UNIVERSIDADE FEDERAL DA BAHIA

INSTITUTO DE SAÚDE COLETIVA

PROGRAMA DE PÓS-GRADUAÇÃO EM SAÚDE COLETIVA

LINDEMBERG ASSUNÇÃO COSTA

ERROS DE ADMINISTRAÇÃO DE MEDICAMENTOS EM UM HOSPITAL UNIVERSITÁRIO: INCIDÊNCIA, NATUREZA, GRAVIDADE E FATORES ASSOCIADOS

Salvador

2022

LINDEMBERG ASSUNÇÃO COSTA

ERROS DE ADMINISTRAÇÃO DE MEDICAMENTOS EM UM HOSPITAL UNIVERSITÁRIO: INCIDÊNCIA, NATUREZA, GRAVIDADE E FATORES ASSOCIADOS

Tese apresentada ao Programa de Pós-Graduação em Saúde Coletiva do Instituto de Saúde Coletiva da Universidade Federal da Bahia como requisito para obtenção do grau de Doutor em Saúde Pública.

Professor orientador: Luís Eugênio Portela Fernandes de Souza

Salvador

2022

UFBA/Instituto de Saúde Coletiva – Biblioteca

Ficha Catalográfica
Elaboração Programa de Pós-Graduação em Saúde Coletiva

C837e

Costa, Lindemberg Assunção.

Erros de administração de medicamentos em um Hospital Universitário: incidência, natureza, gravidade e fatores associados / Lindemberg Assunção Costa. -- Salvador: L.A. Costa, 2022.

151f.: il.

Orientador: Prof. Dr. Luís Eugenio P. Fernandes de Souza.

Tese (doutorado) – Instituto de Saúde Coletiva. Universidade Federal da Bahia.

1. Erros de Medicação. 2. Erros de Administração de Medicamentos. 3. Gravidade. 4. Fatores Associados. 5. Fatores Associados. 5. Segurança do Paciente. 6. Revisão Sistemática. 7. Observação Direta. 8. Hospital. I. Título.

CDU 615

LINDENBERG ASSUNÇÃO COSTA

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*nº

Salvador, 02 de setembro de 2022.

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Salvador

2022

Dedico este trabalho aos profissionais farmacêuticos e de enfermagem

do Hospital Universitário Prof. Edgard Santos

AGRADECIMENTOS

Aos meus filhos Lucas e Maria Eduarda por ser a razão de minha vida neste mundo.

A minha irmã, Lúcia Noblat pelo exemplo de pessoa iluminada e de um coração generoso e sem sombras de dúvidas uma educadora e profissional de excelência.

Aos meus irmãos companheiros de uma vida.

A minha grande amiga e companheira de anos de caminhada, Cleide Valli, pelo apoio e suporte emocional e profissional

A Luís Carlos Pelizarro Romero (*in memorian*) pelo primoroso trabalho na normalização desta tese.

A Juliana Fernandes pela colaboração valiosíssima em todas as etapas desta tese.

Aos colaboradores desta tese, Charleston Ribeiro, Ivellise Sousa, Renata Kelly Rodrigues Silva e Ana Carla do Valle.

As Chefias do setor de farmácia, enfermagem e segurança do paciente do Hospital Universitário Prof. Edgard Santos, Leonardo Kister, Juliana Brasil e Monalisa Santana, respectivamente.

Ao ex-superintendente do Hospital Universitário Prof. Edgard Santos, Doutor Antônio Carlos Moreira Lemos, por todo o suporte institucional para condução deste trabalho.

A Professora Bryony Dean Franklin, pela inspiração e por todas as contribuições valiosas que agregaram valor a essa tese.

Ao meu orientador, Luís Eugênio Portela Fernandes de Souza pela excelência na orientação do meu trabalho e por acreditar no meu potencial como futuro pesquisador.

“Erros são, no final das contas, fundamentos da verdade. Se um homem não sabe o que uma coisa é, já é um avanço do conhecimento saber o que ela não é.”

Carl Jung

COSTA, Lindemberg Assunção. Erros de administração de medicamentos em um hospital universitário: Incidência, natureza, gravidade e fatores associados. 2022. Orientador: Luís Eugênio Portela Fernandes de Souza. 151f. il. Tese (Doutorado em Saúde Pública) – Instituto de Saúde Coletiva, Universidade Federal da Bahia, Salvador, 2022.

RESUMO

Introdução: Os erros de administração de medicamentos são frequentes e têm alto impacto econômico e social no mundo inteiro. Recentemente, a OMS lançou o desafio global "medicamento sem danos" com a meta de reduzir 50% dos danos a medicamentos até 2022. Embora os problemas de segurança do paciente já sejam reconhecidos e dimensionados nos países desenvolvidos, estudos dessa natureza são ainda necessários na nossa realidade. Esta tese teve como objetivo determinar a incidência, a natureza, a gravidade e os fatores de risco associados aos erros de administração de medicamentos (EAM) em um hospital brasileiro. **Artigo 1** - Drug administration errors in Latin America: A systematic review. Objetivo: Determinar a frequência e a natureza dos EAM identificados através do método da observação direta em hospitais da América Latina. Métodos: revisão sistemática dos estudos publicados entre 1946 e março de 2021 realizada por dois revisores independentes em sete bases de dados: LILACS via Bireme, PubMed, SciELO, Scopus, Latindex, Embase, and CINAHL. Foram também realizadas buscas em referências de artigos e na literatura cinzenta. Resultados: 1615 artigos encontrados sendo 10 estudos incluídos na revisão final. A taxa média de EAM identificada foi de 32% (IQR: 16–35,8%) e de 9,7% (IQR: 7,4%–29,5%) após excluir os erros de horário. Os EAM mais frequentes foram os erros de horário (8.3% a 77.3%), seguidos dos erros de dose (1,7% a 26,4%) e dos erros de omissão (5,3% a 10,5%). Assunção-Costa L, Costa de Sousa I, Alves de Oliveira MR, Ribeiro Pinto C, Machado JFF, Valli CG, et al. (2022) Drug administration errors in Latin America: A systematic review. PLoS ONE 17(8): e0272123. https://doi.org/10.1371/journal.pone.0272123. **Artigo 2** – Observational study on medication administration errors at a university hospital in Salvador, Brazil: incidence, nature and associated factors. Objetivo: Identificar a prevalência, natureza e fatores associados aos EAM em um Hospital Universitário no Brasil. Métodos: Estudo observacional, prospectivo através da técnica da observação direta disfarçada da administração de medicamentos, realizado em duas unidades hospitalares (clínica e cirúrgica). A taxa total de erro foi calculada dividindo o número de doses com um ou mais erros pelo total de erros observados (TOE). Resultados: Foram observados 203 erros em 400 doses administradas. A taxa total de EAM foi de 36,2% (IC95%: 32,3-40,2). Excluindo os erros de horário, a taxa total de erro foi de 25,1 % (IC 95% 24,3-32,4). Os erros mais frequentes foram erros de técnica (15,5%), horário (11,1%), dose (4,8%) e omissão (4,5%). Os fatores de risco associados aos EAM foram via de administração, interrupções, volume de trabalho e classificação anatômica, terapêutica e química (ATC) de medicamentos. **Artigo 3** – Validation of a method to assess the severity of medication administration errors in Brazil: a study protocol". Objetivo: Estabelecer a validade de um método existente para avaliação da gravidade de erros de administração de medicamentos no Brasil. This is the first validation of this method for use in Brazil, will allow researchers to conduct more standardised evaluations of interventions to reduce the impact of medication errors (Assunção-Costa L, Ribeiro Pinto C, Ferreira Fernandes Machado J, Gomes Valli C, Portela Fernandes de Souza LE, Dean Franklin B. Validation of a method to assess the severity of medication

administration errors in Brazil: a study protocol. J Public Health Res. 2022 Mar 14;11(2):2623. doi: 10.4081/jphr.2022.2623. **Artigo 4 -** Validation of a method to assess the severity of Medication Administration Errors in Brazil. Objetivo: Validar o método existente de avaliação do potencial significado clínico dos EAM desenvolvido no Reino Unido, para uso no Brasil. Métodos: Trinta profissionais de saúde de hospitais de 5 regiões do Brasil pontuaram 50 casos de erros de medicação em termos de dano potencial ao paciente em uma escala de 0 a 10, onde 0 representava um caso sem potencial efeito e 10 um caso que resultaria em morte. A validade dos escores foi avaliada através de dezesseis casos com os resultados dos danos reais conhecidos, que serão comparados aos escores pontuados pelos profissionais. A confiabilidade foi avaliada através de 10 erros pontuados em duas ocasiões. Resultados: foram encontrados excelentes coeficientes G (P 0,8) e uma boa correlação entre os valores de gravidade conhecidos e as pontuações médias atribuídas pelos juízes. Conclusão: a escala de Dean e Barber (1999) é válida e confiável para uso no Sistema Único de Saúde. **Artigo 5 –** Severity of Medication Administration Errors in a teaching hospital in Brazil. Objetivo: Avaliar a gravidade potencial de erros de administração identificados por meio da observação direta em um hospital universitário. Os 203 erros identificados previamente foram agrupados quanto a similaridade em 67 erros, que foram submetidos a avaliação de gravidade potencial por 4 profissionais de saúde. Um escore médio foi calculado, sendo considerado como índice de gravidade. Os profissionais julgaram o significado clínico potencial dos erros como leve em 8,8% (18), moderado em 82,8% (168) e grave em 8,4% (17) dos casos. O escore médio da gravidade potencial foi de 5,2 (escore mínimo 2,6 e escore máximo 7,7; DP 1,2).

Palavras-chave: erros de medicação, erros de administração de medicamentos, gravidade, fatores associados, erros de administração de medicamentos; segurança do paciente; revisão sistemática; observação direta; hospital.

COSTA, Lindemberg Assunção. Medication administration errors in a university hospital: incidence, nature, severity and factors associated. 2022. Thesis advisor: Luís Eugênio Portela Fernandes de Souza. 151f. il. Thesis (Professor Doctor in Public Health) – Instituto de Saúde Coletiva, Universidade Federal da Bahia, Salvador, 2022.

ABSTRACT

Introduction: Medication administration errors are frequent and have a high economic and social impact worldwide. Recently, WHO launched the global "undamaged medicine" challenge with the goal of reducing drug damage by 50% by 2022. Although patient safety problems are already recognized and dimensioned in developed countries, studies of this type are still necessary in our reality. This thesis is aimed to determine the incidence, nature, severity and risk factors associated with medication administration errors (MAE) in a Brazilian hospital. **Article 1** - Drug administration errors in Latin America: A systematic review. Objective: To determine the frequency and nature of MAEs identified through the direct observation method in hospitals in Latin America. Methods: systematic review of studies published between 1946 and March 2021 conducted by two independent reviewers in seven databases: LILACS via Bireme, PubMed, SciELO, Scopus, Latindex, Embase, and CINAHL. Searches were also performed in references of articles and in grey literature. Results: 1615 articles were found, and 10 studies were included in the final review. The mean MAE rate identified was 32% (IQR: 16–35.8%) and 9.7% (IQR: 7.4%–29.5%) after excluding time errors. The most frequent MAEs were time errors (8.3% to 77.3%), followed by dose errors (1.7% to 26.4%) and omission errors (5.3% to 10.5%). (Assunção-Costa L, Costa de Sousa I, Alves de Oliveira MR, Ribeiro Pinto C, Machado JFF, Valli CG, et al. (2022) Drug administration errors in Latin America: A systematic review. PLoS ONE 17(8): e0272123. https://doi.org/10.1371/journal.pone.0272123.) **Article 2–** Observational study on medication administration errors at a university hospital in Salvador, Brazil: incidence, nature and associated factors. Objective: To identify the prevalence, nature and factors associated with MAE in a University Hospital in Brazil. Methods: Observational, prospective study through the technique of disguised direct observation in the administration of medications, performed in two hospital units (clinical and surgical). The total error rate was calculated by dividing the number of doses with one or more errors by the total opportunity errors observed (TOE). Results: 203 errors were observed in 400 doses administered. The total MAE rate was 36.2% (95% CI: 32.3-40.2). Excluding time errors, the total error rate was 25.1% (95% CI 24.3-32.4). The most frequent errors were technical errors (15.5%), time (11.1%), dose (4.8%) and omission (4.5%). The risk factors associated with MAE were administration, interruptions, workload and ANATOMICAL-THERAPEUTICAL-CHEMICAL (ATC) class of medications. **Article 3**– Validation of a method to assess the severity of medication administration errors in Brazil: a study protocol. Objective: To establish the validity of an existing method for assessing the severity of drug administration errors in Brazil. This is the first validation of this method for use in Brazil, which will allow researchers to conduct more standardized evaluations of interventions to reduce the impact of medication errors (Assunção-Costa L, Ribeiro Pinto C, Ferreira Fernandes Machado J, Gomes Valli C, Portela Fernandes de Souza LE, Dean Franklin B. Validation of a method to assess the severity of medication administration errors in Brazil: a study protocol. J Public Health Res. 2022 Mar 14;11(2):2623. doi: 10.4081/jphr.2022.2623. **Article 4** - Validation of a method to assess the severity of Medication Administration Errors in Brazil. Objective: To validate the existing method of evaluating the potential clinical significance of MAE developed in the United Kingdom for use in Brazil. Methods: Thirty health professionals from hospitals in

5 regions of Brazil scored 50 cases of medication errors in terms of potential damage to the patient on a scale of 0 to 10, where 0 represented a case without potential effect and 10 a case that would result in death. The validity of the scores was assessed through sixteen cases with the results of the actual known damages, which was compared to the scores given by the professionals. Reliability was evaluated through 10 errors scored on two occasions. Results: excellent G coefficients (≥ 0.8) and a good correlation were found between the known severity values and the average scores attributed by the judges. Conclusion: The Dean and Barber scale (1999) is valid and reliable for use in the Unified Health System in Brazil. **Article 5** – Severity of Medication Administration Errors in a teaching hospital in Brazil. Objective: To evaluate the potential severity of administration errors identified through direct observation in a Brazilian university hospital. The 203 errors previously identified were grouped according to similarity in 67 errors, which were submitted to a potential severity assessment by 4 health professionals. An average score was calculated, being considered as a severity index. The professionals judged the potential clinical significance of errors as mild in 8.8% (18), moderate in 82.8% (168) and severe in 8.4% (17) of the cases. The mean score of potential severity was 5.2 (minimum score 2.6 and maximum score 7.7; SD 1.2).

Keywords: medication errors, medication administration errors, severity, associated factors; patient safety; systematic review; direct observation; hospital.

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LISTA DE ABREVIATURAS E SIGLAS

ASHP	AMERICAN SOCIETY OF HEALTH-SYSTEM PHARMACISTS
ATCC	ANATOMICAL-THERAPEUTICAL-CHEMICAL CLASSIFICATION
EAM	ERRO DE ADMINISTRAÇÃO DE MEDICAMENTOS
HB	HOSPITAL DA BAHIA
HCPA	HOSPITAL DE CLÍNICAS DE PORTO ALEGRE
HCUFMG	HOSPITAL DAS CLÍNICAS DA UNIVERSIDADE FEDERAL DE MINAS GERAIS
HGV	HOSPITAL GETÚLIO VARGAS
HSL	HOSPITAL SÍRIO LIBANÊS
HUPES	HOSPITAL UNIVERSITÁRIO PROFESSOR EDGARD SANTOS
INAFF	INSTITUTO NACIONAL DE ASSISTÊNCIA FARMACÊUTICA E FARMACOECONOMIA
IOM	INSTITUTE OF MEDICINE
IQR	INTERQUARTILE INTERVALS
JBI	JOANNA BRIGGS INSTITUTE
JOÃO XXIII	HOSPITAL JOÃO XXIII
MAE	MEDICATION ADMINISTRATION ERROR
ME	MEDICATION ERRORS
NCC MERP	THE NATIONAL COORDINATING COUNCIL FOR MEDICATION ERROR REPORTING AND PREVENTION
OD	DIRECT OBSERVATION
OMS	ORGANIZAÇÃO MUNDIAL DA SAÚDE
PNSP	PROGRAMA NACIONAL DE SEGURANÇA DO PACIENTE
PRISMA	PREFERRED REPORTING ITEMS FOR SYSTEMATIC REVIEWS AND META-ANALYSIS
PROFAE	PROGRAMA DE FORMAÇÃO DE TRABALHADORES NA ÁREA DE ENFERMAGEM
TOE	TOTAL OPPORTUNITY OF ERROR
UFBA	UNIVERSIDADE FEDERAL DA BAHIA
WHO	WORLD HEALTH ORGANIZATION
SUS	SISTEMA ÚNICO DE SAÚDE

SUMÁRIO

APRESENTAÇÃO

O presente trabalho é o produto do Doutorado em Saúde Pública do Instituto de Saúde Coletiva da Universidade Federal da Bahia (ISC/UFBA), na área de concentração de Planejamento, Gestão e Avaliação de Serviços de Saúde, desenvolvido pelo Programa Integrado de Economia, Tecnologia e Inovação em Saúde (PECS).

A tese intitulada ***Erros de administração de medicamentos em um hospital universitário: incidência, natureza, gravidade e fatores associados*** insere-se em um projeto mais amplo no escopo do Instituto Nacional de Ciência, Inovação e Tecnologia em Saúde (CITECS), uma rede multidisciplinar de pesquisa com sede na Bahia – da qual o ISC/UFBA participa – de abrangência internacional, voltada para a inovação, o desenvolvimento e a avaliação de tecnologias para a saúde.

A avaliação de tecnologias em saúde (ATS) foi definida pelo Ministério da Saúde como o processo contínuo de análise e síntese dos benefícios para a saúde das consequências econômicas e sociais resultantes do emprego de tecnologias, considerando os aspectos: segurança, acurácia, eficácia, efetividade, custo, custo-efetividade e aspectos de equidade, impactos éticos, culturais e ambientais envolvidos na sua utilização (BRASIL, 2010; VIANNA; CAETANO; UGÁ, 2009). No Sistema Único de Saúde (SUS), a avaliação de novas tecnologias se insere em uma dimensão essencial da oferta de serviços de saúde: a segurança do paciente ou usuário.

Em que pese a pesquisa sobre segurança do paciente ter tido muitos avanços nas últimas décadas, permanece, ainda, como um desafio importante, especialmente para os países em desenvolvimento, sendo necessária para descrição e análise da realidade corrente com acurácia (JHA *et al*., 2010; KEERS *et al*., 2013; TOFFOLETO *et al*., 2015).

No Brasil, o Ministério da Saúde implantou o Programa Nacional de Segurança do Paciente (PNSP) em 2013, por meio da Portaria MS/GM nº 529, de 1° de abril de 2013, tendo, como objetivo, contribuir para a qualificação do cuidado em saúde, em todos os estabelecimentos de saúde do território nacional, públicos e privados. Instituído de acordo com a agenda política dos Estados-membros da Organização Mundial da Saúde (OMS) e a respectiva resolução aprovada durante a 57ª Assembleia Mundial da Saúde (BRASIL, 2014), o PNSP representou um grande avanço na institucionalização dessa área no país.

Em recente documento (2017), a OMS incluiu "o uso de medicamentos sem causar danos" como um desafio global da segurança do paciente (DONALDSON *et al*., 2017), definindo-o como uma prioridade para os três anos seguintes. Esse fato confere importância à produção de pesquisas nacionais que respondam questões relevantes para subsidiar políticas e programas de prevenção e redução de danos causados por erros de medicação (de prescrição, de dispensação e de administração), já que muitos são evitáveis e todos são passíveis de atenção.

Sendo assim, esta TESE objetiva contribuir para a caracterização do problema do uso inseguro de medicamentos em nosso meio e para a identificação de estratégias para o seu enfrentamento, bem como contribuir com a produção do conhecimento e aprimoramento das ferramentas de pesquisas para identificar EAM e mensurar o seu potencial de dano aos pacientes.

Ela foi desenvolvida em três etapas. A primeira (artigo 1) consistiu em uma revisão sistemática da literatura latino-americana sobre a incidência, os tipos e a gravidade dos erros de administração de medicamentos, estimados com método de observação direta. As evidências disponíveis sobre os Erros de Administração de Medicamentos no mundo em sua maioria não incluem estudos realizados em hospitais latino-americanos, o que limita a compreensão desta problemática em países em desenvolvimento. Delimitamos esta revisão sistemática a estudos que utilizaram o método da observação direta, por ser considerado o padrão ouro na identificação e mensuração da incidência de EAM. Neste sentido, este trabalho ajuda a compreender melhor a epidemiologia e o impacto dos EAM nesta região. A segunda etapa descreve uma pesquisa empírica, realizada em duas enfermarias do Hospital Universitário Prof. Edgard Santos, dimensionando a incidência dos diferentes tipos de erro (natureza), os fatores associados a eles (artigos 2) e sua gravidade (artigo 3), tendo como referencial metodológico a técnica da observação direta da administração dos medicamentos, cujo observador acompanha o(a) enfermeiro(a) e testemunha a preparação e a administração de cada dose de medicamento (TAXIS; DEAN; BARBER, 1999; DEAN; BARBER, 2001; MCLEOD; BARBER; FRANKLIN, 2013;) e o método da avaliação da gravidade clínica de um erro de administração de medicamentos, que varia de desprezível a muito grave, podendo incluir a morte do paciente. Neste último existe uma variedade de ferramentas para mensurar e classificar os danos associados a erros de medicação. Uma revisão sistemática sobre danos relacionados a erros de prescrição identificou mais de 40 ferramentas de classificação de

danos utilizadas antes de 2013. Os autores buscaram identificar a confiabilidade interexaminador aceitável e a validade através do julgamento do revisor sobre o dano potencial comparado ao real em situações em que o dano real era conhecido. Apenas duas destas ferramentas atenderam a estes dois critérios: o NCC MERP para classificar danos reais e a escala de 10 pontos de Dean & Barber para classificar danos potenciais (GARFIELD et al., 2013). Esta última por se tratar de uma ferramenta válida e confiável foi escolhida para ser validada no Brasil.

Por último, a terceira etapa desta Tese (artigo 4 e 5) é a validação deste método de pontuação para medir a gravidade de erros de administração de medicamentos para uso no Brasil. (DEAN, B. S.; BARBER, 1999; TAXIS; BARBER, 2004). A validação desta escala no Brasil permitirá ampliar o número de publicações com foco em mensurar os danos potenciais relacionados aos erros de medicação, em particular os erros de administração de medicamentos em hospitais e instituições de saúde brasileiros.

1 INTRODUÇÃO

Os temas de segurança do paciente, erros de medicação e eventos adversos ganharam a atenção global a partir da publicação do relatório *To Err is Humane,* do *Institute of Medicine* (IOM), em 1999 (KOHN; CORRIGAN; MOLLA, 1999). A partir dos resultados deste relatório foram realizados vários outros estudos que, utilizando-se da estratégia metodológica de revisão de prontuário, confirmaram que é grande a magnitude do problema e a incidência de eventos adversos é alta em diferentes países, incluindo Austrália (WILSON *et al*., 2012), Inglaterra (NEALE; WOLOSHYNOWYCH; VINCENT, 2001), Canadá (VARADARAJAN et al., 2008), Nova Zelândia (DAVIS et al., 2002), Dinamarca (SCHIØLER et al., 2001), França (WILSON et al., 2012), Portugal (SOUSA et al., 2014), Turquia (LETAIEF et al., 2010), Espanha (ARANAZ-ANDRÉS et al., 2008), Suécia (SOOP et al., 2009), Holanda (ZEGERS et al., 2009) e Brasil (MENDES W, MARTINS M, ROZENFELD S, 2009). Estes estudos estimaram que, em média, 10% dos pacientes internados em hospitais sofrem algum tipo de evento adverso relacionado a medicamentos, 50% dos quais evitáveis (DE VRIES et al., 2008).

Em 2004, a Organização Mundial da Saúde (OMS), preocupada com essa questão, criou a *World Alliance for Patient Safety*, cujos objetivos incluem organizar conceitos e definições sobre segurança do paciente e propor medidas para reduzir os riscos e mitigar os eventos adversos. No ano seguinte, lançou uma iniciativa mundial intitulada *Desafio Global para a Segurança do Paciente*, tendo, como primeiro tema, a higiene das mãos (2005), e, na sequência, as práticas cirúrgicas seguras (2008). Em 2017, a iniciativa tratou do tema '*medication without harm*', ou 'medicação sem danos', focado no uso seguro dos medicamentos**.** Os principais objetivos dessa ação foram sensibilizar e incentivar o empenho de líderes, representantes políticos e ministros da saúde dos países membros em torno desses temas-chave para reduzir globalmente o nível de danos graves e evitáveis relacionados a medicamentos em 50% ao longo de 5 anos (WHO, 2006, 2008, 2017). No Brasil, seguimento as recomendações da OMS, foi criado em 2013 o Programa Nacional de Segurança do Paciente (PNSP) pelo Ministério da Saúde, com o objetivo de melhorar a qualidade do cuidado em todos os estabelecimentos de saúde (BRASIL, 2013).

Os 'erros de medicação' têm sido definidos de diversas maneiras, porém o conceito mais aceito pelas instituições governamentais dos países é o adotado pelo Comitê Nacional de Coordenação para Prevenção e Notificação de Erros de Medicação (NCCMERP, 2001), dos Estados Unidos, que os define como "qualquer incidente

passível de prevenção que pode causar dano ao paciente ou dar lugar a uma utilização inadequada de medicamentos, quando estes estão sob o controle de profissionais de saúde, do paciente ou do consumidor".

Esses incidentes podem estar relacionados com a prática profissional, com procedimentos ou com os sistemas de utilização de medicamentos nos hospitais, incluindo falhas na prescrição, comunicação, etiquetagem, envasamento, denominação, preparação, dispensação, distribuição, administração, monitoramento e utilização dos medicamentos (NCCMERP, 2001).

Apesar do avanço conceitual, a definição da NCCMERP é muito ampla e, para aplicação em pesquisa, é importante que se tenha uma definição mais precisa e que possibilite estimar os erros de medicação com maior acurácia. Os erros de medicação podem ser mais bem estudados quando classificados em erros 'de prescrição', 'de dispensação', 'de administração' e monitoramento (FRANKLIN; TULLY, 2015).

Os medicamentos podem causar danos quando há reações adversas relacionadas ou não às características do produto farmacêutico em si, ou quando os medicamentos são prescritos, dispensados ou administrados de forma inadequada (erros de medicação) (GATES et al., 2018).

Atualmente, os impactos sociais, sanitários e econômicos dos erros de medição são bem conhecidos. Eles causam pelo menos uma morte todos os dias e prejudicam aproximadamente 1,3 milhão de pessoas anualmente apenas nos Estados Unidos. No mundo, o custo associado aos erros de medicação foi estimado em US$ 42 bilhões por ano ou quase 0,7% do total das despesas globais em saúde (DONALDSON et al., 2017).

De acordo com os relatórios de incidentes críticos na Inglaterra, os erros de administração de medicamentos (EAM) respondem pela grande maioria das mortes e dos danos aos pacientes, tanto nos Estados Unidos quanto na Inglaterra (ELLIOTT et al., 2021; PHAM et al., 2011), muito provavelmente porque a administração do medicamento envolva mais procedimentos e pessoas do que a prescrição ou a dispensação, aumentando assim, as oportunidades de erro. Além disso, os EAM são menos susceptíveis de serem interceptados antes de atingirem os pacientes (BERDOT et al., 2016; MCLEOD; BARBER; FRANKLIN, 2013). Desta forma torna-se prioritário entendê-los, dimensioná-los e estabelecer estratégias efetivas para redução dos mesmos, com vistas a aumentar a segurança no uso dos medicamentos.

Embora um ato inseguro na fase de administração possa preceder um incidente relacionado aos medicamentos, é amplamente reconhecido que fatores organizacionais e ambientais existentes no local de trabalho, além de fatores específicos associados à pessoa, contribuem para criar condições propícias à produção de erros (BERDOT et al., 2016; KEERS et al., 2013, 2015; MCLEOD; BARBER; FRANKLIN, 2013).

A importância do presente estudo está em produzir evidências sobre a natureza, a frequência e os fatores associados aos EAM e, pela primeira vez, validar uma metodologia sobre a gravidade dos mesmos no Brasil.

Nesse sentido, esta tese pretende responder as seguintes **perguntas**:

1. Qual a frequência de EAM em hospitais da América Latina, identificados pelo método da observação direta?
2. Quais são os erros de administração de medicamentos e a frequência com que ocorrem em um hospital universitário?
3. Qual é a gravidade desses erros?
4. Quais os fatores associados aos erros de administração de medicamentos?
5. O método proposto por Dean & Barber (1999) é válido e confiável para ser utilizado no Brasil?

2 OBJETIVOS

Objetivo principal

Determinar a incidência, a gravidade e os fatores de risco associados aos erros de administração de medicamentos em um hospital brasileiro.

Objetivos secundários

1. Determinar a incidência dos EAM em hospitais da América Latina;
2. Determinar a incidência por tipos de EAM em um hospital universitário brasileiro;
3. Identificar os fatores associados aos EAM um hospital universitário brasileiro;
4. Determinar a gravidade dos EAM ocorridos em um hospital universitário brasileiro.

3 RESULTADOS

3.1 ARTIGO 1: DRUG ADMINISTRATION ERRORS IN LATIN AMERICA: A SYSTEMATIC REVIEW

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Citação: Assunção-Costa L, Costa de Sousa I, Alves de Oliveira MR, Ribeiro Pinto C, Machado JFF, Valli CG, de Souza LEPF. (2022) Drug administration errors in Latin America: A systematic review. PLoS ONE 17(8): e0272123. https://doi.org/10.1371/journal.pone.0272123

ABSTRACT

Purpose: This study systematically reviewed studies to determine the frequency and nature of medication administration errors in Latin American hospitals.

Summary: We systematically searched the medical literature of seven electronic databases to identify studies on medication administration errors in Latin American hospitals using the direct observation method. Studies published in English, Spanish, or Portuguese between 1946 and March 2021 were included. A total of 10 studies conducted at 22 hospitals were included in the review. Nursing professionals were the most frequently observed during medication administration and were observers in four of the ten included studies. Total number of error opportunities was used as a parameter to calculate error rates. The administration error rate had a median of 32% (interquartile range 16%–35.8%) with high variability in the described frequencies (9%–64%). Excluding time errors, the median error rate was 9.7% (interquartile range 7.4%–29.5%). Four different definitions of medication errors were used in these studies. The most frequently observed errors were time, dose, and omission. Only four studies described the therapeutic classes or groups involved in the errors, with systemic anti-infectives being the most reported. None of the studies assessed the severity or outcome of the errors. The assessment of the overall risk bias revealed that one study had low risk, three had moderate risk, and three had high risk. In the assessment of the exploratory, observational, and before-after studies, two were classified as having fair quality and one as having poor quality.

Conclusion: The administration error rate in Latin America was high, even when time errors were excluded. The variation observed in the frequencies can be explained by the different contexts in which the study was conducted. Future research using direct observation techniques is necessary to more accurately estimate the nature and severity of medication administration errors.

Keywords: medication administration errors; patient safety; medication errors; systematic review; direct observation; hospital

1. INTRODUCTION

On average, 10% of patients admitted to hospitals suffer from some type of adverse event related to medications, half of which are preventable.[1] Recently, concerned with this scenario, the World Health Organization launched the third patient safety global challenge to reduce medication use harm by 50% in five years.[2] Harm to patients attributed to medication errors (ME) and preventable adverse events are among the most common hospital incidents. They have significant clinical, economic, and social consequences.[3] The global economic impact of medication error is approximately US$ 42 billion annually,[4] which is 0.7% of the global total health expenditure. However, much of the evidence on medication errors is derived from developed countries.[4]

Research carried out in developing countries revealed that 2.5%–18.4% of hospital admissions were associated with adverse events, of which 84% were preventable and 30% resulted in the death of the patient.[5] These rates were higher than those identified in developed countries, probably because of the low qualifications of health professionals and inadequate infrastructure of health systems.[6] Understanding the context and solutions for reducing the risks of drug-related harm in developing countries is essential for providing safe and effective care to the population.[6]

Medication errors can be understood as those arising during prescription, dispensing, and administration of medications.[7] Several studies have shown high frequency of medication errors.[8-12] Some recent systematic reviews using direct observation alone have shown mean medication administration error (MAE) rates of 8–10% (excluding time errors).[12-15] The detection and quantification of medication administration errors are essential to establish the frequency at which they occur and identify underlying causes and factors that allow interventions to reduce their occurrence.[14]

Administration is the final stage of the drug use process, and errors in this stage are least likely to be intercepted before reaching the patient.[16] Medication administration error is defined as any discrepancy between the prescribed drugs and the drugs administered to the patient.[14,17] Medication preparation errors at the ward level are also considered as administration errors. Prescription and dispensing errors are excluded from this review.

Several methods are used to measure medication administration errors, including self-reporting, incident reporting, medical record review, trigger tool, and direct observation. Each has its own advantages and disadvantages. Incident reporting and self-reporting methods produce error rates that underestimate the prevalence of errors in medication administration. Direct observation is the most appropriate method for accurately identifying a variety and significant number of medication administration errors. This allows the comparison of medication administration error rates among published studies. A disadvantage of this method is that it is more labor intensive and expensive and can lead to changes in the participants' behavior in the observers' presence.[14]

Most systematic reviews of medication administration errors in hospitals are published in English and include very few studies conducted in Latin America because they exclude studies in Portuguese and Spanish.[13,14,18] No systematic review has reported the incidence of medication administration errors based on the direct observation method in Latin America. Two reviews found in the literature, published in Portuguese and Spanish, studied nurses in Latin American hospitals and evaluated errors in the preparation and administration of medications. One study attempted to describe the qualitative aspects,[20,21] while the other sought to identify the types and factors associated with them.[21] Therefore, to the best of our knowledge, this is the first systematic review that aims to determine the frequency and nature of medication administration errors identified through the direct observation method in Latin American hospitals.

2. METHODS

This systematic literature review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) 2020 guidelines.[22,23] (S2 Appendix)

2.1 Eligibility Criteria

We included studies reporting the rate of administration errors using only the direct observation method, published between 1946 and March 2021 in Portuguese, English, or Spanish, performed in hospitals in Latin American countries (Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Cuba, El Salvador, Ecuador, French Guiana, Guatemala, Haiti, Honduras, Mexico, Nicaragua, Panama, Paraguay, Peru, Puerto Rico, Dominican Republic, Uruguay, or Venezuela). Prospective, cross-sectional, observational, or interventional before-after studies were included in our analysis. For interventional before-after studies, only the administration error rate calculated in the period before the intervention was considered.

We excluded studies such as narrative reviews; guides; protocols; qualitative studies; case reports; studies that used interviews, questionnaires, or focus groups to identify factors or causes of medication errors or professionals' feelings regarding medication errors; studies that did not stratify the types of medication errors; conference summaries that did not provide enough information to determine the prevalence and nature of medication administration errors; studies on medication administration errors associated with a medication or medication class or that reported only a subcategory of administration errors (e.g., dose error); studies that assessed the rate of administration errors during home care; and studies that provided only information about serious medication administration errors, instead of information about all medication errors.

2.2 Information Sources

Two researchers (MR and IC) independently reviewed the following seven electronic databases: LILACS via Bireme, PubMed, SciELO, Scopus, Latindex, Embase, and CINAHL, applying search strategies described in S1 appendix. Gray literature (searched using Google Scholar), reference lists of included studies, and relevant review articles were manually searched to identify additional eligible studies. Unpublished papers obtained from the thesis and research database files from academic libraries were also reviewed. The search was conducted between August 2019 and March 2021.

2.3 Search Strategies

Search strategies aimed to retrieve studies on medication errors, especially administration errors in hospital care, carried out in Latin American countries, as in the example: (“medication error$” OR “administration error$” OR “medication preparation” OR “omission error$” OR “medication handling”) AND “hospital$” AND (“Latin America” OR “Argentina” OR “Bolivia” OR “Brazil” OR “Chile” OR “Colombia” OR “Costa Rica” OR “Cuba” OR “El Salvador” OR “Ecuador” OR “Guatemala” OR “Haiti” OR “Honduras” OR “Mexico” OR “Nicaragua” OR “Panama” OR “Paraguay” OR “Peru” OR “Puerto Rico” OR “Dominican Republic” OR “Uruguay” OR “Venezuela”).

We also reviewed the gray literature, reference lists of the included studies, and relevant reviews to minimize the risk of loss of eligible studies.

2.4 Selection Process

Eligibility was initially assessed by reading the title and abstract of each article. When the title and abstract did not provide sufficient information to determine whether the study met this review’s objectives, the paper was retrieved and thoroughly read to analyze its fit with the inclusion and exclusion criteria. All eligible studies were retrieved for full-text reading. Two independent reviewers (MR and CI) applied the eligibility criteria, and the results were subsequently validated by a third reviewer (LAC) to consolidate the final selection of studies. Discrepancies were resolved by consensus among the three reviewers after discussion.

2.5 Data Collection Process

Data extraction was performed independently and in pairs. We developed a standardized form on a Microsoft Excel® spreadsheet (version 16.43, Mac) to extract the authors’ names, year of publication, country of origin, hospital where the study was conducted, study duration, study type, data collection method (who the observer was, the number of observers, and the observed professional), the numerator (administration errors observed or recorded), the denominator (type and value), the definition of medication error or medication administration error, disguised and undisguised observation technique, type of errors (omission, dose, and time) based on the classifications proposed

by ASHP,[24] NCC MERP,[25] or Barker and Allan[17] (S1 Annex), the severity of medication error or medication administration error and which classification was used, administration route, risk factors, therapeutic classes involved with medication administration error, and the frequency of administration errors observed or recorded. IC and MR extracted the data independently, and the results were validated by a third reviewer (LAC). Discrepancies were resolved by consensus among the reviewers.

