in the military setting where its use is prominent in trauma cases which are most likely to be seen in military medicine practice during situational conflict or operational zones [3].

Medication Administration Errors (MAEs) among patients are possible and may cause potentially serious or fatal effect. Parenteral antibiotics medication has particularly been associated with serious and life threatening errors. Therefore, this study was conducted to determine the common types of error and to improve the rate of Correct Medication Administration (CMA) particularly in antibiotics served via parenteral route of administration.

METHODS

Definitions

The Correct Medication Administration (CMA) is defined as proper administration of a drug based on the Formulari Ubat-ubatan Perkhidmatan Kesihatan Angkatan Tentera (FORSIHAT) guidelines and five rights hospital medication policy; i.e. right patient, right medication, right dose, right time and right route. The CMA target is 100%. A Medication Administration Error (MAE) is defined as a discrepancy between drug therapy received by patient and intention of the prescriber or according to standard hospital policies and procedures. In this study, it also encompassed the process of drug preparation in the ward but excluded prescribing errors. The error rate was calculated using the Total Opportunities for Error (TOE) which is the sum of all doses ordered plus all the unordered doses given. The MAE rate was then calculated as the number of doses with errors (incorrect in one or more ways) divided by the TOE and multiplied by 100 to obtain the percentage of errors, which would not exceed 100% [5,6,7,8].

Drug administration errors in this study were classified into 10 categories, similar to that used by other authors; i.e. deteriorated drug, incorrect administration technique, incorrect drug, incorrect drug preparation, incorrect dose, incorrect rate, incorrect time, omission, unauthorized drug and others for errors which were not specified. Some drug administration errors would lead to subsequent errors. For example, incorrect drug preparation would result in incorrect dose but only incorrect preparation technique was considered as an error and not the incorrect dose. The core error was taken into account.

Deteriorated drug error was defined as the administration of a drug that has expired or for which physical or chemical dosage-form integrity has been compromised. In this study, this encompasses unusual appearance of the drug product in terms of color; i.e. discoloration and smell; i.e. pungent [7]. Incorrect administration technique error was defined as the inappropriate procedure or improper technique in the administration of a drug other than wrong route. In this study, this is based on the method of administration recommendations stated in drug product leaflets or guidelines based on Formulari Ubat-ubatan Perkhidmatan Kesihatan Angkatan Tentera (FORSIHAT). Incorrect drug error was defined as the administration of the wrong medication intended by prescriber [7,8].

In this study, it was the administration of the wrong drug to the right patient. Incorrect drug preparation error was defined as the drug product incorrectly formulated or manipulated before administration [7]. In this study, this encompasses cases where drug dilution or reconstitution is incorrect due to error in diluent type or diluent volume. Incorrect dose was defined as the administration to the patient of a dose that is lesser than or greater than the amount ordered by the prescriber or administration of multiple doses to the patient, i.e. one or more dosage units in addition to those that were ordered [7,8,9]. In this study, this is dependent upon intended dosing regimens frequency (STAT, OD, BD, TDS or QID). Incorrect rate error was defined as the administration to the patient of a drug dose at a rate that is lesser than or greater than the rate ordered by the prescriber. In this study, this is based on the method of administration rate recommendations stated in drug product leaflets or guidelines based on Formulari Ubat-ubatan Perkhidmatan Kesihatan Angkatan Tentera (FORSIHAT). Incorrect time error was defined as the administration of medication outside a predefined time interval from its scheduled administration time. In this study, administration of drugs an hour or more before or after the scheduled time which is dependent upon intended dosing regimens frequency (STAT, OD, BD, TDS or QID). Omission error was defined as failure to administer an ordered dose to a patient before the next scheduled dose 7. In this study, this excludes patient's refusal and clinical decision or any other valid reason not to administer. Unauthorized drug error was defined as administration to the patient of medication not authorized by a legitimate prescriber without proper documentations 9. In this study, this encompasses cases of right or wrong drug but towards the wrong patient. The tenth error type was categorized under others for errors which were not specified in other categories.

Undisguised direct observation was used to evaluate medication administration at two medical wards (Male Medical and Female Medical). One observer who is a pharmacist followed

the nursing staff during medication rounds and documented the parenteral antibiotic drug preparation and administration process. Observation information was collected at baseline and after interventions. During baseline data collection, the perceived contributing factors were documented when there were errors.

