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Errors in the administration of intravenous medication in Brazilian hospitals

Maria Luiza Anselmi PhD, RN
Associate Professor, University of São Paulo at Ribeirão Preto College of Nursing, WHO Collaborating Centre for Nursing Research Development, Ribeirão Preto, SP, Brazil

Marina Peduzzi PhD, RN
Faculty, University of São Paulo College of Nursing, São Paulo, SP, Brazil

Claudia Benedita dos Santos PhD
Statistician, Faculty, University of São Paulo at Ribeirão Preto College of Nursing, WHO Collaborating Centre for Nursing Research Development, Ribeirão Preto, SP, Brazil

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Correspondence:
Maria Luiza Anselmi
University of São Paulo at Ribeirão Preto
College of Nursing
WHO Collaborating Centre for Nursing
Research Development
Rua Manoel Ache, 920/1403
Ribeirão Preto, SP
Brazil
Telephone: +55 16 36023398
E-mail: anselmi@eerp.usp.br

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Aim. To verify the frequency of errors in the preparation and administration of intravenous medication in three Brazilian hospitals in the State of Bahia.

Background. The administration of intravenous medications constitutes a central activity in Brazilian nursing. Errors in performing this activity may result in irreparable damage to patients and may compromise the quality of care.

Design. Cross-sectional study, conducted in three hospitals in the State of Bahia, Brazil.

Methods. Direct observation of the nursing staff (nurse technicians, auxiliary nurses and nurse attendants), preparing and administering intravenous medication.

Results. When preparing medication, wrong patient error did not occur in any of the three hospitals, whereas omission dose was the most frequent error in all study sites. When administering medication, the most frequent errors in the three hospitals were wrong dose and omission dose.

Conclusions. The rates of error found are considered low compared with similar studies. The most frequent types of errors were wrong dose and omission dose. The hospitals studied showed different results with the smallest rates of errors occurring in hospital 1 that presented the best working conditions.

Relevance to clinical practice. Studies such as this one have the potential to improve the quality of care.

Key words: intravenous, medication errors, nurses, nursing, observation errors

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Introduction

In Brazil, the nursing workforce historically consists of workers with distinct professional qualifications: nurses with university degrees; auxiliary nurses with primary education and a one-year technical nursing course; nurse technicians, with secondary education and a two-year technical nursing course; nurse attendants, who only need basic reading and writing skills and receive in-service training. In 2002, the nursing workforce included: 70,175 (13%) nurses; 49,604 (9·2%) nurse technicians; 339,766 (62·7%) auxiliary nurses; 82,040 (15·1%) nurse attendants or workers with other denominations and without any training for nursing work (Brasil 2002).

Brazilian nurses indicate that their activities are mainly administrative (planning, supervision, control, evaluation and continuing education) rather than direct patient care. Nursing procedures like medication administration and wound dressing have been mainly exercised by auxiliaries, technicians and nurse attendants.

The discussion and formulation of public policies for education and human resource development in this field have gained strength since 1986, when Law 7498/86 was implemented (Brasil 1986), regulating professional activities and even more through the implementation of the *Sistema Único de Saúde* (*SUS*) [Single Health System] in 1990.

In 2000, the *Projeto de Profissionalização dos Trabalhadores da Área de Enfermagem* [Professionalization of Workers in the Area of Nursing Project] (*PROFAE*) was implemented by the Ministry of Health, with international financial support. It covered approximately 5505 municipalities throughout the country. It aimed to professionalize 225 000 nursing workers without any formal technical qualification (nursing attendants and similar denominations), as well as to supplement the education of 90 000 auxiliary nurses, transforming them into nursing technicians and to give pedagogical preparation to 12 000 nurses, to teach in these courses (Brasil 2001, Baraldi 2005).

The existence of a large contingent of workers with no formal technical qualification was considered a potential source of risk for patients submitted to countless care procedures in the health services (Sório 2002). The professionalization project was expected to improve nursing personnel's performance both in terms of technical interventions, including medication administration, patient communication and team work, so as to contribute to the achievement of the services' objectives, particularly health-care quality.

Background

The medication administration process has become an important issue in hospitals. Although it benefits patients, it also represents a source of potential risks. The characteristics of this process (complexity of the procedures, multiplicity of professionals and services involved, rapid introduction of new drugs, diagnostic and therapeutic technologies, etc.) frequently provoke errors that jeopardize care security and quality, generating an increase in costs as well (Pepper 1995, Dean 1999, Greengold *et al.* 2003, Taxis & Barber 2003a).