Some authors were contacted to clarify doubts about the findings of the studies, especially regarding error-frequency calculations.

2.6 Evaluated Outcomes

We extracted the following data from each study:

1. Study characteristics: country, year, duration, design, and clinical setting;
2. Identification of MAE: definition of MAE, observation method, frequency of administration errors, and severity assessment of MAE;
3. Information relating to the MAE: frequently reported medications; medication errors involving intravenous administration route, and drugs associated with medication errors.

2.7 Risk of Bias Assessment

We used the Joanna Briggs Institute (JBI) checklist for analytical cross-sectional studies for each cross-sectional study included. The tool comprises eight questions to determine the quality of studies.[26] At the end of the assessment, according to the criteria met by each study, we considered high risk of bias as studies that met 0% to 50% of the criteria, moderate risk of bias as those that met 51% to 75% of the criteria, and low risk of bias as those that met 76% to 100% of the criteria.

For observational, multicenter, exploratory, and interventional before-after designs, we applied the Newcastle-Ottawa Quality Assessment Form for Cohort Studies. This tool is structured into three domains of bias (selection, comparability, and outcome) that include questions that inform the risk of bias judgments. Based on the obtained scores, studies were classified as having good, fair, or poor quality.[27]

2.8 Effect Measures

The denominator extracted from the studies was the “Total Opportunity of Error” (TOE), defined as the total number of doses administered, correctly or incorrectly, plus the number of doses omitted. Whenever possible, we converted the values presented in the studies into TOE. The numerator data represent the total number of errors observed. When the studies evaluated the impact of an intervention using the before-after method, we extracted only the data from the pre-intervention period. The total ME rate was used for multicenter studies.

The studies included in this review showed a wide variation, and for this reason, the median error rates were calculated with interquartile intervals (IQR). Median error rates were calculated with and without time error rates. For studies that reported different error rates for the medication administration and preparation stages in inpatient units, the combined data were used to build a total administration error rate. The error rate was used in the pre-intervention stage in “before-after” intervention studies.

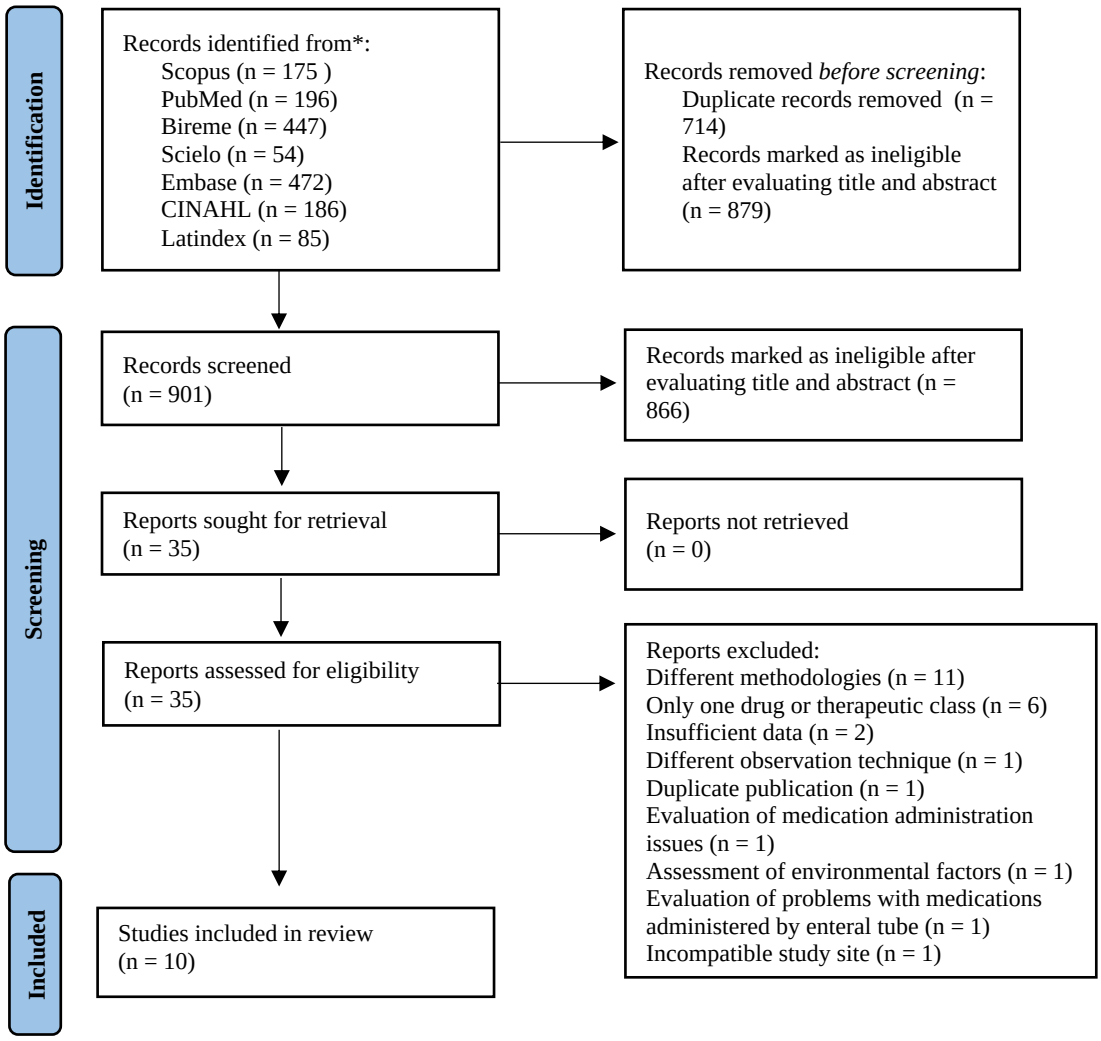
2.9 Synthesis Methods

Meta-analysis was not performed due to methodological differences among studies, within-study biases, and diversity of outcomes. Instead, we presented the results of individual studies in descriptive tables, according to the identified medication administration error frequency.

3. RESULTS

The search for information sources resulted in the initial identification of 1,615 papers, of which 914 duplicates were excluded. Another 666 papers were excluded after reading the titles and abstracts because they did not meet the inclusion criteria. The remaining 35 papers were retrieved for full-text reading and detailed analysis. Finally, ten papers were included in this review (Figure 1).

Figure 1. Flowchart of the systematic literature review process



3.1 Characteristics of Included Studies

3.1.1 Country and Year of Publication

Eight (80%) of the included studies were conducted in Brazil and two (20%) in Chile and were published between 2006 and 2018. Detailed information is provided in Table 1.

Table 1. Characteristics of the included studies

Reference	Country of origin	Hospital context	Duration (days)	Study type	Observation method	Participants		Denominator, n	Numerator	Frequency	Error definition used	Error type*
						Observer, n	Observed, n					
Costa et al., 2006	Brazil	2 units (1 MC and 1 SC) of 1 private hospital and 1 unit (MC) of 1 public hospital	30	Cross-sectional	DO	NI, 2	NI	TOE, 638	209	32.9%	Barker et al., 2002	Omission (10.5%) Non-prescribed dose (10.2%) Time error (8.3%) Wrong dose (3.3%)
Opitz, 2006	Brazil	1 unit (MC) of 1 teaching hospital	15	Observational and cross-sectional	DDO	Nurses and nursing students, NI	Nurses (3), Nursing Assistant (2), and Nursing Technician (17), 22	TOE, 1129	404	35.8%	NCC MERP	Time error (19.0%) Omission error (9.4%) Dose error (5.7%) Unauthorized medications (1.4 %)
Anselmi et al., 2007	Brazil	5 units (IM, pediatrics, obstetrics, SC, and emergency) of 3 hospitals	35	Cross-sectional	DO	Nurses (3) and nursing students (14), 17	Nurses (49), Nursing Assistants (44), and Nursing Technicians (27), 120	TOE, 1315	104	16%	Barker et al., 2002	Wrong dose (9.2%) Dose omission (5.3%) Wrong patient (1.2%) Wrong medication (0.3%)
Reis et al., 2009	Brazil	5 units (MC) of 5 teaching hospitals	30	Multicenter exploratory/ descriptive	DO	NI, 15	Nursing professionals, NI	TOE, 4958	1500	30.3%	Barker et al., 2002	Time error (77.3%) Wrong dose (14.4%) Route error (6.1%) Unauthorized medication (1.7%)
De Bortoli Cassiani et al., 2010	Brazil	6 units of MC of 6 hospitals, 4 of which were teaching hospitals	30	Cross-sectional	DDO	Nurses (6) category NI (18), 24	Nursing professionals, NI	TOE, 6169	1049	17%	NCC MERP	Time error (53.8%) Wrong dose (26.4%) Unauthorized medications (9.8%) Wrong route (8.5%)
Teixeira and Cassiani, 2010	Brazil	1 unit (MC) of 1 university hospital	30	Cross-sectional	DO	NI	Nursing Assistants, Nursing Technicians, NI	TOE, 824	74	9%	NCC MERP/ ASHP	Dose errors (24.3%) Time errors (22.9%) Unauthorized medications (13.5%) Technique errors (12.2%)
Romero et al., 2013	Chile	2 SC of 1 teaching hospital	180	Before/After	DDO	Pharmacists, NI	Nursing Teams, NI	TOE, 194	66	34%	Ferner & Aronson	Administration error (26%) prescription error (10%) Preparation error (7%) Transcription error (4%)
Grou Volpe, 2014	Brazil	1 unit (MC) of 1 general hospital	10	Cross-sectional	DO	Nurses, 2	Nurses (8) and Nursing Technicians (16), 24	TOE, 531	337	64%	NCC MERP	Time errors (48.5%) Dose omissions (9.5%) Wrong dose (1.7%) Monitoring errors (0.4%)
Smith M, 2014	Chile	1 ICU of 1 university hospital	180	Observational	DDO	Pharmacists and pharmacy students, NI	NI	TOE, 132	52	38.6%	NCC MERP	Time error (76.8%) Incomplete prescription (13.8%) Dispensation error (7%)
Mendes et al., 2018	Brazil	1 FA of 1 university hospital	180	Cross-sectional	NDDO	NI, 1	Nursing Assistants, Nursing Technicians, and Nurses, 303	TOE, 303	33	10.8%	NCC MERP	Time error (5.6%) Dose error (2.6%) Technique error (2.6%)

MC: medical clinic, SC: surgical clinic, IM: internal medicine, ICU: intensive care unit, FA: first aid, DO: direct observation, DDO: disguised direct observation, NDDO: non-disguised direct observation, NI: not informed

*Four types of errors described most frequently in each included study.

3.1.2 Study Locations

The studies were conducted in 22 hospitals, of which 14 (64%) were university or teaching hospitals and 8 (36%) were general hospitals. The units chosen for observation were medical clinic units (16, 61.5%), surgical clinics (4, 15.4%), emergency care (2, 7.7%), intensive care (1, 3.8%), pediatrics (1, 3.8%), obstetrics (1, 3.8%), and internal medicine (1, 3.8%). Four (40%) studies were conducted in two or more institutions.[28-31] The drug distribution systems found in these hospitals were individualized,[29], mixed,[29,33] and unit-dose.[34] Other studies did not report the distribution system used.

3.1.3 Study Design

Seven (70%) cross-sectional studies, two (20%) "before and after" studies, and one (10%) descriptive, exploratory, multicenter study were included. Disguised direct observation was performed in four (40%) studies to assess medication administration, a method in which the observed team is not aware of the study to avoid changes in usual behavior. The individual professional category observed was described in eight (80%) studies, represented by nursing professionals (nurses, nursing assistants, and technicians).

3.1.4 Patient Profile

The studies did not inform the age groups of the patients. However, patients from adult and pediatric units were included in the observations. Most of the observations were made in clinical units of hospitals (16, 61.5%), characterized in the studies as units providing care to patients with chronic diseases, using a high number of medications.

3.1.5 Administration Route

Two studies examined medication administration errors associated with intravenous drugs.[28,35] In one study, observations were restricted to doses administered either parenterally or enterally. The same study excluded from its evaluation medications administered by inhalation or through a continuous infusion pump.[33] Other studies evaluated errors that occurred without restrictions regarding the medication administration route.

3.1.6 Observers and Error Detection

Nurses were the most frequent observers in the studies and were involved in data collection in four of the ten studies included; in one of them they were the sole responsible professional. Nursing students participated in the collection of three studies, pharmacists in two, and pharmacy students in one. The observer's professional category was not described in four of the studies. Six studies (60%) confirmed the error when comparing the observations, registered in a specific form, to the medical prescription after the observation period.[29-32,34,36] Two studies (20%) confirmed the error simultaneously with the observation.[28,33] Two studies did not report whether the error was confirmed during or after the observation.[35,37]

Six studies reported the training provided to the observer.[28,30,31,33,34,37] As described by Barker et al., proper training and technique are an important part of reducing bias or the Hawthorne effect in persons administering medication.[42]

The contents addressed in this study included the concept of medication errors, types of errors, ways of approaching the person being observed, presentation, orientation, and discussion of the research instrument, culture of safety, medication use system, and detection and classification of. Three studies revealed a total training time of 20 hours.[30,31,33]

3.1.7 Error Validation

Only one study[35] did not include two or more observers in data collection. Four studies (44.4%) among those with two or more observers reported that they underwent training to standardize the validation process.[28-30,37] Five studies validated the form used in data collection before the observation's onset.[30,31,33,34,37] Three of them described that the validation was performed by experts on the subject.[30,31,33] Divergences were resolved by consensus among observers[28] or involving a supervisor.[28] One study reported that patient safety experts validated the data collected,[31] and another reported the use of an external supervisor who collected the data from 10% of the observed patients and compared it with the observations of the other collectors.[34] Eight of the included studies stated that observers were instructed to intervene in errors that could harm patients. None of the studies evaluated the severity of errors.

3.1.8 Error Definition

Four different error definitions were used in the studies. The most frequently employed were NCC MERP[24] (6; 60%) and Barker[25] (3; 30%). One study adopted two definitions (ASHP[23] and NCC MERP[24]). One study used the definition of Ferner and Aronson.[38]

3.2 Frequency of Administration Errors

3.2.1 Denominator and Numerator

All studies presented a denominator using the TOE definition. The numerator corresponded to the total number of errors observed during the data-collection period. The median error rates were 32% (IQR: 16–35.8%) and 9.7% (IQR: 7.4%–29.5%) without time errors.

3.2.2 Frequently Reported Types of Administration Errors

The most frequent error was the wrong time error, defined as medication administration before or after one hour of the prescribed time[28-31,33] or drug administration before or after 30 minutes of the prescribed time.[32,34,35] The reported frequency of incorrect time errors in these studies ranged from 8.3% to 77.3%. Wrong dose errors were observed, with frequencies ranging from 1.7% to 26.4%. Omission errors were another common error subtype, with frequencies ranging from 5.3% to 10.5%.

3.2.3 Intravenous Administration Route

Two studies investigated medication errors involving only drugs administered intravenously.[28,35] The most frequently described underlying errors were dose, omission, and incorrect time errors. Regarding medication preparation, the errors described were dose errors, lack of hand hygiene before preparation, non-use of aseptic techniques in preparation, incorrect identification of the medication, non-verification of the patient's identification, and dilution of the medication in a volume below the manufacturer's recommendation. The errors described in the administration stage were omission of medication, non-hand hygiene before administration, non-use of aseptic techniques for administration, and incorrect administration speed. One study[32] performed an analysis of

the observed medication errors and the administration route, with 49.7% of the observed errors involving the intravenous route, 68% involving the administration, 56% involving preparation errors, and 44.4% involving wrong time errors. The study did not identify a statistical difference when considering the intravenous administration route as a risk factor for medication administration errors, as was the case for the other evaluated routes. Other included studies described the main types of errors observed, as described in Table 1.

3.2.4 Drugs Associated with Medication Administration Errors

Four studies reported the classes[37] or therapeutic groups[31,32,34] associated with the observed medication administration errors according to the Anatomical Therapeutic Chemical code. The groups most frequently involved in medication administration errors were anti-infectives for systemic use, nervous system, blood and forming organs, cardiovascular system, digestive system, metabolism, and the respiratory system. One study[31] reported the frequency of medication administration errors associated with high-alert medications and a narrow therapeutic index. High-alert medications, most often involved in errors, were heparin, tramadol, and insulin. High-alert medications bear a heightened risk of causing significant patient harm when used in error.[39]

The drugs with narrow therapeutic indices mentioned in the studies were heparin, vancomycin, and clindamycin.

3.3 Study Quality Evaluation

In the overall bias risk judgement for cross-sectional studies using the JBI assessment, one study was classified as having low risk, three as having moderate risk, and three as having high risk. In the analysis of the remaining studies using the Newcastle-Ottawa Quality Assessment, two studies were classified as having fair quality and one study as having poor quality (S3 Appendix).

4. DISCUSSION

The median medication administration error rate was 32% (IQR: 16%–35.8%), with significant variability in the described frequencies (between 9% and 64%). When excluding time errors, the administration error rate ranged from 6.9% to 32.7% with a median of 9.7% and interquartile interval of 7.4% and 29.55%. The wide variation observed in frequencies can be explained by the different contexts in which the research was conducted, involving different types of hospitals, medication distribution systems, and professional categories, including students participating in data collection.

These studies adopted different classifications of medication errors. Barker[25] and NCC MERP[24] were the most frequent, whereas ASHP's classification[23] was used in only one publication. Consequently, the error definitions varied in different studies. Only four studies reported observer training to ensure homogeneity in the identification of errors. The identified medication administration error rate was higher than that described in other systematic reviews.[13,14] However, it approached when time errors were excluded, with a median TOE of 9.7%.

The error rates identified in studies that evaluated only intravenously administered drugs were 10.8% and 16%.[28,35] One study[32] did not identify an increased risk of errors in the intravenous administration of drugs. These results differ from those of international systematic reviews that show a greater risk of errors (53.3%) in this route of medication administration.[14]

However, the intravenous route was not identified as a risk factor for medication administration errors in other publications in the literature.[40,41] The intravenous administration route is associated with considerable complexity and more significant risks to the patient because intravenous drugs may require elaborate preparation and administration processes, leading to additional error opportunities compared with other routes.[42] One study did not include an aseptic technique in the preparation and administration of the observed errors.[28]

The denominator "Total Opportunity of Error" was used in all the included studies, corroborating the literature that suggests TOE as the measure most frequently used for studies to identify medication administration errors based on direct observation.[16,25] As an observation technique, variations were identified in describing the data collection method used in each study: undisguised or disguised direct observation. The observer's

presence can lead the observed professional to be more careful or prone to error. However, the literature describes that participants tend to resume regular habits in their routine over time if the observer is discrete.[14,43-45] Adequate observer training can minimize the effects of observer presence.[16,45]

The underlying error type most frequently described in eight of the ten included studies was wrong time error, similar to that observed by other authors.[13,14] The classification varied between studies, which considered 30 or 60 minutes as the time between the established time and the time when the medication was administered to determine the error. The relevance of this type of error is discussed in the literature, as they are usually classified as minor clinical errors. The clinical impact of incorrect time errors should be evaluated when timing is a critical factor in avoiding potential harm to patients.[13,14]

After incorrect time errors, dose (wrong dose or non-prescribed dose) and omission errors were the most frequently described medication administration errors. Dose, time, and omission errors were frequent among studies that evaluated errors involving intravenous drugs.[28,35] These results were similar to those reported in the literature. One study[35] included aseptic techniques and non-hand hygiene among errors in the administration and preparation stages, which were not described in other studies.[28,32] In the preparation stage, inadequate infusion rate and non-use of the aseptic technique were the most described errors, while incorrect dose and non-use of aseptic technique were the most common in the administration stage. Other published studies have included inadequate preparation techniques among the types of medication errors, which can result in a higher frequency of preparation errors.[46,47]

The studies did not categorize the clinical relevance or severity of the error outcomes. Only four studies assessed the frequency of different therapeutic groups involved in medication administration errors. The profile identified was similar to that described in previous studies,[14,48] with anti-infectious groups for systemic use, nervous system, blood and forming organs, cardiovascular system, respiratory and digestive systems, and metabolism as the most frequently involved in medication administration errors.[14,48] One study identified high-alert medications and those with a narrow therapeutic index as the most frequently described. The frequent description in the literature of these therapeutic groups as the ones most involved in medication errors

highlights the need for attention owing to the high risk of medication administration error damage, especially those involving high-alert medications. It is necessary to establish strong barriers to prevent these errors. The efficacy of many drugs in the afore mentioned therapeutic groups is associated with specific administration times, and it is essential to adopt strategies to reduce time errors.[14,15,48]

To the best of our knowledge, this is the first systematic review on the prevalence and nature of medication administration errors in Latin American hospitals. Owing to the scarcity of published information on medication administration errors in Latin American countries, this review aimed to include only studies conducted in Latin American hospitals. This study had some limitations. First, only two countries, Brazil and Chile, have reported studies using direct observation techniques to identify medication administration errors, which may not represent the rate in other Latin American countries. Another critical factor was the heterogeneity of the studies, which did not allow us to formally summarize the data or perform a meta-analysis. We also combined studies with different definitions of MEs or administration errors. Finally, we included studies that did not mention whether they used the technique of disguised direct observation, whether the observers were previously trained, or whether the observations were validated.

This review shows the need for further studies in other countries to build a more comprehensive outlook on medication administration errors. Further studies using the disguised direct observation technique are required to achieve a more accurate estimate of the nature of medication administration errors. Another issue that needs more detail is the evaluation of the severity of the errors as none of the studies, even those that proposed to do so, carried out this type of analysis, which is of fundamental importance for good risk management.

5. CONCLUSIONS

The administration error rate is high in Latin America even when time errors are excluded. The primary errors in medication administration described in the studies were time, dose, omission, and administration route. The pharmacological groups most involved in medication administration errors were anti-infectives, central nervous system agents, blood and forming organs, cardiovascular system, digestive system, metabolism, and respiratory system. However, no study has yet evaluated the severity of medication administration errors. Future research using a broader disguised direct observation technique is required to obtain a more accurate estimate of the nature and severity of medication administration errors in Latin America.

Registration and Protocol

Since this study is part of a doctoral thesis and deadlines were very short, we did not have enough time to register it in PROSPERO.

Support

This study was not supported by any funding agencies.

Competing Interests

The authors declare no conflict of interests.

Acknowledgments

We thank Dr. John M Kessler from the USA for their writing assistance and Dr. Artur Siqueira de Brito for their contribution in the analysis process.

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Supporting Information

S1 Appendix. Search strategies used in the literature review.

S2 Appendix. PRISMA checklist.

S3 Appendix. Quality study evaluation.

S1 Annex. Medication error definitions.

S1 APPENDIX - SEARCH STRATEGIES USED IN THE LITERATURE REVIEW

Information source	Search strategy	Results
PubMed	("medication error$" OR "administration error$" OR "medication preparation" OR "omission error$" OR "medication handling") AND hospital$ AND ("latin america" OR argentina OR bolivia OR brazil OR chile OR colombia OR "costa rica" OR cuba OR "el salvador" OR ecuador OR guatemala OR haiti OR honduras OR mexico OR nicaragua OR panama OR paraguay OR peru OR "puerto rico" OR "dominican republic" OR uruguay OR venezuela)'	26
	("medication error" OR "medication errors" OR "administration error" OR "administration errors" OR "medication preparation" OR "omission error" OR "omission errors" OR "medication handling") AND hospital$ AND ("latin america" OR argentina OR bolivia OR brazil OR chile OR colombia OR "costa rica" OR cuba OR "el salvador" OR ecuador OR guatemala OR haiti OR honduras OR mexico OR nicaragua OR panama OR paraguay OR peru OR "puerto rico" OR "dominican republic" OR uruguay OR venezuela)	196
BIREME	(“error de medicacion” OR “errores de medicacion” OR “error de administración” OR “errores de administración”) AND (hospital OR hospitales) AND ("América Latina" OR Argentina OR Bolivia OR Brasil OR Chile OR Colombia OR "Costa Rica" OR Cuba OR "El Salvador" OR Ecuador OR Guatemala OR Haití OR Honduras OR México OR Nicaragua OR panama OR paraguay OR perú OR "puerto rico" OR "república dominicana" OR uruguay OR venezuela)	295
	(“erro de medicação” OR “erros de medicação” OR “erro de administração” OR “erros de administração”) AND (hospital OR hospitais) AND ("América Latina" OR Argentina OR Bolivia OR Brasil OR Chile OR Colombia OR "Costa Rica" OR Cuba OR "El Salvador" OR Equador OR Guatemala OR Haiti OR Honduras OR México OR Nicaragua OR Panama OR paraguai OR peru OR "porto rico" OR "república dominicana" OR uruguai OR venezuela)	138
	('medication error' OR 'medication errors' OR 'administration error' OR 'administration errors') AND (hospital OR hospitals) ('latin america' OR argentina OR bolivia OR brazil OR chile OR colombia OR 'costa rica' OR cuba OR 'el salvador' OR ecuador OR guatemala OR haiti OR honduras OR mexico OR nicaragua OR panama OR paraguay OR peru OR 'puerto rico' OR 'dominican republic' OR uruguay OR venezuela)	11
SCIELO	(“erro de medicação” OR “erros de medicação” OR “erro de administração” OR “erros de administração”) AND (hospital OR hospitais)	10
	(“error de medicacion” OR “errores de medicacion” OR “error de administración” OR “errores de administración”) AND (hospital OR hospitales)	43
SCOPUS	("medication error" OR "medication errors" OR "administration error" OR "administration errors" OR "medication preparation" OR "omission error" OR "omission errors" OR "medication handling") AND hospital AND ("latin america" OR argentina OR bolivia OR brazil OR chile OR colombia OR "costa rica" OR cuba OR "el salvador" OR ecuador OR guatemala OR haiti OR honduras OR mexico)	175
	("medication error" OR "medication errors" OR "administration error" OR "administration errors" OR "medication preparation" OR "omission error" OR "omission errors" OR "medication handling") AND hospital AND (nicaragua OR panama OR paraguay OR peru OR "puerto rico" OR "dominican republic" OR uruguay OR Venezuela)	2
CINAHL	("medication error" OR "medication errors" OR "administration error" OR "administration errors" OR "medication preparation" OR "omission error" OR "omission errors" OR "medication handling") AND hospital AND ("latin america" OR argentina OR bolivia OR brazil OR chile OR colombia OR "costa rica" OR cuba OR "el salvador" OR ecuador OR guatemala OR haiti OR honduras OR mexico OR nicaragua OR panama OR paraguay OR peru OR "puerto rico" OR "dominican republic" OR uruguay OR venezuela)	186
EMBASE	('medication error'/exp OR 'medication error*' OR 'administration error*' OR 'medication preparation' OR 'omission error' OR 'medication handling') AND hospital* AND ('latin america' OR 'argentina' OR 'bolivia' OR 'brazil' OR 'chile' OR 'colombia' OR 'costa rica' OR 'cuba' OR 'el salvador' OR 'ecuador' OR 'guatemala' OR 'honduras' OR 'mexico' OR 'nicaragua' OR 'panama' OR 'paraguay' OR 'peru' OR 'puerto rico' OR 'dominican republic' OR 'uruguay' OR 'venezuela')	472
LATINDEX	erro AND medicacao	72
	error AND medicacion	71
	erro AND administracao	10

S2 APPENDIX – PRISMA CHECKLIST

Section andTopic	Item#	Checklist item	Location where item is reported
TITLE			
Title	1	Identify the report as a systematic review.	1
ABSTRACT			
Abstract	2	See the PRISMA 2020 for Abstracts checklist.	2
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of existing knowledge.	3
Objectives	4	**Provide an explicit statement of the objective(s) or question(s) the review addresses.**	2-4
METHODS			
Eligibility criteria	5	Specify the inclusion and exclusion criteria for the review and how studies were grouped for the syntheses.	5
Informationsources	6	Specify all databases, registers, websites, organizations, reference lists and other sources searched or consulted to identify studies. Specify thedate when each source was last searched or consulted.	4-5
4Search strategy	7	Present the full search strategies for all databases, registers and websites, including any filters and limits used.	S1 appendix
Selection process	8	Specify the methods used to decide whether a study met the inclusion criteria of the review, including how many reviewers screened each record and each report retrieved, whether they worked independently, and if applicable, details of automation tools used in the process.	4-5
Data collectionprocess	9	Specify the methods used to collect data from reports, including how many reviewers collected data from each report, whether they worked independently, any processes for obtaining or confirming data from study investigators, and if applicable, details of automation tools used in theprocess.	5
Data items	10a	List and define all outcomes for which data were sought. Specify whether all results that were compatible with each outcome domain in eachstudy were sought (e.g. for all measures, time points, analyses), and if not, the methods used to decide which results to collect.	5
	10b	List and define all other variables for which data were sought (e.g. participant and intervention characteristics, funding sources). Describe any assumptions made about any missing or unclear information.	4-6
Study risk of biasassessment	11	Specify the methods used to assess risk of bias in the included studies, including details of the tool(s) used, how many reviewers assessed each study and whether they worked independently, and if applicable, details of automation tools used in the process.	6

Section andTopic	Item#	Checklist item	Location where item is reported
METHODS			
Effect measures	12	Specify for each outcome the effect measure(s) (e.g. risk ratio, mean difference) used in the synthesis or presentation of results.	6
Synthesismethods	13a	Describe the processes used to decide which studies were eligible for each synthesis (e.g. tabulating the study intervention characteristics andcomparing against the planned groups for each synthesis (item #5)).	5-6
	13b	Describe any methods required to prepare the data for presentation or synthesis, such as handling of missing summary statistics, or dataconversions.	6
	13c	Describe any methods used to tabulate or visually display results of individual studies and syntheses.	5-6
	13d	Describe any methods used to synthesize results and provide a rationale for the choice(s). If meta-analysis was performed, describe themodel(s), method(s) to identify the presence and extent of statistical heterogeneity, and software package(s) used.	5-6
	13e	Describe any methods used to explore possible causes of heterogeneity among study results (e.g. subgroup analysis, meta-regression).	-
	13f	Describe any sensitivity analyses conducted to assess robustness of the synthesized results.	-
Reporting biasassessment	14	Describe any methods used to assess risk of bias due to missing results in a synthesis (arising from reporting biases).	5
Certainty assessment	15	Describe any methods used to assess certainty (or confidence) in the body of evidence for an outcome.	
RESULTS			
Study selection	16a	Describe the results of the search and selection process, from the number of records identified in the search to the number of studies included inthe review, ideally using a flow diagram.	6; fig 1
	16b	Cite studies that might appear to meet the inclusion criteria, but which were excluded, and explain why they were excluded.	Fig. 1
Study characteristics	17	Cite each included study and present its characteristics.	Table 1
Risk of bias instudies	18	Present assessments of risk of bias for each included study.	Table 2
Results of individual studies	19	For all outcomes, present, for each study: (a) summary statistics for each group (where appropriate) and (b) an effect estimate and its precision(e.g. confidence/credible interval), ideally using structured tables or plots.	Table 1

Section andTopic	Item#	Checklist item	Location where item is reported
RESULTS			
Results ofsyntheses	20a	For each synthesis, briefly summarise the characteristics and risk of bias among contributing studies.	7 to 11
	20b	Present results of all statistical syntheses conducted. If meta-analysis was done, present for each the summary estimate and its precision (e.g. confidence/credible interval) and measures of statistical heterogeneity. If comparing groups, describe the direction of the effect.	7 to 11
	20c	Present results of all investigations of possible causes of heterogeneity among study results.	11 to 12
	20d	Present results of all sensitivity analyses conducted to assess the robustness of the synthesized results.	-
Reporting biases	21	Present assessments of risk of bias due to missing results (arising from reporting biases) for each synthesis assessed.	11 to 12
Certainty ofevidence	22	Present assessments of certainty (or confidence) in the body of evidence for each outcome assessed.	-
DISCUSSION			
Discussion	23a	Provide a general interpretation of the results in the context of other evidence.	11 to 12
	23b	Discuss any limitations of the evidence included in the review.	10 to 12
	23c	Discuss any limitations of the review processes used.	11 to 12
	23d	Discuss implications of the results for practice, policy, and future research.	10 to 12
OTHER INFORMATION			
Registration andprotocol	24a	Provide registration information for the review, including register name and registration number, or state that the review was not registered.	-
	24b	Indicate where the review protocol can be accessed, or state that a protocol was not prepared.	-
	24c	Describe and explain any amendments to information provided at registration or in the protocol.	-
Support	25	Describe sources of financial or non-financial support for the review, and the role of the funders or sponsors in the review.	14
Competinginterests	26	Declare any competing interests of review authors.	14
Availability of data, code andother materials	27	Report which of the following are publicly available and where they can be found: template data collection forms; data extracted from includedstudies; data used for all analyses; analytic code; any other materials used in the review.	-

From: Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ 2021;372:n71. doi: 10.1136/bmj.n7

S3 APPENDIX - QUALITY STUDY EVALUATION.

JBI checklist for analytical cross-sectional studies.

	ANSELMI, 2007	COSTA, 2006	OPTIZ, 2006	DE BORTOLI, 2010	CASSIANI, 2010	VOLPE, 2014	MENDES, 2018
Were the criteria for inclusion in the sample clearly defined?	YES	YES	YES	YES	UNCLEAR	YES	NO
Were the study subjects and the setting described in detail?	YES	NO	YES	NO	NO	YES	NO
Was the exposure measured in a valid and reliable way?	YES	YES	YES	YES	UNCLEAR	YES	UNCLEAR
Were objective, standard criteria used for measurement of the condition?	YES	YES	YES	UNCLEAR	UNCLEAR	UNCLEAR	UNCLEAR
Were confounding factors identified?	YES	YES	YES	YES	YES	YES	YES
Were strategies to deal with confounding factors stated?	YES	NO	NO	NO	NO	YES	UNCLEAR
Were the outcomes measured in a valid and reliable way?	YES	YES	YES	UNCLEAR	YES	UNCLEAR	UNCLEAR
Was appropriate statistical analysis used?	YES	YES	UNCLEAR	UNCLEAR	UNCLEAR	YES	YES
Critérios atendidos	100%	75%	75%	38%	25%	75%	25%

Bias risk assessment: Low risk: 76 to 100% of criteria; Moderate risk: 51 to 75% of criteria; High risk: 0 to 50% of criteria.

Newcastle - Ottawa Quality Assessment Form for Cohort Studies.

	ROMERO, 2013	SMITH, 2014	REIS, 2010
SELECTION			
Representativeness of the exposed cohort	Truly representative (one star)	Truly representative (one star)	No description of the derivation of the cohort
Selection of the non-exposed cohort	Drawn from a different source	No description of the derivation of the non exposed cohort	No description of the derivation of the non exposed cohort
Ascertainment of exposure	Structured interview (one star)	Structured interview (one star)	Structured interview (one star)
Demonstration that outcome of interest was not present at start of study	No	No	No
COMPARABILITY			
Comparability of cohorts on the basis of the design or analysis controlled for confounders	Study controls for other factors (one star)	Study controls for other factors (one star)	Study controls for other factors (one star)
OUTCOME			
Assessment of outcome	Self report	Self report	Self report
Was follow-up long enough for outcomes to occur	Yes (one star)	Yes (one star)	Yes (one star)
Adequacy of follow-up of cohorts	No statement	No statement	No statement
Overall bias risk	**Fair quality**	**Fair quality**	**Poor quality**

Good quality: 3 or 4 stars in selection domain AND 1 or 2 stars in comparability domain AND 2 or 3 stars in outcome/exposure domain
Fair quality: 2 stars in selection domain AND 1 or 2 stars in comparability domain AND 2 or 3 stars in outcome/exposure domain
Poor quality: 0 or 1 star in selection domain OR 0 stars in comparability domain OR 0 or 1 stars in outcome/exposure domain

S1 ANNEX - MEDICATION ERROR DEFINITIONS

Author	**Definition**
BARKER[25]	"A medication error is generally defined as a deviation from the physician's medication order as written on the patient's chart."
ASHP[23]	"Episodes in drug misadventuring that should be preventable through effective systems controls involving pharmacists, physicians and other prescribers, nurses, risk management personnel, legal counsel, administrators, patients, and others in the organizational setting, as well as regulatory agencies and the pharmaceutical industry"
NCC MERP[24]	"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."
FERNER; ARONSON[37]	"A failure in the treatment process that leads to or has the potential to lead to harm to the patient"

3.2 ARTIGO 2: OBSERVATIONAL STUDY ON MEDICATION ADMINISTRATION ERRORS AT A UNIVERSITY HOSPITAL IN SALVADOR, BRAZIL: INCIDENCE, NATURE AND ASSOCIATED FACTORS.

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ABSTRACT

Background: Medication administration errors are frequent and cause significant harm globally. However, only a few data are available on their prevalence, nature, and severity in developing countries, particularly in Brazil. This study attempts to determine the incidence, nature, and factors associated with medication administration errors observed in a university hospital.

Methods: This was a prospective observational study, conducted in a clinical and surgical unit of a University Hospital in Brazil. Two previously trained professionals directly observed medication preparation and administration for 15 days, 24 h a day, in February 2020. The type of error, the category of the medication involved, according to the anatomical therapeutic chemical classification system, and associated risk factors were analyzed. Multivariate logistic regression was adopted to identify factors associated with errors.

Results: The administration of 561 drug doses was observed. The mean total medication administration error rate was 36.2% (95% confidence interval: 32.3–40.2). The main factors associated with schedule errors were interruptions. Regarding technique errors, the primary factors observed were the route of administration, interruptions, and workload.

