RISK FACTORS FOR THE OCCURRENCE OF ERRORS IN THE PREPARATION OF INTRAVENOUS MEDICATIONS: AN INTEGRATIVE REVIEW

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ABSTRACT: This study aimed to identify and analyze the risk factors for the occurrence of errors in the preparation of intravenous medications by nurses, and to propose a checklist in order to promote greater safety in the preparation. A total of 13 articles were selected from the LILACS, BDENF, SciELO and MEDLINE/PUBMED databases, published in the period 2004 – 2013. Four main categories stood out: psychological factors and work overload, errors related to the preparation environment, lack of updating in health education, and errors related to the preparation technique. It is concluded that the preparation technique was the most-mentioned risk factor in the studies, followed by the categories of lack of updating in health and education, preparation environment, and work overload associated with psychological factors. Based in the difficulties identified in the categories found, a checklist was developed related to the preparation technique, with a view to minimizing errors and ensuring quality of care and patient safety.
DESCRIPTORS: Nursing; Medication errors; Risk factors.

FATORES DE RISCO PARA OCORRÊNCIA DE ERRO NO PREPARO DE MEDICAMENTOS ENDOVENOSOS: UMA REVISÃO INTEGRATIVA

RESUMO: Estudo cujo objetivo foi identificar e analisar os fatores de risco para a ocorrência de erros no preparo de medicamentos endovenosos pela enfermagem e propor um *checklist* para promover maior segurança no preparo. Foram selecionados treze artigos das bases de dados LILACS, BDENF, SciELO e MEDLINE/PUBMED entre os períodos de 2004 a 2013. Destacaram-se quatro principais categorias: fatores psicológicos e sobrecarga de trabalho, erros relacionados ao ambiente de preparo, *déficit* de atualização em educação em saúde e erros relacionados à técnicade preparo. Conclui-se que a técnica de preparo foi o fator de risco mais citado nos estudos, seguido das categorias *déficit* de atualização em educação e saúde, ambientes de preparo e sobrecarga de trabalho associada a fatores psicológicos. Baseado nas dificuldades identificadas nas categorias encontradas foi elaborado um *checklist* relacionado à técnica de preparo, visando minimizar erros e garantir a qualidade da assistência e segurança do paciente.
DESCRITORES: Enfermagem; Erros de medicação; Fatores de risco.

FACTORES DE RIESGO PARA OCURRENCIA DE ERRORES EN LA PREPARACIÓN DE MEDICAMENTOS ENDOVENOSOS: UNA REVISIÓN INTEGRATIVA

RESUMEN: Estudio cuyo objetivo fue identificar y analizar los factores de riesgo para la ocurrencia de errores en la preparación de medicamentos endovenosos por la enfermería y proponer un checklist para promover más seguridad en esa preparación. Fueron seleccionados trece artículos de las bases de datos LILACS, BDENF, SciELO y MEDLINE/PUBMED entre los periodos de 2004 a 2013. Se destacaron cuatro principales categorías: factores psicológicos y sobrecarga de trabajo, errores asociados al ambiente de preparación, déficit de actualización en educación en salud y errores referentes a la técnica de preparación. Se concluye que la técnica de preparación fue el factor de riesgo más mencionado en los estudios, seguido de las categorías déficit de actualización en educación y salud, ambientes de preparación y sobrecarga de trabajo asociada a factores psicológicos. Con base en las dificultades identificadas en las categorías halladas, fue elaborado un checklist para la técnica de preparación, con la finalidad de minimizar errores y garantizar la cualidad de la asistencia y seguridad del paciente.
DESCRIPTORES: Enfermería; Errores de medicación; Factores de riesgo.

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INTRODUCTION

It is currently estimated that approximately 30% of harm to patients during the inpatient treatment is associated with medication errors, bringing serious economic consequences to the health institutions[1]. The American Society of Health-System Pharmacists (ASHP) classifies medication errors, according to their nature, in 12 types. Among these is error in preparation of medications[2].

The Brazilian National Health Surveillance Agency (ANVISA, in Portuguese), in Collegiate Directive Resolution (RDC, in Portuguese) N. 45[3], defined preparation as the act of mixing medications for intravenous use, using techniques which ensure their microbiological integrity and physical-chemical balance. This same resolution indicates the nurse as one of the professionals responsible for the preparation of these solutions administered intravenously.

Intravenous medications are much used, and present great potential for harming the patient; due to this fact, medication errors using this route must be prevented[4]. In this regard, it is imperative for the nurse to identify the risk factors related to safety and to the prevention of the occurrence of errors in the preparation of intravenous medications.