According to the National Coordinating Council for Medication Error Reporting and Prevention (NCCMERP, 2001), medication error is '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. Such events may be related to professional practice, health-care products, procedures and systems, including prescribing; order communication; product labelling, packaging and nomenclature; compounding; dispensing; distribution; administration; education; monitoring; and use' (http://www.nccmerp.org/aboutMedErrors.html).

Observational studies approach this theme from different perspectives and methodologies, attempting to comprehend and evaluate medication errors (rates, types, causes and risk factors) as well as to propose security measures to prevent errors (Barker *et al.* 2002, Pepper 2004, Lisby *et al.* 2005). Research about the incidence of medication errors has pointed out that error rates are high (O'Hare *et al.* 1995, Cousins *et al.* 2005). A study in 36 North American hospitals found that 19% of the administered doses presented errors, 43% of which were related to administration time, 30% to omitted doses and 17% to wrong dose errors (Barker *et al.* 2002); in clinical and surgical units in a Danish hospital, of 2467 administered medication doses, 43% presented errors (Lisby *et al.* 2005). Studies indicate a series of risk factors, including: knowledge and training in medication administration procedures; workload and staffing levels; quality of prescriptions, etc. (O'Shea 1999, Tissot *et al.* 1999, Taxis & Barber 2003a,b). The quality of the medication administration process is also influenced by work conditions, supervision, existence of continuing education programmes and professional qualification of the nursing team.

In health-care systems, the medication administration process and particularly intravenous therapy, represent a complex technology and can be defined as a drug directly injected into the patient by means of peripheral venipuncture, which includes the preparation of the drug (Wirtz *et al.*

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2003). Errors in intravenous medication administration may cause irreparable harm to patients and generate interventions that increase costs and compromise care quality (Taxis & Barber 2003a,b, Armitage 2005, Han *et al.* 2005). According to a study in 10 units of a British hospital, errors occurred in 7% of the prepared doses and in 36% of administered doses (Taxis & Barber 2003b). A high incidence of errors related to intravenous therapy was found in a German hospital, where 19% of errors occurred during medication preparation and 23% during administration (Taxis & Barber 2004). Research conducted in UK and German hospitals verified error rates of 26% and 34%, respectively, in the preparation of 337 intravenous medication doses and administration of 278 doses (Wirtz *et al.* 2003). Some authors analyse errors in intravenous therapy without differentiating the preparation and administration phases (O'Hare *et al.* 1995, Han *et al.* 2005); others, although identifying the error rates of each of these phases, do not classify the types of errors according to each phase (Taxis & Barber 2003a, 2004). Two studies indicate rates according to types of errors found in preparing and administering medication (Taxis & Barber 2003b, Wirtz *et al.* 2003).

Intravenous medication administration represents a central activity in the nursing work process. In Brazil, this task is mainly performed by auxiliary nurses and nurse technicians, but also undertaken by nursing attendants in many services. It entails a set of technical and scientific information originating from pharmacology, physiology and biochemistry among others, as well as certain abilities related to medication administration methods and techniques. Therefore, this activity is expected to result in potential benefits to patients and, hence, error rates of zero or almost zero are supposed (Cooper 1995, Bueno *et al.* 1998).

In Brazilian literature, the first studies on medication errors were published at the end of the 1990s. Identification of the occurrence of errors, obtained through questionnaires/interviews with nursing personnel or by consulting error notification reports, indicates that this event is very frequent in Brazilian health services (Bueno *et al.* 1998, Carvalho *et al.* 1999). Studies concerning medication errors based on direct observation of workers' performance were not identified. This article presents the partial results of the first Brazilian study on this theme, using direct observation. It was conducted with support from the Ministry of Health (Peduzzi & Anselmi 2004).

The different phases (prescription, transcription, dispensation, preparation and administration) of medication administration occur in an articulated manner and involve different professionals (physician, pharmacist, nurses, auxiliaries, technicians and nursing attendants).

Medication preparation is the phase in which the nursing professional, based on the medical prescription, separates, organizes and prepares the medications the patients in the work unit will receive. This phase involves: reading the medical prescription; separating the medication(s) for each patient, respecting the prescribed dosage, the application mode and the preparation itself.

Medication administration is the phase in which the nursing professional administers the previously prepared medications to the patients in the work unit. It is considered that the medication has been applied once the patient has effectively taken/ingested/received the drug.

Based on the premise that knowledge and technical ability of nursing personnel constitute important elements in determining the quality of performance, this study investigated errors in the administration of intravenous medication in hospitals whose workers had taken the previously mentioned PROFAE professionalization course, promoted by the Ministry of Health.