Setting

The Malaysian Royal Medical and Dental Corps (RMDC) also known as Kor Kesihatan Diraja (KKD) chief responsibility is to ensure military readiness and maintain the fighting strength of Malaysian Armed Forces (MAF) in wartime and military operations other than war. RMDC also provides medical care to servicemen, veterans and their immediate family members. This is achievable via their organizational structure which consists of medical and dental units throughout the country. RMDC major medical units are five Armed Forces Hospitals, this study was conducted in two medical wards of Tuanku Mizan Armed Forces Hospital (TMAFH) which is situated in Kuala Lumpur, Malaysia. TMAFH has the capacity of 282 plus 100 beds and is a non-Information Technology Health Information System (HIS) hospital. The medical wards are Male Medical Ward (MMW) and Female Medical Ward (FMW). Both wards have a bed capacity of 28 each.

TMAFH Inpatient Pharmacy Department (IPD) practices centralized drug distribution system via medication trolley and floor stock. After doctors clinically review an inpatient, a clinical plan is written onto the patient's medical file, while the drugs prescribed are transcribed onto the inpatient medication prescription.

During IPD active operational hour which is from 0800H to 2359H, the original prescription copy will be sent to the pharmacy by the nurses for the pharmacists to prospectively screen and pharmacist technicians to fill the patient medications trolley on unit-of-use basis. Whereas, the carbon copies of prescription are retained in ward for medication administration documentation purposes. However, during IPD passive operational hours which is from 0001H to 0759H, if a doctor prescribes and the drug is needed to be administered immediately in such case (STAT dose), the nurses will administer the drug using the ward floor stock if available and only sent in the prescription when the IPD is actively operating for the pharmacist to retrospectively screen. The clinical pharmacist will only conduct ward rounds during the active operational hours and note such cases as well. During IPD passive operational hours if the drug is not available as floor stock, there is always a pharmacist and pharmacist technician who are on duty and can be reached for any pharmaceutical care related assistance.

All parenteral drugs are administered by nurses except in certain cases the doctor will assist; i.e. Intrathecal administration. All drugs administration documentation will be signed with date by the nurse who administered the drug and the nurse who observed the process for counter checking measures. Any remainder drug supplied as unit-of-use item to the ward would be recorded in a form and subsequently returned to the pharmacy. IPD will keep records of all these transactions manually.

DATA COLLECTION PROCEDURES

This is a prospective observational study where the researcher observed directly how drugs were administered by nurses or doctors during medication serving rounds. The methodology followed closely to that used in many other studies and has been demonstrated to be the most accurate method for detecting drug administration errors. Similar to the study by Dean and Barber [9], the nurses in charge for both medical wards were briefed verbally in prior about the study which explains the presence of the researcher. One of the main concerns with direct observation method is the effect of the observer on those being observed and hence may bias the study results. However, this Hawthorne effect disappeared after a few days of observation during the pilot study as the ward staff started to forget about the study and behaved as usual. It has also been demonstrated that such observations did not affect the error rate significantly.

The pilot study was conducted for 5 days in the same wards to test the practicability and feasibility of the methodology, to reduce the Hawthorne effect and to face validate the data collection form which will be the only instrument for this study. Amendments were made to the data collection form so that it is more user friendly and practical for the researcher to take notes while observing each drug administration process. It was then content validated [10,11].

One researcher who is a pharmacist acts as an observer and followed during medication serving rounds based on his convenience throughout November 2016. For four weeks, the researcher recorded all aspects of drug preparation and administration in a data collection form as a baseline.

After each round of observation, the observer compared the information recorded with the doctor's orders in the patient's medication file to detect any discrepancies. All the data collected were discussed with the other members of the research team. The identity of the nurses and doctors were recorded in codes and no individual was indicated in the data analysis. For ethical reasons, the observer would intervene if noticed any drug administration errors that could result in potential patient harm but these incidents were still recorded as errors. Other studies also allowed such interventions. Dean and Barber [19] found that such interventions did not have any significant effect on the error rate.

All the drug administration errors were classified into four categories based on that used by Stubbs et al. [22], for prescribing errors: Grade 1: probably clinically insignificant, Grade 2: minimal clinical significance, Grade 3: definitely clinically significant and could cause patient harm and Grade 4: potentially life-threatening. The common contributing factors were determined and discussed with other researchers in this study. The intervention was carried out throughout December 2016, where quick reference guide for parenteral antibiotics was developed and distributed to all wards and departments in TMAFH. Pharmacist-led educational sessions were then conducted to educate the nursing staff on medication safety and the use of reference guides. The post-intervention stage data was then collected throughout January 2017.