In this context, in spite of there already being publications on this issue, it is possible to observe that there is a lack of publications regarding the role of the nurse, specifically in the identification of the risk factors in the preparation of medications.

In one international study undertaken in three different countries, it was observed that of the 824 doses prepared, the labelling was absent or incorrect in 20 to 99% of cases, the dilutant was used incorrectly in one to 49% of cases, and that there was at least one failure in the aseptic technique in 19 to 100% of cases[5].

Brazilian studies also point to the incidence of errors with medications. In one study, of 8,152 drugs analyzed, 1,717 errors of doses or dilutions were identified. Another Brazilian study, undertaken in intensive care units, showed that medications were responsible for 78% of serious errors, most commonly caused by dosage error. Among these, 11% entailed the risk of death[5].

During the study of this issue, the following question arose: What are the principal risk factors for the occurrence of errors in the preparation of intravenous medications by the nursing team in the hospital environment?

The study object of this work, therefore, is the preparation of intravenous medications for adult patients with a view to the analysis and prevention of the risks involved.

Seeking to contribute to the improvement of the nursing care and patient safety, this study aims to identify and analyze in the literature the risk factors for the occurrence of errors in the preparation of medications by nurses, and to propose a checklist so as to promote greater safety in the preparation.

METHODOLOGY

The integrative review was the method used for the present work, in which articles were selected, through online searches, in the following databases: LILACS (Latin American and Caribbean Center on Health Sciences Information), BDENF (Specialized bibliographic database in the area of Nursing), SciELO (Scientific Electronic Library Online) and MEDLINE/PUBMED (Medical Literature Analysis and Retrieval System on-line).

The structured and trilingual DeCS/BVS vocabulary was used: nursing, medication errors, route of administration of medications, intravenous infusions, patient safety, stability of medications, and risk factors. It is emphasized that between the descriptors, the Boolean operator AND was used. The following inclusion criteria were applied for the selection of studies: publication in the selected databases, in the Portuguese language, in the format of an article, available free of charge and in full, from the years covered between 2004 and 2013, addressing the preparation of intravenous medications, in adults in hospital units.

The publications found were firstly selected by title and abstract and those which met the inclusion criteria were evaluated in full. As this is a review study undertaken online, the ethical precepts, citing the authors of the articles and periodicals analyzed, were respected.

RESULTS

Based on the descriptors previously defined, 660 studies were obtained, as shown in Table 1, where one can identify the results found, based on the search, through the combination of the descriptor "Nursing" with the others, according to the Virtual Library and databases selected for the study.

After the analysis of the data in Table 1, of the 660 articles, 575 references were in Portuguese. The duplicated studies were removed from the organization of the publication data. After the comparison of the references found, 26 repeated publications were excluded, producing a total of 549 articles. Articles were excluded if they were not available in full, free of charge, and which did not have the preparation of intravenous medications in adults in a hospital unit as the central theme. After the reading and analysis of the title and abstract of this final sample, 13 publications presented concepts relevant for achieving the objective of this study, and they were analyzed.

Table 1 - Distribution of the studies found, in absolute frequency, by databases. Rio de Janeiro-RJ-Brazil, 2012

Descriptors	LILACS	SCIELO	BDENF	Total by Descriptor
Nursing AND Stability of medications	08	02	06	16
Nursing AND Routes of Admin. of medications	09	03	06	18
Nursing AND Medication errors	104	27	78	209
Nursing AND Patient safety	190	49	137	376
Nursing AND Intravenous infusion	22	03	16	41
Total by Data-bases	333	84	243	660

DISCUSSION

From the 13 studies which met the inclusion criteria of this bibliographic review, four main risk factors related to the preparation of intravenous medications emerged, and these were used as categories of analysis: psychological factors and work overload[6-8], errors related to the preparation environment[9-11], lack of updating in education and health[12-15] and errors related to the preparation technique and the production of the medication[6-7,9,13,16-18].

Psychological Factors and Work Overload

Of the 10 articles analyzed, three indicated relevant aspects related to this category.

One study[6], with a quanti-descriptive methodological approach, aimed to identify the factors which contribute to the occurrence of errors related to the preparation of medications. The factors identified were "lack of attention", "professional/patient relationship" and "excess of work", which totalled more than 70% of the causes of the errors identified.

Supporting the article analyzed, in relation to the aspect "lack of attention", one study[1], undertaken in four hospitals, also indicates this same factor as being that mentioned most by the interviewees.

Another study analyzed in this category[7], undertaken in two hospital institutions in São Paulo, ascertained that 37% of the errors occurred in the afternoon period and 35% in the morning, with a lower percentage at night (of 29%). The differences observed between the shifts are explained by the excess of work during the day, associated with the need to comply with the routines, the larger number of staff, and handling of records, as well as noise, causing tiredness and lack of attention on the part of the professionals.