Conclusions: Here, we identified a high total medication administration error rate, the most frequent being technique, schedule, dose, and omission errors. The factors associated with errors were interruptions, route of administration and workload, which agrees well with the results of other national and international studies.

Keywords: Medication error, hospital, observational study, direct observation, patient safety, medication systems.

BACKGROUND

Medication errors in hospitals are frequent and can cause harm. The social and economic impacts of this challenge are already well known in developed countries, and, more recently, are being described in developing countries[1–4]. In 2017, the World Health Organization (WHO) launched the third global patient safety challenge, entitled "medication without harm," with a bold goal of reducing harm caused by medication errors by 50%. Medication errors can occur at any stage of the medication process: prescription, dispensing, and administration of medicines, with the administration stage presenting the greatest risk, as it is the final stage before reaching the patient. To achieve the goal set by the WHO, it is necessary to obtain epidemiological data on the occurrence of errors, including those related to associated factors and the severity of their consequences, considering that most medication errors do not cause harm to the patient[5].

Little is known about the prevalence, nature, associated factors, and severity of errors in developing countries, particularly in Latin America. A recent systematic review, which included studies with the direct observation technique, identified a drug administration error rate of 32% (16–35.8% interquartile range) in this region, with high variability in prevalence (9–64%); in addition, only one study assessed the factors associated with medication administration errors (MAEs) and none assessed the severity of these errors[6]. A few studies in Brazil have adopted direct observation as the gold standard for estimating the rate of MAE. These studies differ widely in terms of their inclusion/exclusion criteria, definitions, and categorization of errors. Moreover, among all the Brazilian studies included in the afore mentioned systematic review, only one described how to calculate the error rate[7].

Accordingly, this study aims to fill this knowledge gap by identifying the prevalence and nature of medication errors, including the associated factors, in a public university hospital in Brazil.

METHODS

Study Design and Location

This is a prospective observational study that adopts the technique of direct-disguised observation of drug administration conducted in a highly complex public university hospital with 263 beds in the Northeast region of Brazil. This study was conducted in two units: a medical (21 beds) and a surgical (23 beds) clinic; both clinics have patients with acute diseases, mostly with more than one chronic disease, who use prescribed drugs from several pharmacological groups. The medical clinic unit admits patients from neurology, neurosurgery, and orthopedics specialties. In contrast, the surgical clinic unit admits female patients from the specialties of gynecology, plastic surgery, urology, and otorhinolaryngology.

In the nursing care routine of this hospital, nursing technicians are responsible for both the preparation and administration of medications, except chemotherapy drugs, and for bathing, feeding, and providing basic care to patients. In turn, the nurses are responsible for supervising the technicians, performing administrative duties, and applying bandages and catheters, among other duties.

Medicine Distribution System

Medicines are dispensed per patient, accompanied by a copy of the medical prescription, over a 24-h period, via a distribution system for individualized doses. The pharmacist evaluates the prescription regarding the indication, dose, route of administration, frequency of administration, and drug interactions. After validating the prescription, pharmacy assistants prepare the medication doses per patient, which are checked by the pharmacists before dispensing. Subsequently, the medications are distributed to the units, where they are received and checked by the nursing technicians. After checking, the medications are prepared in the wards and administered to patients by the nursing team at predetermined times, using the original prescription to record the administered times. Unused doses are returned to the pharmacy, using medication carts.

Data Collection

Data were collected in February 2019 by two researchers with at least two years of experience in the hospital's Pharmacy, who were trained in the direct observation method by the main researcher. A pilot study was conducted to habituate the professionals to the direct

observation method and refine the data collection instrument. Here, the preparation and administration of 23 doses by the same nursing technician was simultaneously observed by the two researchers, and then an agreement between them was determined by calculating the Kappa index (0.8), which was considered satisfactory. Nurses and technicians were informed that the study aimed at improving the hospital's medication distribution system; however, the objective of identifying MAEs was not explained.

A form for data collection was developed (Appendix I), containing fields to fill in the following information: date, name of the observer, time of the round, shift, census of the unit, name of the patient (subsequently coded), medication, dose (amount administered), pharmaceutical form, route of administration, time and technique of administration, interruptions, and number of beds per technician.

The observation period in each unit was 15 consecutive days, and the observations were performed 24 h a day in three shifts: morning (7:00 am–1:00 pm), afternoon (1:00 pm–7:00 pm) and night (7:00 pm–07:00 am). The ratios of nursing technician per bed were 5:1 and 4:1 in the medical and surgical clinic units, respectively.

The field researcher was always present in the unit 2 h before the starting times of each medication administration established by hospital standards, until the end of the procedures performed by nurses, thereby witnessing the entire preparation and administration processes of these doses by the nurses.

Some measures were taken to prevent already known biases that may adversely affect the validity of the study. During the data collection process, the observer was not obstructive, neither did they make judgments about the nurse/technician's work, thereby maintaining a distance that allowed the performance observation of the procedure without disturbing the observed professional (nurse/technician). All selected researchers were experienced pharmacists who were trained in the direct observation method by the main researcher. For two days, a test was conducted to familiarize the research team with the clinical unit and identify the need to improve the data collection form, which attested the reliability of the tool.

The data collection process comprised the following steps:

1. Two researchers accompanied the nurses/technicians in the rounds of medication administration, observing the preparation and administration steps, with each researcher in one of the selected units.

2. Each field researcher took notes on the data collection form, detailing the actions of the nurse/technician at the time of medication preparation and administration (medication, dose administered, route of administration, time, etc.).
3. After each round, the observer and main researcher prepared their independent prescription copies of the patients involved. Each dose observed was compared with the dose prescribed by the physician, and in the case of discrepancy, the error was described and categorized.

After comparing all observed doses, each researcher determined whether an additional medication should have been administered during the observation period, based on the medical prescription. If yes, the researcher recorded this as a "dose omission," unless there was a valid reason for non-administration (e.g., patient discharge, death, or transfer). All collected data were reviewed by the researcher to ensure data validity and reliability. All the obtained information was forwarded to the main investigator, who independently determined administration errors by comparing each dose from the data collection forms with the copies of prescriptions used by the field researchers. Only the errors confirmed by the main researcher were ultimately reported.

Ethical considerations

The study was submitted to the Research Ethics Committee of the University Medical Center (Professor Edgard Santos) and was approved under opinion number 3,102,570/2019. For ethical reasons, if any error with harmful potential was identified by the field researcher, the researcher would intervene, thereby preventing administration and averting the occurrence of harm to the patient.

Definitions

A medication administration error has been defined as "the administration of a dose of medication that differs from the prescription, as written in the medical record, or from standard hospital policy and procedures"[8,9].

Accordingly, drug administration errors were classified into the following categories: omission, non-prescribed dose, extra dose, wrong dose, wrong route, wrong pharmaceutical form, wrong technique, and schedule error (Appendix II).

The drugs administered were classified according to the https://en.wikipedia.org/wiki/Anatomical_Therapeutic_Chemical_Classification_System *Anatomical-Therapeutical-Chemical Classification* (ATCC) of the World Health Organization.

Factors Contributing to the Occurrence of MAE

The following variables were considered to assess the risk factors that may contribute to the occurrence of errors: type of unit, number of patients under the care of the health professional, ATCC, interruptions during medication preparation and administration, day of the week or shift or time/round, route of administration (oral, intravenous (IV), subcutaneous, inhalation, nasoenteric catheter), and IV or non-IV.

Data Analysis

The analysis solely considered the doses prepared and administered in the presence of the observer and the doses mistakenly not administered during the observation period. The doses prepared and administered by nursing students or assistants under training were not considered, nor were those prescribed illegibly, rejected by the patient, administered by the patient themself, or referring to missing medications.

Error Rate Calculation

The basic measurement unit used was the "total opportunity of error (TOE),” which is defined as all administered and omitted doses, corresponding to the denominator of Equation 1 (The total error rate was calculated by dividing the number of doses with one or more errors by the TOE. Similarly, the rate of each type of error was calculated by dividing the number of errors of that particular type by the sum of the administered and omitted doses.

Error rate = [(Number of errors (<1 error/dose))/(Number of administered doses + omitted doses)]*100

Equation 1. Calculation of the general error rate

The following rates were calculated:

- Total error rate.
- Error rate by category types (omission, non-prescribed dose, etc.).

Sample size

To determine the rate of administration errors (% of success in the population (incidence) the period of time (day) was used as a reference. The sample size was calculated using the rationale of the previous study and based on the error rate of estimated medication (10%) from a pilot study of 50 observations[10]. A sample size of 139 doses would be required to achieve 80% power in a two-sided test with a 5% significance level. Dropout rate of 10% (data not valid), approximately 153 doses were considered for the study.

Statistical analyses

Data were analyzed using descriptive statistics. Errors were scaled by simple frequency per category. For each error category, the mean and standard deviation of the error rate were determined. The SPSS software for Windows, version 26, was employed. Initially, an analysis of the agreement between the two observers was conducted using the Kappa index. All variables were examined in univariate and multivariate formats. The level of significance was set at 5%. The *odds ratio* (OR) was calculated with 95% confidence intervals (CI) and the authors adopted the chi-square and Mann–Whitney tests for associations. The data were tabulated according to the relative frequency of the types of errors and CI. Subsequently, error rates were compared between the medical and surgical clinics, thereby estimating the significance level of the difference between the percentages (rates) for each clinic.

Multivariate analysis was performed to explore the possible factors associated with errors. The independent variables included characteristics of the medication (ATCC and administration route); characteristics related to administration (day of the week, round of medication, shift and time of administration and interruptions during preparation and administration); characteristics of the observed professional (years of experience and number of patients under the professional's care); and type of ward.

RESULTS

The administration of 561 doses of drugs in two in-patient facilities of a university hospital was analyzed. In total, 400 doses (71.3%) were administered in the surgical clinic unit and 161 (28.7%) in a medical clinic unit.The total medication administration error rate was 36.2% (95% CI: 32.3–40.2). Excluding schedule errors, the total error rate was 25.1 % (95% CI 24.3–32.4). In general, 203 errors were identified. Considering both wards, the most frequent errors were technique (15.5%), schedule (11.1%), dose (4.8%), and omission (4.5%) errors. Extra dose (0.7%), pharmaceutical form (0.5%), non-prescribed dose (0.4%), and route of administration (0.2%) errors were significantly less frequent (Table 1). When comparing the total medication administration error rates between the two inpatient units, it was observed that the clinical unit had 1.7 times more errors than the surgical unit (Table 2).

Table 1. Number and frequency (%) of MAEs, according to type, in two inpatient units. University Hospital Edgard Santos, Salvador, BA, Brazil. September 2019.

Error category	**n**	**%**
Error of administration technique	87	15.5
Time error	62	11.1
Wrong dose	27	4.8
Error of omission	25	4.5
Extra dose	4	0.7
Pharmaceutical form error	3	0.5
Non-prescribed dose	2	0.4
Administration route error	1	0.2
Total	203	100.0

Table 2. Number (N) and proportion (%) of medication administration errors, according to the inpatient unit. University Hospital Edgard Santos, Salvador, Bahia, Brazil. September 2019.

Unit type	**Surgical**		**Clinic**		**Total**	
Error	*N*	*%*	*N*	*%*	*N*	*%*
Yes	120	30.0*	83	51.6*	203	36.2
No	280	70.0	78	48.4	358	63.8
Total	400	100.0	161	100.0	561	100.0

* $p < 0.001$

Comparing the types of administration errors, there were statistically significant differences between the two in-patient units regarding the total error rate. Technique errors were four times more frequent in the clinical unit (Table 3).

Table 3. Number and frequency of MAEs, according to the type of error and in-patient unit. University Hospital Edgard Santos, Salvador, Bahia, Brazil. September 2019.

Error category	Surgical Unit		Clinical Unit		Total	
	N	%	N	%	N	%
Technique error	34/366	8.5*	53/108	32.9*	87/561	15.5
Time error	45/400	11.3	17/161	10.6	62/561	11.1
Extra dose	2/398	0.5	2/159	1.2	4/561	0.7
Pharmaceutical form error	3/397	0.8	-/161	-	3/561	0.5
Non-prescribed dose	2/398	0.5	-/161	-	2/561	0.4
Wrong route	-/400	-	1/160	0.6	1/561	0.2
Wrong dose	20/380	5.0	7/154	4.3	27/561	4.8
Dose omission	18/382	4.5	7/154	4.3	25/561	4.5
Total	120/400	30.0*	83/161	51.6*	203/561	36.2

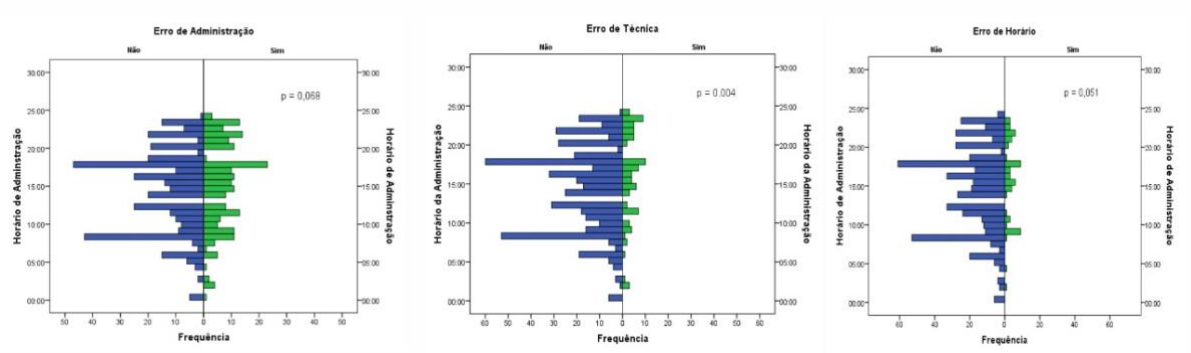
* $p < 0.001$

Considering the most frequently observed error categories in this study, we selected some examples of MAE. (Chart 1). When analyzing the occurrence distribution of MAEs, according to the time of dose administration, it was observed that technique errors were more frequent between 4:18 pm and 5:44 pm, while time errors occurred mostly between 2:27 pm and 5:28 pm. It can be observed that the two most frequent errors occurred predominantly in the afternoon shift. Hence, it was determined that the two most frequent errors occurred predominantly in the afternoon shift (Figure 1).

Chart 1. Examples of MAEs, according to the most frequent categories. University Hospital Edgard Santos, Salvador, Bahia, Brazil. September 2019.

Type of MAE	Examples
Technique error	Vancomycin (1 g) was prescribed to be given for 2 h by intravenous infusion and was administered for 40 min.
Time error	Clonidine (0.2 mg) was prescribed for 8:00 pm and was administered at 9:10 pm.
Error of omission	4 IU of regular insulin was prescribed for HGT = 190–250. The patient had HGT = 191.
Dose error	Atenolol (50 mg) was prescribed and a dose of 25 mg was administered.
Error of non-prescribed dose	Codeine (30 mg, without association) was prescribed and codeine (30 mg) + paracetamol (500 mg) was administered.
Route error	Oral metoclopramide (10 mg) was prescribed and intravenous metoclopramide (10 mg) was administered.

Figure 1. Distribution of MAEs, according to the time of dose administration.



The ATCC categories associated with higher frequencies of errors were digestive system and metabolism (category A) medicines, anti-infective medicines for systemic use (category J), and medicines of the nervous system (category N). These categories were concentrated with approximately 40% of the MAEs observed in all administered doses. Higher error frequencies were observed in the administration of drugs for the musculoskeletal system (category M) (50.0%) and for the sense organs (category S) (42.9%); however, the number of observations was negligible. Errors were observed in a quarter of the administrations for medicines of the blood and hematopoietic organs (category B) and those of the cardiovascular system (category C). (Table 4)

Table 4. Number (N) and frequency (%) of MAEs, according to the pharmacological class of the administered medication (ATCC, WHO, 2020).

ATCC Classification of Medicinal Products	Error				Total	
	No		Yes			
	N	%	N	%	N	%
M - Musculoskeletal system	3	50.0	3	50.0	6	100.0
S - Sense organs	4	57.1	3	42.9	7	100.0
A - Digestive system and metabolism	87	58.4	62	41.6	149	100.0
J - General anti-infectives for systemic use	44	58.7	31	41.3	75	100.0
N - Nervous system	87	58.8	61	41.2	148	100.0
C - Cardiovascular system	45	73.8	16	26.2	61	100.0
B - Blood and hematopoietic organs	57	74.0	20	26.0	77	100.0
R - Respiratory system	8	88.9	1	11.1	9	100.0
H - Systemic hormonal preparations*	16	94.1	1	5.9	17	100.0
Other	7	58.3	5	41.7	12	100.0
Total	358	63.8	203	36.2	561	100.0

* Excluding sex hormones and insulin

Factors Associated with the Occurrence of MAEs

The independent variables analyzed to assess the existence of risk factors for the occurrence of MAEs are presented in Table 5. The administration route and ATCC classification were risk factors with statistical significance for the occurrence of any error ($p < 0.05$); however, considering the measure of association and its CI, there are no differences between groups. The occurrence of interruptions was identified as a statistically significant factor for the occurrence of technique and schedule errors, 1.6 times more likely to trigger technique error and 2 times more likely to cause schedule error. A 1.8 times greater chance of technique error was identified when a technician was responsible for more than 4 beds.

Table 5. Risk factors associated with the occurrence of any error, technique errors, and schedule errors. Values are expressed as simple frequencies and percentages. (continua)

Risk factors	n (%)	Some Error		Technique error		Schedule Error	
		n (%)	OR (95%CI)	n (%)	OR (95%CI)	n (%)	OR (95%CI)
Administration hours			p = 0.761		p = 0.565		p = 0.859
Day	338 (60.2)	124 (36.7)	1.036 (0.826 – 1.298)	50 (14.8)	1	38 (11.2)	1.045 (0.645 – 1.692)
Night	223 (39.8)	79 (35.4)	1	37 (16.6)	1.122 (0.759 – 1.657)	24 (10.8)	1
Administration Shift			p = 0.881		p = 0.323		p = 0.783
Morning	144 (25.7)	51 (25.1)	0.998 (0.753 – 1.321)	17 (19.5)	0.737 (0.432 – 1.259)	15 (24.2)	1.003 (0.544 – 1.846)
Afternoon	186 (33.2)	70 (34.5)	1.060 (0.822 – 1.386)	33 (37.9)	1.108 (0.722 – 1.699)	23 (37.1)	1.190 (0.695 – 2.039)
Night	231 (41.2)	82 (40.4)	1	37 (42.5)	1	24 (38.7)	1
Day			p = 0.346		p = 0.977		p = 0.170
Monday	66 (11.8)	24 (11.8)	1	11 (12.6)	1	6 (9.7)	1
Tuesday	148 (26.4)	60 (29.6)	1.115 (0.767 – 1.621)	23 (26.4)	0.932 (0.483 – 1.799)	20 (32.3)	1.486 (0.626 – 3.530)
Wednesday	98 (17.5)	33 (16.3)	0.926 (0.607 – 1.414)	14 (16.1)	0.857 (0.415 – 1.770)	8 (12.9)	0.898 (0.327 – 2.469)
Thursday	131 (23.4)	50 (24.6)	1.050 (0.713 – 1.545)	18 (20.7)	0.824 (0.414 – 1.642)	17 (27.4)	1.427 (0.591 – 3.450)
Friday	59 (10.5)	17 (8.4)	0.792 (0.475 – 1.323)	11 (12.6)	1.119 (0.524 – 2.388)	4 (6.5)	0.746 (0.221 – 2.515)
Saturday	32 (5.7)	7 (3.4)	0.602 (0.290 – 1.246)	6 (6.9)	1.125 (0.457 – 2.769)	1 (1.6)	0.344 (0.043 – 2.736)
Sunday	27 (4.8)	12 (5.9)	1.222 (0.720 – 2.074)	4 (4.6)	0.889 (0.310 – 2.548)	6 (9.7)	2.444 (0.865 – 6.911)
Route of administration			**p < 0.001**				
Intravenous	208 (37.1)	127 (61.1)	2.290 (0.982 – 5.337)	85 (40.9)	-	26 (12.5)	-
Oral	275 (49.0)	54 (19.6)	0.736 (0.308 – 1.762)	2 (0.7)	-	30 (10.9)	-

Table 5. Risk factors associated with the occurrence of any error, technique errors, and schedule errors. Values are expressed as simple frequencies and percentages. (conclusão)

Risk factors	n (%)	Some Error		Technique error		Schedule Error	
		n (%)	OR (95%CI)	n (%)	OR (95%CI)	n (%)	OR (95%CI)
Subcutaneous	63 (11.2)	18 (28.6)	1.071 (0.425 – 2.704)	0 (0.0)	-	6 (9.5)	-
Other	15 (2.7)	4 (26.7)	1	0 (0.0)	-	0 (0.0)	-
ATCC Classification			**p = 0.023**			p = 0.463	
A	149 (26.6)	62 (30.5)	1.632 (0.898 – 2.968)	27 (31)	-	18 (29)	1.540 (0.521 – 4.551)
B	77 (13.7)	20 (9.9)	1.019 (0.507 – 2.048)	7 (8.0)	-	8 (12.9)	1.325 (0.399 – 4.399)
C	61 (10.9)	16 (7.9)	1.029 (0.495 – 2.139)	4 (4.6)	-	5 (8.1)	1.045 (0.721 – 6.778)
J	75 (13.4)	31 (15.6)	1.622 (0.849 – 3.099)	18 (20.7)	-	13 (21)	2.210 (0.721 – 6.6778)
N	148 (26.4)	61 (30)	1.617 (0.889 – 2.943)	31 (35.6)	-	14 (22.6)	1.206 (0.397 – 3.3664)
Other	51 (9.1)	13 (6.4)	1	0 (0)	-	4 (6.5)	1
Interruptions			**p = 0.001**		**p = 0.04**		**p = 0.01**
Yes	83 (14.8)	44 (53)	1.594 (1.255 –2.024)	19 (22.9)	1.609 (1.024 – 2.529)	16 (19.3)	2.003 (1.192 – 3.366)
No	478 (85.2)	159 (33.3)	1	68 (14.2)	1	46 (9.6)	1
Beds per technician			p = 0.228		**p =0.023**		p = 0.908
< 4	104 (18.5)	34 (16.7)	1	13 (14.9)	1	12 (19.4)	1
4	322 (57.4)	112 (55.2)	1.064 (0.77 – 1.456)	43 (49.4)	1.068 (0.598 – 1.907)	34 (54.8)	0.915 (0.492 – 1.701)
> 4	135 (24.1)	57 (28.1)	1.292 (0.920 – 1.813)	31 (35.6)	1.837 (1.013 – 3.331)	16 (25.8)	1.027 (0.508 – 2.076)

Technique and Time Errors

Considering the schedule errors, the most important factors associated were the technicians' *interruptions* during the medication preparation and administration processes. Regarding the technique errors, the most important factors were *the route of administration, interruptions, and workload (ratio of number of patients/assisted beds per technician).*

ATCC

Medicines of therapeutic group A (digestive system and metabolism) and N (nervous system) were the most related to the occurrence of errors, with proportions of 30.5% and 30%, respectively ($p = 0.023$).

Route of Administration

Intravenous administration was 5.71 times more associated with errors than non-intravenous administration. (Table 6) Considering the in-patient unit, there was a 1.6 times higher risk of error in intravenous administration in surgical wards than in medical clinic wards. (Table 7)

Table 6. Number (N) and frequency (%) of MAEs, according to the route (intravenous and non-intravenous administration).

Administration error	No		Yes		Total	
Route of administration	N	%	N	%	N	%
Intravenous	277	74.4	76	37.4	353	62.9
Not intravenous	81	22.6	127	62.6	208	37.1
Total	358	100	203	100	561	100.0

$p < 0.05$; Direct Observation 5.71 (95% CI 3.9–8.3) risk for intravenous route compared to non-intravenous route

Table 7. Number (N) and frequency (%) of MAEs, according to the route (intravenous and non-intravenous administration) and in-patient unit.

Administration Route	Surgical		Clinic		Total	
	N	***%***	***N***	***%***	***N***	***%***
Intravenous	59	49.2	17	20.5	76	37.4
Not Intravenous	61	50.8	66	79.5	127	62.6
Total	120	100.0	83	100.0	203	100.0

$p < 0.05$; OD = 1.61 (95% CI 3.9–8.3) of intravenous route risk in surgical ward when compared to clinical

DISCUSSION

This study, conducted in two inpatient units of a university hospital, identified a total rate of MAEs of 36.2% (203/561), which is relatively high, even when scheduling errors (25.1%) are excluded. This finding is similar to those described in studies carried out in Brazil and other countries[4,11-14].

However, it should be noted that there is a wide variation in the rates of MAE deduced from both international (8.6% to 28.3%) and national (9% to 64%) studies. In studies conducted in Latin America, including Brazil, using the same methodology, the average rate of MAE was approximately 30%[7,15-18], which is three times the average rates in developed countries (10%) [14,19].

The large variation identified in the studies may be related to methodological factors such as different definitions and/or adopted MAE classification, including the approach employed in calculating the error rates, as well as the inclusion and exclusion criteria adopted[20].

Technique, schedule, dose, and omission errors occurred more frequently than other errors. Most technique errors were related to injectable drugs whose administration speeds were inadequate when compared to the permissible speed rate determined by the hospital dilution manual[21]. It was observed that technique errors occurred 3.5 times more often in the clinical medicine unit than in the surgical unit. Although the university hospital has a dilution manual and a Patient Safety Program, there was a substantially high rate of technique errors when compared to other national studies[7]. Technique errors, especially in the case of intravenously administered doses, have a significantly high potential to cause harm. Taxis and Barber determined the lack of training of the nursing team as one of the main causes of errors in intravenous drug administration[14]. These errors may also be associated with the complexity in the preparation and administration of these medications.

The cause of technique errors can be multifactorial, thereby requiring further studies[4,19,22]. A study on the evaluability of the Medication Dilution Manual of HUPES determined the need for team training on the proper use of the manual as the main result reported by physicians, pharmacists, nurses, and nursing technicians, which can contribute to minimizing the technique errors, because, as identified in this study, these errors were often related to non-compliance with the recommendations described in the dilution manual[23].

The schedule error was the second most frequent error, and it occurred significantly more in the afternoon shift, precisely at 14:27 ± 5:28 pm, while technique errors occurred more at

16:18 ± 5:44 pm. The scheduling error is frequently identified in most studies and is usually not severe. However, it may become increasingly serious for some medications, especially those that need to be administered in a very narrow time window to achieve the desired therapeutic result and/or avoid adverse events[4,11]. In these cases, some institutions specify the medications that are considered critical in terms of administration time, such as those that can cause harm or have a significant negative impact on their therapeutic or pharmacological effect, if they are administered early or late (more or less than thirty minutes from the scheduled time)[24]. Hence, "potentially dangerous" medications are important because maintaining the therapeutic effect depends on the accuracy of the schedules relative to feeding or the maintenance of plasma levels[25].

The third most frequent error was the dose error, whose rate was 4.8%, occurring both in the administrations of injectable and solid-oral medications. Eight studies conducted in Latin American hospitals determined a huge variation in dose errors, ranging from 1.7% to 50%. It is unclear how this variation can be explained: whether by differences in the concept of dose error or by the inclusion of the administration of extra dose in this same category[7,15-17, 26-30]. Berdot and collaborators in a meta-analysis, deduced an average in dose error rate of 1.4%, three times lower than that identified in this study[19]. Dose errors are crucial, both for treatment effectiveness and patient safety.

The fourth most frequent error was omission, with 4.5% rate on average - less than half the rates identified in other studies that adopted the direct observation method (10% of omitted doses)[7, 13, 15, 19, 31]. Errors of omission are frequent and can cause harm to patients, especially if they involve the intravenous route. The causes and contributing factors of these errors are well known and mostly related to communication problems[32].

Associated Factors

The risk factors associated with the MAEs presented in this study were route of administration, interruptions, workload (number of beds per nursing technician), and drug class (ATCC).

Complexity in preparation and administration is, by itself, a risk factor. Complexity is mainly observed with drugs administered intravenously. In this study, this route of administration had 5.71 times ($p < 0.05$; 95% CI 3.9–8.3) higher risk of error than the non-intravenous route. In the reviewed studies, the rates of administration errors by the intravenous

route varied widely, ranging from 1% to 70%. Again, this variation is probably attributed to methodological differences between them. A number of authors have studied intravenous medications alone[33], whereas others have studied both intravenous and non-intravenous medications[14]. In some studies, error rates were determined in both the preparation and administration phases, while in others, rates were solely calculated in one phase[34]. Finally, there were differences in the definitions and classification of errors among the various studies[7,13-15].

Even considering that these differences make comparisons difficult, research evidence suggest that the intravenous route should be prioritized in hospital strategies to reduce errors with higher potential for causing harm[20]. The hospital where the study was conducted recently published a Procedures Manual for Intravenous Administration; however, a high rate of errors by this route was still observed, particularly in the surgical clinic when compared to the medical clinic. These differences between in-patient units may be associated with their characteristics in terms of patient profiles, with more frequent intravenous administrations in the surgical unit than in the medical clinic unit, including the organization of nursing work, knowledge, and skills of nursing technicians, and already known risk factors for MAEs[22].

The analysis indicated that doses administered by nursing technicians with interruptions during administration had 1.59 times (95% CI 1.255–2.024), 1.61 times (95% CI 1.02–2.53), and 2.00 times (95% CI 1.19–3.37) more route of administration, technique, and schedule errors, respectively, compared to those administered without interruptions, thereby demonstrating that this risk factor offers a higher occurrence probability of errors, thereby causing harm to patients[33,35-37].

Few Brazilian studies have explored the risk factors associated with MAEs. A single study demonstrated that the nursing workload generally increases the risk of MAE occurrence, by a factor of 7, which is higher in the case of schedule errors (8 times). These findings are consistent with those of the international literature[7,37,38].

Another important factor is related to the number of assisted beds per professional. In this study, a 1.8 times higher risk of technique errors was determined in cases where there were more than a four-bed distribution per professional, compared to cases in which there were up to 4 beds per professional. The number of patients under the care of a single nursing professional also related to the occurrence of any type of error and scheduling errors, but without statistical significances in these cases. These risk factors were also identified in a study conducted by Grou Volpe et al[7]. Increased workload was also related to a higher risk of scheduling and preparation errors.

When correlating therapeutic classes to MAEs, it was deduced that the drugs for the digestive system and metabolism (A) and those for the nervous system (N) were the most associated with technique errors, while those of classes A, N, and J (anti-infective of systemic use) were more associated with schedule errors. In a study conducted at a university hospital in Brasília, Volpe et al[7] determined that the therapeutic classes most related to schedule errors were the drugs for the cardiovascular system (C), nervous system (N), and injectable antibiotics (J).

The findings of this study are important because they indicate that the most frequent errors such as technique and schedule errors are related to the therapeutic class of the medication, interruptions, and route of administration. It is known that the severity of errors is significantly higher when the medication is intravenously administered [1,7]. Prevention strategies should be aimed at controlling these contributing factors, especially for potentially dangerous drugs and intravenously administered drugs.

Although the university hospital has an active patient safety program, a pharmacy service with clinical pharmacists in in-patient units, and an available medication administration manual (dilution manual), this study still identified a high rate of MAEs, thereby demonstrating the need for further studies focusing on MAEs with higher severity and potential risk of causing harm.

This study made important contributions, as it was the first to calculate the occurrence of MAEs in our hospital. Its results reinforce the need to conduct new studies with the same methodology, to facilitate designing interventions that reduce the current error rate to permissible levels.

Although it followed an internationally validated methodology in identifying MAEs, the present study was solely conducted in two units of a university hospital, which limits the possibilities of comparing and extrapolating results to other healthcare environments. The possible adverse influence of the presence of an observer on the observations was minimized by the training of the observers, who were guided to adopt an ethical and non-obstructive approach.

CONCLUSION

The total MAE rate was high, with technique, schedule, dose, and omission errors being the most frequent, especially in the clinical medicine unit, which agrees with the results of other national and international studies. In addition, it is noteworthy that the highest risk of error was observed in intravenous drug administrations.

Specifically, regarding the hospital studied, these findings indicate the need to develop a safer medication use system that ensures less risk to patients and professionals in the studied environment. In general, although the study was conducted in a single hospital, the details provided by the types of errors and their severity can be beneficial in other contexts, thereby ensuring the adoption of more specific risk minimization strategies.

Declarations

Funding

This work was supported by the Instituto Nacional de Assistência Farmacêutica e Farmacoeconomia (INAFF). The views expressed are those of the author(s) and not necessarily those of the INAFF.

Ethics approval

The study was submitted to the Research Ethics Committee of the University Medical Center (Professor Edgard Santos) and was approved under opinion number 3,102,570/2019. For ethical reasons, if any error with harmful potential was identified by the field researcher, the researcher would intervene, thereby preventing administration and averting the occurrence of harm to the patient.

Availability of data and materials

The dataset(s) supporting the conclusions of this article is(are) included within the article (and its additional file(s)

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APPENDIX I - DATA COLLECTION FORM

Date:	**Observer:**	**Ward census:**
Which round?	**Nurse/auxiliary:**	**Page _____ of _____**

Schedule	**Sample**	**Pack ID / bed**	**Did you check the ID?**	**Medicines (details)**	**Admin. obs.?**	**Will you sign?**	**Cod.**

APPENDIX II – CATEGORIES OF MEDICATION ERRORS

- **Omission:** A dose of medication that has not been administered by the time of the next scheduled dose. Doses according to physician instructions, nurse clinical judgment, or the absence of the patient from the ward, are not included in this category.

- **Unprescribed dose:** The administration of a drug dose that was never prescribed for the patient. It is classified as a wrong drug if drug X was given instead of the prescribed drug Y.

- **Extra (dose):** The administration of an additional dose to the prescribed medicine. It includes taking the medicine more times a day than prescribed and taking another dose when the prescription is terminated.

- **Dose (wrong):** Any dose of a correct drug via the correct route, but in a different amount than prescribed (Inappropriate amount or number). For injectable drugs, any dose that is ±10% or more of the correct dose; for any other pharmaceutical form, any dose that is ±17% or more of the correct dose in the observer's judgment. In the judgment of doses, the measurements obtained with devices or appliances usually used in the institution should be considered (graduation in syringes, dosing burette, dropper, etc.)

- **Route (wrong):** The administration of a correct drug via a route or place of administration that differs from the prescription. Administration of a drug via the oral route when the prescription required the intramuscular route. Included in this category is the administration of eye drops to the left eye when it was prescribed to be applied to the right eye.

- **Pharmaceutical form (wrong):** The administration of the correct dose of a drug via the correct route, but not prescribed in a pharmaceutical form, especially when this has been specified. Included in this category is the administration of a slow-release pharmaceutical form when a rapid release form had been prescribed.

- **Technique (wrong):** Exclusion or inadequate performance of a prescribed procedure immediately before the administration of each dose. For example, taking a pulse before administering a beta-blocker.

- **Time (wrong):** the administration of a dose more than 60 min before or after the time scheduled by the nurse. For medications prescribed to be taken before, after, or at food, the administration of a dose more than 30 min before or after food. The time for comparison is the time used by the nurse in the prescription.

3.3. ARTIGO 3: VALIDATION OF A METHOD TO ASSESS THE SEVERITY OF MEDICATION ADMINISTRATION ERRORS IN BRAZIL: A STUDY PROTOCOL

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Citação: Assunção-Costa L, Ribeiro Pinto C, Ferreira Fernandes Machado J, Gomes Valli C, Portela Fernandes de Souza LE, Dean Franklin B. Validation of a method to assess the severity of medication administration errors in Brazil: a study protocol. J Public Health Res. 2022 Mar 14;11(2):2623. doi: 10.4081/jphr.2022.2623. PMID: 35286053; PMCID: PMC8973210.

ABSTRACT

Background: Medication errors are frequent and have a high economic and social impact and is critical to know their severity. A variety of tools exist to measure and classify the harms associated with medication errors, but few are internationally validated. **Design and methods:** It was decided to validate a method proposed by Dean and Barber for assessment of the potential severity of medication administration errors. A number of thirty health care professionals (doctors, nurses and pharmacists) from Brazil will receive an invitation to take part by scoring 50 cases of medication errors gathered from an original UK study regarding their potential harm to the patient on scale 0 to 10. Sixteen cases with known actual harm outcomes will be used to assess the validity of their scoring. By looking at 10 errors (out of the 50 cases) scored twice, reliability shall be assessed; and potential sources of variability in scoring will be evaluated depending on the severity of each of error case, the occasion when the scores were given, the scorer, their profession, and interactions among these variables. Generalizability theory will be used for analysing data. **Expected Impact of the study for Public Health:** This study was submitted to the evaluation of the Research Ethics Committee of the Complexo Hospitalar Universitário Professor Edgard Santos and approved under no. 3.102.570/2019. This is the first validation of this method for use in Brazil, will allow researchers to conduct more standardised evaluations of interventions to reduce the impact of medication errors.

Keywords: medication errors; hospitals; medication administration errors; patient outcome assessment; medication-related harm.

INTRODUCTION

Several studies conducted in hospitals have shown that medication errors are frequent and have high economic and social impact[1-7]. Recently, the World Health Organization launched the global "medication without harm" challenge with the goal of reducing medication-related harm by a half by 2022. For institutions to achieve this goal, it is critical not only to know the frequency and nature of errors but also their severity[8].

Among the steps in the medication process in hospitals, the administration of medications is considered a critical step, subject to a high occurrence of errors and the highest probability of patient harm because it is the last step before the error reaches the patient. This is due, in part, to the complexity in medication administration processes and the absence of many of the barriers that could prevent errors from occurring[9].