RESULTS

During the pre-intervention study period, 559 TOE were observed and 284 doses had at least one error. This gives MAE rate of 50.8%, CMA rate of 49.2%. Of the 284 doses with errors, 36 had two types of errors, giving a total of 320 administration errors. Of these 320, 75 (23.4%) errors were intervened. The researcher intervened 46 (61.4%) errors, doctors with nurses intervened 19 (25.3%) errors and patients themselves intervened 10 errors (13.3%). Hence, 28% were near miss and did not reach the patient.

During the post-intervention study period, 468 TOE were observed and 152 doses had at least one error. This gives MAE rate of 32.5%, CMA rate of 67.5%. Of the 152 doses with errors, 35 had two types of errors, giving a total of 187 administration errors. Of these 187, 80 (42.8%) errors were intervened. The researcher intervened 45 (56.0%) errors and doctors with nurses intervened 35 (44.0%) errors. Hence, 42.8% were near miss and did not reach the patient. The results observed are shown in **Table 1**.

Table 1. Statistics on Pre & Post Intervention

Intervention		Pre		Post	
Total Opportunities of Error (TOE)		559		468	
Total Medication Administration Errors (MAE)		284 (50.8%)		152 (32.5%)	
Total Correct Medication Administration (CMA)		49.2%		67.5%	
Types of MAE's					
1	Drug Preparation	93	32.7%	32	21.0%
2	Administration Technique	66	23.2%	56	36.8%
3	Rate	56	19.7%	22	14.5%
4	Deteriorated Drug	33	11.6%	10	6.6%
5	Omission	11	3.8%	6	3.9%
6	Incorrect Drug	3	1.0%	7	4.6%
7	Incorrect Dose	2	0.8%	3	2.0%
8	Incorrect Time	5	1.8%	5	3.3%
9	Unauthorized Drug	9	3.2%	3	2.0%
10	Others	6	2.2%	8	5.3%

DISCUSSION

The pre-intervention MAE rate is 50.8%. Nationally, this figure is relatively higher when compared with other local studies which were conducted in non-military settings. However, this figure is relatively similar to other studies globally [10,11,12]. During the pre-intervention, 23.4% errors were intercepted which the increased to 42.8% during post-intervention. This implies that double checking by an independent person is essential. In this study, the researcher as a pharmacist played a significant role. Some of the errors were also intercepted by the patients themselves and hence, patient education is also important to prevent medication errors.

Initially, the most common error was incorrect drug preparation. Most of the errors made under this category were categorized as grade 2 error, which means the error was minimal but clinical significant towards the patient care. This is followed by incorrect administration technique, incorrect rate error, deteriorated drug error and omission error in decreasing score order. These results were similar to that reported by Wirtz et al. [15]. MAE's such as incorrect drug, incorrect dose, incorrect time, unauthorized drug and others scored lower in comparison. However, errors made under incorrect time and unauthorized drug category were grade 3 errors. This means these errors were definitely clinically significant and could cause patient harm.

Cases of incorrect drug preparations were mostly related to error in reconstitution of dry powder injections. Either the reconstitution is incomplete or wrong due to error in type and volume of diluents. Incorrect administration technique involved mainly the presence of air bubbles in intravenous infusion. Proper methods of preparation and administration of parenteral drugs are important to prevent thrombus formation, hypersensitivity reactions and infections. When inquired, most nurses admit that the common contributing factors were inadequate knowledge and insufficient time to recheck their doubts with guidelines. The researcher observed that guidelines were not readily and widely available for references purposes in the wards. Instead of calling the pharmacy, most nurses verbally refer to each other. This indicates that training in drug administration preparation and technique as well as awareness programs needed to be conducted periodically.

Some infusion pumps did not produce the rate of infusion stated and this led to incorrect rate error. Ward devices such as infusion pumps should be checked and calibrated regularly. This is important as some medications have to be administered over a specific time interval to achieve the optimal therapeutic effect and minimum side-effects. Ward floor stock should be checked regularly to ensure that there is adequate supply and also to detect any expired or deteriorated drugs. Most reconstituted vials for multiple uses were stored in improper conditions [15,16,17].