One of the articles selected[8] addresses the work overload among the nursing technicians as the main problem in the preparation of medications. The results indicate that the most common errors are related to the preparation of the medications, and the explanations for the occurrence of errors evidence the work overload and lack of attention.

As reported in studies[7-8], one study[19] addresses the overload of work as a factor commonly mentioned in the articles; in this study[19], interviews were held with nursing technicians, in which work overload was one of the most prevalent risk factors.

With this, it is possible to observe that the excess of work is the risk factor mentioned most in the articles as a factor triggering stress, lack of attention and tiredness, which promote an environment which facilitates the occurrence of errors.

Errors related to the preparation environment

Of the articles selected, three reported the environment as a risk factor for the occurrence of errors.

In one study[9] related to the factors which interfere in the preparation of the medications, it stands out that the noise, disorganization, lighting, ventilation, and circulation of people interfere in the preparation of the medications. In the same article, the author mentions that the errors related to the environment (45.9%) correspond to the largest percentage of errors analyzed.

In a separate article[10], the noises in the place of preparation, the large circulation of people in the nursing station, and unrelated conversations during the preparation were factors which evidenced the probability of the occurrence of errors.

Another study[11] refers to errors related to the environment, and mentions that the environmental factors predispose to the distraction of the nursing team during the preparation and administration of medications. The study mentions that 100 factors were identified which could distract the nurses, predisposing them to make mistakes; these included the ringing of the institution's landline telephone or people's cellphones, interruption by other professionals, non-standardized changes in medical prescriptions, overlapping different tasks by the same professional in periods allocated to the preparation of medication, and the absence of formal planning of the care[11].

One study[20] which corroborates the above-mentioned research points to the noisy preparation environment covering 68% of the situations which facilitated errors with intravenous medications. An environment with more than one person in the preparation area corresponded to 25% of the risk factors for error, and constant interruptions were also evidenced in this study, at 33%. Interruptions for clarification of doubts or answering the telephone were mentioned in 15% of cases.

Collegiate Directive Resolution (RDC) 45, issued by ANVISA[3] specifies that lighting and ventilation must be sufficient such that the temperature and air humidity do not damage the medications and facilitate the activities undertaken. Access to the environment where intravenous solutions are prepared must be restricted to those professionals who are directly involved, thus ensuring greater safety and minimizing the risk factors.

Another article[21], argues that error is an unchanging characteristic of human beings, and that it is necessary to transform the environment in which they work so as to promote an environment where it is difficult to make errors.

Lack of updating in health education

In this category, four articles emphasized continuous education as an essential tool for the promotion of safe practice.

In one article[12], the nursing professionals identified certain difficulties in the daily activities, including the preparation of intravenous medications. Another article also focuses on the need for the professionals to have knowledge, referring more specifically to antibiotic therapy, as errors during the preparation of antibiotics can lead to therapeutic failure and to the increase of bacterial resistance[13].

One study[14] which indicates the professionals' main doubts referred to the type of bottle and to the appropriate replacement times and concentration for the solution. One factor which contributed to the failure of the therapy was the use of I.V administration sets which were not specific for the administration of insulin therapy, favoring the increase of the adsorption of the medication. Through this, the need is ascertained for the professional to have knowledge in relation to the material to be used during the preparation of intravenous medications.

One study undertaken in a university hospital[15] over a six-month period described the activities which could be undertaken by a Drug Information Center. Of the 8,035 requests

received by this center, 45% came from nursing professionals, given that these are responsible for various stages of the process of medication. This demonstrates that the need to provide fast, up-to-date information to these professionals significantly contributes to the prevention of errors and the promotion of the safe and rational use of medications.

The importance of educational programs, emphasized in another study[22] warns that they should be geared to the context of each institution, as a pre-established routine may fail to achieve satisfactory results. The technique of preparing intravenous medications, therefore, must be continuously monitored so as to promote safe practice.

Errors related to the preparation technique

For intravenous medications to be used safely, it is essential to meet the minimum requirements during their preparation, with the aim of maintaining their physical-chemical characteristics, their stability, and their sterility, as well as respecting the drug interactions and incompatibilities[3]. In this context, for this category, seven works were selected, which identified errors related to the technique of preparation of intravenous medications.

The preparation of the solution ahead of time was identified as an error in two of these studies(9,16), with the occurrence being over 50% in one of these. The author relates this occurrence to the large quantity of medications scheduled for the same period of time[9].