Assessing the severity of medication errors is a crucial point in improving patient safety during medication use. This assessment makes it possible to differentiate errors in relation to their severity, and thus to establish risk minimization strategies targeting those errors with the greatest potential to harm patients[10]. The term "error severity" refers to the extent of the potential or actual impact of medication errors. However, in many studies it is not clear when reporting the prevalence and severity of medication errors whether what is being assessed is actual or potential harm to the patient[11]. This distinction between actual and potential harm is crucial because an actual harm has an obvious severity when compared to a potential harm. Medication errors that actually cause harm represent a small fraction of errors, and many are intercepted before reaching the patient[11]. The assessment of potential harm and actual harm are different processes, each one involving two steps: 1) identifying the potential or actual harm to the patient related to a medication error; 2) rating the degree or severity of that harm[12].

A variety of tools exist to measure and classify the harms associated with medication errors. A systematic review on harm related to prescription errors identified over 40 harm classification tools used prior to 2013[13]. The authors sought to identify acceptable inter-examiner reliability and validity through reviewer judgment of potential harm compared to actual harm in situations where actual harm was known. Only two of these tools met the criteria of inter-reviewer reliability and validity: the National Coordinating Council for Medication Error Reporting and Prevention (NCC MERP)[14] for classifying actual harm and the Dean and Barber 10-point scale for classifying potential harm[15,16].

The NCC MERP and DEAN and BARBER methods are the only methods that have been validated internationally[13]. The NCC MERP method classifies an error according to the severity

of the outcome. It considers factors such as whether the error reached the patient, if the patient was harmed, and to what degree. This method classifies errors into 9 categories (A to I) where A means no error and I, error causing death. The Dean and Barber scale assesses the potential severity of medication administration errors by calculating the mean subjective score of four different healthcare professionals (including pharmacists, nurses and physicians). This method has already been used to assess the potential clinical significance of medication administration errors identified in studies conducted in the UK[15] and Germany[17] and has been shown to be valid and reliable in the contexts in which these studies were conducted.

A recent systematic review on medication administration errors detected by the direct observation method in Latin American hospitals identified 10 studies that estimated the rate of medication administration errors (MAEs); however, none of them assessed the severity of these errors[18].

As far as we are aware, this is the the first scientific work on the validity of a scale to assess the severity of MAEs in South America and particularly in Brazil. In this context, we have decided to use the method developed by Dean and Barber[15] for assessing the potential severity of MAEs because it is a more appropriate method for research when compared to the NCC MERP, it has been validated in studies conducted in other countries (UK and Germany) for this purpose, and it may later be used to assess the potential severity of medication errors, which do not have a known outcome, in Brazilian hospitals. Considering the differences between Brazil and countries such as Germany and the United Kingdom regarding health systems, professional training and performance, and cultural context, it is necessary to validate the method within the Brazilian context.

Thus, this study aims to validate the existing Dean and Barber method for assessing the potential clinical significance of medication errors developed in the UK for use in Brazil, using the same procedures involved in developing and testing the method in the UK. For due that our specifics objectives will be: a) To determine the minimum number of judges required to produce a reliable mean severity score in the Brazilian context; b) to determine whether the judge's profession has an effect on the score; c) to determine if the repeated assessment has an effect on the score and d) to explore the validity of the mean severity score[15].

DESIGN AND METHODS

The existing method

When creating their method Dean and Barber[15] chose 50 medication error cases from the literature in nearly equal numbers showing minor, moderate and severe potential clinical outcomes; in 16 of these cases, the patient outcome was already known. These cases were then sent to 30 different healthcare professionals (ten physicians, ten nurses and ten pharmacists). These judges were asked to score the potential clinical significance on a visual analogue scale ranging from 0 to 10 (with 0 corresponding to "no harm" and 10 corresponding to "patient death").

Specifically, this error severity classification involves: 1) Minor - very unlikely that the patient will develop any adverse event; 2) Moderate - likely to cause an adverse event in the patient or interfere with the therapeutic goal, but very unlikely to cause death or harm lasting more than a week; 3) Serious - error that could lead to permanent harm or death to the patient. A subset of ten cases was evaluated on a second occasion by all judges. The data were analyzed using generalizability theory[19].

Generalizability Theory

Cronbach et al[19] developed generalizability theory, a method that systematically allows the effect of multiple sources of variance and their interactions on scores to be measured at the same time in a single study, based on the premise that in any assessment procedure, variance in scores can be attributed to different identifiable sources.

Generalizability theory also emphasizes the estimation of variance components. Once the variance attributed to each of these sources can be calculated, the most efficient way to reduce unwanted variation can be determined. The results of this can be used to identify methods for improving the reliability of a test[20].

The application of generalizability theory takes place in stages. In the first, a generalizability analysis begins with the specification of a universe of admissible observations through the identification of different sources of variation. In the second stage, a generalizability or G-study estimate variance components for this universe. This involves creating an appropriate research design, collecting data, and determining the extent to which each of the variables influences the score. Different coefficients of variation can be calculated representing the different situations. For example, a coefficient can be calculated showing the

extent to which one can generalize the score assigned to a case by a physician to the score assigned to the same case by a pharmacist. The final step is a decision (or D-study) associated with a prespecified universe of generalization[19,20.] Broadly speaking, D studies emphasize the estimation, use, and interpretation of variance components for decision-making with well-specified measurement procedures. Perhaps the most important D study to consider is the specification of a universe of generalization, where the universe to which a decision-maker wants to generalize based on the results of a D study using a particular measurement procedure[20].

From the estimated variance, the effect of a change in the number of observations on the generalization coefficient can be explored. For example, the change in the generalization coefficient can be determined by changing the number of judges. This is done by dividing each term (variance) by the number of observations. This step allows exploration of the conditions that can achieve a sufficient level of reliability.

Case selection

The original instrument will be used, keeping the described cases. These cases will be translated into Portuguese, updated (if the drugs are no longer available or not in routine use), and adapted to the Brazilian context (making any necessary adjustments regarding the drugs, doses, concentrations, units of measurement, pharmaceutical forms and available presentations). The maintenance of the cases submitted to evaluation will allow comparison with the previous studies carried out in the UK and Germany.

Translation of the cases to Portuguese

All 50 cases will be translated by the principal investigator and adapted if needed. (Appendix A presents the original cases and the translation into Portuguese). The reason for doing so is because some of the drugs mentioned in the original cases may not be used in Brazil. The translated and adapted version will then be submitted to the evaluation by two experienced hospital pharmacists regarding the pharmaceutical product, drug concentration, route of administration, pharmaceutical dosage to make sure the degree of severity remains unchanged; and, in case there is no consensus, they will be sent to a more experienced pharmacist with expertise in clinical medicine and patient safety.

After this process, the document will be translated back to English; and, to ensure that this process has preserved the essential characteristics of the errors described in the original version, the adapted document will be sent to the authors of English version.

Recruitment of the evaluators

After contacting and receiving the permition of the chief of services in each hospital, thirty health professionals (10 physicians, 10 nurses, 10 pharmacists) with at least three years of clinical practice will be invited and recruited from different public and private hospitals, from all five Brazilian geographic regions. Health professionals from specialized areas such as pediatrics and oncology and with less than three years of clinical practice will not be included in the sample. In each hospital, two physicians, two nurses and two pharmacists will be initially selected. Next, the indicated physicians, nurses, and pharmacists will be contacted via email, a letter will be sent to participants for their consent, plus a document explaining the objectives of the study, the method for assessing the severity of medication administration errors based on the scoring scale, and practical examples of how to perform the scoring.

The professionals who agree to participate in the evaluation will be grouped according to profession, degree of training and the country's region, and a stratified random sample of thirty professionals (ten physicians, ten nurses, ten pharmacists) will be selected using SPSS software. Those not randomly selected will be informed through a thank you letter for agreeing to participate in the study. No incentives will be offered to professionals to participate in this study.

Scoring process

The 30 professionals initially selected will receive a file with the descriptions of the 50 cases of MAEs and will be instructed to score the cases in terms of their potential clinical significance, using the scale proposed by Dean and Barber[15]. The scores provided by those professionals will then be analyzed.

Two weeks after the receiving of the severity assessments based on the fifty cases, each respondent will be sent ten of the cases randomly selected, for rescoring. In this way it will be possible to measure whether the occasion on which the cases were scored was an important source of variance of the responses obtained.

Evaluators will be asked to record the time spent assessing all fifty cases and invited to make relevant comments about the scoring process in a specific space of the form and complete a short questionnaire on demographic details, including their occupation and the number of years of work experience (Appendix B).

Reliability analysis

Universe of observations

The analysis in this study will be identical to that of the original study[15]. The sources of variance in the process of assessing the severity of medication administration errors will be considered as inherent in the cases themselves (CASE), the occasion on which they are assessed (OCASION), the evaluator (JUDGE), the professional background of the judge (PROFESSION), and the interactions among these sources. Since each judge is a member of a single profession, the JUDGE factor is considered nested with the PROFESSION factor (JUDGE:PROFESSION).

Since the scores for the fifty cases of errors will be obtained on two occasions in a sample of ten cases, there are two models for conducting the G-study, depending on the data set used:

Model 1: OCASION X CASE X JUDGE (using the ten cases scored twice).

Model 2: CASE X JUDGE:PROFESSION (using all 50 cases)

Model 1 ignores the effect of different professions, while model 2 ignores the effect of occasion. A model that would take into account all sources of variance for the ten cases with repeated scores, OCASION X CASE X JUDGE:PROFESSION, will not be used because the variance per case is anticipated to be too high to perform an analysis of variance.

G Study

The data will be evaluated considering models 1 and 2 in order to determine the contributions of each factor to the variance in scores. First, repeated measures of variance analysis will be performed, using SPSS software (version 26.0, SPSS mc, Chicago).

An analysis of variance will be performed and seven sources of variance will be estimated for model 1, being these: case, occasion, occasion x case, judge, judge x case, occasion x judge, and judge x case x occasion. For model 2, the sources of variance are: profession, judge 'nested' in profession, case, case x profession, and a residual variance (case x judge:profession). The

equations used to calculate each variance (estimated mean square) will be provided with the results. Equations to calculate the generalizability coefficients are provided in Annex A. The data will be analyzed using the Statistical Package for the Social Sciences (version 26.0, SPSS mc, Chicago).

The resulting mean square values will then be used to calculate the attributable variance for each source, using equations for the mean squares based on that described by Streiner and Norman[21] and Cronbach et al[19]. When the estimated variance components are computed as negative, a value of zero will be assumed[22]. An overall generalizability coefficient, coefficients equivalent to inter-examiner reliability and test-retest reliability will be computed.

D Study

In a D study, the effects of different modifications in the evaluation procedure on the generalizability coefficient will be investigated, and the accuracy of the obtained measurement results will be evaluated. Therefore, different scenarios based on the results of study G will be investigated in study D. The same model of study G will be used to calculate the generalizability coefficients for different numbers of judges and different occupations. This will be done to allow identification of how many judges were needed to obtain a reliable average score. Study D will also investigate whether judges need to be of different professions or of the same profession. Generalizability coefficients for different numbers of judges and different numbers of test occasions will be calculated using the formula described by Streiner and Norman[21]. As in previous studies, a generalizability coefficient greater than 0.8 will be considered to represent acceptable reliability[15].

Validity Analysis

A sample of 16 medication administration errors with known outcomes will be included among the cases that will undergo evaluation by the judges. The premise is that if the scoring method is valid, the scores assigned to cases with known outcomes should reflect the relative severity of those outcomes. In this way, it will be possible to test the validity of the method by comparing the scores assigned by the 30 raters to the 16 MAEs with previously established scores.

The researchers in the original study grouped the 16 cases that had a known severity into cases with a 'minor' outcome, meaning the errors resulted in no adverse effects, 'moderate',

meaning the errors resulted in some adverse event with no lasting impairment, and cases with a 'severe' result, meaning the errors resulted in death or lasting impairment. The cases with known severity were distributed as follows: 5 cases with minor severity, 5 cases with moderate severity, and 6 cases considered severe[15]. The average scores assigned to these 16 cases by the raters will be compared to the known outcomes described for the same 16 cases in the original study.

ETHICS AND DISCLOSURE

This study is part of a larger study on MAEs in a university hospital: incidence, severity, and associated factors, which was submitted to the evaluation of the Research Ethics Committee of the Complexo Hospitalar Universitário Professor Edgard Santos and approved under opinion number 3.102.570/2019.

We believe that the results of this study will be particularly important for an audience of professors, researchers, and health professionals from health institutions in Brazil. These results will be published in international peer-reviewed journals, as well as disseminated through scientific congresses focused on patient safety and quality of healthcare services.

The validation of this scale in Brazil will allow the expansion of research in the area of patient safety with the aim of measuring the potential harm related to medication errors, particularly medication administration errors in hospitals and health care institutions.

Patients and Public involvement

Patients and the public were not involved in co-production of this protocol.

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APPENDIX A - 50 CASES OF ADMINISTRATION ERRORS: ORIGINAL VERSION IN ENGLISH AND VERSION INTO ENGLISH AFTER ADAPTATIONS TO BRAZILIAN REALITY

Original	Version translated into english after adaptations to the brazilian reality
1. A hypertensive patient had his blood pressure controlled with enalapril 2.5mg once daily. One dose was missed	1. A hypertensive patient had his blood pressure controlled with enalapril 5mg once daily. One dose was missed.
2. An elderly patient with a cardiac pacemaker was prescribed enteric coated aspirin 75mg once daily. One dose was omitted.	2. An elderly patient with a cardiac pacemaker was prescribed enteric coated acetylsalicylic acid (ASA) 100mg once daily. One dose was omitted.
3. A patient was prescribed lithium carbonate 600mg daily (one tablet) but was given a single dose of 1200mg (two tablets).	3. A patient was prescribed lithium carbonate 600mg daily (two 300mg tablets) but was given a single dose of 1200mg (four 300mg tablets).
4. The first two doses of chloramphenicol eye ointment, prescribed to be administered four times a day, were omitted in a patient with a suspected conjunctivitis.	4. The first two doses of chloramphenicol eye ointment, prescribed to be administered four times a day, were omitted in a patient with a suspected conjunctivitis.
5. An elderly patient with swallowing difficulties was prescribed ranitidine effervescent tablets 150mg twice daily, for the prophylaxis of ulceration while on diclofenac therapy. An ordinary non-soluble ranitidine tablet was given instead, which the patient swallowed with some difficulty.	5. An elderly patient with swallowing difficulties was prescribed ranitidine effervescent tablets 150mg twice daily, for the prophylaxis of ulceration while on diclofenac therapy. An ordinary non-soluble ranitidine tablet was given instead, which the patient swallowed with some difficulty.
6. A patient had been receiving warfarin 5mg daily, which was stopped when her INR was found to be 5.4. However, for three days she continued to receive a daily dose of warfarin 5mg.	6. A patient had been receiving warfarin 5mg daily, which was stopped when her INR was found to be 5.4. However, for three days she continued to receive a daily dose of warfarin 5mg.
7. A patient was prescribed vitamin B compound strong tablets, two daily. One dose of only one tablet was given.	7. A patient was prescribed vitamin B compound strong tablets, two daily (high dosage of vitamin B compound). One dose of only one tablet was given.
8. A patient with oral Candida was prescribed fluconazole 50mg daily for one week. Fluconazole 200mg capsules were dispensed, which the patient received for the week's course.	8. A patient with oral Candida was prescribed fluconazole 50mg daily for one week. Fluconazole 150mg capsules were dispensed, which the patient received for the week's course.
9. A patient prescribed Lacrilube eye drops for her dry eyes was given instead one dose of 30ml lactulose orally.	9. A patient prescribed Lacrifilm® lubricating eye drops for her dry eyes was given instead one dose of 30ml lactulose orally.
10. A patient with an itchy rash was prescribed calamine lotion to be applied three times a day. The first five doses were omitted	10. A patient with an itchy rash was prescribed calamine lotion to be applied three times a day. The first five doses were omitted
11. A patient with a history of heart failure was administered a dose of oral atenolol 100mg which was intended for another patient	11. A patient with a history of heart failure was administered a dose of oral atenolol 100mg which was intended for another patient
12. A patient was prescribed six doses of oral folinic acid (15mg three times a day) as rescue therapy following methotrexate treatment. The patient instead received six doses of folic acid 15mg.	12. A patient was prescribed six doses of oral folinic acid (15mg three times a day) as rescue therapy following methotrexate treatment. The patient instead received six doses of folic acid 15mg.

Original	Version translated into english after adaptations to the brazilian reality
13. An elderly patient prescribed oral co-amilofruse 2.5/20 (Frumil LS) once a day, for the treatment of mild heart failure, was instead given a dose of co-amilofruse 5/40 (Frumil).	13. An elderly patient prescribed 20mg furosemide once a day, for the treatment of mild heart failure, was instead given a dose of 40mg furosemide
14. A patient was prescribed soluble insulin 10 units every six hours. This was initially interpreted as 10ml (1000 units), but the mistake was realised and the injection stopped after 2ml (200 units) had been given.	14. A patient was prescribed soluble insulin 10 units every six hours. This was initially interpreted as 10ml (1000 units), but the mistake was realised, and the injection stopped after 2ml (200 units) had been given.
15. A patient prescribed 5mg morphine IV was given intravenously 5mg of Oramorph (oral morphine solution 10mg/5ml) solution.	15. A patient prescribed 5mg morphine IV was given intravenously 5mg of Oramorph (oral morphine solution (Dimorf® 10mg/ml).
16. A patient was being treated for acute sciatica by lumbar epidural injection of methylprednisolone acetate. The vial of drug was reconstituted with 30% sodium chloride instead of 0.9% sodium chloride and then administered.	16. A patient was being treated for acute sciatica by lumbar epidural injection of methylprednisolone acetate. The vial of drug was reconstituted with 20% sodium chloride instead of 0.9% sodium chloride and then administered.
17. A patient with chronic obstructive airways disease was prescribed Augmentin 250/62 suspension, 5ml three times daily for the treatment of a chest infection. The first five doses were omitted.	17. A patient with chronic obstructive airways disease was prescribed Clavulin® (amoxicillin and potassium clavulanate 250/62) suspension, 5ml three times daily for the treatment of a chest infection. The first five doses were omitted.
18. One 10pm dose of oral metronidazole 400mg was omitted in a patient receiving the drug three times daily for surgical prophylaxis. He was three days post surgery.	18. One 10pm dose of oral metronidazole 400mg was omitted in a patient receiving the drug three times daily for surgical prophylaxis. He was three days post-surgery.
19. A patient with a known penicillin allergy was prescribed oral ciprofloxacin 500mg twice a day for the treatment of a chest infection. He was given one dose of flucloxacillin 500mg.	19. A patient with a known penicillin allergy was prescribed oral ciprofloxacin 500mg twice a day for the treatment of a chest infection. He was given one dose of oxacillin 500mg.
20. A patient was prescribed 100mg lamotrigine daily. Lamotrigine 100mg tablets were dispensed instead of the 25mg tablets intended. The patient therefore received 400mg daily for six days instead of 100mg daily.	20. A patient was prescribed 100mg lamotrigine daily. Lamotrigine 100mg tablets were dispensed instead of the 25mg tablets intended. The patient therefore received 400mg daily for six days instead of 100mg daily.
21. One dose of oral hydrocortisone 10mg was omitted in a patient with chronic adrenal insufficiency who was prescribed 20mg every morning and 10mg every evening.	21. One dose of oral hydrocortisone 10mg was omitted in a patient with chronic adrenal insufficiency who was prescribed 20mg every morning and 10mg every evening.
22. An elderly patient prescribed paracetamol suspension 250mg/5ml in a dose of 10ml (500mg) every six hours was given one dose of 20ml (1g).	22. An elderly patient prescribed paracetamol suspension 100mg/ml in a 5ml (500mg) dose every six hours was given one 10ml (1g) dose.
23. One dose of oral metformin 500mg was omitted in a diabetic patient receiving 500mg three times daily.	23. One dose of oral metformin 500mg was omitted in a diabetic patient receiving 500mg three times daily.
24. A patient prescribed 10ml of morphine elixir 2.5mg/5ml (5mg morphine) was given instead a dose of 10ml of the concentrated elixir 100mg/5ml (200mg morphine).	24. A patient prescribed 2ml of morphine IV (1mg/ml vials, with 2mg morphine content) was given instead a 20ml (200mg de morphine) dose from an IV 10mg/ml vial.

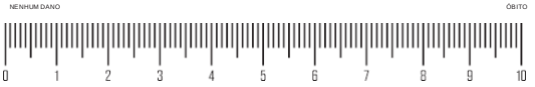
Original	Version translated into english after adaptations to the brazilian reality
25. A patient was receiving oral ranitidine 150mg twice a day as prophylaxis against peptic ulceration, while he was also receiving steroids. One evening dose of the ranitidine was missed. He had no history of peptic ulceration.	25. A patient was receiving oral ranitidine 150mg twice a day as prophylaxis against peptic ulceration, while he was also receiving steroids. One evening dose of the ranitidine was missed. He had no history of peptic ulceration.
26. A patient was prescribed oral vancomycin 125mg four times a day for the treatment of Clostridium difficile colitis. Three days into therapy, two consecutive doses were omitted.	26. A patient was prescribed oral vancomycin 125mg four times a day for the treatment of Clostridium difficile colitis. Three days into therapy, two consecutive doses were omitted.
27. A patient with long standing Parkinson's disease was prescribed co-beneldopa 250mg (benscrazide 50mg and levodopa 200mg) four times a day, but was dispensed a week's supply of modified release co-careldopa 250mg (carbidopa 50mg and levodopa 200mg) in a bottle labelled co-beneldopa.	27. A patient with long standing Parkinson's disease was prescribed Prolopa® 250mg (Benscrazide 50mg and Levodopa 200mg) four times a day but was dispensed a week's supply of Cronomet® 250mg (Carbidopa 50mg and levodopa 200mg) in a bottle labelled Prolopa®.
28. A patient with Crohn's disease was prescribed prednisolone enteric coated tablets 5mg once daily, but was given plain uncoated 5mg prednisolone tablets throughout his four day hospital stay.	28. A patient with Crohn's disease was prescribed prednisolone enteric coated tablets 5mg once daily but was given plain uncoated 5mg prednisolone tablets throughout his four-day hospital stay.
29. An elderly patient was prescribed oral ranitidine 150mg twice a day as prophylaxis against NSAID-induced ulceration. The first six doses were omitted.	29. An elderly patient was prescribed oral ranitidine 150mg twice a day as prophylaxis against NSAID-induced ulceration. The first six doses were omitted.
30. A patient prescribed oral penicillin 250mg four times daily was dispensed penicillamine 250mg, which the patient was given for three days before the error was discovered.	30. A patient prescribed oral penicillin 250mg four times daily was dispensed penicillamine 250mg, which the patient was given for three days before the error was discovered.
31. One dose of oral diltiazem 60mg was omitted in a newly admitted patient with angina who normally took the drug three times a day.	31. One dose of oral diltiazem 60mg was omitted in a newly admitted patient with angina who normally took the drug three times a day.
32. A newly diagnosed asthmatic patient was prescribed beclomethasone 100 mcg per metered dose, two puffs twice a day. He was given an inhaler containing 250mcg beclomethasone per metered dose, containing sufficient quantity for three weeks.	32. A newly diagnosed asthmatic patient was prescribed beclomethasone 100 mcg per metered dose, two puffs twice a day. He was given an inhaler containing 250mcg beclomethasone per metered dose, containing sufficient quantity for three weeks.
33. A patient written up for warfarin 10mg was given two 5mg tablets that had expired one month previously.	33. A patient written up for warfarin 10mg was given two 5mg tablets that had expired one month earlier.
34. A patient was prescribed thyroxine 25 microgrammes daily. The patient was instead administered methotrexate 25mg daily for several days.	34. A patient was prescribed thyroxine 25 micrograms daily. The patient was instead administered methotrexate 25mg daily for several days.
35. An elderly patient prescribed digoxin elixir 125 micrograms daily for the treatment of chronic atrial fibrillation was given 50 micrograms of the elixir daily for several weeks.	35. An elderly patient prescribed digoxin elixir 125 micrograms daily for the treatment of chronic atrial fibrillation was given 50 micrograms of the elixir daily for several weeks.

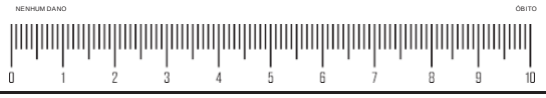
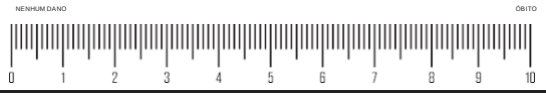
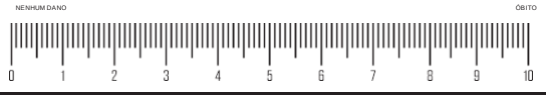
Original	Version translated into english after adaptations to the brazilian reality
36. A terminally ill patient was prescribed morphine sulphate SR tablets 60mg twice daily. He was given a dose of 60mg Sevredol (non-modified release morphine sulphate) rather than the intended MST tablets.	36. A terminally ill patient was prescribed morphine sulphate SR tablets 60mg (DIMORF® LC) twice daily. He was given a dose of 60mg (two 30mg tablets) non-modified release morphine sulphate rather than the intended DIMORF® LC (CR).
37. A patient prescribed vancomycin 1g IV twice daily was given one of the doses as a bolus rather than by infusion.	37. A patient prescribed vancomycin 1g IV daily was given one of the doses as direct IV (bolus) rather than by intermittent infusion.
38. A patient was prescribed gentamicin ear drops, two drops three times a day to the right ear, for the treatment of an ear infection shown to be sensitive to gentamicin. On the second day of treatment, one dose was administered to the left ear instead of the right ear.	38. A patient was prescribed gentamicin ear drops, two drops three times a day to the right ear, for the treatment of an ear infection shown to be sensitive to gentamicin. On the second day of treatment, one dose was administered to the left ear instead of the right ear.
39. The first two doses of topical Teejel (choline salicylate dental gel BP), prescribed to be applied four times daily, were omitted in a patient with mouth ulcers.	39. The first two doses of OMCILON-A ORABASE (Triamcinolone acetonide), prescribed to be applied four times daily, were omitted in a patient with mouth ulcers.
40. A patient prescribed cefotaxime 1g IV three times a day for post-partum pyrexia had a dose reconstituted with 10ml of 15% potassium chloride solution instead of 0.9% sodium chloride. The dose was then administered by bolus injection.	40. A patient prescribed cefotaxime 1g IV three times a day for post-partum pyrexia had a dose reconstituted with 10ml of 19% potassium chloride solution instead of 0.9% sodium chloride. The dose was then administered by bolus injection.
41. An elderly non-diabetic patient was given another patient's 5mg glibenclamide tablet.	41. An elderly non-diabetic patient was given another patient's 5mg Glibenclamide tablet.
42. An elderly patient with cellulitis was prescribed oral flucloxacillin lg four times daily. One week after the start of the treatment she was given two consecutive doses of 500mg instead of 1g.	42. An elderly patient with cellulitis was prescribed oral dicloxacillin 500mg four times daily. One week after the start of the treatment the patient was given two consecutive doses of 250mg instead of one 500mg dose.
43. An elderly patient with a hospital-acquired chest infection was prescribed cefotaxime 1g IV three times a day. Two days into the treatment course he was given one oral dose of cephradine 500mg instead of the dose prescribed. He was able to swallow oral medication.	43. An elderly patient with a hospital-acquired chest infection was prescribed cefotaxime 1g IV three times a day. Two days into the treatment course he was given one oral dose of Cephalexin 500mg instead of the dose prescribed. He was able to swallow the oral medication.
44. One dose of salbutamol 400mcg rotacaps was omitted in a patient with chronic obstructive airways disease.	44. One dose of salbutamol 100mcg rotacaps was omitted in a patient with chronic obstructive airways disease.
45. A patient stabilised on warfarin 5mg daily was given one dose of 7.5mg.	45. A patient stabilised on warfarin 5mg daily was given one dose of 7.5mg.
46. A patient who was prescribed oral diltiazem 60mg three times a day was given instead one dose of diazepam 60mg.	46. A patient who was prescribed oral diltiazem 60mg three times a day was given instead one dose of diazepam 60mg.
47. A patient prescribed oral diclofenac 50mg three times a day for post-operative pain control missed the first three doses.	47. A patient prescribed oral diclofenac 50mg three times a day for post-operative pain control missed the first three doses.

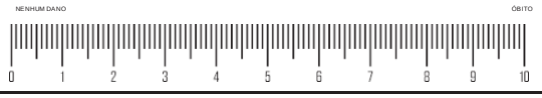
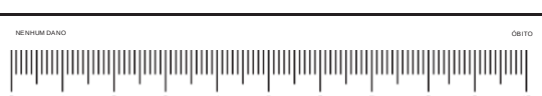
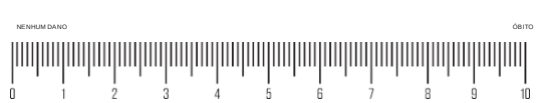
Original	Version translated into english after adaptations to the brazilian reality
48. A patient with oesophagitis was prescribed omeprazole (Losec) 20mg daily. For three days the patient instead received frusemide (Lasix) 20mg.	48. A patient with oesophagitis was prescribed omeprazole (Losec®) 20mg daily. For three days the patient instead received frusemide (Lasix®) 20mg.
49. A patient with anaemia was prescribed oral ferrous sulphate 200mg three times a day. One dose was omitted.	49. A patient with anaemia was prescribed oral ferrous sulphate 200mg three times a day. One dose was omitted.
50. A patient prescribed Augmentin (co-amoxiclav 250/125), one tablet three times a day for a chest infection, was given one dose of two tablets on the third day of therapy. Her renal function was normal.	50. A patient prescribed Clavulin® (Amoxicillin/ potassium clavulanate – 250/125) one tablet three times a day for a chest infection, was given one dose of two tablets on the third day of therapy. Her renal function was normal.

APPENDIX B – 50 CASOS DE ERROS DE ADMINISTRAÇÃO DE MEDICAMENTO: ESCALA PARA ATRIBUIÇÃO DE GRAVIDADE POTENCIAL

50 CASOS DE ERROS DE ADMNISTRAÇÃO DE MEDICAMENTOS	ESCALA PARA ATRIBUIÇÃO DE GRAVIDADE POTENCIAL
1. Um paciente hipertenso tem sua pressão sanguínea controlada com enalapril 5mg uma vez ao dia. Uma dose não foi administrada (omitida)	
2. Ácido acetilsalicílico 100mg com revestimento entérico foi prescrito para um paciente idoso com marca-passo cardíaco, para uso uma vez ao dia. Uma dose foi omitida.	
3. Foi prescrito para um paciente carbonato de lítio 600mg diariamente (dois comprimidos de 300mg), mas foi administrado em dose única 1200mg (quatro comprimidos de 300mg).	
4. Um paciente com suspeita de conjuntivite teve as duas primeiras doses de pomada oftálmica de cloranfenicol, prescritas para serem administradas quatro vezes ao dia, omitidas.	
5. Um paciente idoso com dificuldade de deglutição recebeu a prescrição de ranitidina efervescente 150mg duas vezes ao dia para profilaxia de ulceração durante a terapia contínua com diclofenaco. Foi administrado um comprimido comum de ranitidina não solúvel, que o paciente engoliu com um pouco de dificuldade.	
6. Uma paciente estava recebendo varfarina 5mg e parou quando seu RNI alcançou o valor de 5.4. No entanto, ela continuou recebendo por três dias uma dose diária de varfarina.	
7. Foram prescritos para um paciente dois comprimidos de complexo de vitamina B forte (vitaminas do complexo B em dosagens elevadas) diariamente. Foi administrada uma dose de um único comprimido.	
8. Foi prescrito para um paciente com candidíase oral fluconazol 50mg diariamente por uma semana. Foram dispensadas cápsulas de fluconazol 150mg, as quais o paciente recebeu para o período de uma semana.	
9. Foi prescrito para uma paciente o colírio lubrificante lacrifilm® para olhos secos, ao invés disso, foi dada uma dose de 30ml de lactulose por via oral.	
10. Foi prescrita para um paciente com prurido loção de calamina para ser aplicada três vezes ao dia. As primeiras cinco doses foram omitidas	
11. Foi administrada a um paciente com história de insuficiência cardíaca uma dose de atenolol 100mg oral que era destinada a outro paciente.	
12. Foram prescritas para um paciente seis doses de ácido folínico oral (15mg três vezes ao dia) como terapia de resgate após tratamento com metotrexato. Ao invés disso, o paciente recebeu seis doses de ácido fólico 15mg.	
13. Foi prescrito furosemida 20mg uma vez ao dia para o tratamento de insuficiência cardíaca moderada em paciente idoso. Em vez disso, foi administrada uma dose de furosemida 40mg.	

50 CASOS DE ERROS DE ADMNISTRAÇÃO DE MEDICAMENTOS	ESCALA PARA ATRIBUIÇÃO DE GRAVIDADE POTENCIAL
14. Foram prescritas para um paciente 10 unidades de insulina a cada seis horas. Inicialmente, isso foi interpretado como 10 ml (1000 unidades), mas o erro foi percebido e a administração interrompida após administração de 2ml (200 unidades).	
15. Um paciente com prescrição de 5 mg de morfina IV, recebeu por via intravenosa 5 mg de morfina solução oral (Dimorf® 10mg/ml).	
16. Um paciente estava sendo tratado com acetato de metilprednisolona para dor ciática aguda por injeção epidural lombar. O frasco ampola do medicamento foi reconstituído com cloreto de sódio 20% em vez de cloreto de sódio 0,9% e depois foi administrado.	
17. Foi prescrito para um paciente com doença pulmonar obstrutiva crônica suspensão de Clavulin® (amoxicilina + clavulanato de potássio 250/62), 5mL, três vezes ao dia para o tratamento de uma infecção pulmonar. As primeiras cinco doses foram omitidas.	
18. Um paciente recebendo metronidazol 400mg três vezes ao dia por via oral, para profilaxia cirúrgica, teve uma dose das 22 horas omitida. Ele estava no terceiro dia de pós-operatório.	
19. Um paciente com alergia conhecida a penicilina, recebeu prescrição de ciprofloxacino oral 500mg duas vezes ao dia para tratamento de uma infecção pulmonar. Foi administrada uma dose de oxacilina 500mg.	
20. Foi prescrito para um paciente lamotrigina 100mg diariamente. Foram dispensados comprimidos de lamotrigina 100mg ao invés de comprimidos de 25mg como pretendido. O paciente recebeu uma dose diária de 400mg por 6 dias, ao invés de 100mg ao dia.	
21. Uma dose de hidrocortisona 10mg oral foi omitida para um paciente com insuficiência adrenal crônica, com prescrição de hidrocortisona 20mg oral toda ma- nhã e 10mg toda noite.	
22. Foi prescrito para um paciente idoso paracetamol suspensão oral (100mg/ml), em uma dose de 5ml (500mg) a cada seis horas. Foi administrada uma dose de 10ml (1g).	
23. Uma dose de metformina 500mg oral foi omitida em um diabético que fazia uso de 500mg três vezes ao dia.	
24. Foi prescrito para um paciente 2ml de morfina para administração IV (ampolas de 1mg/ml, contendo 2mg de morfina). Ao invés disso, foi utilizada a ampola de 10mg/ml (uso IV) e administrada uma dose de 20ml (200mg de morfina).	
25. Um paciente estava recebendo ranitidina 150mg oral duas vezes ao dia como profilaxia contra úlcera péptica, enquanto ele estava recebendo também esteroides. Uma dose de ranitidina para ser tomada a noite foi esquecida. O paciente não tinha história de úlcera péptica.	

50 CASOS DE ERROS DE ADMNISTRAÇÃO DE MEDICAMENTOS	ESCALA PARA ATRIBUIÇÃO DE GRAVIDADE POTENCIAL
26. Foi prescrita vancomicina 125mg oral quatro vezes ao dia para tratamento de colite causada pelo Clostridium difficile em um paciente. Três dias após início da terapia, duas doses consecutivas foram omitidas.	
27. Foi prescrito para um paciente com doença de Parkinson em estágio avançado Prolopa® 250mg (benserasida 50mg e levodopa 200mg) quatro vezes ao dia, mas foi dispensada quantidade para uma semana de Cronomet® 250mg (carpidopa 50mg e levodopa 200mg) em um frasco rotulado como Prolopa®.	
28. Foram prescritos para um paciente com doença de Crohn comprimidos entéricos revestidos de prednisolona 5mg diariamente, mas ele recebeu comprimidos sem revestimento de prednisolona 5mg por quatro dias de internação.	
29. Foi prescrito para um paciente idoso ranitidina 150mg oral duas vezes ao dia para profilaxia contra ulceração induzida por AINE. As primeiras seis doses foram omitidas.	
30. Foi prescrita para um paciente penicilina 250mg oral quatro vezes ao dia, e dispensado penicilamina 250mg. O paciente recebeu este medicamento por três dias antes do erro ser descoberto.	
31. Uma dose de diltiazem oral 60mg foi omitida em um paciente recém-admitido no hospital com angina que normalmente tomava o medicamento três vezes ao dia.	
32. Um paciente asmático recém-diagnosticado recebeu prescrição de beclometasona 100 mcg, aerossol dosimetrado, dois jatos duas vezes ao dia. Foi dispensado um inalador de beclometasona 250 mcg, aerossol dosimetrado com quantidade suficiente para três semanas.	
33. Um paciente com prescrição de Varfarina 10 mg recebeu dois comprimidos de 5 mg que haviam vencido um mês antes.	
34. Foi prescrito para um paciente tiroxina 25 microgramas diariamente. Ao invés disso, foi administrado ao paciente metotrexato 25mg ao dia por vários dias.	
35. Foi prescrito para um paciente idoso elixir de digoxina 125mcg diariamente para o tratamento de fibrilação atrial crônica. O paciente recebeu 50mcg de elixir diariamente por várias semanas.	
36. Foi prescrito para um paciente em estado terminal sulfato de morfina 60mg comprimidos de liberação controlada (DIMORF® LC) duas vezes ao dia. Ele recebeu uma dose de 60mg (2 comprimidos de 30mg) de sulfato de morfina de liberação não modificada ao invés de DIMORF® LC.	
37. Um paciente com uma prescrição de vancomicina 1g IV ao dia recebeu uma das doses por administração IV direta (bolus) em vez de infusão intermitente.	