Aim of the study

This study aimed to determine the frequency of intravenous medication preparation and administration errors in three Brazilian hospitals.

Methods

Design and setting

This is a cross-sectional study, undertaken in three hospitals in the State of Bahia, Brazil, between 21 October–7 December 2002. All services had nursing personnel (auxiliary nurses, nursing attendants and nurse technicians) who had participated in the PROFAE training courses.

The hospitals (1, 2 and 3) had the following inclusion criteria: they had a contingent of 10 or more nursing professionals without any previous formal technical and regular nursing qualification, participating in the PROFAE, who were responsible for administering medications; expeditious geographical access and willingness of the hospital to provide information and collaborate with the research.

Hospital 1 is located in a municipality with more than 250,000 inhabitants. In 2002, there were a total of 10,086 hospital admissions in the 166 available hospital beds, which represented an 80·4% occupancy rate. There were 171 nursing professionals in this hospital (41 nursing attendants, 97 auxiliary nurses, 22 nurse technicians, 11 nurses). This roster represents, respectively, 34·8% and 62·1% of the estimated demand for nurses and auxiliary nurses/nurse

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technicians. The practice of sharing nursing supervisory responsibilities among nurses, technicians and auxiliaries was identified. However, continuing education was not being undertaken.

The municipality in which hospital 2 is situated had over 20,000 inhabitants. This hospital had 73 beds and, in 2002, there were a total of 1512 hospital admissions, with a 25·6% occupancy rate. There were 25 nursing professionals (nine attendants, 15 auxiliary nurses and one nurse). This roster represented, respectively, 20% and 62·5% of the estimated demand of nurses and auxiliary nurses. An auxiliary nurse was responsible for coordinating the nursing work when data were being collected for this study. No supervisory or continuing education activity was observed or mentioned during field work for this study.

Hospital 3 is situated in a municipality with over 70,000 inhabitants. This hospital had 225 beds and in 2002, there were 12,163 admissions with a 69·9% occupancy rate. The nursing staff was composed of 180 workers (47 attendants, 76 auxiliaries, 52 technicians and five nurses). This roster represented, respectively, 14% and 69·2% of the estimated demand for nurses and auxiliaries/technicians. Neither supervision nor continuing education was observed at this hospital.

Definition of intravenous medication error

Intravenous medication error was defined as a dose prepared and/or administered by nursing personnel different than that prescribed by the physician and on the patient's records. (Allan & Barker 1990, Wirtz *et al.* 2003, Cousins *et al.* 2005). The three study hospitals used the traditional medication distribution system (Tissot *et al.* 2003).

Four types of errors traditionally referred to in the literature and called typical errors here were selected for verification (Allan & Barker 1990, Barker *et al.* 2002, Han *et al.* 2005): wrong patient: preparation/administration of a dose of intravenous medication to another patient for whom it was not prescribed; wrong drug: the preparation or administration of a drug which was not the prescribed one; wrong dose: the preparation or administration of an amount of drug greater or smaller than that prescribed; omission dose: failure to administer a prescribed dose during the observation time.

The dose prepared and/or administered constitutes an opportunity to incur in error and each of these was considered a unit of analysis (Allan & Barker 1990). For each dose, only two mutually exclusive situations are verifiable: correct or incorrect. The total number of opportunities for error represents the sum of all prepared and/or administered doses, plus all doses omitted during preparation or application.

Study participants

A previous study investigated the relation between technical qualification of nursing personnel and care quality in three Brazilian hospitals (Peduzzi & Anselmi 2004) and considered professionals' performance with respect to some nursing procedures, including medication administration. The result obtained indicated that, for the three professional categories being studied (attendants, auxiliary nurses and nurse technicians), there were no statistically significant differences with respect to performance. Based on these results, the subjects selected for this study are the same as those who participated in the above-mentioned study and worked in different units (internal medicine, surgery, obstetrics, paediatrics and emergency) at the study hospitals.