Due to the wide variability of medications, the period of validity after their reconstitution differs, and it is suggested that preparation should be undertaken immediately prior to administration, so as to minimize the possibility for errors and possible reduction in the therapeutic effect.

In one of the studies in this category, inappropriate dilutions and doses made up nearly 30% of the errors[6]. One study[13] on antibiotic therapy confirms the importance of the quantity of dilutant necessary for the therapeutic effectiveness of each medication, in accordance with its pharmacological characteristics.

One study[7] undertaken in two hospital institutions in São Paulo aimed to characterize errors and evaluate consequences in the severity of the patients' conditions, and nursing workload, prior to and after the error. Of the total of 52 errors, 21.15% were related to the preparation of the wrong medication.

In relation to the technique of handwashing prior to the preparation of medications, one article[9] ascertained that this procedure was absent in two of the four hospitals investigated, while a separate article[15] obtained an error rate of 29.2% in the evaluation of this same index.

The absence of disinfection of ampoules and/or ampoule-bottles was identified in three studies[9,13,16], varying between 57 and 80%. The guidelines of the Centers for Disease Control and Prevention state that in this case, the risk of contamination is minimal, but that when it occurs, it can pose the risk of death to the patient[23].

It is necessary, therefore, to follow the international recommendations[23], which stipulate that the disinfection of this type of material must be undertaken through rubbing with alcohol 70% three times prior to use.

Observation of the work surface where the medications were prepared was undertaken in other studies[16,20]. These evidenced that the disinfection of the work surface with alcohol 70% was not undertaken in approximately 77% of the number of doses observed[16], while another study[20] stated that the work surface was not dry in 33% of cases.

It is important for the routine of disinfection of surfaces to be guided by the Hospital Infection Control Committee, so that there may be control of the number of microorganisms present on the work surface, which – through this type of precaution – can be reduced by around 90%[16,24-25].

The last article analyzed in this category indicates that the lack of technical knowledge was one of the weaknesses which facilitated the occurrence of errors during the preparation and administration of medications[18].

Preparation ahead of time, inadequate reconstitution and dilution, absence of disinfection of ampoules and work surfaces and the omission of the stage of handwashing were the principal risk factors identified in this category.

It should be noted that the comparison of these studies was hindered due to the fact that the authors valued different information, and

due to the type of methodological approach used. Therefore, the need is noted for setting up and validating a specific checklist for the stage of preparing intravenous medications, for better comparisons of observational studies. To this end, the checklist was developed, seeking to provide guidance relating to the important aspects to be observed in the stage of preparation, which is found in the endo of this article

CONCLUSION

Intravenous medications are widely used in professional practice; their preparation deserves special attention.

The main risk factors for the occurrence of errors evidenced in this study were overload of work associated with psychological factors, lack of updating in education and health and the incorrect handling of the medications in an inadequate environment.

Overload of work associated with psychological factors and the preparation environment appeared in a total of four articles. The category of a lack of updating in education and health reached the same number during the analysis of the studies, which emphasized the relevancy of this dynamic in the health institutions.

The studies which addressed the preparation technique were present in six articles, with differing approaches referent to the criteria for evaluating this stage of the medication process.

The use of an instrument which allows the comparison of the results could promote a basis for health education to guide training based on the best scientific evidence available, with a consequent increase in the quality of the nursing care.

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CHECKLIST FOR THE PREPARATION OF INTRAVENOUS MEDICATIONS

1.Prepare the environment so as to avoid interruptions during the preparation of the medication and reduce excess noise in the area.

2.Avoid more than one professional in the preparation room

3.Check and control the temperature and lighting in the preparation room

4.Use the medical prescription during the preparation

5.Undertake the preparation on a dry work surface

6.Disinfect the work surface with the solution established by the Hospital Infection Control Committee

7.Disinfect the tray where the medications prepared will be placed

8.Use Personal Protective Equipment in accordance with institutional protocols

9.Undertake the procedure with another nursing professional in the case of potentially dangerous medications, to establish double-checking

10.Disinfect bottle-ampoules and/or ampoules

11.Wash hands or use alcohol gel

12.Separate medications individually, checking name, dosage and expiry date

13.Consult the protocol for preparation established by the unit, affixed in a visible place

14.Use material which is compatible with the solution (polifix I.V administration set and bottle)

15.Change needle after the preparation of the medication

16.Protect the plunger of the syringe with its packaging after preparation

17.Remove the air from the syringe after preparation with the needle sheathed

18.Do not prepare the medications for various patients at the same time

19.Prepare the medications immediately prior to their administration

20.Inspect the medication regarding its physical and chemical integrity

22.Identify the medication correctly with the patient's full name, bed number, date , time and route of administration, and the name of the professional who prepared it