50 CASOS DE ERROS DE ADMNISTRAÇÃO DE MEDICAMENTOS	ESCALA PARA ATRIBUIÇÃO DE GRAVIDADE POTENCIAL
38. Foram prescritas para um paciente duas gotas de gentamicina (solução para uso auricular), três vezes ao dia, no ouvido direito, para tratamento de uma infec- ção que demonstrou ser sensível a gentamicina. No segundo dia de tratamento, uma dose foi administrada no ouvido esquerdo ao invés do direito.	
39. As primeiras duas doses de OMCILON-A ORABASE (triancianolonaacetonida) prescritas para serem aplicadas quatro vezes ao dia foram omitidas em um paciente com úlceras na boca.	
40. Uma paciente com uma prescrição de cefotaxima 1g IV três vezes ao dia para a febre pós-parto teve uma dose reconstituída com 10mL de solução de cloreto de potássio a 19% ao invés de cloreto de sódio a 0,9%. A dose foi administrada por injeção em bolus.	
41. Um paciente idoso não diabético recebeu um comprimido de 5mg de glibenclamida de outro paciente.	
42. Foi prescrito para paciente idoso com celulite dicloxacilina 500mg oral, quatro vezes ao dia. Uma semana depois do início do tratamento, o paciente recebeu duas doses consecutivas de 250mg ao invés de uma de 500mg.	
43. Foi prescrito para paciente idoso com infecção pulmonar adquirida no hospital cefotaxime 1g IV três vezes ao dia. Dois dias após iniciar o tratamento, o paciente recebeu uma dose oral de cefalexina 500mg ao invés da dose prescrita. Ele conseguiu engolir o medicamento.	
44. Uma dose de salbutamol spray 100mcg foi omitida em um paciente com doença pulmonar obstrutiva crônica.	
45. Foi administrado a um paciente estabilizado com varfarina 5mg diariamente uma dose de 7,5mg.	
46. Foi prescrito para um paciente diltiazem oral 60mg três vezes ao dia, mas ao invés disso foi dada uma dosede diazepam 60mg.	
47. Um paciente com uma prescrição de diclofenaco oral 50mg três vezes ao dia para o controle da dor pós-operatória teve as três primeiras doses omitidas.	
48. Foi prescrito para um paciente com esofagite omeprazol (Losec®) 20mg diariamente. Ao invés disso, o paciente recebeu por três dias furosemida (Lasix®)20mg.	
49. Foi prescrito para um paciente com anemia sulfato ferroso oral 200mg três vezes ao dia. Uma dose foi omitida.	
50. Uma paciente com infecção pulmonar recebeu prescrição de Clavulin® amoxicilina/ácido clavulânico (250/125), um comprimido três vezes ao dia. Foi administrada uma dose com dois comprimidos no terceiro dia de tratamento. Sua função renal estava normal.	

Nome: Idade: Profissão:
Tempo de experiência: Tempo de preenchimento:
Observações:

ANNEX A - EQUATION USED FOR THE G STUDY AND D STUDY

σ^2 = variance, n_p = number of professions, n_j = number of judges

$$G_{coefficient} = \frac{\sigma_c^2}{\sigma_c^2+\sigma_{c\times p}^2+\sigma_{c\times j:p}^2} \quad \text{(Equation 1)}$$

$$G_{coefficient} = \frac{\sigma_c^2+\sigma_{c\times p}^2}{\sigma_c^2+\sigma_{c\times p}^2+\sigma_{c\times j:p}^2} \quad \text{(Equation 2)}$$

$$G_{coefficient} = \frac{\sigma_c^2+\sigma_{c\times p}^2}{\sigma_c^2+\frac{\sigma_{c\times p}^2}{n_p}+\frac{\sigma_{c\times j:p}^2}{n_p \times n_j}} \quad \text{(Equation 3)}$$

Fonte: Taxis K. The incidence, severity and causes of intravenous medication errors in hospitals Katja Taxis. The School of Pharmacy University of London. 2001. p. 337. (Doctoral thesis)

3.4. ARTIGO 4: VALIDATION OF A METHOD TO ASSESS THE SEVERITY OF MEDICATION ADMINISTRATION ERRORS IN BRAZIL.

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Introduction: medication errors are frequent and have a high economic and social impact and is critical to know their severity. A variety of tools exist to measure and classify the harms associated with medication errors, but few are internationally validated. **Methods:** It was decided to validate a method proposed by Dean and Barber (1999) for assessment of the potential severity of medication administration errors. A number of thirty health care professionals (doctors, nurses and pharmacists) from Brazil will receive an invitation to take part by scoring 50 cases of medication errors gathered from an original UK study regarding their potential harm to the patient on scale 0 to 10. Sixteen cases with known actual harm outcomes were used to assess the validity of their scoring. By looking at 10 errors (out of the 50 cases) scored twice, reliability shall be assessed; and potential sources of variability in scoring were evaluated depending on the severity of each of error case, the occasion when the scores were given, the scorer, their profession, and interactions among these variables. Generalizability theory were be used for analyzing data. A G coefficient of 0.8 or more was considered reliable, and a Bland and Altman analysis was used to reconfirmed reliability. **Results:** It was evident that, to obtain a reliable generalizability coefficient, a minimum of three judges would need to score each case, each on a different occasion, with the mean score used as a severity indicator. It also demonstrated to be valid if all judges scored twice compared to 16 of the cases with known actual harm outcomes. **Conclusion:** The results of this study demonstrated the evident validity and reliability of Dean and Barber's (1999) scale for use in the Brazilian Health System.

INTRODUCTION

Assessing the severity of medication errors is a crucial point in improving patient safety during medication use. This assessment makes it possible to differentiate errors in relation to their severity, and thus to establish risk minimization strategies targeting those errors with the greatest potential to harm patients (WALSH, 2017).

The assessment of potential harm and actual harm are different processes, each one involving two steps: 1) identifying the potential or actual harm to the patient related to a medication error; 2) rating the degree or severity of that harm (MORIMOTO, 2004). A variety of tools exist to measure and classify the harms associated with medication errors. A systematic review on harm related to prescription errors identified over 40 harm classification tools used prior to 2013 (GARFIELD, 2013). A recent systematic review on medication administration errors detected by the direct observation method in Latin American hospitals identified 10 studies that estimated the rate of medication administration errors (MAEs); however, none of them assessed the severity of these errors (ASSUNÇÃO-COSTA et al., 2002a).

The Dean and Barber scale assesses the potential severity of medication administration errors by calculating the mean subjective score of four different healthcare professionals (including pharmacists, nurses and physicians). This method has already been used to assess the potential clinical significance of medication administration errors identified in studies conducted in the UK (DEAN; BARBER) and Germany (TAXIS; BARBER, 2004) and has been shown to be valid and reliable in the contexts in which these studies were conducted.

In the previous article, we describe the protocol for validate a scale to assess the severity of MAEs in South America and particularly in Brazil. We use the method developed by Dean and Barber (1999) for assessing the potential severity of MAE. Considering the differences between Brazil and countries such as Germany and the United Kingdom regarding health systems, professional training and performance, and cultural context, it is necessary to validate the method within the Brazilian context.

Thus, this study aims to validate the existing Dean and Barber method for assessing the potential clinical significance of medication errors developed in the UK for use in Brazil, using the same procedures involved in developing and testing the method in the UK. For due that our specifics objectives will be: a) to determine the minimum number of judges required for a reliable mean severity score; b) to determine the effect of a judge's profession on the score; c) to test the validity of the mean score.

METHODS

The adopted method was described in an article by Assunção-Costa et al. (2022b). To validate a method proposed by Dean and Barber for assessment of the potential severity of medication administration errors. A number of thirty health care professionals (doctors, nurses and pharmacists) from Brazil will receive an invitation to take part by scoring 50 cases of medication errors gathered from an original UK study regarding their potential harm to the patient on scale 0 to 10. Sixteen cases with known actual harm outcomes will be used to assess the validity of their scoring. By looking at 10 errors (out of the 50 cases) scored twice, reliability shall be assessed; and potential sources of variability in scoring will be evaluated depending on the severity of each of error case, the occasion when the scores were given, the scorer, their profession, and interactions among these variables. Generalizability theory will be used for analysing data. Expected impact of the study for public health: This study was submitted to the evaluation of the Research Ethics Committee of the Complexo Hospitalar Universitário Professor Edgard Santos and approved under no. 3.102.570/2019.

The original instrument will be used, keeping the described cases. These cases were translated into Portuguese and adapted to the Brazilian context (making any necessary adjustments regarding the drugs, doses, concentrations, units of measurement, pharmaceutical forms and available presentations). The maintenance of the cases submitted to evaluation were allowed comparison with the previous studies carried out in the UK and Germany. All 50 cases were translated by the principal investigator and adapted. (Appendix A) The reason for doing so is because some of the drugs mentioned in the original cases may not be used in Brazil. The translated and adapted version were submitted to the evaluation by two experienced hospital pharmacists regarding the pharmaceutical product, drug concentration, route of administration, pharmaceutical dosage to make sure the degree of severity remains unchanged.

RESULTS:

Judge recruitment

The heads of service of nine Brazilian hospitals were contacted to identify doctors, nurses, and pharmacists willing to evaluate the potential severity of 50 medication errors. One of the southeastern hospitals was unable to participate due to the time constraints. The eight participating hospitals were located in four regions of the country (four in the southeast, two in the northeast, one in the south, and one in the north region). The consent forms and letters (S1 and S2) on scoring process guidelines were sent to 37 professionals, six of whom declined participation. Ultimately, 30 health professionals participated in the study, including ten nurses, ten pharmacists, and ten doctors.

Table 1. Initially contacted professionals, response rate, and final participants

Hospital	Region	Professional group	Letters sent	Response	Response rate (%)	Number of final participants
HUPES	NE	Doctors	6	4	66,7	4
HCPA	SO	Doctors	2	2	100	2
HCUFMG	SE	Doctors	2	2	100	2
HB	NE	Doctors	1	1	100	1
HGV	NO	Doctors	1	1	100	1
HUPES	NE	Nurses	2	2	100	2
HCPA	SO	Nurses	2	2	100	2
HCUFMG	SE	Nurses	2	1	50	1
HB	NE	Nurses	2	2	100	2
HSL	SE	Nurses	2	2	100	2
HGV	NO	Nurses	1	1	100	1
HUPES	NE	Pharmacists	5	3	60	2
HCPA	SO	Pharmacists	2	2	100	2
HCUFMG	SE	Pharmacists	2	2	100	2
HB	NE	Pharmacists	2	2	100	2
HSL	SE	Pharmacists	1	0	0	0
João XXIII	SE	Pharmacists	2	1	50	1
HGV	NO	Pharmacists	1	1	100	1

The range of response time for 50 cases was between 14 to 53 minutes, with a mean of 26.3 minutes. The mean score for each medication administration error (MAE) ranged from 1.6 to 9.3 (Appendix B). All judges submitted completed forms for these 50 cases and 10 MAE evaluations, with the absence of one judge's expended evaluation time.

Two judges commented on the scoring process and case clarification.

Ex. 1: "I faced doubts regarding certain questions, including the lack of knowledge about two to three medications' further serious adverse events."

Ex. 2: "I found it difficult to contextualize the case specific available information, and to separate process error analysis from the analysis of the patient's potential harm."

Analyses:

All analyses were conducted using the R programming language, version 4.0.3.

Generalizability study

MODEL 1

The analysis of variance (ANOVA) for model 1 (OCCASION X CASE X JUDGE) is presented in Tables 2 and 3. The following ANOVA were performed, and seven sources of variance were estimated through the cross-sectional design, including Case, Judge, Occasion; Case "crossed" with Judge; Case "crossed" with Occasion; Judge "crossed" with Occasion; and Case "crossed" with Judge "crossed" with Occasion. This model was evaluated by judges from three professions — doctors, pharmacists, and nurses — who separately evaluated the ten identical medication error cases on two separate occasions.

Table 2. Analysis of variance (ANOVA)

Sources of Variation	Degrees of freedom	Sum of squares	Mean sum of squares
Case	9	3224	358.2
Judge	29	496	17.1
Occasion	1	2	2.3
Case x Judge	261	990	3.8
Case x Occasion	9	16	1.7
Judge x Occasion	29	665	22.9
Case x Judge x Occasion	261	932	3.6

Source: the author, 2022.

The generalizability study (G study) analyzed variance partitioning to understand the interaction between the different variation sources in model 1. Table 3 presents the estimated variance components that portray the main source of variance as the difference between MAE cases, followed by the "judge x occasion" design. The evaluation occasion was not an important source of variance. The decision study (D study) was based on G study results and obtained the necessary decision-making information for the reliable usage of generalized scoring scales. D study was also used with model 1 to calculate G coefficients that identified the required number of judges to reach sufficient reliability of the scale's usage. The overall generalizability coefficient was 0.99.

Table 3. Crossed design study with 30 participants on two separate occasions

G STUDY		
Sources of Variation	**Estimated variance**	**Percentage of total variance**
Case	5.906	52.9
Judge	0.000	0.0
Occasion	0.000	0.0
Case x Judge	0.131	1.2
Case x Occasion	0.000	0.0
Judge x Occasion	1.610	14.4
Residual	3.518	31.5
D STUDY		
Case	0.591	37.3
Judge	0.000	0.0
Occasion	0.000	0.0
Case x Judge	0.013	0.8
Case x Occasion	0.000	0.0
Judge x Occasion	0.805	50.8
Residual	0.176	11.1
G coefficients		
P	0.99	
Φ	0.98	

Source: the author, 2022.

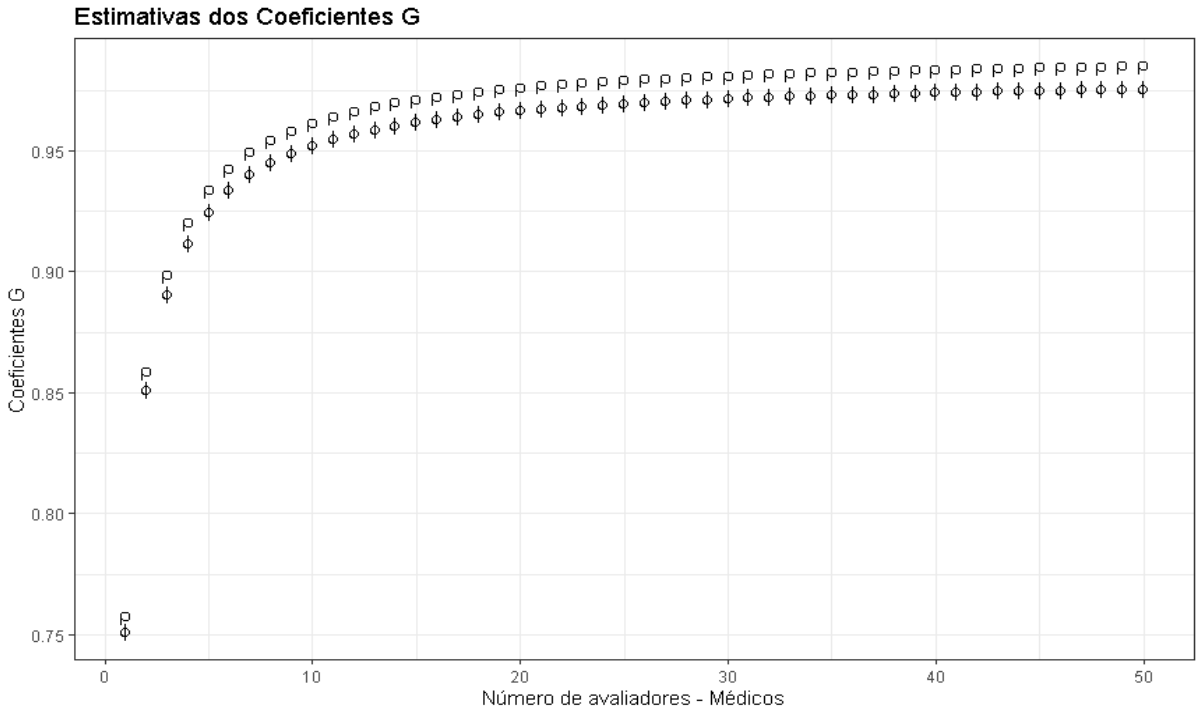
Tables 4, 5, and 6 present the estimates given by the doctors, pharmacists, and nurses, respectively, and demonstrate a constant G coefficient by three judges, regardless of profession. Figures 1, 2, and 3 illustrate these results.

Table 4. G coefficient estimates to maximize scale reliability of future studies (doctors)

Number of judges	G coefficients	
	ρ	**Φ**
1	0.76	0.75
2	0.86	0.85
3	0.90	0.89
4	0.92	0.91
5	0.93	0.92
6	0.94	0.93
9	0.96	0.95
12	0.97	0.96
15	0.97	0.96
18	0.97	0.96
21	0.97	0.97

Source: The author, 2022.

Figure 1. G coefficient estimates to maximize scale reliability of future studies (doctors)



Source: The author, 2022.

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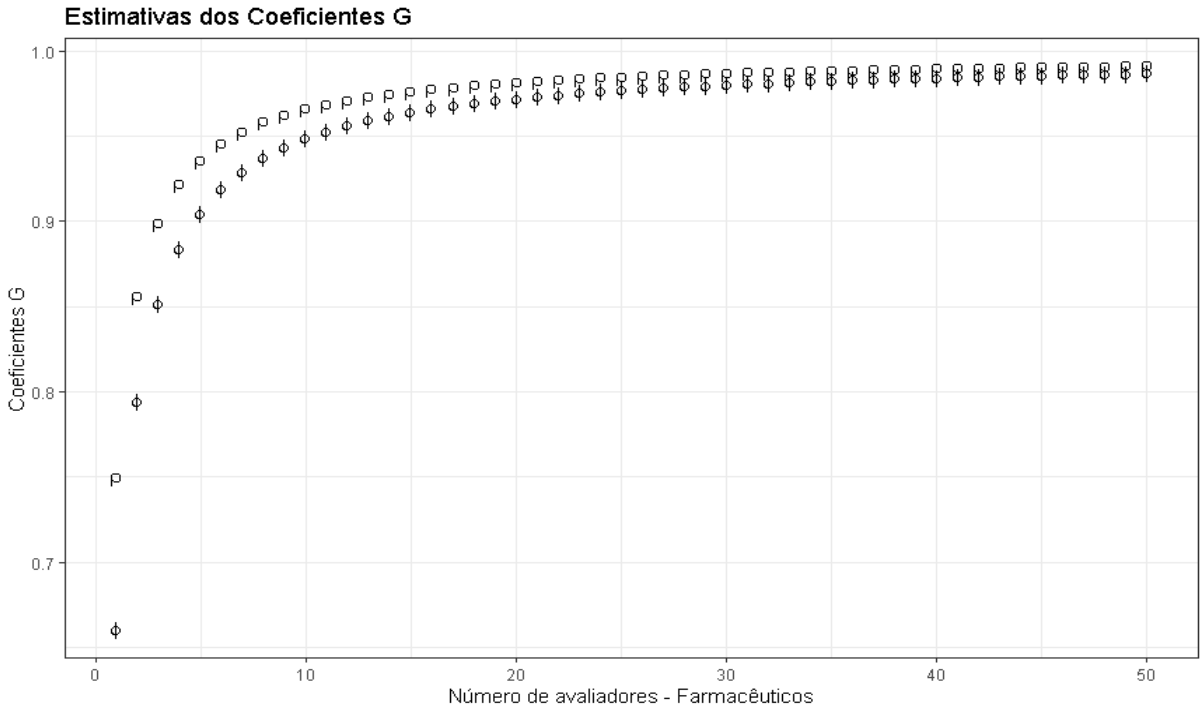
G coefficients/ G coefficient estimates/ number of judges - doctors

Table 5. G coefficient estimates to maximize scale reliability of future studies (pharmacists)

Number of judges	G coefficients	
	ρ	ϕ
1	0.75	0.66
2	0.85	0.79
3	0.90	0.85
4	0.92	0.88
5	0.93	0.90
6	0.94	0.91
9	0.96	0.94
12	0.97	0.96
15	0.97	0.96
18	0.98	0.97
21	0.98	0.97

Source: The author, 2022.

Figure 2. G coefficient estimates to maximize scale reliability of future studies (pharmacists)



Source: The author, 2022.

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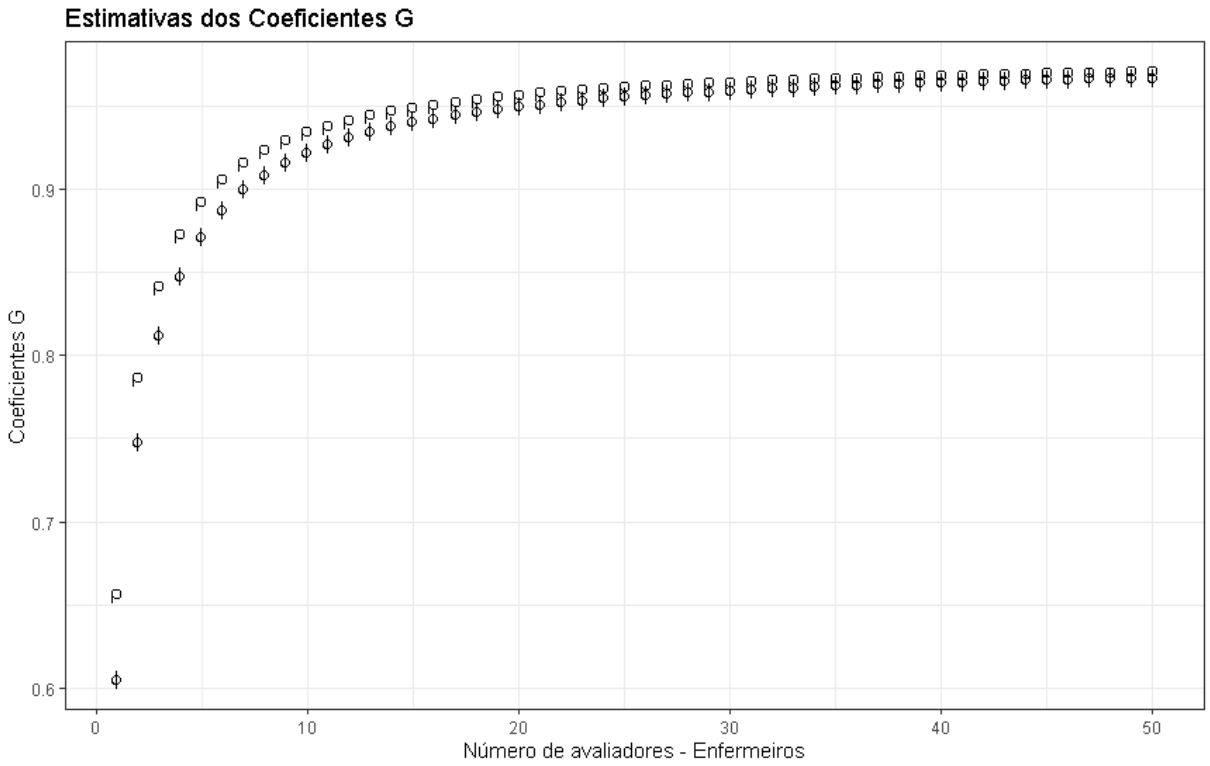
G coefficients/ G coefficient estimates/ number of judges - pharmacists

Table 6. G coefficient estimates to maximize scale reliability of future studies (nurses)

Number of judges	G coefficients	
	ρ	Φ
1	0.66	0.60
2	0.79	0.75
3	0.84	0.81
4	0.87	0.85
5	0.89	0.87
6	0.90	0.89
9	0.93	0.92
12	0.94	0.93
15	0.95	0.94
18	0.95	0.95
21	0.96	0.95

Source: The author, 2022.

Figure 3. G coefficient estimates to maximize scale reliability of future studies (nurses)



Source: The author, 2022.

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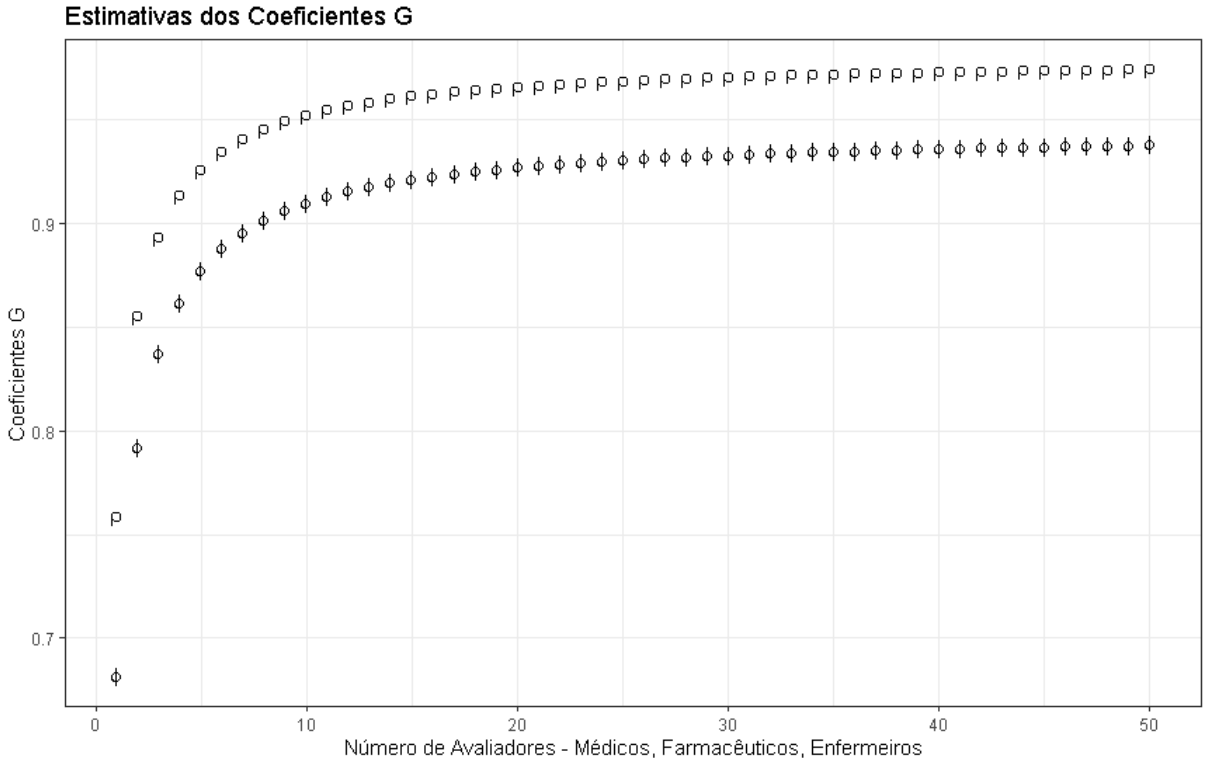
G coefficients/ G coefficient estimates/ number of judges – nurses

MODEL 2

Model 2 had the following design: Profession; Judge "nested" in Profession; Case; Case "crossed" with Profession; and Residual (Case crossed with Judge "nested" in Profession). This model was evaluated by all 30 participants simultaneously using all 50 cases. Table 7 presents sources of variance results, Table 8 presents the G and D studies, Table 9 presents the number needed to obtain the reliable G coefficients, and Figure 4 presents a graph with these estimates considering the different professions of doctors, pharmacists, and nurses.

Figure 4. G coefficient estimates to maximize protocol reliability of future studies (Doctors, Pharmacists, Nurses)



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G coefficients/ G coefficient estimates/ number of judges – doctors, pharmacists, nurses

Table 7. Sources of variance (Doctors, Pharmacists, Nurses)

Sources of Variation	**Degrees of freedom**	**Sum of squares**	**Mean sum of squares**
Case	49	6068	123.84
Profession	2	577	288.42
Profession x Judge	27	1857	68.77
Case x Profession	98	585	5.97
Case x Profession *x* Judge	1323	4653	3.52

Source: The author, 2022.

Table 8. Generalizability study (Doctors, Pharmacists, Nurses)

G STUDY		
Sources of Variation	**Estimated variance**	**Percentage of total variance**
Case	3.923	41.7
Profession	0.434	4.6
Case x Profession	0.245	2.6
Judge: Profession	1.305	13.8
Residual	3.517	37.3
D STUDY		
Case	0.078	12.0
Profession	0.434	66.3
Case x Profession	0.005	0.7
Judge: Profession	0.130	19.9
Residual	0.007	1.1
G coefficients		
P	0.97	
Φ	0.98	

Source: The author, 2022.

*Note: The symbol "**x**" indicates cross.*

Table 9. G coefficient estimates to maximize scale reliability for future studies (Doctors, Pharmacists, Nurses).

Number of judges	**G coefficients**	
	ρ	**ϕ**
1	0.76	0.68
2	0.85	0.79
3	0.89	0.84
4	0.91	0.86
5	0.92	0.88
6	0.93	0.89
9	0.95	0.91
12	0.96	0.91
15	0.96	0.92
18	0.96	0.92
21	0.97	0.93

Source: The author, 2022.

G coefficients were calculated considering judges with different professions, and are presented in Table 10. For example, a pharmacist, nurse, and doctor scoring the same case results in a good G coefficient of 0.89.

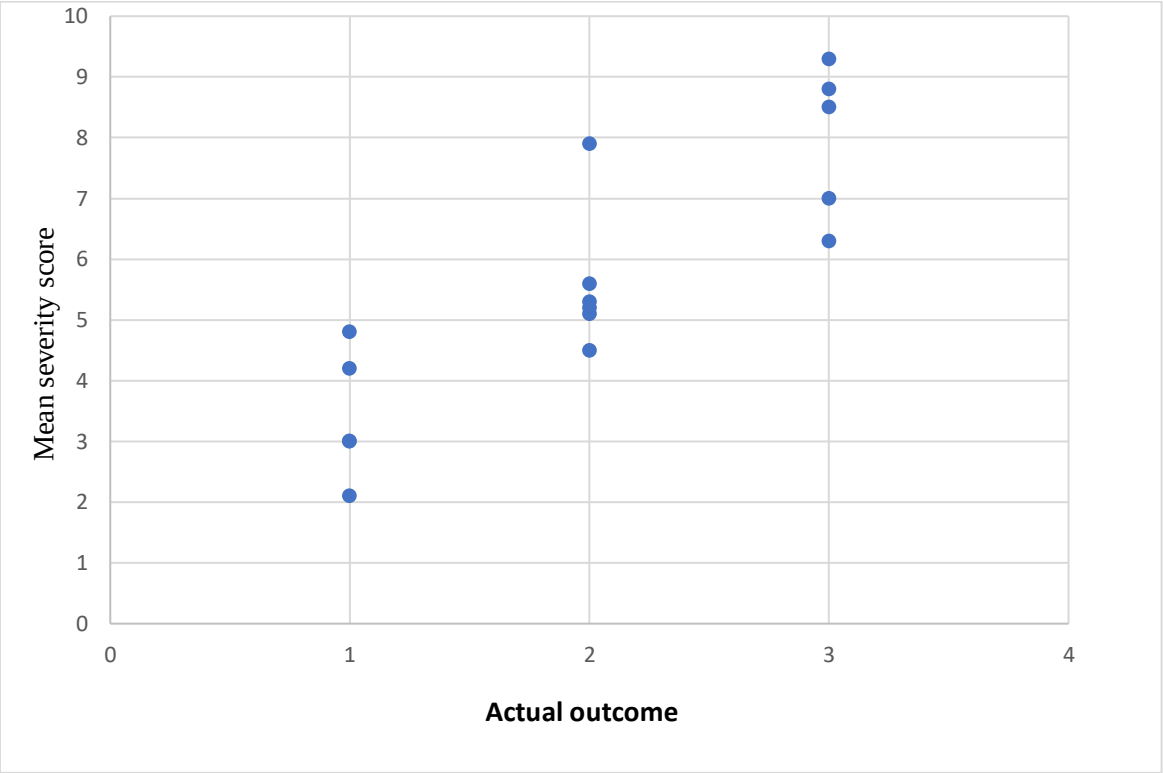
Table 10. G coefficients for a varied number of judges representing different professions

Scenario	G coefficient
1 judge from every two professions (2 judges in total)	0.85
1 judge from each profession (3 judges in total)	0.89
2 judges from every 2 professions (4 judges in total)	0.88
2 judges from every 3 professions (6 judges in total)	0.93

Validity

Figure 7 presents the mean scores of the 16 cases of known severity. A correlation existed between known severity values and the mean scores assigned by the judges. Minor severity cases had mean scores ranging from 2.1 to 5.1, moderate cases had mean scores ranging from 4.5 to 7.9, and severe cases had mean scores from 6.3 to 9.3. Mean scores overlapped in two minor severity cases (items 5 and 22), in one moderate severity case (item 15) with a high mean score (7.9), and in a severe case (item 22) with a mean assigned score of 6.25. Judge-based individual scores assigned for each of these errors indicated the contribution of extremely high or low values towards these results. Cases of overlapped scores are described in Table 11.

Figure 5. Comparing the judges' mean scores and the actual outcome severity



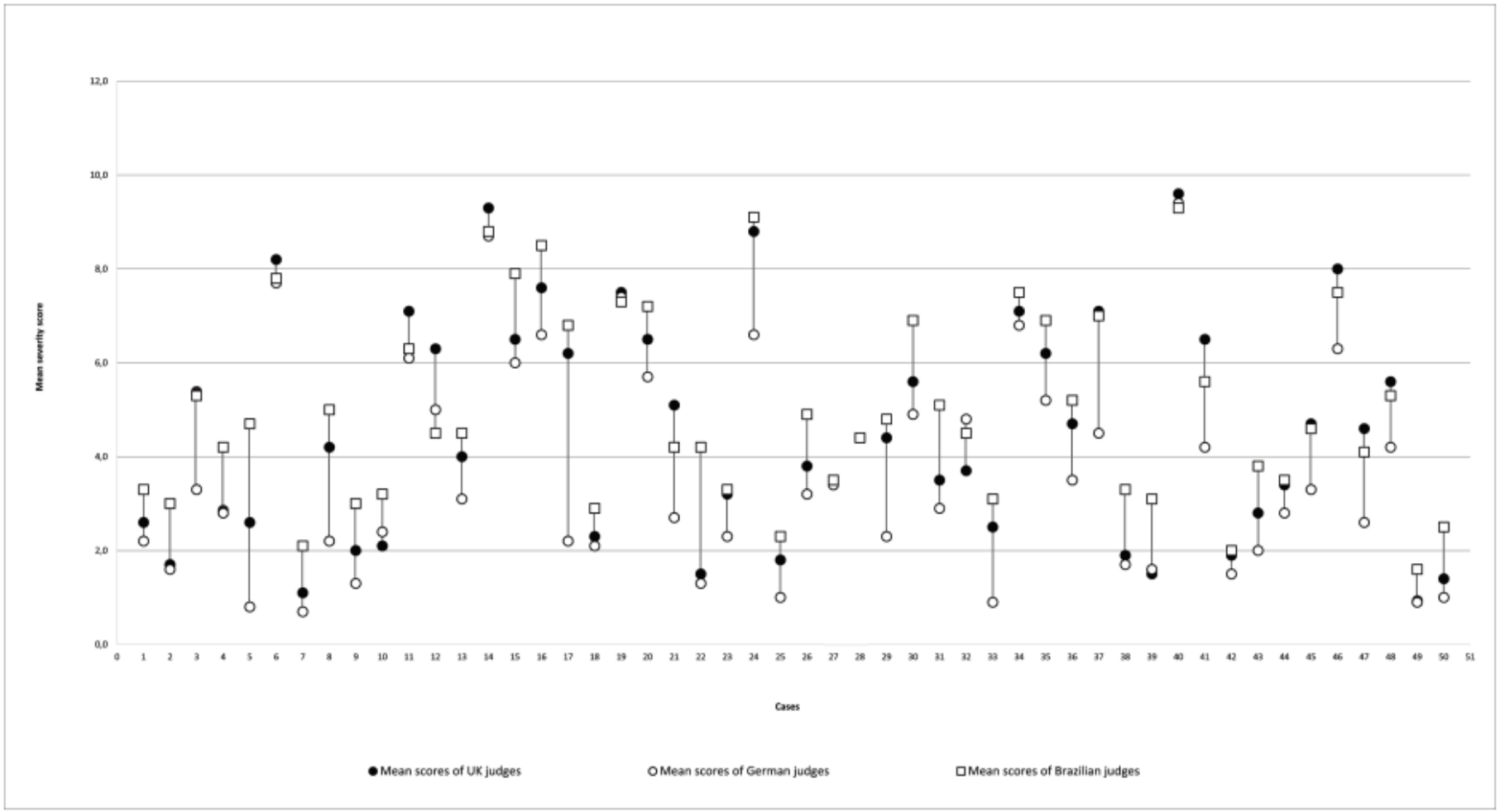
** 1 = minor, 2 = moderate, 3 = severe*

Table 11. Cases of overlapped scores

Case #	Description	Known score	Mean assigned score
5	An older patient facing difficulties in swallowing was prescribed effervescent ranitidine 150 mg twice daily for ulceration prophylaxis during continuous diclofenac therapy. A common non-soluble ranitidine tablet was administered, which the patient swallowed with some difficulty.	2.6	4.8
11	A patient with a history of heart failure was given a 100 mg oral dose of atenolol that was intended for another patient.	7.1	6.3
15	A patient prescribed 5 mg of IV morphine, received 5 mg of oral morphine solution intravenously (Dimorf® 10 mg/ml).	6.5	7.9
22	An older patient was prescribed paracetamol oral suspension (100 mg/ml) at a dose of 5 ml (500 mg) every six hours. A dose of 10 ml (1g) was administered.	1.5	4.1

In general, the mean scores obtained in Brazil were higher than those obtained in German and UK studies (Figure 8). The mean scores of Brazilian judges were 1.36 times higher (95% confidence interval 1.11–1.62; $p < 0.001$; paired samples t-test $t(49) = 10.669$) than those of German judges. Compared to the scores of the United Kingdom's judges, the mean scores of the Brazilian judges were 0.49 higher (95% confidence interval 0.24–0.74; $p < 0.001$; paired samples t-test $t(48) = 4.046$) (Dean & Barber, 1999; Taxis et al., 2002). Only six of the four cases had a mean score lower than the score calculated for UK and German judges, respectively. The maximum difference between scores obtained in Brazil and the United Kingdom was 2.7, and was 3.9 between Brazil and Germany.