A convenience sample was used given financial and operational limitations for data collection. The maximum amount of workers to be observed within each professional category was 15, with a 30% safety margin, resulting in 21 subjects per professional category, per hospital. In those hospitals where the number of workers in a given professional category was fewer than 21, all workers were considered. In those hospitals with more than 21 workers in a given category, sample members were drawn in a raffle. Forty-nine nursing professionals were originally included in the sample in hospital 1; 24 in hospital 2 and 73 in hospital 3. However, there were sample losses because of either professional's refusal to participate or the fact that they were not working at the hospital during the study period for various reasons (vacation, leave of absence, or because they were no longer employed there). The final samples in each hospital were composed as follows: at hospital 1, there were 13 nurse attendants, 19 auxiliary nurses and 12 nurse technicians; at hospital 2, eight nurse attendants and 12 auxiliary nurses; at hospital 3, 28 nurse attendants, 13 auxiliary nurses and 15 nurse technicians. The study objectives and data collection technique were presented to all subjects, who were asked to sign a consent term.

Data collection

Due to the reliability and fidelity that it presents, direct individual observation of the worker during the administration of intravenous medication was the technique used in collecting data for this study (Allan & Barker 1990, Barker *et al.* 2002, Flynn *et al.* 2002).

Once a week, the observer consulted the weekly working schedule of the nursing staff and verified the respective work hours of the professionals included in the sample. The observer elaborated a list of the subjects that would be

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observed each day that week. On the scheduled day, the observer arrived at the work unit and informed the worker, who had already agreed to participate, that the observer would be accompanying his/her activities that day. The presence of the observer may interfere with the performance of the worker; however, it is understood that the presence of the observer in the study unit for a long period (35 days) minimizes this possible source of bias. Furthermore, discrete attitudes on the part of the observer may also contribute to maintaining the observed subject's habitual pattern of work and, in this way, not modify the occurrence of errors (Dean & Barker 2001, Barker *et al*. 2002).

Direct observation in this study includes: the previous consultation of the medical prescription and transcription of the intravenous doses to be observed on the form used for the collection of data; the observation itself of the worker's performance with respect to both the preparation and administration of medication, verifying the following aspects: name of the patient, name of the medication, dose and route of administration. The observers were also instructed to intervene vis-á-vis the observed subject when they detected an imminent error so as to impede patient injury. The error was registered even though it had not actually occurred. In this manner, this study sought to respect the ethical principals of research. At least three observations were conducted with each subject.

The data collection instrument was elaborated on the basis of literature (Cassiani 2000) and divided into two parts:

1 Identification of unit, observed worker, number of doses prescribed, prepared and administered intravenously, date and time of observation, name of observer.
2 Checklist with error types and the number of doses, on which the observer ticked the dose number and the type(s) of error(s) observed. The observer used one checklist for the preparation phase and another, with identical contents, for the medication administration phase.

Considering that the organization of work in the hospitals studied was predominantly functional, the two moments of the process of administering medication (preparation and administration) were taken as independent events and data were collected with distinct instruments, as in several situations, it was not always the same participant who was responsible for carrying out the entire process.

Observation took place from 21 October to 7 December 2002, except for Saturdays and Sundays, summing up to 35 days during the periods of the day when the administration of medications occurred most frequently, that is, between 8 and 10 AM, 11 and 12 AM and 4 and 6 PM.

The data collection instrument was tested and validated in a pilot study, undertaken in the year 2000 at an Outpatient Reference Center and at a General Hospital (surgical clinic and intensive care centre) in the State of Espírito Santo, site where the first PROFAE professionalization courses were implemented.

Considering that the three study hospitals were situated in different regions in the State of Bahia, a research team was composed for each of these sites. In hospitals 1 and 3, the research team was composed of one supervisor and six observers; in hospital 2, the research team was composed of a one supervisor and two observers. The supervisor was a nurse, with experience in field research; the observers were also nurses or nursing students in the last semester of their undergraduate studies who had mastered the process of administration of medications. Supervisors and observers were submitted to training to guarantee the standardization of data collection.

The need to standardize field workers' performance refers to establishing uniformity in the procedures involved in observation, constructing consensus by attempting to reach the highest possible level of agreement during the training period. This process may minimize the information bias, for, although the option for the technique of direct observation may avoid the larger part of foreseen biases in the collection of data, it creates other types of biases, among which, the bias of the difference among observers and the possibility of underestimating errors depending upon the degree of knowledge of the observer, as well as his/her technical, scientific and other beliefs.

Theoretical and practical training was conducted with the supervisors initially in a teaching hospital. The contents addressed included: the concept of medication errors, types of errors, ways of approaching the person being observed and the presentation, orientation and discussion of the research instrument; this was followed by direct observation in different inpatient units of the preparation and administration of medications and registration in the instrument, simulating the process of data collection. The results obtained were compared and the divergences were analysed and elucidated until a consensus was obtained among the observers. These were considered standardized with respect to completing the forms at the moment in which a level of agreement of over 90% was attained, thus assuring the reliability of the process of data collection.