Cohen [18] reported that documentation of drug administration is one of the contributory factors to administration errors in the ward. This was also observed in this study. Once a dose of the drug has been administered, it must be signed or recorded immediately.

Otherwise, it may be forgotten and the patient may be given another dose. Similarly, recording the administration of drugs before it is given may run the risk of a dose omission if the staff is called off to attend to other duties before the dose is delivered. Although incorrect time errors score was low, however errors made under this category were categorized as grade 3, as these errors mostly involved antibiotics that required close serum concentration monitoring. This type of errors may be an indicator of a system failure. The meal serving time and medication serving time in TMAFH is still not well regulated.

Unauthorized drug errors cases were mostly associated with grade 3 errors as well.

There were cases where the administration of drugs to patients who were fasting for some procedures as the ward staff did not notice the 'fasting' sign. Perhaps, such sign should be more conspicuous so that it would not be missed. Drugs were almost given to the wrong patients. Misreading the medication files was a common cause of errors in this study. The ward management should rearrange patient medication files. The researcher observed that the medical file, clinical observation chart and medication chart for a single patient are always kept separately or mixed up. This creates inconveniences when a dose needs to be administered or a sudden patient review needs to be done. The nurses stated that the contributing factor attributed to is due to heavy workload [19,20,21]. In most hospitals, the scheduled time for drug administration is the busiest time where the nurses have to monitor patients' physical signs and assist the doctors in their ward rounds as well. The drug administration schedule can also be planned such that not all patients take their once daily medications at a fixed time.

Medications that are prescribed as a once daily dose only could be administered during noon or evening time when the staff workload is lighter. For example, certain oral antihypertensive agents show a more sustained and consistent 24 hours mechanism profile which includes greater night time blood pressure (BP) reduction when served evening instead of morning. The nursing staffs are either soldiers or civilians in TMAFH. Military nurses tend to have a larger job scope and more work burden than civilian nurses as they can also be called to assist in military duties. One possible solution is to reshuffle available human resource and accommodate equal ratio of military and nursing staff in wards or higher number of civilians' nurses in wards where the Bed Occupancy Rate (BOR) is higher. The other long term solution is to increase the number of ward staff.

Based on the pre-intervention data and the nurses' feedback, the researcher as a pharmacist developed a quick reference guide for parenteral antibiotics. This was made in a form of a chart and was distributed to all wards in TMAFH. Pharmacist-led educational sessions were conducted to educate the nursing staff on medication safety and the use of reference guide. Post-intervention MAE rate is 32.5%. The CMA increased from 49.2% to 67.5%. Based on a previous study conducted in TMAFH which was to identify the safety culture perceptions, nurses rated teamwork climate as the most important factor in establishing a safe working environment.This relatively suggests that presence of a pharmacist in the ward would definitely assist HCP's to achieve more in terms of medication safety and further increasing the CMA rate [23,24].

A clinical pharmacist may serve as a resourceful person during medical rounds before a doctor prescribes and serve as a safety net in assisting and double checking before a drug is administered by a nurse [25].

This study was one of the first on drug administration errors to be conducted in Malaysian military setting and it serves to open the minds of HCP's and to stimulate further interest and concern in patient safety. In addition, a non-punitive system of reporting medication errors should be established to encourage more comprehensive data to be documented so that HCP's and all military institutions could share and learn from the mistakes of each other, and appropriate measures could be implemented to prevent any future errors.

LIMITATIONS

One of the limitations of the study was that there could be more than one ward staff administering drugs at the same time but there was only one observer, therefore, some drug administrations may have been missed. The researcher also observed based on his convenience to follow medication serving rounds hence the data collected was limited. Only two specific wards were studied and hence may not be representative of all wards in the hospital. The results may also be different between the military hospitals in Malaysia.

CONCLUSION

Military pharmacists have a role in peace time, during operational deployments and in war time. In peace time their principle duties are in the distribution of medical supplies and the provision of pharmaceutical care within Ministry of Defence units and military hospitals. This study indicates that the MAE's in a Malaysian military hospital maybe significantly higher when compared to other studies. However, the CMA rates can be further increased with the presence of military pharmacists participating actively in clinical decisions. Future strategies should be implemented to further reduce MAEs for all class of medications. This includes regular updates of reference guide, continuing joint education programs between prescriber, pharmacists and nurses on medication safety besides conducting periodic audits on medication administration to identify areas that require remedial actions.

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