Figure 6. Mean score comparison of Brazil, Germany, and the United Kingdom

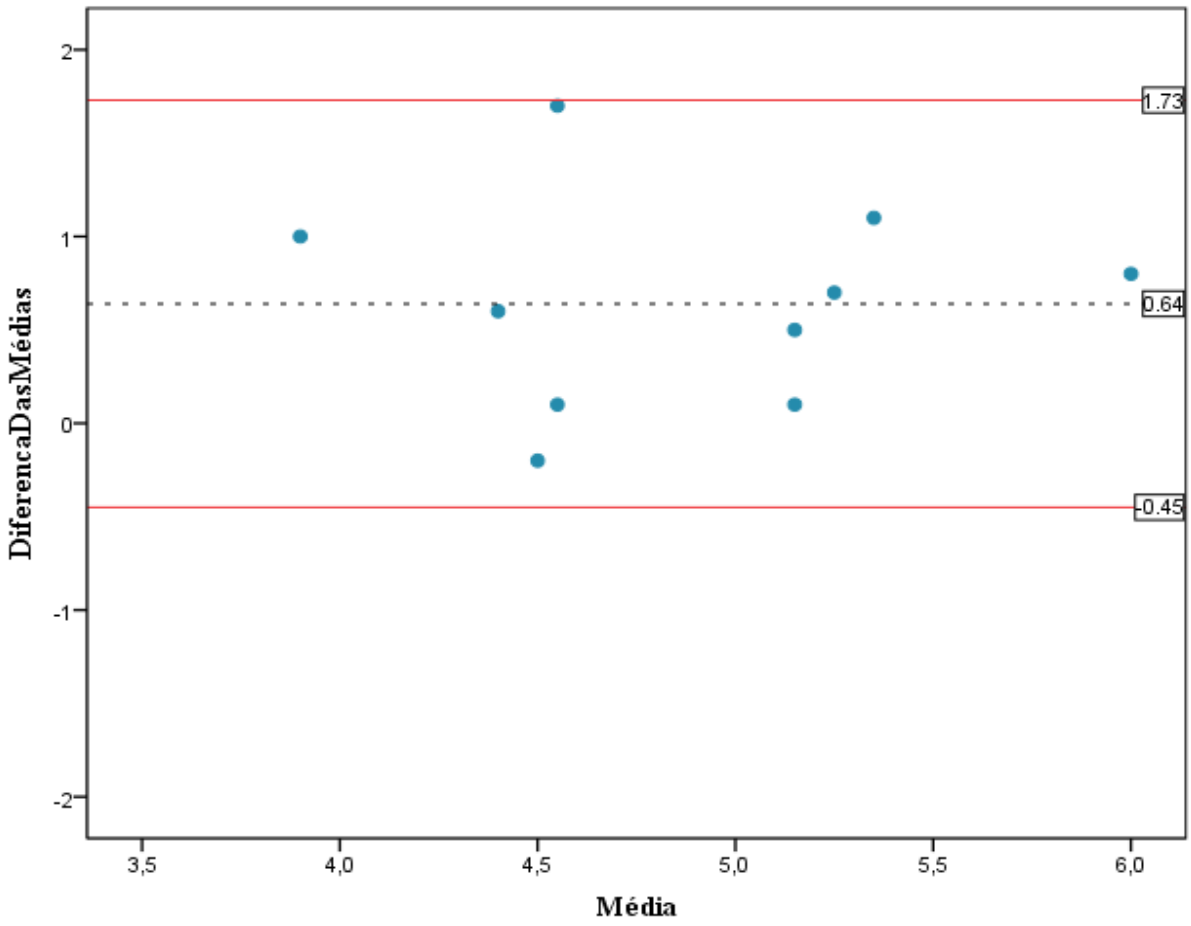


Test-Retest Reliability

Test-retest agreement was assessed using the Bland-Altman test. The sample consisted of 30 professionals, including ten doctors, ten nurses, and ten pharmacists who responded to the same protocol at two different instances.

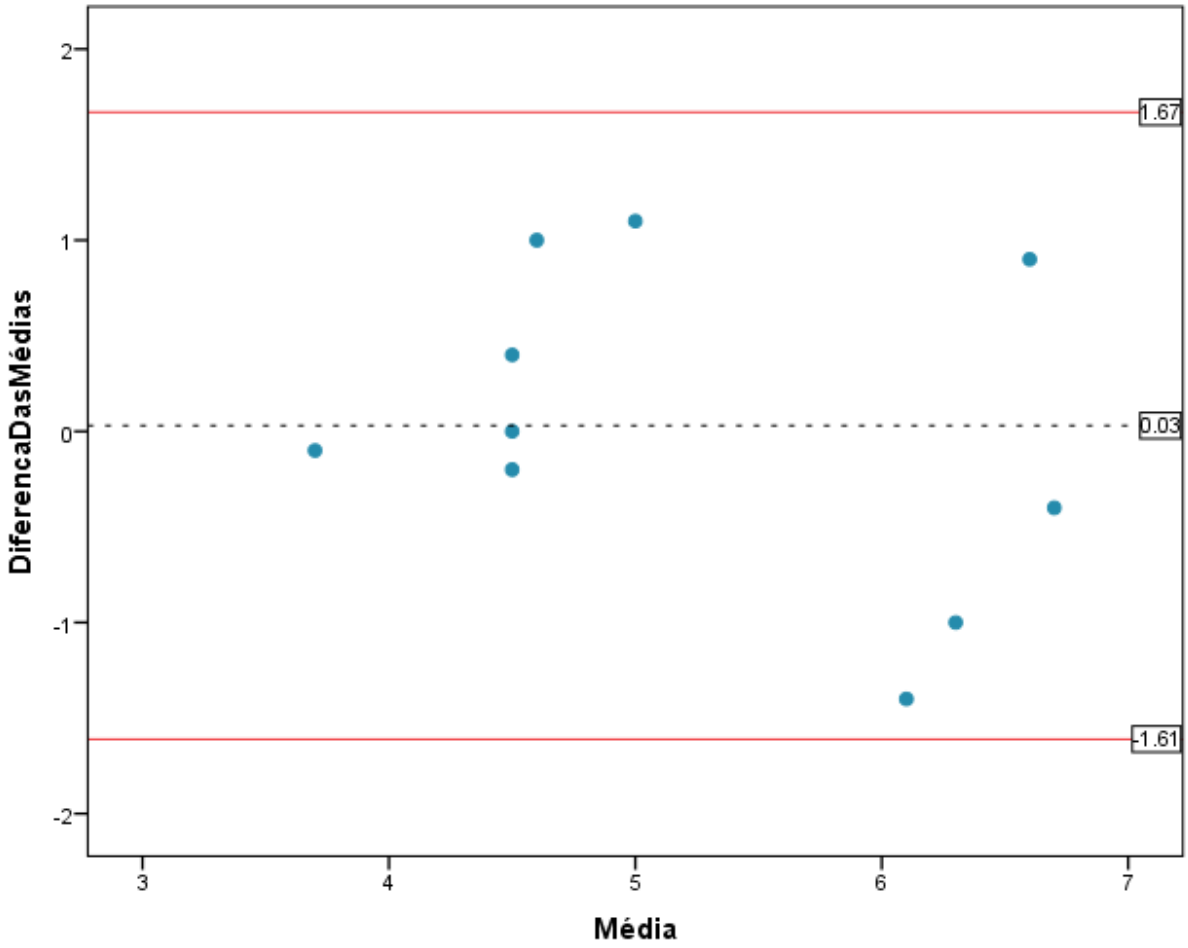
The Bland-Altman plot helps visualize and interpret the test-retest agreement. By definition, 95% of the differences between repeated measures must be within the agreement limits. Due to the lack of proportion bias, the distribution was homogeneous above and below the mean difference between the two instances of p = 0.96 doctor, 0.63 nurses, and 0.38 pharmacists. Bland-Altman plots for doctors, nurses, and pharmacists are illustrated in Figures 9, 10, and 11, respectively.

Figure 7. Bland-Altman plot (Doctors)



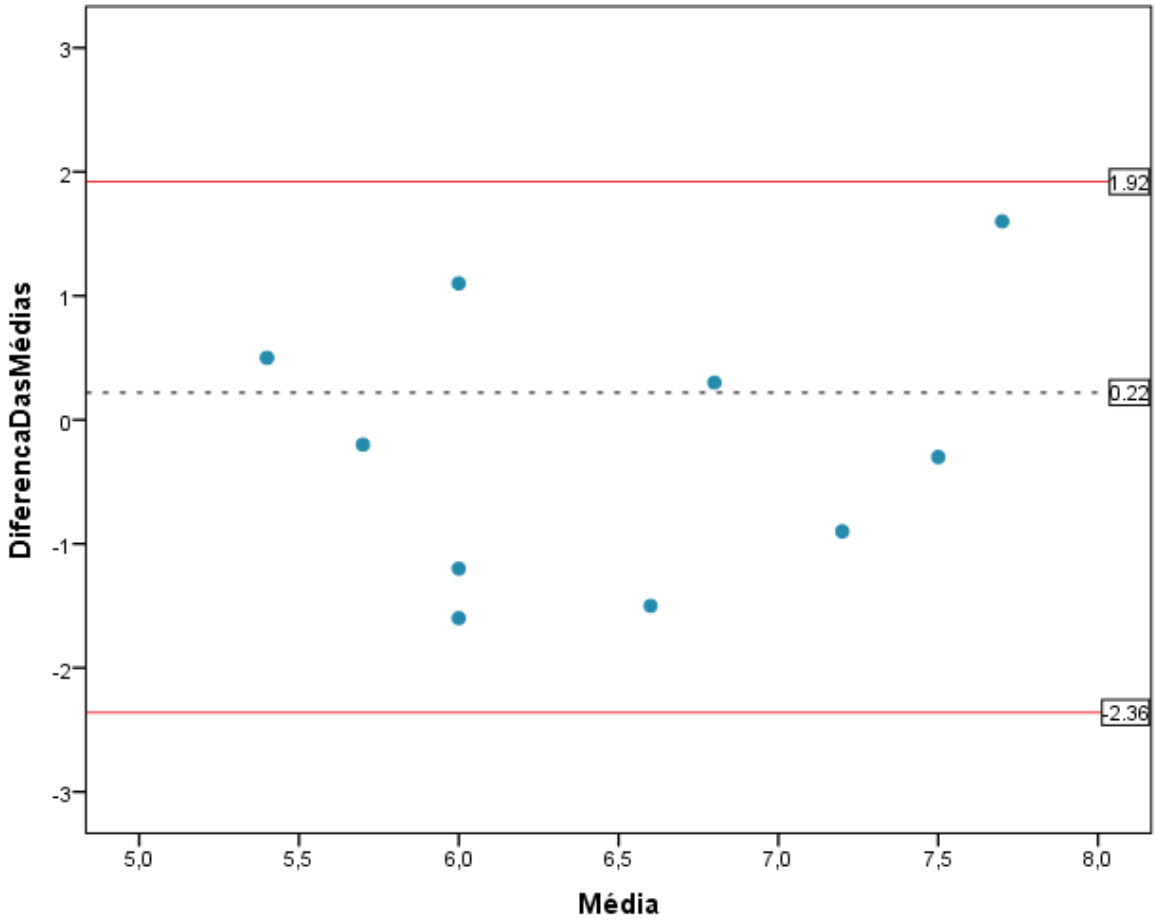
Embedded text: Variations between means/ Mean

Figure 8. Bland-Altman plot (Pharmacists)



Embedded text: Variations between means/mean

Figure 9. Bland-Altman plot (Nurses)



Embedded text: Variations between means/mean

DISCUSSION

Our findings indicate the suitability of Dean and Barber's (1999) MAE clinical severity scoring scale for use in the Brazilian Health System. A Brazilian doctor, nurse, and pharmacist's mean score results are reliable and valid due to their potential generalization towards the same group of health professionals, allowing the differentiation of minor, moderate, and severe errors.

The reliability of this method in Brazil had remarkable resemblance to the original British study as well as the German research by Taxis, Dean & Barber (2002) based on similar coefficients. In both studies, variance was insignificantly affected by judges and their professions. Compared to German and English judges, Brazilian judges took similar time periods to score cases.

We reported results similar to those of Taxis, Dean & Barber (2002), who concluded the sufficiency of three judges from different professions in obtaining a reliable mean score in

contrast to the requirement of four judges reported in the English study. Taxis, Dean & Barber (2002) claim the origin of this difference to be the model used in the D study that calculated the generalization coefficient through the no occasion facet, which minutely contributed to the variance. Yet this was not confirmed in our study, even with the usage of the occasion facet. Due to the unavailability of UK data, it remains unknown if having three judges (each from a different profession) could also produce a reliable mean UK score.

Our study's novelty lies in the robust evidence of reliability using the Bland-Altman analysis, which also confirmed agreement between the responses of each sampled professional given at two separate instances, corroborating the results obtained by the G Theory.

The other important finding was that the comparison of the means of cases with known severity results suggests that the scale is valid in Brazil for differentiating minor, moderate, or severe cases. Overall, the scores were higher in this study than in the original study. For example, there was a mean score overlap in two of the minor cases which had mean scores assigned as moderate or severe errors. We do not know why Brazilian judges assigned these scores to these cases, nor why the mean scores of all Brazilian judges were higher. Perhaps this is due to considering errors with the greatest severity potential, or perhaps the cases were not well contextualized, as one of the judges suggested, or it may be due to translation problems, but this is unlikely to have occurred as they were proofread by both an experienced translator and a UK healthcare professional. Furthermore, the drugs involved in the cases are well known in the Brazilian context, which suggest the judges' familiarity with the errors described.

There is also a debate regarding instruments for assessing the severity of medication errors and their ability to reflect the actual harmful effect on each patient. This is either due to the absence of an ideal assessment method of the scale's validity, or due to the cases of the validation process not reflecting actual regular cases, thus leading to interpretation biases (Taxis, Dean, Barber, 2002). Newly developed tools reduce uncertainties in this evaluation, yet lack international validation (Gates et al., 2019).

Finally, the results reinforce the validity of this scale, which distinctly differentiates minor harmless cases from moderate and severe cases. In general, judges considered errors with a mean score less than two as minor errors posing a low probability of harm to patients. On the other hand, mean scores above two, considered moderate and severe, can be attributed to errors adversely affecting patients. Our results corroborate those of Taxis, Dean & Barber (2002).

CONCLUSION:

The results of this study demonstrate the evident validity and reliability of Dean and Barber's (1999) scale for use in the Brazilian Health System.

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APPENDIX A - 50 CASES OF ADMINISTRATION ERRORS: ORIGINAL VERSION IN ENGLISH AND VERSION INTO ENGLISH AFTER ADAPTATIONS TO BRAZILIAN REALITY

Original	Version translated into english after adaptations to the brazilian reality
1. A hypertensive patient had his blood pressure controlled with enalapril 2.5mg once daily. One dose was missed	A hypertensive patient had his blood pressure controlled with enalapril 5mg once daily. One dose was missed.
2. An elderly patient with a cardiac pacemaker was prescribed enteric coated aspirin 75mg once daily. One dose was omitted.	An elderly patient with a cardiac pacemaker was prescribed enteric coated acetylsalicylic acid (ASA) 100mg once daily. One dose was omitted.
3. A patient was prescribed lithium carbonate 600mg daily (one tablet) but was given a single dose of 1200mg (two tablets).	A patient was prescribed lithium carbonate 600mg daily (two 300mg tablets) but was given a single dose of 1200mg (four 300mg tablets).
4. The first two doses of chloramphenicol eye ointment, prescribed to be administered four times a day, were omitted in a patient with a suspected conjunctivitis.	The first two doses of chloramphenicol eye ointment, prescribed to be administered four times a day, were omitted in a patient with a suspected conjunctivitis.
5. An elderly patient with swallowing difficulties was prescribed ranitidine effervescent tablets 150mg twice daily, for the prophylaxis of ulceration while on diclofenac therapy. An ordinary non-soluble ranitidine tablet was given instead, which the patient swallowed with some difficulty.	An elderly patient with swallowing difficulties was prescribed ranitidine effervescent tablets 150mg twice daily, for the prophylaxis of ulceration while on diclofenac therapy. An ordinary non-soluble ranitidine tablet was given instead, which the patient swallowed with some difficulty.
6. A patient had been receiving warfarin 5mg daily, which was stopped when her INR was found to be 5.4. However, for three days she continued to receive a daily dose of warfarin 5mg.	A patient had been receiving warfarin 5mg daily, which was stopped when her INR was found to be 5.4. However, for three days she continued to receive a daily dose of warfarin 5mg.
7. A patient was prescribed vitamin B compound strong tablets, two daily. One dose of only one tablet was given.	A patient was prescribed vitamin B compound strong tablets, two daily (high dosage of vitamin B compound). One dose of only one tablet was given.
8. A patient with oral Candida was prescribed fluconazole 50mg daily for one week. Fluconazole 200mg capsules were dispensed, which the patient received for the week's course.	A patient with oral Candida was prescribed fluconazole 50mg daily for one week. Fluconazole 150mg capsules were dispensed, which the patient received for the week's course.
9. A patient prescribed Lacrilube eye drops for her dry eyes was given instead one dose of 30ml lactulose orally.	A patient prescribed Lacrifilm® lubricating eye drops for her dry eyes was given instead one dose of 30ml lactulose orally.
10. A patient with an itchy rash was prescribed calamine lotion to be applied three times a day. The first five doses were omitted	A patient with an itchy rash was prescribed calamine lotion to be applied three times a day. The first five doses were omitted
11. A patient with a history of heart failure was administered a dose of oral atenolol 100mg which was intended for another patient	A patient with a history of heart failure was administered a dose of oral atenolol 100mg which was intended for another patient

Original	Version translated into english after adaptations to the brazilian reality
12. A patient was prescribed six doses of oral folinic acid (15mg three times a day) as rescue therapy following methotrexate treatment. The patient instead received six doses of folic acid 15mg.	A patient was prescribed six doses of oral folinic acid (15mg three times a day) as rescue therapy following methotrexate treatment. The patient instead received six doses of folic acid 15mg.
13. An elderly patient prescribed oral co-amilofruse 2.5/20 (Frumil LS) once a day, for the treatment of mild heart failure, was instead given a dose of co-amilofruse 5/40 (Frumil).	An elderly patient prescribed 20mg furosemide once a day, for the treatment of mild heart failure, was instead given a dose of 40mg furosemide
14. A patient was prescribed soluble insulin 10 units every six hours. This was initially interpreted as 10ml (1000 units), but the mistake was realised and the injection stopped after 2ml (200 units) had been given.	A patient was prescribed soluble insulin 10 units every six hours. This was initially interpreted as 10ml (1000 units), but the mistake was realised, and the injection stopped after 2ml (200 units) had been given.
15. A patient prescribed 5mg morphine IV was given intravenously 5mg of Oramorph (oral morphine solution 10mg/5ml) solution.	A patient prescribed 5mg morphine IV was given intravenously 5mg of Oramorph (oral morphine solution (Dimorf® 10mg/ml).
16. A patient was being treated for acute sciatica by lumbar epidural injection of methylprednisolone acetate. The vial of drug was reconstituted with 30% sodium chloride instead of 0.9% sodium chloride and then administered.	A patient was being treated for acute sciatica by lumbar epidural injection of methylprednisolone acetate. The vial of drug was reconstituted with 20% sodium chloride instead of 0.9% sodium chloride and then administered.
17. A patient with chronic obstructive airways disease was prescribed Augmentin 250/62 suspension, 5ml three times daily for the treatment of a chest infection. The first five doses were omitted.	A patient with chronic obstructive airways disease was prescribed Clavulin® (amoxicillin and potassium clavulanate 250/62) suspension, 5ml three times daily for the treatment of a chest infection. The first five doses were omitted.
18. One 10pm dose of oral metronidazole 400mg was omitted in a patient receiving the drug three times daily for surgical prophylaxis. He was three days post surgery.	One 10pm dose of oral metronidazole 400mg was omitted in a patient receiving the drug three times daily for surgical prophylaxis. He was three days post-surgery.
19. A patient with a known penicillin allergy was prescribed oral ciprofloxacin 500mg twice a day for the treatment of a chest infection. He was given one dose of flucloxacillin 500mg.	A patient with a known penicillin allergy was prescribed oral ciprofloxacin 500mg twice a day for the treatment of a chest infection. He was given one dose of oxacillin 500mg.
20. A patient was prescribed 100mg lamotrigine daily. Lamotrigine 100mg tablets were dispensed instead of the 25mg tablets intended. The patient therefore received 400mg daily for six days instead of 100mg daily.	A patient was prescribed 100mg lamotrigine daily. Lamotrigine 100mg tablets were dispensed instead of the 25mg tablets intended. The patient therefore received 400mg daily for six days instead of 100mg daily.
21. One dose of oral hydrocortisone 10mg was omitted in a patient with chronic adrenal insufficiency who was prescribed 20mg every morning and 10mg every evening.	One dose of oral hydrocortisone 10mg was omitted in a patient with chronic adrenal insufficiency who was prescribed 20mg every morning and 10mg every evening.

Original	Version translated into english after adaptations to the brazilian reality
22. An elderly patient prescribed paracetamol suspension 250mg/5ml in a dose of 10ml (500mg) every six hours was given one dose of 20ml (1g).	An elderly patient prescribed paracetamol suspension 100mg/ml in a 5ml (500mg) dose every six hours was given one 10ml (1g) dose.
23. One dose of oral metformin 500mg was omitted in a diabetic patient receiving 500mg three times daily.	One dose of oral metformin 500mg was omitted in a diabetic patient receiving 500mg three times daily.
24. A patient prescribed 10ml of morphine elixir 2.5mg/5ml (5mg morphine) was given instead a dose of 10ml of the concentrated elixir 100mg/5ml (200mg morphine).	A patient prescribed 2ml of morphine IV (1mg/ml vials, with 2mg morphine content) was given instead a 20ml (200mg de morphine) dose from an IV 10mg/ml vial.
25. A patient was receiving oral ranitidine 150mg twice a day as prophylaxis against peptic ulceration, while he was also receiving steroids. One evening dose of the ranitidine was missed. He had no history of peptic ulceration.	A patient was receiving oral ranitidine 150mg twice a day as prophylaxis against peptic ulceration, while he was also receiving steroids. One evening dose of the ranitidine was missed. He had no history of peptic ulceration.
26. A patient was prescribed oral vancomycin 125mg four times a day for the treatment of Clostridium difficile colitis. Three days into therapy, two consecutive doses were omitted.	A patient was prescribed oral vancomycin 125mg four times a day for the treatment of Clostridium difficile colitis. Three days into therapy, two consecutive doses were omitted.
27. A patient with long standing Parkinson's disease was prescribed co-beneldopa 250mg (benscrazide 50mg and levodopa 200mg) four times a day, but was dispensed a week's supply of modified release co-careldopa 250mg (carbidopa 50mg and levodopa 200mg) in a bottle labelled co-beneldopa.	A patient with long standing Parkinson's disease was prescribed Prolopa® 250mg (Benscrazide 50mg and Levodopa 200mg) four times a day but was dispensed a week's supply of Cronomet® 250mg (Carbidopa 50mg and levodopa 200mg) in a bottle labelled Prolopa®.
28. A patient with Crohn's disease was prescribed prednisolone enteric coated tablets 5mg once daily, but was given plain uncoated 5mg prednisolone tablets throughout his four day hospital stay.	A patient with Crohn's disease was prescribed prednisolone enteric coated tablets 5mg once daily but was given plain uncoated 5mg prednisolone tablets throughout his four-day hospital stay.
29. An elderly patient was prescribed oral ranitidine 150mg twice a day as prophylaxis against NSAID-induced ulceration. The first six doses were omitted.	An elderly patient was prescribed oral ranitidine 150mg twice a day as prophylaxis against NSAID-induced ulceration. The first six doses were omitted.
30. A patient prescribed oral penicillin 250mg four times daily was dispensed penicillamine 250mg, which the patient was given for three days before the error was discovered.	A patient prescribed oral penicillin 250mg four times daily was dispensed penicillamine 250mg, which the patient was given for three days before the error was discovered.
31. One dose of oral diltiazem 60mg was omitted in a newly admitted patient with angina who normally took the drug three times a day.	One dose of oral diltiazem 60mg was omitted in a newly admitted patient with angina who normally took the drug three times a day.

Original	Version translated into english after adaptations to the brazilian reality
32. A newly diagnosed asthmatic patient was prescribed beclomethasone 100 mcg per metered dose, two puffs twice a day. He was given an inhaler containing 250mcg beclomethasone per metered dose, containing sufficient quantity for three weeks.	A newly diagnosed asthmatic patient was prescribed beclomethasone 100 mcg per metered dose, two puffs twice a day. He was given an inhaler containing 250mcg beclomethasone per metered dose, containing sufficient quantity for three weeks.
33. A patient written up for warfarin 10mg was given two 5mg tablets that had expired one month previously.	A patient written up for warfarin 10mg was given two 5mg tablets that had expired one month earlier.
34. A patient was prescribed thyroxine 25 microgrammes daily. The patient was instead administered methotrexate 25mg daily for several days.	A patient was prescribed thyroxine 25 micrograms daily. The patient was instead administered methotrexate 25mg daily for several days.
35. An elderly patient prescribed digoxin elixir 125 micrograms daily for the treatment of chronic atrial fibrillation was given 50 micrograms of the elixir daily for several weeks.	An elderly patient prescribed digoxin elixir 125 micrograms daily for the treatment of chronic atrial fibrillation was given 50 micrograms of the elixir daily for several weeks.
36. A terminally ill patient was prescribed morphine sulphate SR tablets 60mg twice daily. He was given a dose of 60mg Sevredol (non-modified release morphine sulphate) rather than the intended MST tablets.	A terminally ill patient was prescribed morphine sulphate SR tablets 60mg (DIMORF® LC) twice daily. He was given a dose of 60mg (two 30mg tablets) non-modified release morphine sulphate rather than the intended DIMORF® LC (CR).
37. A patient prescribed vancomycin 1g IV twice daily was given one of the doses as a bolus rather than by infusion.	A patient prescribed vancomycin 1g IV daily was given one of the doses as direct IV (bolus) rather than by intermittent infusion.
38. A patient was prescribed gentamicin ear drops, two drops three times a day to the right ear, for the treatment of an ear infection shown to be sensitive to gentamicin. On the second day of treatment, one dose was administered to the left ear instead of the right ear.	A patient was prescribed gentamicin ear drops, two drops three times a day to the right ear, for the treatment of an ear infection shown to be sensitive to gentamicin. On the second day of treatment, one dose was administered to the left ear instead of the right ear.
39. The first two doses of topical Teejel (choline salicylate dental gel BP), prescribed to be applied four times daily, were omitted in a patient with mouth ulcers.	The first two doses of OMCILON-A ORABASE (Triamcinolone acetonide), prescribed to be applied four times daily, were omitted in a patient with mouth ulcers.
40. A patient prescribed cefotaxime 1g IV three times a day for post-partum pyrexia had a dose reconstituted with 10ml of 15% potassium chloride solution instead of 0.9% sodium chloride. The dose was then administered by bolus injection.	A patient prescribed cefotaxime 1g IV three times a day for post-partum pyrexia had a dose reconstituted with 10ml of 19% potassium chloride solution instead of 0.9% sodium chloride. The dose was then administered by bolus injection.

Original	Version translated into english after adaptations to the brazilian reality
41. An elderly non-diabetic patient was given another patient's 5mg glibenclamide tablet.	An elderly non-diabetic patient was given another patient's 5mg Glibenclamide tablet.
42. An elderly patient with cellulitis was prescribed oral flucloxacillin lg four times daily. One week after the start of the treatment she was given two consecutive doses of 500mg instead of 1g.	An elderly patient with cellulitis was prescribed oral dicloxacillin 500mg four times daily. One week after the start of the treatment the patient was given two consecutive doses of 250mg instead of one 500mg dose.
43. An elderly patient with a hospital-acquired chest infection was prescribed cefotaxime 1g IV three times a day. Two days into the treatment course he was given one oral dose of cephradine 500mg instead of the dose prescribed. He was able to swallow oral medication.	An elderly patient with a hospital-acquired chest infection was prescribed cefotaxime 1g IV three times a day. Two days into the treatment course he was given one oral dose of Cephalexin 500mg instead of the dose prescribed. He was able to swallow the oral medication.
44. One dose of salbutamol 400mcg rotacaps was omitted in a patient with chronic obstructive airways disease.	One dose of salbutamol 100mcg rotacaps was omitted in a patient with chronic obstructive airways disease.
45. A patient stabilised on warfarin 5mg daily was given one dose of 7.5mg.	A patient stabilised on warfarin 5mg daily was given one dose of 7.5mg.
46. A patient who was prescribed oral diltiazem 60mg three times a day was given instead one dose of diazepam 60mg.	A patient who was prescribed oral diltiazem 60mg three times a day was given instead one dose of diazepam 60mg.
47. A patient prescribed oral diclofenac 50mg three times a day for post-operative pain control missed the first three doses.	A patient prescribed oral diclofenac 50mg three times a day for post-operative pain control missed the first three doses.
48. A patient with oesophagitis was prescribed omeprazole (Losec) 20mg daily. For three days the patient instead received frusemide (Lasix) 20mg.	A patient with oesophagitis was prescribed omeprazole (Losec®) 20mg daily. For three days the patient instead received frusemide (Lasix®) 20mg.
49. A patient with anaemia was prescribed oral ferrous sulphate 200mg three times a day. One dose was omitted.	A patient with anaemia was prescribed oral ferrous sulphate 200mg three times a day. One dose was omitted.
50. A patient prescribed Augmentin (co-amoxiclav 250/125), one tablet three times a day for a chest infection, was given one dose of two tablets on the third day of therapy. Her renal function was normal.	A patient prescribed Clavulin® (Amoxicillin/potassium clavulanate – 250/125) one tablet three times a day for a chest infection, was given one dose of two tablets on the third day of therapy. Her renal function was normal.

APPENDIX B - MEAN SCORE FOR EACH MEDICATION ADMINISTRATION ERROR

ERROR	MEAN SCORE
1	3.3
2	3
3	5.3
4	4.2
5	4.7
6	7.8
7	2.1
8	5
9	3
10	3.2
11	6.3
12	4.5
13	4.5
14	8.8
15	7.9
16	8.5
17	6.8
18	2.9
19	7.3
20	7.2
21	4.2
22	4.2
23	3.3
24	9.1
25	2.3
26	4.9
27	3.5
28	4.4
29	4.8
30	6.9
31	5.1
32	4.5
33	3.1
34	7.5
35	6.9
36	5.2
37	7
38	3.3
39	3.1
40	9.3
41	5.6
42	2.0
43	3.8
44	3.5
45	4.6
46	7.5
47	4.1
48	5.3
49	1.6
50	2.5

3.5 ARTIGO 5: SEVERITY OF MEDICATION ADMINISTRATION ERRORS IN A TEACHING HOSPITAL IN BRAZIL

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Introduction: The degree and nature of harm associated with medication errors differs among low-, middle-, and high-income countries. However, epidemiological data on the occurrence of medication errors and, above all, on their severity, are scarce in Latin American countries. **Purpose:** Assess the potential severity of administration errors identified by direct observation in a university hospital. **Method:** The study followed the methodology used by Barber and Dean (1999) and Taxis (2004) to assess the potential severity of errors. The survey used a 10-point scale, where 0 = no harm to the patient and 10 = death of the patient. This scale was validated for Brazil[3] using generalisability theory, which allowed the authors to conclude that the potential severity attributed by at least four professionals is considered valid and reliable. A prospective observational study[4] using disguised direct observation of medication administration identified 203 medication administration errors. In the present study, these errors were organised according to similarity; similar errors were described only once in a list of cases, totalling 67 errors. This list was assessed in terms of severity by four professionals (physician, nurse, and two pharmacists) working in the hospital area and with more than three years of experience in the clinical area. An average score was calculated for each of the 67 medication administration errors considering the scores assigned by the four judges. This score was used as a severity index. Errors with severity index 3 were considered mild; those between 3 and 7, moderate; and above 7, severe[1]. The same score was assigned to errors considered similar, and the severity of the 203 errors initially identified was analysed at the end. **Results:** Professionals classified the potential clinical significance of errors as mild in 8.8% (18), moderate in 82.8% (168), and severe in 8.4% (17) of cases. The mean potential severity score was 5.2 (minimum score 2.6 and maximum score 7.7; SD 1.2). Most of the errors considered potentially serious (41%, 7 errors) were technical errors. Meanwhile, 18% were errors of omission, dose, and extra dose (3 errors of each type), and one error of unprescribed dose. According Anatomical Therapeutic Chemical (ATC) category, potentially serious errors involved medications for the alimentary tract and metabolism (29%), systemic use (29%), blood and forming organs (24%), respiratory system, cardiovascular system, and nervous system (6% each). Insulin was the medication most involved in potentially serious errors (2 dose, 2 omission, and 1 technique errors). As for route of administration, nine potentially serious errors (53%) involved medications administered intravenously, five (29%) administered subcutaneously, and three (18%) administered orally. One of the cases assessed required the intervention of the observer, being classified as potentially serious (severity index >7). **Conclusion:** Most errors were classified as potentially moderate in terms of severity. However, the frequency of errors considered potentially serious was higher than that found in previous studies using the same methodology, which highlights the need for a better understanding of the causes of these errors and strategies to reduce their occurrence.

Keywords: medication errors, medication administration errors, severity, patient safety; hospital.

INTRODUCTION

Unsafe practices of medication use and medication errors are among the leading causes of preventable harm in health systems worldwide (GATES et al., 2018). In 2017, the World Health Organisation launched the 3rd Global Patient Safety Challenge aiming to strengthen these systems, reduce medication errors and preventable harms associated with their occurrence (DONALDSON et al., 2017).

The magnitude and nature of harms associated with medication errors differ between low, middle-, and high-income countries. However, epidemiological data on the occurrence of medication errors and their severity are scarce in many countries, including Latin American countries (DE OLIVEIRA, 2018; DONALDSON et al., 2017; GATES et al., 2019a; ASSUNÇÃO-COSTA et al, 2022a)

Factors that may limit the assessment of the prevalence and severity of medication errors include differences in the definition of what constitutes harm related to medication use, limitations in the ability to define whether harm related to medication errors is real or potential, and doubts about the tools used to assess the severity of harm (potential or real) and their use. (ASSUNÇÃO-COSTA et al., 2022b; FAHMY et al., 2018; GATES et al., 2019b). The term "severity of error" is typically used to describe the extent of the potential or real impact of medication errors. However, this term does not refer to the error as such, but rather to the potential or real harm to the patient believed to be associated with the error. This distinction is important given the obvious severity of the real "harm" to the patient when compared to the potential to cause that harm. Furthermore, since many errors are intercepted before they reach the patient, errors that actually cause harm account for only a small proportion of all errors (GATES et al., 2018, 2019b).

The assessment of potential and real harm involves two distinct processes: identifying the potential or real harm to the patient associated with a medication error, and classifying its severity (MORIMOTO, 2004). The potential harm is evaluated according to its expected severity. To evaluate the real harm, the severity of harm is considered after the occurrence of a medication error (GATES et al., 2019b; MORIMOTO et al., 2004).

A recent systematic review conducted by Assunção-Costa et al. (2022a), identified 10 studies that used the direct observation technique to assess the prevalence of medication administration errors (MAE) in Latin America hospitals. None of these studies used tools to assess the severity of the errors that occurred, highlighting the need for a better understanding of the harms associated with MAE in this region, as a strategy to reduce their occurrence and promote the safe use of medicines.

A variety of tools for measuring and classifying harms associated with medication errors are available. Here we use the 10-point scale developed by Dean and Barber (1999) to classify potential harm. This tool proved to be highly reliable and valid, being used in studies in the United Kingdom and Germany (TAXIS; DEAN; BARBER, 2002), and was recently validated in Brazil (ASSUNÇÃO-COSTA et al., 2022c). As far as we are aware, this is the first paper that used a validated, reliable method of scoring the severity of MAEs in Brazil. This research is part of a larger study of medication administration errors in a University Hospital and aims to assess the potential severity of medication administration errors detected in this hospital.