Besides the pretest, the pilot study and the training of supervisors and observers, another measure taken to control the information bias, was the elaboration of a guide that gave detailed instructions on how to fill out each field in the form used to collect data.

Monitoring of data collection occurred in two distinct phases. The first phase was undertaken daily by the

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supervisor, who checked how the forms were completed and codified the replies, based on the codifying manual, previously elaborated. The second monitoring phase was conducted by the investigators responsible for this study.

The research project was approved by the *Comitê de Ética em Pesquisa da Escola de Enfermagem da Universidade de São Paulo* [Research Ethics Committee of the University of São Paulo Nursing School]. Authorization for conducting this research was obtained from the hospital directory and all the observed subjects signed an informed consent form. Both the institutions and professionals involved were guaranteed anonymity.

Data analysis

Data were coded and stored in a FOX-PRO formatted data bank and processed by the Statistical Package for the Social Sciences 10·0 (SPSS Inc., Chicago, IL, 1999) software program.

The rate of intravenous medication errors was calculated for each of the instances of dose preparation, as a percentage, dividing the sum of all the doses prepared/administered in which an error was detected, by the sum of all the observed doses prepared and administered and the doses omitted (Allan & Barker 1990, Flynn *et al.* 2002).

Confidence intervals with a 5% descriptive level of significance were obtained for rates of errors in the preparation and administration of the medication. These intervals were not used for comparing the values among the three hospitals, as this was not the aim of this study. They were used to estimate, with a 95% probability, the minimum and maximum values for the rates of errors.

Results

In the three hospitals studied, the preparation of 1391 doses of medication, including those doses omitted, was observed, being 804 (57·8%) in hospital 1; 100 (7·2%) in hospital 2 and 487 (35%) in hospital 3. The administration of 1315 doses of medication was observed, being 753 (57·3%) in hospital 1; 91 (6·9%) in hospital 2 and 471 (35·8%) in hospital 3.

Considering the number of doses observed in each hospital, in hospital 1, there was an estimation error of 1·7 for the preparation phase and of 1·1 for the administration; as to hospital 2, there was an estimation error of 6·6 for the preparation and of 4·2 for the administration phase; and, as to hospital 3, there was an estimation error of 2·7 for the preparation and of 2·6 for the administration.

Table 1 indicates the distribution among the hospitals investigated, of the doses observed, the number and mean rate of errors and the respective confidence interval (95%). Hospital 2 had the greatest rate of errors in the preparation of the medications (error rate 13%; 95% confidence interval 6·4–19·6%), in the administration, the largest rate of errors occurred in hospital 3 (error rate 9·3%; 95% confidence interval 6·7–12·0%). In both phases, hospital 1 had the lowest rates of error.

The types of error (%) observed in the preparation and administration of medications are presented in Figs 1 and 2.

In the preparation of the intravenous medications there were no *wrong patient* errors in any of the three hospitals; wrong drug error was observed only in hospital 3; wrong dose occurred in all three hospitals, with the greatest percentage of errors occurring in hospital 3; omission dose was the most frequent error in hospitals 1 and 2 (Fig. 1).

As to the administration of intravenous medication, wrong dose presents the greatest percentage of errors in all three hospitals; omission doses occurred in greater percentage in hospital 3 (Fig. 2).

Discussion

Literature indicates a wide range of results obtained from observational studies about errors in intravenous medications. Taxis and Barber (2004) found a global error rate (preparation and administration) of 48% in intravenous medications, being 19% in the preparation phase and 23% in the administration; in another study on intravenous drug errors, these same authors found a 49% global rate of errors and a 7% and 36% rate of errors, respectively, in the preparation and administration of medications (Taxis and

Table 1 Doses, errors, mean rate of error and 95% CI in the preparation and administration of intravenous medications, according to the hospitals investigated, Bahia – Brazil: 2002

Hospital	Doses of observed preparation (*n*)	Preparation errors (%)*	95% CI	Doses of observed administration (*n*)	Administration errors (%)*	95% CI
1	804	54 (6·7)	5·0–8·4	753	18 (2·4)	1·3–3·5
2	100	13 (13)	6·4–19·6	91	4 (4·4)	0·2–8·6
3	487	51 (10·5)	7·8–13·2	471	44 (9·3)	6·7–11·9

*Valid for: wrong patient, wrong drug, wrong dose and omission dose.