METHODS

A prospective observational study based on the disguised direct observation approach of medication administration in a University Hospital was conducted by Assunção-Costa et al. (2022b), that identified 203 medication administration errors, categorised by type: time error, technique error, dose error, route of administration error, omission, extra dose, non-prescribed dose, and wrong pharmaceutical form. Subsequently, errors were organised according to similarity, resulting in a list of 67 errors (Appendix A), which was assessed according to their severity, replicating the assigned severity for the remaining 136 of the total 203 errors. This synthesis was performed to make the assessment process objective and to reduce the workload for the judges.

The methodology proposed by Barber and Dean (1999) and Taxis (2004) was used to assess the severity of the errors, using a scale to measure the potential severity of medication errors that was validated for Brazil by Assunção-Costa et al. (2022c). This validation concluded that at least 3 professionals, regardless of the profession (doctor, a nurse, and a pharmacist) are required to consider the rating scale reliable.

The study used a severity scale in which zero represents no harm to the patient and ten represents patient death.

Afterwards, four professionals were selected: a physician, a nurse, and two pharmacists, all of them working in the hospital area and having more than three years of clinical experience. The professionals received a file with the description of the 67 errors and the severity scale (Appendix A) for evaluation. A letter with instructions on how to assess the potential severity of the errors was sent (Appendix B).

Data Analysis

Judges were asked to record their observations and the time required to assess all errors. An average score among the 4 judges was calculated and used as the severity index, for each medication administration error. Errors with a severity index <3 were classified minor, between 3 and 7 moderate, and above 7 severe (ASSUNÇÃO-COSTA et al., 2022c; DEAN; BARBER, 1999).

RESULTS

The professionals rated the potential clinical significance of the errors as minor in 8.8% (18), moderate in 82.8% (168), and severe in 8.4% (17) of cases. The average potential severity score was 5.2 (minimum score 2.6 and maximum score 7.7; SD 1.2). The two pharmacists took 40 and 52 minutes, respectively, to respond to the 67 cases. The physician took 48 minutes and the nurse 62 minutes (average time of 50 minutes). The scores and severity levels assigned for each case are listed in Appendix C.

Chart 1 describes some examples of errors classified as potentially minor, moderate, or severe. The case in which an observer had to intervene was classified as potentially severe (severity index > 7).

Chart 1. Examples of medication errors by severity index

MINOR (Severity Index between 0 and 3)
An excess drop of Hyabak® (ophthalmic solution, 0.15%) was administered into the patient's right eye.
Prescribed dimethicone (drops, 75 mg/mL) and administered 1 tablet (40 mg).
MODERATE (Severity Index between 3 and 7)
Patient taking spironolactone (tablet, 100mg). Medication was not administered.
Prescribed furosemide (solution for injection, 10mg/mL). The dilution manual advises infusion between 1 and 2 minutes. Administration performed in 11 seconds.
SEVERE (Severity Index above 7)
Warfarin* (tablet, 5 mg) was offered to the patient, however the medication was prescribed for another patient. Intervention performed before administration.
Patient taking hydralazine (tablet, 25 mg), instructed not to administer the antihypertensive on haemodialysis days. Administration occurred on the same day of haemodialysis.

* Only cases that required intervention to avoid MAE.

Most of the errors classified as potentially severe (41%, 7 errors) were technical errors. Dose, omission, and overdose errors were also classified as potentially severe, with a frequency

of 18% each (3 errors of each type), in addition to 1 non-prescribed dose error. According to the ATC category, potentially severe errors involved medicines in category A – digestive tract and metabolism (29%), J – anti-infectives for systemic use (29%), B – blood and hematopoietic organs (24%), R – respiratory system, C – cardiovascular system, and N – nervous system (6% each). The main medicine in which potentially severe errors occurred was insulin, involved in 2 dose errors, 2 omission errors, and 1 technical error. Concerning the route of administration, 9 (53%) potentially serious errors involved for intravenous medication administration, 5 (29%) subcutaneous medication administration, and 3 (18%) oral medication administration.

DISCUSSION

The frequency of errors classified as potentially moderate and severe was high compared to international studies (ASSUNÇÃO-COSTA et al., 2022; BERDOT et al., 2013; DE OLIVEIRA, 2018; KEERS et al., 2013a; TAXIS; BARBER, 2004; DEAN; BARBER, 1999). The average severity score for medication administration errors was also high (5.2). Dean & Barber (1999) found an average error score of 2.7, while Taxis (2004) found an average error score of 3.1. We do not know the reasons why both the frequency of errors considered severe and the average severity score were high in our study, but we do know that some related factors may have contributed, such as the intravenous route and potentially dangerous medications, which are already known to cause the greatest harm to patients when an error happens (REIS et al., 2010; WESTBROOK et al., 2011; ASSUNÇÃO-COSTA ET AL, 2022a).

A study conducted in a Brazilian University Hospital found a greater association between intravenous administration and the occurrence of errors, especially in the medication preparation phase (GROU VOLPE et al., 2014). The relationship between the severity of potential errors and intravenous administration is well established. A similar study observed that errors in intravenous administration, in a sample of 10 wards from 2 hospitals in England, occurred in half of the doses administered and caused potential harm in one-third of them (WIRTZ; TAXIS; BARBER, 2003). Another similar study was conducted in Germany, in which the same author found that 3% of 65 intravenous medication administration errors were severe. Several international studies have demonstrated the greater severity of errors in intravenous administration (KALE et al., 2012; KEERS et al., 2013b; WESTBROOK et al., 2011; WIRTZ; TAXIS; BARBER, 2003). However, there is no information on the severity of

administration errors in the reality of Latin America and Brazil, thus being necessary to better investigate the potential for harm to patients caused by medication errors, especially in the context of low- and middle-income (DE OLIVEIRA, 2018; KEERS et al., 2013a; TOFFOLETO et al., 2015; ASSUNÇÃO-COSTA ET AL., 2022A).

Another important finding was that almost half of the errors assessed as potentially severe were technical errors, which differs from the results found in national and international literature (ASSUNÇÃO-COSTA, 2022a; BERDOT et al., 2013; KEERS et al., 2013a). Furthermore, the potentially severe errors involved categories A, J, and B medications, with insulin being the main medication. The literature indicates that medication errors related to insulin are common, and approximately one-third of it involves fatal errors. Nguyen et al. (2014) examined insulin administration and found that most errors were potentially moderate and severe, emphasising the need to create interventions focused on clinically important errors, as insulin requires timely dosing, administration, and careful monitoring (NGUYEN et al., 2014).

When studying the incidence or prevalence of medication errors, it is important to determine their clinical significance. However, it is often difficult to doing so, as in many studies, the actual clinical outcomes are unknown due to the lack of longitudinal follow-up of patients or due to researchers intervening to prevent errors from causing harm to patients. There are several methods for assessing the severity of errors. The two most common are the National Coordinating Council for Medication Error Reporting and Prevention (NCCMERP) severity index and Dean and Barber's method (DEAN, 1999). This was the first study using a validated scale to assess the severity of errors in Brazil (ASSUNÇÃO- COSTA et al., 2022c). The scale developed by Dean et al. seems to be more suitable for use in research (WALSH et al., 2017). Assessing potential error severity is a complex judgement and can be influenced by many sources. The use of this scale in future research may help to determine the clinical significance of medication errors more clearly in the Brazilian context, contributing to the development of interventions aimed at reducing the associated harm.

CONCLUSION

This was the first study conducted in Brazil using a validated, reliable severity scale. Medication administration errors were frequent and most of them were potentially moderate and severe.

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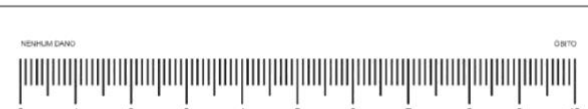
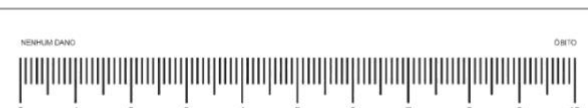
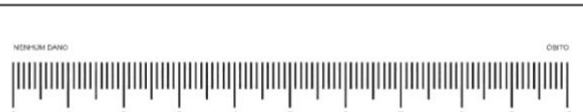
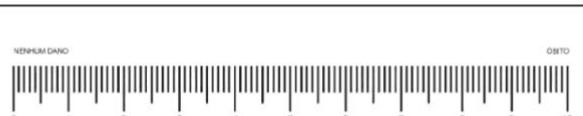
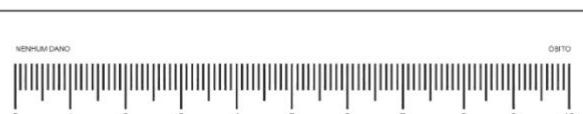
APPENDIX A – LIST OF 67 SIMILAR MEDICATION ADMINISTRATION ERRORS

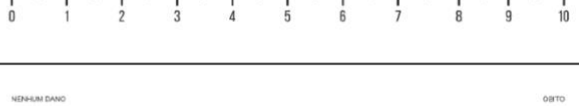
1	Paciente com hipertensão arterial sistêmica, em uso contínuo de losartana 50 mg. A técnica de enfermagem não administrou o medicamento por julgar que a pressão arterial do paciente estava baixa, e o mesmo seria encaminhado para o Centro Cirúrgico nas horas seguintes.	
2	Paciente em uso de carbonato de cálcio + vitamina D comprimido (1250 mg + 400 UI). O medicamento não foi administrado, mas foi checado na prescrição como sendo dado.	
3	Prescrito permanganato de potássio solução (1:80.000) para lavagem de lesões de pele do paciente. A técnica de enfermagem registra que não tem o medicamento na unidade, porém o medicamento estava disponível.	
4	Paciente em uso contínuo de dipirona solução injetável 1g e codeína + paracetamol, ambos prescritos para controle da dor. A dipirona não foi preparada pela técnica, pois durante a administração da codeína + paracetamol, o paciente referiunão sentir dor e técnica não administrou a dipirona. Foi marcado na prescrição como administrado.	
5	Paciente em uso contínuo de dipirona solução injetável 2g para controle da dor. Foi checado na prescrição de um paciente, entretanto o medicamento foi administrado em outro paciente.	
6	Paciente em uso de insulina regular. Prescrito 4 unidades se HGT entre 190 e 250 mg/dL. A glicemia capilar (HGT) foi de 209 mg/dL. A administração não realizada.	
7	Paciente em uso de bromoprida (ampola 5 mg), com queixade dor no acesso venoso, teve administração interrompida. Na prescrição foi marcado administrado com observação desem acesso e a administração do medicamento não foi concluída.	
8	Paciente em uso de Insulina NPH (10 unidades). Técnica registrou na prescrição que não administrou medicamento por paciente ter risco de hipoglicemia. Entretanto, não tinha nenhuma informação que referendasse esta decisão.	
9	Paciente em uso de amitriptilina 25 mg. O medicamento não foi administrado e foi encontrado no box da paciente sem justificativas.	

10	Foi administrado ao paciente bisacodil (1 comprimido de 5 mg) às 16:08 horas. Às 16:36 foi realizada intervenção pois a prescrição orientava a administração de quatro comprimidos para preparo para colonoscopia.	
11	Foi prescrito Ivermectina 18mg e administrado 12mg.	
12	Foi prescrito amitriptilina (02 comprimidos de 25 mg). Administrado 1 comprimido de 25 mg. Paciente informou que dose estava errada, técnica ficou de verificar prescrição e não retornou.	
13	Foi prescrito solução fisiológica 0,9% (500ml) + glicose 25% (40 mL). Aspiradas quatro ampolas de glicose 25% e adicionado ao soro de 500 ml. Volume do soro não foi ajustado com a adição do volume de 40 ml. Tempo do medicamento de 20 gotas/minuto.	
14	Foi prescrito hioscina + dipirona 3ml. Administrado 2 ml.	
15	Foi prescrito enoxaparina 70 mg, solução injetável. Utilizada uma seringa de 60 mg + 10 mg de uma seringa de 20mg (desprezada metade do conteúdo com a seringa virada para baixo). A seringa de 20 mg não é graduada, não sendo possível precisar o volume final após ser desprezada metade do conteúdo.	
16	Prescrito clindamicina (solução injetável 150 mg/ml, 4 ml). A técnica de enfermagem desprezou algum volume do medicamento para retirar bolha de ar do equipo. Usou equipo previamente utilizado. Não foi possível precisar o volume desprezado.	
17	Foi prescrito 01 frasco Ringer Lactato + 12,5 ml KCl + 7 ml NaCl + 10 ml glicose + 2,5 ml MgSo4. A técnica escovou equipo após introduzir eletrólitos e teve perda de volume do medicamento que não foi possível precisar quantidade. Foi adicionado 32mL de medicamento, mas não se sabe o volumetotal após perda. Vazão programada de acordo com a prescrição.	
18	Foi prescrito Azatioprina 150mg (03 comprimidos), feito 50 mg (01 comprimido)	
19	Foram prescritos 3 comprimidos de sulfametoxazol + trimetropina (400 mg + 80 mg). Administrado 1 comprimido.	
20	Foi prescrito 50mg de Dimenidrinato, mas administrado 30mg (1 ampola).	

21	Prescrito Hyabak ® solução oftálmica 0,15% (01 gota em cada olho). Foram administradas duas gotas no olho direito;	
22	Prescrito tramadol se necessário (solução injetável 50 mg/ml,2 ml). O tramadol foi diluído em solução compatível, mas descartaram parte do da solução com o medicamento, não sendo possível precisar o impacto da perda;	
23	Foi prescrito Atenolol 2 comprimidos (50mg). Administrado1 comprimido (25mg);	
24	Foi prescrito ibuprofeno (suspensão oral gotas 50 mg/ml). A técnica de enfermagem não posicionou frasco conta gotas na posição vertical e não houve formação de gota. A dose administrada foi incorreta;	
25	Foi prescrito Ringer Lactato com adições de eletrólitos (KCl; NaCl; Glicose; MgSO4). O profissional escovou o equipo após introduzir eletrólitos e teve perda de volume do medicamento, não sendo possível precisar a quantidade. Foi adicionado 32mL de medicamento, mas não se sabe o volume total após perda.	
26	Foi prescrito codeína 30mg sem associação. Administrado codeína 30mg + paracetamol 500mg	
27	Foi prescrito codeína (1 comprimido 30 mg) se dor, mas medicamento foi administrado de forma contínua.	
28	Foi prescrito hidralazina (comprimido 25 mg), porém havia uma observação na prescrição para não fazer anti- hipertensivos nos dias de hemodiálise (terça, quinta e sábado). Mesmo assim administração foi administrado na quinta-feira.	
29	Foi prescrito metoclopromida comprimido via oral e administrado ampola (5 mg/ml) por via intravenosa durante23 segundos.	
30	Foi prescrito hioscina simples (10mg) via oral. Foi feito porvia endovenosa no tempo de 35 segundos.	
31	Foi prescrito o medicamento dimenidrinato + vitamina B, se necessário, por via oral. Foi administrada solução injetável (30 mg/ml) por via endovenosa.	

32	Foi prescrito dimeticona emulsão oral (gotas) e foiadministrado comprimido de 40 mg.	
33	Foi prescrito ondansentrona (1 ampola de 4 mg). Manual de diluição indica infusão entre 15-30 minutos. Feito em uma hora e 40 minutos.	
34	Foi prescrito albumina (20%) frasco de 50 ml, 8 frascos. A administração ocorreu da seguinte forma: 1º e 2º frascos em30 min (15 min cada); 3º frasco em 35 min; 4º ao 7º frasco em 1:45h (aproximadamente 25min cada). O manual de diluição orienta de 1 a 2 ml/min o que corresponde ao tempomínimo de 25 minutos para cada frasco. Equipo escovado aspirando, devido a dificuldade de fluidez. O conteúdo que ficou na seringa foi administrado IV direto (cerca de 5 ml).	
35	Prescrito meropenem (02 frascos de 500 mg). o manual de diluição orienta infundir entre 15-30 minutos, feito em uma hora.	
36	Prescrito furosemida (10 mg/ml – 2 ml), 2 ampolas. O manual de diluição orienta infundir entre 1 e 2 min, feitoentre 10-11 segundos.	
37	Foi prescrito SF 0,9%/ frasco de 500 ml para administração em 8 horas. Feito em aproximadamente quatro horas.	
38	Foi prescrito metoclopramida (1 ampola de 2mL - 5mg/mL).O manual de Diluição orienta administrar IV direto por 1 a 2min sem diluir. Foi feito em 10 segundos.	
39	Foi prescrito metoclopramida (1 ampola de 2m - 5mg/mL). O manual orienta administração IV direto não diluído, de 1 a 2 minutos. Foi administrado em uma hora e 10 minutos.	
40	Foi prescrito 2 g de dipirona para administração endovenosa. O manual de diluição recomenda administração IV direto muito lentamente e não exceder 500 mg/min. Foi feito em 40 segundos.	
41	Foi prescrito 1 g de dipirona para administração endovenosa. O manual de diluição recomenda velocidade deinfusão máxima de 500 mg/min. Foi feito em três horas e 20 minutos.	

42	Foi prescrito 1 g de dipirona para administração endovenosa.O paciente se recusou a usar todo conteúdo porque estava sentindo dor no acesso.	
43	Foi prescrito cefazolina (1g) para administração endovenosa.O manual de diluição orienta reconstituição em 10mL de águapara injeção, havendo expansão para 10,6mL e administração endovenosa direta entre 3-5 minutos, de acordo com a bula do KEFAZOL ®. Administração foi feita em cerca de 32 segundos.	
44	Foi prescrito cefazolina (1g) para administração endovenosa.O manual de diluição recomenda o tempo de administração de intravenoso direto entre 3 - 5 minutos e não recomenda diluir em soro fisiológico 0,9%. Feito em 56 segundos e reconstituição em 10ml de SF 0,9%.	
45	Paciente em uso de AAS (comprimido de 100 mg). Paciente teve acidente cardiovascular cerebral e técnica preferiu dissolver e diluir o comprimido do medicamento. Paciente estava deglutindo alimentos, líquidos e comprimidos normalmente.	
46	Prescrito vancomicina (1g) para administração endovenosa. Ao chegar ao leito da paciente, a técnica verifica que a dose anterior havia sido preparada em 250mL de soro fisiológico 0,9%. A mesma retornou ao posto e aspirou volume de soro fisiológico 0,9% necessário para chegar ao volume de 250mL, pois tinha preparado o medicamento com 100 mL de SF 0,9%.	
47	Foi prescrito vancomicina (1g) para administração endovenosa. O manual diluição orienta infundir em 2 horas. Feito em uma hora.	
48	Foi prescrito omeprazol (40 mg) para administração endovenosa. O manual de diluição orienta infundir no máximo 4ml/min. Foi feito entre 15 e 18 segundos.	
49	Foi prescrito cetoprofeno (100 mg) para administração endovenosa. O manual de diluição orienta reconstituiçãocom água para injeção e tempo de administração de 20minutos. Foi reconstituído em 100 ml de SF 0,9% cadministrado em 51 minutos e 28 segundos (39 gotas/minuto).	
50	Foi prescrito Bromoprida (5mg) para administração endovenosa. O manual de diluição orienta infusão lentamente superior a 3 minutos. Feito em 43 segundos.	
51	Foi prescrito clindamicina (600 mg) para administração endovenosa. O manual de diluição orienta diluir 600mg em 50ml e infundir em 20min. Foi diluído em 100ml e feito em 40 minutos.	

52	Foi prescrito hioscina (20 mg) para administração endovenosa. Recomendado administrar 1mL/min, sem diluição, como orienta o manual de diluição. Administrado em cerca de 15 segundos (1 ml da medicamento + 9 ml de SF0,9%).	
53	Foi prescrito cefepime (1g) para administração endovenosa.O manual de diluição orienta infundir 30 minutos. Foi feito em duas horas.	
54	Foi prescrito ceftriaxona (1g). O manual recomenda IV infusão entre 15-30 minutos, feito em cerca de 85 minutos (60 gotas/minuto). O medicamento foi infundido juntamente com clindamicina e manual informa serem incompatíveis para infusão em Y.	
55	Foi prescrito ceftriaxona (1g). Manual de diluição orienta IV direto entre 2-4 minutos. Feito em um minuto.	
56	Foi prescrito oxacilina (2g) para administração endovenosa. Medicamento usualmente diluído em 100 ml, foi aspirado 10 ml de água para injeção e utilizado para reconstituir os quatro frascos ampola, utilizando a mesma seringa de 10 ml.Aspirado produto reconstituído e diluído em SF 0,9% 250 ml.	
57	Foi prescrito dexametasona (16 mg) para administração endovenosa. O manual de diluição orienta infundir durante 1 minuto ou mais, se necessário. foi feito em 30 segundos.	
58	Foi prescrito glicose (25%), administração de 60 ml. O manual orienta que a solução de 25% deve ser administrada a 6 mL/minuto. Feito em 43 segundos seringa com 20mL.	
59	Foi prescrito tramadol (100 mg) para administração endovenosa. O manual de diluição orienta IV gota. Foi feito cerca de 10 gotas/minuto.	
60	Foi prescrito sulfassalazina (4comprimidos de 500 mg). O medicamento foi aprazado para 08:00 e 16:00, e prescrito de 12/12. Foi Administrado às 18:00.	
61	Foi prescrito cefazolina (1g) para administração endovenosa.A administração foi realizada uma hora e quatro minutos depois do horário da ronda.	

62	Foi prescrito dipirona 1 g para ser administrada na ronda de 00:00 e foi administrado às 22:55 horas.	
63	Foi prescrito clonidina (1 comprimido de 0,200 mg). O medicamento aprazado para 20:00 e foi administrado 21:10, pois prescrição foi para farmácia na ronda das 19:30. Houve interrupções. Erro não foi da enfermaria.	
64	Foi prescrito SF 0,9% frasco de 500 ml e aprazado para às 16:00 horas. Foi feito na ronda às 17:32h	
65	Foi prescrito fluoxetina (20 mg). O paciente preferiu tomar medicamento após o lanche, atrasando em mais de uma horado horário aprazado	
66	Foi prescrito vancomicina 1g. Os problemas com o acesso do paciente retardaram o início da administração de 14:50 horas para 16:05 horas	
67	Enalapril 10 mg prescrito e aprazado para administração às10 horas. Foi Administrado às 11:40 horas.	

APPENDIX B – CARTA DE ORIENTAÇÃO AOS AVALIADORES

Nome Data

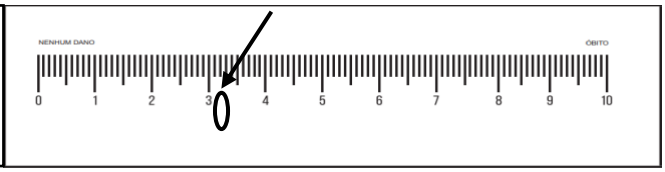
Título E-mail

Prezado: _____

Obrigado por concordar em colaborar no processo de validação transcultural para avaliar a significância das falhas no sistema de distribuição de medicamentos. A escala será validada para posterior avaliação de gravidade dos erros identificados em um estudo de incidência de erros de administração de medicamentos, e possibilitará o uso desta metodologia em outros estudos que se destinem a determinar a gravidade de erros de medicação.

Incluem-se aqui breves descrições de cinquenta exemplos de falhas no sistema de distribuição de medicamentos que resultaram em pacientes não receberem os medicamentos prescritos conforme planejado. Por favor, classifique cada um deles em termo do seu significado clínico potencial. A escala vai de zero a dez, onde zero deve ser dado a um incidente que não resultaria em efeitos no paciente e dez a um incidente que resultaria na morte do paciente.

Marque a escala claramente circulando o número apropriado ou colocando uma marca clara em qualquer lugar entre os números, conforme exemplo abaixo. Suponha que todos os pacientes sejam adultos internados enfermarias de clínica geral ou cirúrgica. É fundamental registrar quanto tempo você levará para concluir a avaliação de todos os cinquenta casos. Se você tiver quaisquer comentários adicionais, inclua-os no espaço fornecido.

Paciente X, 50 anos, em uso contínuo de 25 mg de medicamento Y. Utilizou por dois dias seguidos a dose de 50 mg.	

Solicitei a participação de diferentes profissionais com distintas formações e titulação acadêmica, de modo que uma ampla gama de profissionais de saúde esteja representada. Suas respostas são importantes, portanto, avalie os casos individualmente. Todas as respostas serão anônimas e agrupadas com as de outros profissionais de saúde para produzir uma resposta média para cada caso.

Por favor, responda o formulário de pontuação em até duas semanas e em caso de dúvidas, não hesite em me contatar através do número (71) 991642210 ou por e-mail lindembergrn@gmail.com.

Muito obrigado por sua colaboração,

Lindemberg Assunção Costa,
Farmacêutico, Mestre em Medicina e Saúde pela Universidade Federal da Bahia, Professor Adjunto da Faculdade de Farmácia, Universidade Federal da Bahia.

APPENDIX C - SCORES AND SEVERITY LEVELS ASSIGNED FOR EACH MEDICATION ADMINISTRATION ERROR

Erro	Medicamento envolvido	Descrição	Score médio	Gravidade
1	AAS (comprimido 100 mg)	Paciente teve acidente cardiovascular cerebral e a técnica preferiu diluir medicamento. Paciente estava deglutindo alimentos, líquidos e comprimidos.	4,25	Moderado
2	AAS (comprimido 100 mg)	Medicamento aprazado para 14h e administrado na ronda das 16h, às 16h34.	5,175	Moderado
3	Ácido fólico (comprimido 5 mg)	Medicamento aprazado para 20h e foi administrado 21h10, pois prescrição foi para farmácia na ronda das 19h30. Houve interrupções. Erro não foi da enfermaria.	5,175	Moderado
4	Albumina (frasco de 50 ml - 20%)	1º e 2º frascos em 30 min (15 min cada) 3º frasco em 35 min / 4º ao 7º frasco em 1h45 (aproximadamente 25min cada). Manual de diluição orienta de 1 a 2 ml/min = Mínimo de 25 minutos cada. Equipo escovado aspirando, devido à dificuldade de fluidez, o que ficou na seringa foi administrado IV direto, aproximadamente 5 ml. Houve interrupções.	5,575	Moderado
5	Amitriptilina (comprimido 25 mg)	Administrado com água. Medicamento aprazado para 20h e administrado na ronda de 22h, dose prescrita de 50 mg (02 comprimidos). Paciente informou que dose estava errada, técnica ficou de verificar prescrição e não retornou.	4,025	Moderado
6	Amitriptilina (comprimido 25 mg)	Não administrado na ronda de 20h, a qual o medicamento foi aprazado. Acompanhei ronda e não vi dose do medicamento. Medicamento encontrado em box da paciente.	5,25	Moderado
7	Amitriptilina (comprimido 25 mg)	Administrado com água. Medicamento aprazado para 20h, administrado 22h07 na ronda de 22h.	5,125	Moderado
8	Anlodipino (comprimido 5 mg)	Medicamento da ronda de 08h e foi administrado 09h15.	5,175	Moderado
9	Atenolol (comprimido de 50 mg)	Prescrito atenolol 50mg. Uso 25mg via oral. Houve interrupções.	6,08	Moderado
10	Azatioprina (comprimido de 50 mg)	Prescrito 150mg (03 comprimidos), feito 50 mg (01 comprimido). Técnico sofreu interrupção.	7	Grave
11	Bisacodil (comprimido 5 mg)	Medicamento da ronda de 16h e administrado as 16h08. As 16h36 foi realizada intervenção pois prescrição era de quatro comprimidos para preparo.	4,025	Moderado
12	Bromoprida (ampola 2 ml - 5 mg/ml)	Manual de diluição orienta IV direto em 3 minutos. Feito em uma hora e 10 minutos.	4,6	Moderado
13	Bromoprida (ampola 5 mg/2ml)	Paciente com queixa de dor no acesso. Teve administração interrompida. A prescrição foi bolada com observação de sem acesso.	4,275	Moderado
14	Bromoprida (ampola 5 mg/2ml)	Manual de diluição orienta tempo de infusão lentamente superior a 3 minutos. Feito em 43 segundos.	4,6	Moderado
15	Bromoprida (ampola 5 mg/2ml)	Manual de diluição orienta tempo de administração de infusão intravenoso intermitente lentamente (superior a 3 min). Feito em 38 segundos.	4,6	Moderado
16	Bromoprida (solução injetável 5 mg/ml - 2 ml)	Paciente em crise alérgica e agitada. Manual de diluição recomenda IV infusão intermitente lentamente (superior a 3 minutos). Mesma recomendação dada em bula de medicamento referência, Digesan ®. Feito em cerca de 30 segundos.	4,6	Moderado
17	Captopril (comprimido de 25 mg)	Não foi administrado devido PA baixa (8x6). Não tinha nenhuma observação na prescrição para não fazer.	5,75	Moderado
18	Carbonato de cálcio + vitamina D/ comprimido (1250 mg + 400 UI)	Observador relata que acompanhou a ronda da técnica e esse medicamento não foi administrado, mas foi checado.	2,9	Leve
19	Cefazolina (FA - pó liófilo, 1000mg)	Manual de diluição recomenda tempo de administração de intravenoso direto entre 3-5 minutos. Feito em 35 segundos.	5,2	Moderado
20	Cefazolina (FA - pó liófilo, 1000mg)	Manual de diluição recomenda tempo de administração de intravenoso direto entre 3-5 minutos. Feito em 35 segundos.	5,2	Moderado
21	Cefazolina (FA - pó liófilo, 1000mg)	Administração foi realizada uma hora e quatro minutos depois do horário da ronda. Observador informa em observações que manual de diluição recomenda tempo de administração intravenoso direto entre 3 e 5 minutos, porém não informa em quanto tempo o profissional administrou o medicamento.	6	Moderado

Erro	Medicamento envolvido	Descrição	Score médio	Gravidade
22	Cefazolina (FA - pó liófilo 1000mg)	Administração foi realizada uma hora e quatro minutos depois do horário da ronda. Observador informa em observações que manual de diluição recomenda tempo de administração intravenoso direto entre 3 e 5 minutos, porém não informa em quanto tempo o profissional administrou o medicamento.	4,825	Moderado
23	Cefazolina (FA - pó liófilo 1000mg)	Manual de diluição orienta reconstituição em 10mL de água para injeção, havendo expansão para 10,6mL e administração endovenosa direta entre 3-5 minutos, corroborando a bula do KEEFAZOL®. Administração foi feita em cerca de 32 segundos.	5,2	Moderado
24	Cefazolina (FA - pó liófilo 1000mg)	Manual de diluição recomenda tempo de administração de intravenoso direto entre 3-5 minutos e não recomenda diluir em soro fisiológico 0,9%. Feito em 56 segundos e reconstituição em 10ml de SF 0,9 (aspirado todo conteúdo).	7,1	Grave
25	Cefazolina (FA - pó liófilo 1000mg)	Manual de diluição orienta administração endovenosa direta entre 3-5 minutos e não recomenda diluir em soro fisiológico 0,9%. Foi feita reconstituição em 20 ml de soro fisiológico 0,9%. Administração foi feita em 30 segundos.	7,1	Grave
26	Cefazolina (FA - pó liófilo 1000mg)	Era para ter sido administrado na ronda de 24h e foi administrado 22h55.	4,825	Moderado
27	Cefepime (FA - pó liófilo 1000mg)	Manual de diluição orienta infundir 30 minutos. Feito em duas horas.	5,5	Moderado
28	Cefepime (FA - pó liófilo 1000mg)	Manual de diluição orienta infundir em 30 minutos. Infusão por gotejamento superou esse tempo.	5,5	Moderado
29	Ceftriaxona (FA - pó liófilo 1000mg)	Este medicamento deve ser diluído em 10 ml de água ou SF 0,9% e infusão entre 15-30 minutos. Diluído em 100 ml de SF 0,9% e infundido a 60 gotas/minuto, cerca de 33 minutos.	7,125	Grave
30	Ceftriaxona (FA - pó liófilo 1000mg)	Manual recomenda IV infusão entre 15-30 minutos, feito em cerca de 85 minutos (60 gotas/minuto). Medicamento infundido juntamente com clindamicina e manual informa serem incompatíveis para infusão em Y.	7,125	Grave
31	Ceftriaxona (FA - pó liófilo 1000mg)	Manual de diluição orienta 1 g em 10 ml, C + 10 a 40 mg/ml. IV direto entre 2-4 minutos, feito em um minuto. Houve interrupções.	6,1	Moderado
32	Cetoprofeno (FA - pó liófilo 100mg)	Manual de diluição orienta reconstituição com água para injeção e tempo de administração de 20 minutos. Reconstituído em 100 ml SF 0,9% e administrado em 51 minutos e 28 segundos (39 gotas/minuto). Houve duas interrupções, uma após instalar o medicamento, teve que parar para lavar o acesso e a segunda, a médica residente interrompeu para examinar paciente.	3,75	Moderado
33	Clindamicina (ampola de 600 mg)	Manual de diluição recomenda tempo de administração de 600mg intravenoso de 20 minutos e diluição em 50mL de soro fisiológico 0,9%, soro glicosado 5%. Foi diluído em 100 ml num tempo de 27,39 minutos (73 gotas/min).	4,05	Moderado
34	Clindamicina (ampola de 600 mg)	Manual de diluição orienta diluir 600mg em 50ml e infundir em 20min. Diluído em 100ml e feito em 40 minutos.	4,525	Moderado
35	Clindamicina (ampola de 600 mg)	Manual de diluição orienta diluir 600mg em 50ml e infundir em 20min. Diluído em 100ml e feito em 30 minutos.	4,525	Moderado
36	Clindamicina (solução injetável 150 mg/ml - 4 ml)	Técnica não lavou as mãos, apenas calçou as luvas. Despreza algum volume do medicamento do sistema para retirar bolha de ar do equipo. Beira leito. Usou equipo previamente utilizado.	6,575	Moderado
37	Clindamicina (solução injetável 150 mg/ml - 4 ml)	Técnico despreza algum volume para preenchimento do sistema e retiradas de bolhas de ar. Como houve desprezo de volume de solução do sistema que Ji continha medicamento, apesar de pequeno volume, não se pode precisar o impacto da perda. Erro no processo de preparo.	6,575	Moderado
38	Clonidina (comprimido de 0,200 mg)	Medicamento aprazado para 20h e foi administrado 21h10, pois prescrição foi para farmácia na ronda das 19h30. Houve interrupções. Erro não foi da enfermaria.	5,175	Moderado
39	Codeína + paracetamol (30 + 50 mg, comprimido)	Prescrito codeína 30mg sem associação. Administrado codeína 30mg+paracetamol 500mg.	6,325	Moderado
40	Codeína + paracetamol (30 + 50 mg, comprimido)	Prescrito se dor, mas estava aprazado sistemático.	6,95	Moderado
41	Codeína (30 + 50 mg, comprimido)	O paciente não estava no leito. Não observei a técnica retornar em horário posterior, nem estava checado.	2,9	Leve

Erro	Medicamento envolvido	Descrição	Score médio	Gravidade
42	Codeína (30 mg, comprimido)	Prescrito se dor, mas medicamento estava aprazado sistemático. Profissional sofreu interrupções, além de estar em dobra de 24 horas, responsável por três leitos, sendo censo do dia 17/23.	6,95	Moderado
43	Complexo B/ drágea	Medicamento aprazado para 20h e foi administrado 21h10, pois prescrição foi para farmácia na ronda das 19h30. Houve interrupções. Erro não foi da enfermaria.	5,175	Moderado
44	Dexametasona (solução injetável 4 mg/ml - 2,5 ml)	Manual de diluição orienta infundir durante 1 minuto ou mais, se necessário, feito em 30 segundos.	6	Moderado
45	Dimenidrinato + Vit. B (solução injetável 30 mg/ml - 10 ml)	Prescrito para administrar 50mg de Dimenidrinato, mas foi feito 30mg (1 ampola). A prescrição era oral e foi modificado de caneta mudança para via endovenosa (erro de prescrição).	4,175	Moderado
46	Dimenidrinato + Vit. B (solução injetável 30 mg/ml - 10 ml)	Interrupção por conta do acesso. Medicamento prescrito como se necessário, por via oral. Foi administrado por infusão intravenosa.	3,525	Moderado
47	Dimeticona (comprimido de 40 mg)	Prescrito gotas, administrado comprimido	2,8	Leve
48	Dimeticona (gotas, 75 mg/ml)	Prescrito 40 gotas, feitas 45 gotas.	4,025	Moderado
49	Dipirona (solução injetável, 500 mg/ml - 2 ml)	Manual de diluição recomenda IV direto muito lentamente e não exceder 500 mg/min. Feito em 17 segundos.	6,325	Moderado
50	Dipirona (solução injetável, 500 mg/ml - 2 ml)	Era para ter sido administrado na ronda de 24h e foi administrado 22h55.	2,9	Leve
51	Dipirona (solução injetável, 500 mg/ml - 2 ml)	Manual de diluição orienta velocidade de infusão máxima de 500mg/min. Feito em uma hora e 30 minutos.	3,925	Moderado
52	Dipirona (solução injetável, 500 mg/ml - 2 ml)	Manual de diluição orienta velocidade de infusão máxima de 500mg/min. Feito em 46 segundos.	6,325	Moderado
53	Dipirona (solução injetável, 500 mg/ml - 2 ml)	Manual de diluição orienta velocidade de infusão máxima de 500mg/min. Feito entre 27 - 35 segundos.	6,325	Moderado
54	Dipirona (solução injetável, 500 mg/ml - 2 ml)	Manual de diluição orienta velocidade de infusão máxima de 500mg/min. Feito em 35 segundos.	6,325	Moderado
55	Dipirona (solução injetável, 500 mg/ml - 2 ml)	Foi preparado às 22h30 e descartado umas 23h55.	4	Moderado
56	Dipirona (solução injetável, 500 mg/ml - 2 ml)	Manual de diluição recomenda velocidade de infusão máxima de 500 mg/min. Feito entre 20 e 50 segundos.	6,325	Moderado
57	Dipirona (solução injetável, 500 mg/ml - 2 ml)	Manual de diluição recomenda velocidade de infusão máxima de 500 mg/min. Feito em três horas e 20 minutos.	3,925	Moderado
58	Dipirona (solução injetável, 500 mg/ml - 2 ml)	Manual de diluição recomenda velocidade de infusão máxima de 500 mg/min. Feito em uma hora e cinco minutos.	3,925	Moderado
59	Dipirona (solução injetável, 500 mg/ml - 2 ml)	Paciente se recusou usar todo conteúdo porque estava sentindo dor no acesso.	2,9	Leve
60	Dipirona (solução injetável, 500 mg/ml - 2 ml)	Medicamento não foi administrado na ronda de 12h. Na prescrição estava bolado com observação se pressão arterial baixa. (Sem medida de pressão obtida pelo observador).	4	Moderado
61	Dipirona (solução injetável, 500 mg/ml - 2 ml)	Medicamento não foi preparado pela técnica, pois durante a administração do comprimido de codeína + paracetamol paciente referiu não sentir dor e técnica não administrou dipirona. Bolado na prescrição.	4	Moderado
62	Dipirona (solução injetável, 500 mg/ml - 2 ml)	Medicamento administrado em outra paciente, mas checado na prescrição desta paciente	6	Moderado
63	Dipirona (solução injetável, 500 mg/ml - 2 ml)	MANUAL RECOMENDA: IV – muito lentamente (não exceder 500mg/ min). Feito em cerca de 27 segundos.	6,325	Moderado
64	Dipirona (solução injetável, 500 mg/ml - 2 ml)	Manual de diluição recomenda tempo de administração IV IV – muito lentamente (não exceder 500mg/ min). Feito em 27 segundos.	6,325	Moderado
65	Dipirona (solução injetável, 500 mg/ml - 2 ml)	Medicamento aprazado para 24h, antecipado após consenso da equipe de enfermagem.	2,9	Leve
66	Dipirona (solução injetável, 500 mg/ml - 2 ml)	Manual de diluição recomenda tempo de administração IV IV – muito lentamente (não exceder 500mg/ min). Feito em 31 segundos.	6,325	Moderado
67	Dipirona (solução injetável, 500 mg/ml - 2 ml)	Medicamento prescrito se dor ou febre; 1g endovenoso até 6/6h. Manual de diluição da instituição, assim como bula da Novalgina (R) orienta administrar muito lentamente, não excedendo 500 mg/min. Feito em 41 segundos.	6,325	Moderado
69	Dipirona (solução injetável, 500 mg/ml - 2 ml)	Manual de diluição recomenda IV direto muito lentamente e não exceder 500 mg/min. Feito em 64 segundos.	6,325	Moderado
70	Dipirona (solução injetável, 500 mg/ml - 2 ml)	Técnica não lavou as mãos, apenas calçou as luvas. Técnica me relata que não administra todo volume de seringas para evitar que bolha de ar seja administrada. Administrado entre 30 e 50 segundos.	6,325	Moderado

Erro	Medicamento envolvido	Descrição	Score médio	Gravidade
71	Dipirona (solução injetável, 500 mg/ml - 2 ml)	Manual de diluição recomenda IV direto muito lentamente e não exceder 500 mg/min. Feito entre 20 e 30 segundos.	6,325	Moderado
72	Dipirona (solução injetável, 500 mg/ml - 2 ml)	Manual de diluição: Velocidade de infusão máxima 500mg/min. Foi preparado as 22h30. Manual de diluição: Preparo imediatamente antes da administração.	6,325	Moderado
73	Dipirona (solução injetável, 500 mg/ml - 2 ml)	Manual de diluição: Velocidade de infusão máxima 500mg/min. Foi preparado as 22h30. Manual de diluição: Preparo imediatamente antes da administração.	6,325	Moderado
74	Dipirona (solução injetável, 500 mg/ml - 2 ml)	Técnica não lavou as mãos, apenas calçou as luvas. Técnica me relata que não administra todo volume de seringas para evitar que bolha de ar seja administrada. Administrado em cerca de 50 segundos.	6,325	Moderado
75	Dipirona (solução injetável, 500 mg/ml - 2 ml)	Técnica não lavou as mãos, apenas calçou as luvas. Técnica me relata que não administra todo volume de seringas para evitar que bolha de ar seja administrada. Administrado em cerca de 30 segundos.	6,325	Moderado
76	Dipirona (solução injetável, 500 mg/ml - 2 ml)	Manual recomenda: IV muito lentamente (não exceder 500mg/ min); no ajuste de volume de seringa houve desprezo de quantidade não quantificada de medicamento. Administração foi em cerca de 38 segundos.	6,325	Moderado
77	Dipirona (solução injetável, 500 mg/ml - 2 ml)	Manual recomenda: IV muito lentamente (não exceder 500mg/ min); no ajuste de volume de seringa houve desprezo de quantidade não quantificada de medicamento. Administração foi em cerca de 32 segundos.	6,325	Moderado
78	Dipirona (solução injetável, 500 mg/ml - 2 ml)	Durante preparo técnica aspirou soro fisiológico 9% e não aspirou volume das ampolas de dipirona. Ao desprezar resíduos, percebeu erro e refez processo.	2,9	Leve
79	Dipirona/ solução injetável 500 mg/ml (2 ml)	MANUAL RECOMENDA: IV – muito lentamente (não exceder 500mg/ min); No ajuste de volume da seringa, houve desprezo de quantidade não quantificada de medicamento. Feito em cerca de 40 segundos	6,325	Moderado
80	Dipirona/ solução injetável 500 mg/ml (2 ml)	Manual de diluição orienta não exceder taxa de 500mg/min. Feito em 20 segundos.	6,325	Moderado
81	Dipirona (solução injetável, 500 mg/ml - 2 ml)	Manual de diluição orienta tempo de administração IV – muito lentamente (não exceder 500mg/ min). Feito em 20 segundos.	6,325	Moderado
82	Dipirona (solução injetável, 500 mg/ml - 2 ml)	Medicamento de horário, paciente queixando de cefaleia intensa, a despeito do uso de morfina 10 mg VO SN; Administração não deve exceder 500 mg/min. Feito em 75 segundos.	6,325	Moderado
83	Dipirona (solução injetável, 500 mg/ml - 2 ml)	Preparo do medicamento 05h15. Manual de diluição orienta não exceder taxa de 500mg/min. Feito em 40 segundos.	6,325	Moderado
84	Dipirona (solução injetável, 500 mg/ml - 2 ml)	10 mL em 28 segundos. Em 18 segundos foi administrado o volume restante	6,325	Moderado
85	Dipirona (solução injetável, 500 mg/ml - 2 ml)	Prescrito Dipirona 1g EV 6/6h (aprazado às 18/24/06/12); Checada dose das 24h. Paciente estava com acesso perdido na ronda das 20h, por isso parte do medicamento foi administrado às 20h28h (10 mL) e após troca de acesso, o volume restante foi administrado às 21h16.	6,325	Moderado
86	Dipirona (solução injetável, 500 mg/ml - 2 ml)	Técnica não lavou as mãos, apenas calçou as luvas. Técnica me relata que não administra todo volume de seringas para evitar que bolha de ar seja administrada. Administrado em cerca de 50 segundos.	6,325	Moderado
87	Dipirona (solução injetável, 500 mg/ml - 2 ml)	No momento que medicamento foi administrado, prescrição foi verbal. Medicamento consta em prescrição. Paciente estava acabando de ser admitido. Injeção foi rápida, manual de diluição orienta de não exceder 500 mg/min. Feito em 17 segundos.	6,325	Moderado
88	Varfarina (comprimido de 5 mg)	Foi ofertado o comprimido para o paciente, entretanto o medicamento estava prescrito para outro paciente	7,7	Grave
89	Dipirona (solução injetável, 500 mg/ml - 2 ml)	Manual de diluição: Velocidade de infusão máxima: 500mg/min. Feito em cerca de 40 segundos	6,325	Moderado
90	Enalapril (comprimido de 10 mg)	Administração para ronda de 10h, feito 11h40. Técnica responsável por quatro leitos, sendo censo 12/21.	4,575	Moderado
91	Enoxaparina (seringa pré-carregada 40 mg)	Administrado rapidamente. Prescrito 70 mg, técnica deveria ajustar a dose com a seringa de 60 mg UE graduada (linha 108-está correta essa expressão?). Foi utilizada técnica incorreta no ajuste, não garantido dose de 50 mg na seringa. Observador não interveio.	5,55	Moderado

Erro	Medicamento envolvido	Descrição	Score médio	Gravidade
92	Enoxaparina (seringa pré-carregada 40 mg)	Administrado rapidamente. Prescrito 70 mg, técnica deveria ajustar a dose com a seringa de 60 mg UE graduada (linha 108-está correta essa expressão?). Foi utilizada técnica incorreta no ajuste, não garantido dose de 50 mg na seringa. Observador não interveio.	5,5	Moderado
93	Enoxaparina (seringa pré-carregada 40 mg)	Manual de diluição orienta tempo de administração IV – muito lentamente (não exceder 500mg/ min). Administrado rapidamente.	5,5	Moderado
94	Enoxaparina (seringa pré-carregada 40 mg)	Administrado na ronda de 14h, as 15h50. Técnica (Patrícia) estava responsável por quatro leitos, sendo o censo 19/21.	5,175	Moderado
95	Enoxaparina (seringa pré-carregada 40 mg)	Aprazado para ronda de 08h, administrado 09h27. Técnica estava responsável por seis leitos, sendo o censo 21/23.	5,175	Moderado
96	Enoxaparina (seringa pré-carregada 40 mg)	Administrado na ronda de 16h, às 17h05. Técnica (Patrícia) estava responsável por três leitos, sendo o censo 17/23.	5,175	Moderado
97	Enoxaparina (seringa pré-carregada 40 mg)	Medicamento estava checado e foi aprazado para 10h. Administrado na ronda de 08h, às 08h15.	5,175	Moderado
98	Enoxaparina (seringa pré-carregada 40 mg)	Utilizada uma seringa de 60 mcg + 10 mcg de uma seringa de 20mcg que foi desprezada metade do conteúdo com a seringa virada para baixo. Seringa de 20 mg não é graduada, não sendo possível precisar o volume final após desprezar.	5,5	Moderado
99	Espironolactona (comprimido 100 mg)	Observador relata que acompanhou técnica no horário das 09h30, quando a mesma medicou pacientes das 08h e das 10h. Após isso foi dar banhos e não mais medicou até as 12h, medicamento da ronda das 10h. Técnica estava responsável por seis leitos, sendo o censo 21/23.	2,9	Leve
100	Fluoxetina (comprimido 20 mg)	Paciente preferiu tomar medicamento após o lanche.	2,6	Leve
101	Furosemida (solução injetável, 10 mg/ml – 2 ml)	Manual de diluição orienta infundir entre 1 e 2 min, feito entre 10-11 segundos.	5,55	Moderado
102	Furosemida (solução injetável, 10 mg/ml – 2 ml)	Manual de diluição orienta infundir entre 1 e 2 min, feito entre 18 segundos.	5,55	Moderado
103	Glicose (solução 25%)	Durante preparo, colegas queriam fazer sorteio dos horários de descanso. Interrupção levou ao não seguimento do manual que orienta solução 25%: 6 mL/minuto. Feito em 43 segundos seringa com 20mL.	6,575	Moderado
104	Hidralazina (comprimido de 150 mg)	Medicamento aprazado para 20h e foi administrado 21h10, pois prescrição foi para farmácia na ronda das 19h30. Houve interrupções. Erro não foi da enfermaria.	5,175	Moderado
105	Hidralazina (comprimido de 25 mg)	Observação na prescrição para não fazer anti-hipertensivos nos dias de hemodiálise (terça, quinta e sábado). Administração foi feita na quinta-feira.	7,725	Grave
106	Hidralazina (comprimido de 25 mg)	Observação na prescrição para não fazer anti-hipertensivos nos dias de hemodiálise (terça, quinta e sábado). Administração foi feita na quinta-feira.	7,725	Grave
107	Hidralazina (comprimido de 25 mg)	Observação na prescrição para não fazer anti-hipertensivos nos dias de hemodiálise (terça, quinta e sábado). Administração foi feita na quinta-feira.	7,725	Grave
108	Hioscina + dipirona (solução injetável, 5 ml)	Manual de diluição orienta infundir 1 ml/minuto e foi feito em uma hora e 17 minutos. Além disso, foi prescrito 3 ml ao invés de 2 ml, como foi feito.	5	Moderado
109	Hioscina + dipirona (solução injetável, 5 ml)	Manual de diluição orienta infundir 1 ml/minuto e foi feito em uma hora e 17 minutos. Além disso, foi prescrito 3 ml ao invés de 2 ml, como foi feito.	3,8	Moderado
110	Hioscina simples (solução injetável 20 mg/ml, 1 ml)	Prescrito 10mg via oral para o dia dessa administração, 06.02.19. No dia anterior, 05.02, estava prescrito EV. Foi feito pela via endovenosa no tempo de 35 segundos.	5,6	Moderado
111	Hioscina (solução injetável 20 mg/ml, 1 ml)	Interrupção do enfermeiro passando queixas da paciente que foi admitida no dia na unidade. Ao invés de administrar 1mL/min, sem diluição como orienta o manual de diluição, fez em cerca de 15 segundos as 1 ml da solução + 9 ml de SF 0,9%.	5,6	Moderado
112	Hyabak ® (solução oftálmica 0,15%)	Administrada uma gota excedente no olho direito; prescrito uma gota em cada olho de 6/6h.	3	Leve
113	Hyabak ® (solução oftálmica 0,15%)	Administrada uma gota excedente no olho esquerdo; prescrito uma gota em cada olho de 6/6h.	3	Leve
114	Hyabak ® (solução oftálmica 0,15%)	Administrada 01 gota excedente em cada olho; prescrito uma gota em cada olho.	3	Leve
115	Ibuprofeno (suspensão oral gotas, 50 mg/ml)	Técnica não posicionou frasco conta gotas na posição vertical e não houve formação de gota. Pelo que foi dosado, dose administrada foi incorreta.	4,78	Moderado

Erro	Medicamento envolvido	Descrição	Score médio	Gravidade
116	Ibuprofeno (suspensão oral gotas, 50 mg/ml)	A contabilização da dose foi prejudicada porque a técnica não posicionou o conta gotas corretamente e não havia formação de gotas.	4,78	Moderado
117	Insulina NPH (suspensão injetável)	Medicamento não foi administrado. Confirmado com paciente que o mesmo não foi feito. HGT = 126.	7,1	Grave
118	Insulina NPH (suspensão injetável)	Técnica registrou na prescrição que não administrou medicamento por paciente ter risco de hipoglicemia. HGT (20h). Observador relata: não vi omissão ser discutida com enfermeiro plantonista, sendo essa técnica também enfermeira.	7,1	Grave
119	Insulina regular (solução injetável, 100 UI/ml)	Prescrito 4ui de Insulina R para HGT = 190-250, HGT = 191 do paciente. Não foi administrado.	6,25	Moderado
120	Insulina regular (solução injetável, 100 UI/ml)	Prescrito 4 ui se HGT entre 190 e 250. HGT = 209. Observador relata: não observei a técnica fazer e não estava checado.	6,25	Moderado
121	Insulina regular (solução injetável, 100 UI/ml)	Prescrição de insulina regular, se necessário, conforme HGT. HGT (22h)	6,25	Moderado
122	Insulina regular (solução injetável, 100 UI/ml)	Medicamento não foi administrado. Confirmado com paciente que o mesmo não foi feito. HGT = 126.	6,25	Moderado
123	Insulina regular (solução injetável, 100 UI/ml)	Prescrito insulina regular se HGT>190. Não foi checado	6,25	Moderado
124	Ivermectina (comprimido de 6 mg)	Prescrito 18mg, administrado 12mg.	3,5	Moderado
125	Lactulose (xarope, 667mg/ml)	Aprazado para 14h horas, administrado às 15h50	5,175	Moderado
126	Losartana (comprimido de 50 mg)	Paciente refere que usa losartana porque quando está com dor sua pressão sobe. Como a pressão arterial estava em 100x70 mmHg e sem dor no momento, a técnica opta por não administrar o medicamento.	5,75	Moderado
127	Losartana (comprimido de 50 mg)	PA = 96x46mmHg (única informação considerável a explicação do erro é a pressão, não há observações feitas pelo observador). Pensamento de Bruna: devido pressão do paciente estar baixa, provavelmente técnico não quis administrar a dose. Porém deve ser analisado se a pressão está controlada ou realmente baixa, porque sendo o último, é necessário ajuste de dose ou troca de medicamento por um mais fraco.	5,75	Moderado
128	Losartana (comprimido de 50 mg)	Técnica não administrou o comprimido de Losartana por julgar que a pressão arterial do paciente estava baixa e ele ia ser encaminhado para o Centro Cirúrgico nas próximas horas.	5,75	Moderado
129	Meropenem (pó liófilo, 500 mg)	Na ronda de 08h foi necessário trocar acesso da paciente, por isso medicamento foi administrado por outra técnica às 09h22 que fez essa troca. Manual de diluição recomenda tempo de administração IV infusão entre 15-30 minutos, feito em 32 minutos e 26 segundos (62 gotas/minuto).	4,825	Moderado
130	Meropenem (pó liófilo, 500 mg)	Manual de diluição orienta infundir entre 15-30 minutos, feito em uma hora. Houve interrupções.	5,175	Moderado
131	Meropenem (pó liófilo, 500 mg)	Aprazado para 16h, administrado na ronda de 18h, às 17h45. Técnica presente desde a ronda das 08h e responsável por quatro leitos, sendo censo 22/23.	4,825	Moderado
132	Mesalazina (comprimido de 400 mg)	Não foi administrado na ronda de 08h, pois só tinha um medicamento no box do paciente. Dose completa foi enviada pela farmácia na ronda das 10h e administrado 10h35.	5,125	Moderado
133	Metoclopramida (solução injetável 5 mg/ml -2 ml)	Manual de Diluição orienta IV direto por 1 a 2 min sem diluir. Foi feito em 10 segundos.	5,7	Moderado
134	Metoclopramida (solução injetável 5 mg/ml -2 ml)	Manual orienta IV direto não diluído, de 1 a 2 minutos. Diluído em 16 segundos.	5,7	Moderado
135	Metoclopramida (solução injetável 5 mg/ml -2 ml)	Manual orienta IV direto não diluído, de 1 a 2 minutos. Diluído em uma hora e 10 minutos.	3,8	Moderado
136	Metoclopramida (solução injetável 5 mg/ml -2 ml)	Manual orienta IV direto não diluído, de 1 a 2 minutos. Diluído em 35 segundos.	5,7	Moderado
137	Metoclopramida (solução injetável 5 mg/ml -2 ml)	Manual orienta IV direto não diluído, de 1 a 2 minutos. Aprazado para 14h e administrado às 15h	3,8	Moderado
138	Metoclopramida (solução injetável 5 mg/ml -2 ml)	Manual orienta IV direto não diluído, de 1 a 2 minutos. Aprazado para 15h30 e administrado às 18h15	3,8	Moderado
139	Metoclopramida (solução injetável 5 mg/ml -2 ml)	Manual de diluição recomenda IV direto não diluído por 1 a 2 minutos; IV infusão intermitente em 15 minutos (50 ml de solução compatível). Administração feita em 45 segundos.	5,7	Moderado

Erro	Medicamento envolvido	Descrição	Score médio	Gravidade
140	Metoclopramida (solução injetável 5 mg/ml -2 ml)	Manual de diluição orienta tempo de administração IV direto sem diluição, por 1-2 minutos. Feito em 30 segundos.	5,7	Moderado
141	Metoclopramida (solução injetável 5 mg/ml -2 ml)	Manual de diluição orienta tempo de administração IV direto sem diluição, por 1-2 minutos. Feito em cerca de 40 segundos.	5,7	Moderado
142	Metoclopramida (solução injetável 5 mg/ml -2 ml)	Manual de diluição orienta tempo de administração IV direto sem diluição, por 1-2 minutos. Feito em cerca 50 segundos.	5,7	Moderado
143	Metoclopramida (solução injetável 5 mg/ml -2 ml)	Manual de diluição orienta tempo de administração IV direto sem diluição, por 1-2 minutos. Feito em 30 segundos.	5,7	Moderado
144	Metoclopramida (solução injetável 5 mg/ml -2 ml)	Manual de diluição orienta tempo de administração IV direto sem diluição, por 1-2 minutos. Feito em cerca de 40 segundos.	5,7	Moderado
145	Metoclopramida (solução injetável 5 mg/ml -2 ml)	Manual orienta IV direto não diluído, por 1 a 2 minutos e prescrito lentamente. Administrado em 42 segundos com sobra de pequeno volume em seringa.	5,7	Moderado
146	Metoclopramida (solução injetável 5 mg/ml -2 ml)	Manual de diluição orienta tempo de administração IV direto sem diluição, por 1-2 minutos. Feito em tempo 45 segundos.	5,7	Moderado
147	Metoclopramida (solução injetável 5 mg/ml -2 ml)	Manual de diluição orienta tempo de administração IV direto sem diluição, por 1-2 minutos. Aprazado para às 14h e administrado às 15h50	3,8	Moderado
148	Metoclopromida (solução injetável 5 mg/ml -2 ml)	Prescrito comprimido via oral e administrado por via intravenosa durante 23 segundos.	5,55	Moderado
149	Metoclopromida (solução injetável 5 mg/ml -2 ml)	Prescrito comprimido via oral e administrado por via intravenosa durante 23 segundos.	5,55	Moderado
150	Metoclopromida (solução injetável 5 mg/ml -2 ml)	Prescrito comprimido via oral e administrado por via intravenosa durante 23 segundos.	5,55	Moderado
151	Omeprazol (pó liófilo, 40 mg)	Manual de diluição orienta infundir no máximo 4ml/min. Feito em 15 segundos	5,575	Moderado
152	Omeprazol (pó liófilo, 40 mg)	Manual de diluição orienta infundir no máximo 4ml/min. Feito em 40 segundos.	5,575	Moderado
153	Omeprazol (pó liófilo, 40 mg)	Foi prescrito pelo médico plantonista devido intercorrência do paciente. Profissional não seguiu manual de diluição para o preparo.	5,575	Moderado
154	Ondansentrona (solução injetável 2 mg/ml - 2 ml)	Manual de diluição indica infusão entre 15-30 minutos. Feito em uma hora e 40 minutos.	3,675	Moderado
155	Ondansentrona (solução injetável 2 mg/ml - 2 ml)	Aprazado para 22h horas, administrado às 23h.		
156	Ondansentrona (solução injetável 2 mg/ml - 4 ml)	Manual de diluição orienta infundir entre 15-30 minutos. Feito em 50 minutos.	3,675	Moderado
157	Ondansentrona (solução injetável 2 mg/ml - 4 ml)	Manual de diluição orienta infundir entre 15-30 minutos. Feito em 45 minutos.	3,675	Moderado
158	Ondansentrona (solução injetável 2 mg/ml - 4 ml)	Manual de diluição orienta tempo de administração de 15-30 min. Feito em uma hora e 10 minutos.	3,675	Moderado
159	Ondansentrona (solução injetável 2 mg/ml - 2 ml)	Manual de diluição orienta diluir em 50 ml e infundir em 15-30. Feito em 31,7 minutos e antes do tramadol.	3,675	Moderado
160	Ondansentrona (solução injetável 2 mg/ml - 2 ml)	Manual de diluição orienta tempo de administração de 15-30 min. Feito em 32 segundos.	3,675	Moderado
161	Ondansentrona (solução injetável 2 mg/ml - 2 ml)	Infusão feita em cerca de 33 minutos. Manual de diluição orienta infusão intermitente de 15 a 30 minutos. Prescrição orienta administrar antes do tramadol, foi administrado concomitante com esse medicamento.	3,675	Moderado
162	Ondansentrona (solução injetável 2 mg/ml - 2 ml)	Medicamento prescrito se necessário para náusea e vômito ou antes do tramadol. O aprazamento foi de 8/8h (16h/ 24h/ 08h). Foi administrado na ronda de 22h, as 23h01. Manual de diluição recomenda infundir por 15-30 minutos, bula Vonau ® orienta diluir 50-100 mL SF 0,9% ou SG5% e infundir por não menos do que 15 minutos. Diluído em 100 ml de SF 0,9%, 22 gotas/25 segundos, ou seja, 37,8 minutos.	3,675	Moderado
163	Oxacilina (pó liófilo, 500 mg)	Manual de diluição recomenda tempo de administração IV infusão entre 15 - 30 minutos, foi feito em 35,7 minutos (56 gotas/minuto).	5,675	Moderado
164	Oxacilina (pó liófilo, 500 mg)	Conectado frasco em equipo que foi utilizado em dose anterior no leito. Manual de diluição recomenda tempo de administração IV infusão entre 15 - 30 minutos. Feito em 41,66 minutos (48 gotas/minuto).	5,675	Moderado

Erro	Medicamento envolvido	Descrição	Score médio	Gravidade
165	Oxacilina (pó liófilo, 500 mg)	Medicamento usualmente diluído em 100 ml, foi aspirado 10 ml de água para injeção e utilizado para reconstituir os quatro frascos ampola, utilizando a mesma seringa de 10 ml. Aspirado produto reconstituído e diluído em SF 0,9% 250 ml. Falta de SF 0,9% na unidade devido pedido insuficiente. Técnica se nega a retirar volume de SF 0,9% 250 ml e verbaliza essa informação. Não há erro de horário, a ronda é de 22h e o medicamento foi administrado 21h49. Seria erro de técnica porque não seguiu o manual de diluição.	5,675	Moderado
166	Oxacilina (pó liófilo, 500 mg)	Problemas com o acesso do paciente retardou administração em uma hora, na ronda de 16h, foi administrado 17h10. Tempo de medicamento programado para 25 minutos.	4,825	Moderado
167	Permanganato de potássio (solução 1:80.000)	Técnica registra que não tem, porém em plantão do dia anterior solicitei medicamento para paciente e confirmei o recebimento com o mesmo depois.	5,03	Moderado
168	Propranolol (comprimido de 10 mg)	Medicamento não foi administrado na ronda de 8h devido pressão arterial. Aguardou para verificá-la novamente, mas medicamento não foi administrado. Na prescrição estava bolado com observação se pressão arterial baixa. (PA= 100x60 mmHg).	5,75	Moderado
169	Ranitidina (comprimido de 25 mg)	Medicamento aprazado para 20h e foi administrado 21h40, pois prescrição foi para farmácia na ronda das 19h30. Houve interrupções. Erro não foi da enfermaria.	5,175	Moderado
170	Ringer lactato KCl; NaCl; Glicose; MgSO4 (solução injetável)	Prescrito 7 gotas/minuto, ou seja, 21 mL/h (23,8 horas). Feito 6 gotas/minutos, ou seja, 27,8 horas.	5,2	Moderado
171	Ringer Lactato; KCl; NaCl; Glicose; MgSO4 (solução injetável)	Escovou equipo após introduzir eletrólitos e teve perda de volume do medicamento que não foi possível precisar quantidade. Foi adicionado 32mL de medicamento, mas não se sabe o volume total após perda. Vazão programada de acordo com a prescrição.	7	Grave
172	Ringer Lactato; KCl; NaCl; Glicose; MgSO4 (solução injetável)	Escovou equipo após introduzir eletrólitos e teve perda de volume do medicamento que não foi possível precisar quantidade. Foi adicionado 32mL de medicamento, mas não se sabe o volume total após perda. Vazão programada de acordo com a prescrição.	7	Grave
173	Ringer Lactato; KCl; NaCl; Glicose; MgSO4 (solução injetável)	Bomba foi programada considerando volume total de 500mL na bolsa, sendo que no preparo foi aspirado com mesma seringa para cada eletrólito 12,5mL KCl + 7mL NaCl + 10mL glicose + 2,5mL MgSO4 e adicionado em frasco 500mL de Ringer Lactato. Além disso, houve interrupções.	7	Greve
174	SF 0,9% (solução injetável, 500 ml)	Prescrito 1500ml/24h = 500ml/8hs. Feito em aproximadamente quatro horas.	4,95	Moderado
175	SF 0,9% (solução injetável, 500 ml)	Prescrito 21 gotas/minuto. Feito 42 gotas/minuto.	4,95	Moderado
176	SF 0,9% (solução injetável, 500 ml)	Prescrito 1500ml/24h = 500ml/8hs. Aprazado para 16h e feito na ronda das 18h às 17h32.	3	Leve
177	SF 0,9% (solução injetável, 500 ml)	Medicamento checado as 02h, porém não foi instalado nesse horário, nem em parte da ronda de 04h, uma vez que a dose anterior não estava com a vazão correta e não havia terminado ainda.	5,175	Moderado
178	SF 0,9% (solução injetável, 1000 mL)	Prescrito 1.000mL em 24 horas, 41mL/H ou 0,7mL/min (14 gotas). Infusão mais lenta do que a prescrita, logo soro não finalizou no período. Profissional optou por não instalar soro em BIC para conforto do paciente.	5,2	Moderado
179	Solução fisiológica 0,9% + glicose 25% (solução injetável, 500 ml)	Aspiradas quatro ampolas de glicose 25% e adicionado ao soro 500 ml. Volume do soro não foi ajustado com a adição do volume de 40 ml. Tempo do medicamento de 20gotas/minuto.	4,775	Moderado
180	Sulfametoxazol + trimetropina (comprimido de 400 mg + 80 mg)	Iniciou administração às 15h35, sendo a ronda de 14h. Além disso, estava prescrito 3 comprimidos, administrou 1. Houve interrupção. Técnica estava em dobra de 24 horas, responsável por três leitos, sendo o censo do dia 17/23.	7	Grave
181	Sulfassalazina (comprimido de 500 mg)	Medicamento aprazado para 08h e 16h, prescrito de 12/12. Administrado 18h.	5,125	Moderado
182	Tramadol (solução injetável, 100 mg/2 ml)	Prescrito "em caso de dor abdominal". Aprazado sistemático e administrado em 30 minutos.	7	Grave

Erro	Medicamento envolvido	Descrição	Score médio	Gravidade
183	Tramadol (solução injetável, 100 mg/2 ml)	Medicamento prescrito como se necessário. Manual recomenda IV infusão gota a gota, feito cerca de 30 gotas/minuto, ou seja, mais de 60 minutos. Como houve desprezo de volume de solução do sistema Ji que continha o medicamento, apesar de pequeno volume, não se pode precisar o impacto da perda. Erro no processo de preparo.	4,5	Moderado
184	Tramadol (solução injetável, 100 mg/2 ml)	Gotejamento bastante lento, logo infusão muito lenta de um medicamento que necessita de efeito mais precoce.	5,175	Moderado
185	Tramadol (solução injetável, 100 mg/2 ml)	Manual de diluição orienta IV gota. Feito cerca de 10 gotas/minuto.	5,175	Moderado
186	Vancomicina (pó liófilo, 500 mg)	Manual diluição orienta infundir em 2 horas, porém problemas com o acesso do paciente retardou o início da administração de 14h50 para 16h05.	5,25	Moderado
187	Vancomicina (pó liófilo, 500 mg)	Manual diluição orienta infundir em 2 horas. Feito em uma hora	5,075	Moderado
188	Vancomicina (pó liófilo, 500 mg)	Manual diluição orienta infundir em 2 horas. Risco de síndrome do homem de pescoço vermelho. Feito em cerca de 41 minutos, 120 gotas/minuto.	5,075	Moderado
189	Vancomicina (pó liófilo, 500 mg)	Manual diluição orienta infundir em 2 horas. Feito em uma hora e meia.	5,075	Moderado
190	Vancomicina (pó liófilo, 500 mg)	Ao chegar ao leito da paciente, técnica verifica que dose anterior havia sido preparada em 250mL de soro fisiológico 0,9%. A mesma retornou ao posto e aspirou volume de soro fisiológico 0,9% necessário para chegar ao volume de 250mL, pois tinha preparado o medicamento com 100 mL de SF 0,9%.	6,025	Moderado
191	Vancomicina (pó liófilo, 500 mg)	Manual diluição orienta infundir em 2h. Feito em uma hora e meia.	5,075	Moderado
192	Omeprazol (pó liófilo, 40 mg)	Manual de diluição: infundir no máximo 4ml/min. Feito em 18 segundos.	5,575	Moderado
193	Dapsona (comprimido de 100 mg)	Paciente preferiu tomar medicamento após o lanche. Aprazado para 8h e administrado às 10h26.	5,25	Moderado
194	Insulina regular (solução injetável)	Medicamento não foi administrado. Confirmado com paciente que o mesmo não foi feito. HGT = 233.	6,25	Moderado
195	Insulina regular (solução injetável)	Medicamento não foi administrado. Confirmado com paciente que o mesmo não foi feito. HGT = 249.	6,25	Moderado
196	Insulina regular (solução injetável)	O técnico levou insulina NPH aspirada antes de fazer HGT, após glicemia capilar, voltou e aspirou insulina regular. Insulina regular SN (04 unidades). Técnico checou no item de uso sistemático bolou o horário de 08h e checou 22h.	6,25	Moderado
197	Insulina regular (solução injetável)	Medicamento não administrado.	6,25	Moderado
198	Sulfametoxazol + trimetropina/ comprimido de 400 mg + 80 mg	Prescrito 3 comprimidos e administrado 1 comprimido.	7,1	Grave
199	Sulfametoxazol + trimetropina/ comprimido de 400 mg + 80 mg	Aprazado para 8h e administrado às 9h12	6,75	Moderado
200	Dimeticona/ comprimido de 40 mg	Aprazado para às 14h e administrado às 15h40	2,9	Leve
201	Dimeticona/ comprimido de 40 mg	Aprazado para às 14h e administrado às 15h15	2,9	Leve
202	Tramadol/ ampola 100 mg/2 ml	Aprazado para 16 horas e administrado às 18h15	2,9	Leve
203	Tramadol/ ampola 100 mg/2 ml	Aprazado para 14 horas e administrado às 18h35	2,9	Leve

4. CONCLUSÃO DA TESE

4.1 Síntese dos resultados

A partir da revisão sistemática realizada, foi possível depreender que os erros de administração de medicamentos (EAM) ocorrem com frequência nos hospitais estudados. A taxa permanece elevada mesmo após remoção dos erros de horário. Nenhum dos estudos incluídos na revisão realizou análise da gravidade dos erros observados. Como parte desta tese, os resultados obtidos a partir da observação dos EAM ocorridos em um hospital público permitem reforçar os achados da revisão sistemática realizada, em vistas da elevada frequência de EAM. Foram observados 203 erros de administração. Destaca-se a alta frequência de erros de técnica, inclusive envolvendo medicamentos de administração endovenosa, visto que este não é o tipo de erro mais frequente de acordo com estudos realizados previamente. Diante da frequência elevada dos erros, faz-se necessário estabelecer estratégias para redução do risco de dano ao paciente. Essas estratégias usualmente estão relacionadas à gravidade (potencial ou real) do erro, entretanto a falta de padronização de ferramentas para mensuração da gravidade, de forma confiável e válida, pode contribuir para a escassez dos dados e limitar as ações. Visando permitir a utilização no Brasil de uma ferramenta validada em outros países, foi realizada a validação da escala de gravidade potencial de erros de medicação proposta por Dean & Barber (1999). Após validação, a escala foi utilizada para avaliar a gravidade potencial dos 203 erros. Observamos que a maior parte dos erros no nosso estudo foram potencialmente moderados, entretanto é importante destacar a frequência elevada de erros considerados como potencialmente graves, especialmente quando a frequência é comparada aos estudos realizados em países desenvolvidos.

4.2 Principal contribuição do estudo

Destacamos como principais contribuições:

1. A necessidade evidenciada da realização de novos estudos que utilizem a técnica de observação direta para estimar a frequência dos EAM, sobretudo nos outros países da América Latina;
2. A demonstração de que a taxa de EAM é alta nesta região, o que demanda a realização de ações para prevenção de danos associados aos erros;

3. A validação da escala para avaliação da gravidade potencial dos erros de medicação, permitindo a sua difusão e utilização no Brasil, o que poderá contribuir para priorização e delineamento de ações com vistas a promover o uso seguro de medicamentos.
4. O uso dessa escala em pesquisas futuras pode ajudar a determinar a importância clínica dos erros de medicação de forma mais clara no contexto brasileiro, contribuindo para o desenvolvimento de intervenções voltadas à redução dos danos associados;
5. Até onde temos conhecimento, este é o primeiro estudo com uma escala de gravidade de erros validada no Brasil que mostrou uma elevada taxa de EAM com gravidade alta e moderada.

4.3 Limites e perspectivas

Outros estudos que utilizem a metodologia de observação direta são essenciais para uma melhor descrição do perfil e da frequência de EAM na América Latina, dado que os estudos identificados que preenchiam os critérios de inclusão da revisão sistemática foram realizados no Brasil e Chile, portanto as realidades de outros países latino-americanos não foram contempladas.

A observação realizada ocorreu em apenas um hospital, o que limita a extrapolação dos resultados identificados para outras realidades.

Como o atual desafio global em segurança do paciente é “medicação sem danos”, abrem-se novas perspectivas para a criação de uma linha de pesquisa na Universidade Federal da Bahia (UFBA) nesta problemática, não só para melhor compreender a epidemiologia dos erros de medicação, mas também para avaliar o potencial de causar danos através desta escala validada na nossa realidade. Existem oportunidades para fortalecer o programa de segurança do paciente do Ministério da Saúde através de pesquisas que abordem o sistema de utilização de medicamentos envolvendo a prescrição, dispensação, administração e monitoramento dos erros de medicação nos hospitais brasileiros como também na atenção básica do Sistema Único de Saúde (SUS).

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