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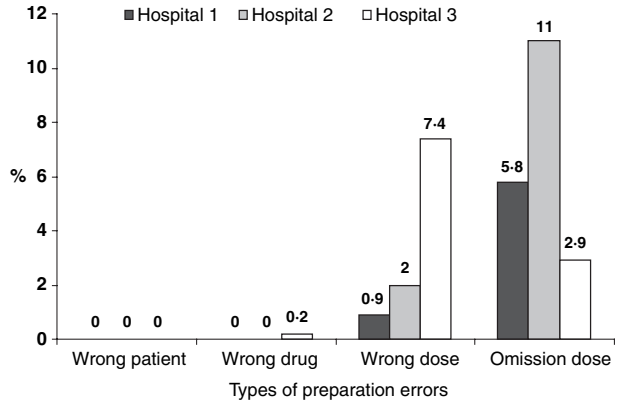

Figure 1 Percentage of errors in the preparation of intravenous medications. Hospital 1 ($n = 804$); hospital 2 ($n = 100$); hospital 3 ($n = 487$). Bahia – Brazil: 2002.

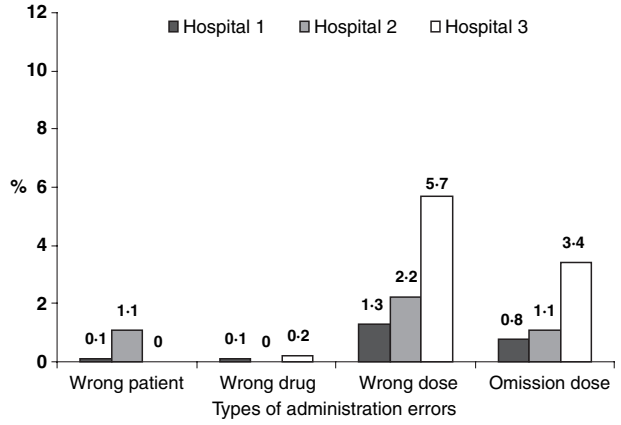

Figure 2 Percentage of errors in the administration of intravenous medications. Hospital 1 ($n = 753$); hospital 2 ($n = 91$); hospital 3 ($n = 471$). Bahia – Brazil: 2002.

Barber 2003a,b). Wirtz *et al.* (2003) identified, in three hospitals, the following rates of errors: in the preparation of medication, 22%, 23% and 31%; in the administration, 27%, 49% and 22%. The rates of errors presented refer to all types of errors observed, differentiating the methodology adopted in that study form which limited itself to verifying specific typical errors: wrong patient, wrong drug, wrong dose and omission dose.

Wirtz *et al.* (2003) verified that the most frequent medication preparation errors at the three hospitals studied were wrong dose and omission dose. In one of these hospitals, wrong dose presented a 21% rate of error; in another the omission dose was 20%. The most common error in the administration of medication was wrong rate of administration. These percentages are higher than those identified in this study. In the three Brazilian hospitals, the rate of wrong dose in the preparation of medication varied between 0·9% and 7·4%; and the rate of omission dose varied from 2·9% to 11%. In medication administration, wrong dose was the most frequent error.

Han *et al.* (2005) identified, in three surgical units of a hospital in Australia, a 11·9% rate of omission dose and a 1·6% rate of wrong patient. However, the study does not mention whether these errors occurred during the preparation or administration of medications.

Cousins *et al.* (2005), studying the errors in the preparation and administration of intravenous therapy in four UK general hospitals, three units of one hospital in Germany and one hospital department in France, found rates of errors with respect to omission doses, of 29% within the units in Germany, 8% in France and 0% in the UK; for wrong dose errors the results were, 1%, 2% and 5% respectively. However, these rates refer to the global process of administration of medications.

When comparing the results of this study to those above, it must be taken into consideration that, although the subject is the same, the contexts, in terms of both the countries and the hospitals in which observation took place, are very different.

The results of the study indicate differentiated trends in the rates of errors among the three hospitals. In hospital 1, lower mean rates of error occur in both the preparation and administration of intravenous medications than in the other two hospitals. Lower percentages of the four types of errors analysed were also found in this hospital compared with both other hospitals. The only exception was the rates of omission dose error during the preparation of intravenous medication, in which case, hospital 3 exhibited lower rates of error.

In the three Brazilian hospitals investigated, the most frequent error in the preparation of intravenous medication was omission dose in hospital 2 and in hospital 1, whereas wrong dose occurred more frequently in hospital 3; in the phase of intravenous medication administration, hospital 3 presented the highest percentage of wrong dose and omission dose errors.

The performance of the nursing staff in the preparation and administration of medications indicates low mean rates of error compared with the literature; however, the types of errors analysed may bring about immediate consequences to the patient including irreparable injuries. The omission doses may also delay the effects of the patient's treatment, implying in a longer hospital stay.

Errors in medication have multiple causes and, therefore, cannot be attributed only and exclusively to the agents that conduct this activity. The influence of working conditions in the occurrence of these errors must be stressed. Although all three hospitals present a scarcity of human resources in

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nursing, hospital 1 is more adequately staffed (Peduzzi & Anselmi 2004).

The presence of an insufficient number of nursing personnel in the three hospitals frequently entails the extension of working hours and, consequently, workload and dissatisfaction on the part of the professionals. These aspects have been pointed out as aspects influencing the rate of medication errors (O'Shea 1999).

In the three hospitals investigated, supervisory and continued education activities were seriously jeopardized. Hospital 1 could be considered an exception insofar as supervisory activities were concerned, for the practice of shared supervision between nurses, auxiliary nurses and nurse technicians was observed (Peduzzi & Anselmi 2004).

Hongoro and McPake (2004) point out the important contribution of auxiliary workers in the promotion and protection of health in poor countries and in those that are developing and the need to study and document the activities that these workers are capable of executing. In this sense, investigations concerning the roles played by these workers in the administration of medications and the ways in which to improve their training to undertake these tasks are considered pertinent. The possibility of reproducing the research design utilized in this study in other health services in Brazil represents another contribution of the present investigation.

Conclusions

This study made it possible to measure, by means of direct observation, the occurrence of errors in the administration of intravenous medications conducted by nursing personnel. The mean rates of errors found are considered low when compared with those of similar studies. The most frequent types of errors were wrong dose and omission dose. There were differences among the hospitals studied, with lower rates of errors in both phases in hospital 1, which presents better working conditions with respect to both the personnel employed and the existence of nursing supervision.

The principal limitation of this investigation is the wide range of variation in the number of doses observed in each hospital, for it was not possible to expand the period of observation because of operational restrictions. The structural differences between services, particularly with respect to the number of hospital beds, the rate of occupancy and the roster of nursing personnel must also be pointed out.

The lack of national observational studies on rates of errors in medication as well as the differences between the results of this study and the few international studies that analyse the rates of error in the preparation and administration of medications separately reinforce the need to produce investigations with direct observation on rates of medication error with the objective of establishing parameters for Brazilian nursing practice to increase the quality of care and the safety of the patient.

Contributions

Study design: MLA, MP, CBS; data collection: MLA, MP; data analysis: MLA, MP, CBS; manuscript preparation: MLA, MP.

References

Allan EL & Barker KN (1990) Fundamentals of medication error research. *American Journal of Hospital Pharmacy* **47**, 555–571.

Armitage G (2005) Drug errors, qualitative research and some reflections on ethics. *Journal of Clinical Nursing* **14**, 869–875.

Baraldi S (2005) *Supervisão, Flexibilização e desregulamentação no mercado de trabalho: antigos modos de controle, novas incertezas nos vínculos de trabalho da enfermagem*. Tese, Escola de Enfermagem/USP, São Paulo, SP.

Barker KN, Flynn EA, Pepper GA, Bates DW & Mikeal RL (2002) Medication errors observed in 36 health care facilities. *Archives Internal Medicine* **48**, 1931–1937.

Brasil (1986) *Lei n. 7.498, de 24 de junho de 1986. Dispõe sobre a regulamentação do exercício da enfermagem e dá outras providências*. Diário Oficial da República Federativa do Brasil, Brasília, 26 de junho 1986. Seção 1, 1.

Brasil (2001) Secretaria de Gestão de Investimento em Saúde. Projeto de Profissionalização de Trabalhadores da Área de Enfermagem (PROFAE). *Revista Formação* **1**, 7–12.

Brasil (2002) *Anuário estatístico de saúde do Brasil*. Ministério da Saúde, Departamento de Informática do SUS, Fundação SEADE, Ministério da Saúde I, Brasília, pp. 289–290.

Bueno E, Cassiani SHB & Miquelin JL (1998) Erros na administração de medicamentos: fatores de risco e medidas empregadas. *Revista Baiana de Enfermagem* **11**, 101–119.

Carvalho VT, Cassiani SHB, Chiericato C & Miasso AI (1999) Erros mais comuns e fatores de risco na administração de medicamentos em unidades básicas de saúde. *Revista Latino-am Enfermagem* **7**, 67–75.

Cassiani SHB (2000) *Administração de medicamentos*. EPU Editora, São Paulo.

Cooper MC (1995) Can a zero defects philosophy be applied to drug errors? *Journal of Advanced Nursing* **21**, 487–491.

Cousins DH, Sabatier B, Begue D, Schmitt C & Hoppe-Tichy T (2005) Medication errors in intravenous drug preparation and administration; a multicentre audit in the UK, Germany and France. *Quality and Safety in Health Care* **14**, 190–195.

Dean B (1999) Errors in medication administration. *Intensive Care Medicine* **25**, 341–342.

Dean B & Barker N (2001) Validity and reliability of observational methods for studying medication administration errors. *American Journal of Health System Pharmacy* **58**, 54–59.

Flynn EA, Barker KN, Pepper GA, Bates DW & Mikeal RL (2002) Comparison of methods for detecting medication errors in 36

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hospitals and skilled-nursing facilities. *American Journal of Health System Pharmacy* **59**, 436–446.

Greengold NL, Shane R, Schneider P, Flynn E, Elashoff J, Hoying CL, Barker K & Bolton LB (2003) The impact of dedicated medication nurses on the medication administration error rate. *Archives Internal Medicine* **163**, 2359–2367.

Han PY, Coombes ID & Green B (2005) Factors predictive of intravenous fluid administration errors in Australian surgical care wards. *Quality and Safety in Health Care* **14**, 179–184.

Hongoro C & McPake B (2004) How to bridge the gap in human resources of health. *Lancet* **364**, 1451–1456.

Lisby M, Nielsen LP & Mainz J (2005) Errors in the medication process: frequency, type and potential. *International Journal for Quality in Health Care* **17**, 15–22.

National Coordinating Council for Medication Error Reporting and Prevention: (NCCMERP) (2001) *Taxonomy of Medication Errors*. United States Pharmacopoeia, Rockville. Available at: http://nccmerp.org/aboutMedErrors.html (accessed 28 November 2005).

O'Hare WCB, Bradley AM, Gallagher T & Shields MD (1995) Errors in administration of intravenous drugs. *British Medicine Journal* **10**, 1536–1537.

O'Shea E (1999) Factors contributing to medication errors: a literature review. *Journal of Clinical Nursing* **8**, 496–504.

Peduzzi M & Anselmi ML (2004) *Relatório de Pesquisa Final: Avaliação do impacto do PROFAE na qualidade dos serviços de saúde. São Paulo*. Ministério da Saúde/Universidade de São Paulo, Escola de Enfermagem de São Paulo, Escola de Enfermagem de Ribeirão Preto.

Pepper G (1995) Errors in drug administration by nurses: from understanding and preventing drug misadventures. *American Journal of Health System Pharmacy* **52**, 385–390.

Pepper G (2004) Pesquisas em segurança na administração de medicamentos. In *A segurança dos pacientes na utilização da medicação*. (Cassiani SHDB ed.). Artes Médicas, São Paulo, pp. 93–109.

Sório RER (2002) Inovações no campo da gestão de projetos sociais: uma reflexão à luz da experiência do PROFAE. In *PROFAE: Educação profissional em saúde e cidadania*. (Castro JL ed.) Ministério da Saúde, Brasília, pp. 17–29.

SPSS 10.0 (1999) *Statistical Program for Social Sciences*, versão 10.0 Base 10.0. User's Guide Copyright by SPSS Inc., Chicago, IL.

Taxis K & Barber N (2003a) Causes of intravenous medication errors: an ethnographic study. *Quality and Safety in Health Care* **12**, 343–348.

Taxis K & Barber N (2003b) *Ethnographic Study of Incidence and Severity of Intravenous Drug Errors*. Available at: http://bmj.com (accessed 16 November 2005).

Taxis K & Barber N (2004) Incidence and severity of intravenous drug errors in a German hospital. *European Journal of Clinical Pharmacology* **59**, 815–817.

Tissot E, Cornette C, Demoly P, Jacquet M, Barale E & Capellier G (1999) Medication errors at the administration stage in an intensive care unit. *Intensive Care Medicine* **25**, 353–359.

Tissot E, Cornette C, Limat S, Mourand JL, Becker M, Etievent JP, Dupond JL, Jacquet M & Lemsi-Woronoff MC (2003) Observational study of potential risk factors of medication administration errors. *Pharmacy World and Science* **25**, 264–268.

Wirtz V, Taxis K & Barber ND (2003) An observational study of intravenous medication errors in the United Kingdom and in Germany. *Pharmacy World and Science* **25**, 104–111.

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