PREPARATION OF INJECTABLE MEDICATION PERFORMED BY NURSES: OBSERVATIONAL STUDY

Preparação de medicação injetável realizada por enfermeiros: estudo observacional

Preparación de medicación inyectable realizada por personal de enfermería: estudio observacional

Mariana Duarte do Vale Lima *, Cristina Carvalho Pinto **, Celeste Bastos ***

ABSTRACT

Background: the preparation of injectable medication is a clinical procedure often performed by nurses, and the literature highlights the low standardisation of practices between institutions and professionals, as well as deviations regarding safety principles. **Objectives:** to identify the nurses' practice in preparing injectable medication; assess the nurses' level of importance assigned to the safe preparation of injectable medication; and analyse the association between the importance assigned to the safe preparation of injectable medication and the socioprofessional variables. **Methodology:** observational, descriptive and cross-sectional study. Forty-five situations of injectable medication preparation were observed through an observation grid. Subsequently, 20 nurses completed a questionnaire on the degree of importance assigned to the safe preparation of injectables. **Results:** there were deviations from the recommendations that guarantee the safety of the procedure. A hygiene of the hands stood out positively (95.6% adherence). The questionnaire answers showed a discrepancy between the importance assigned by participants to safety and the practices observed. **Conclusion:** the results allow for a first analysis of the strengths and weaknesses of the preparation of injectable medication performed by nurses, allowing for the identification of intervention strategies that may contribute to improve the practices in use in the studied context.

Keywords: infection control; injections; patient safety; nursing

*MSc., Centro Hospitalar Universitário do Porto - Porto, Portugal – https://orcid.org/0000-0001-8215-8327
** PhD., Escola Superior de Enfermagem do Porto - Porto, Portugal – http://orcid.org/0000-0003-1068-738X
*** PhD., Escola Superior de Enfermagem do Porto - Porto, Portugal, – https://orcid.org/0000-0001-5907-6702

Autor de correspondência:
Mariana Duarte do Vale Lima
mariana.vale.lima@gmail.com

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RESUMO

Enquadramento: a preparação de medicação injetável é um procedimento clínico realizado frequentemente pelos enfermeiros, sendo que a literatura salienta a baixa uniformização das práticas entre instituições e entre profissionais, bem como, desvios no que respeita aos princípios da segurança. **Objetivos:** conhecer a prática de preparação de medicação injetável realizada pelos enfermeiros; avaliar o grau de importância que os enfermeiros atribuem à preparação segura; analisar a associação entre a importância atribuída à preparação segura de injetáveis e as variáveis socioprofissionais. **Metodologia:** estudo observacional, descritivo e transversal. Foram observadas 45 situações de preparação de medicação injetável através de uma grelha de observação. Posteriormente, 20 enfermeiros responderam a um questionário sobre o grau de importância que atribuem à preparação segura de injetáveis**. Resultados:** verificou-se desvios às recomendações que garantem a segurança do procedimento. A higiene das mãos salientou-se positivamente (adesão de 95.6%). As respostas aos questionários traduzem uma discrepância entre a importância atribuída pelos participantes à segurança e as práticas observadas. **Conclusão:** os resultados permitem uma primeira análise dos pontos fortes e das fragilidades da preparação de medicação injetável realizada pelos enfermeiros, possibilitando a identificação de estratégias de intervenção que poderão contribuir para a melhoria das práticas em uso no contexto estudado.

Palavras-chave: controle de infeções; injeções; segurança do paciente; enfermagem

RESUMEN

Marco contextual: la preparación de medicamentos inyectables es un procedimiento clínico frecuentemente realizado por enfermeros, y la literatura destaca la baja estandarización de las prácticas entre instituciones y entre profesionales, así como, las desviaciones con respecto a los principios de seguridad. **Objetivos:** conocer la práctica de preparación de medicamentos inyectables realizada por enfermeros; evaluar el grado de importancia asignado por los enfermeros a la preparación segura; analizar la asociación entre la importancia asignada a la preparación segura de inyectables y variables socio profesionales. **Metodología:** estudio observacional, descriptivo y transversal. Cuarenta y cinco situaciones de preparación de medicamentos inyectables fueron observadas a través de una rejilla de observación. Posteriormente, 20 enfermeras respondieron a un cuestionario sobre el grado de importancia asignado a la preparación segura de inyectables. **Resultados:** se verificó el cumplimiento de las recomendaciones que garantizan la seguridad del procedimiento. La higiene de las manos destacó positivamente (adición del 95,6%). Las respuestas a los cuestionarios traducen una discrepancia entre la importancia atribuida por los participantes a la seguridad y las prácticas observadas. **Conclusión:** los resultados permiten un primer análisis de los puntos fuertes y débiles de la preparación de medicamentos inyectables realizada por enfermeros, posibilitando la identificación de estrategias de intervención que puedan contribuir a la mejora de las prácticas en uso en el contexto estudiado.

Palabras clave: control de infecciones; inyecciones; seguridad del paciente; enfermería

INTRODUCTION

Healthcare-associated infections (HAIs) are responsible for deteriorating the patient's health condition, increasing mortality and morbidity, extending the period of hospitalisation and increasing healthcare costs.

Thus, their prevalence and incidence continue to be an indicator of the safety and quality of health services. Globally, the impact of HAIs is being prioritised in policy decisions because they contribute to the global threat of antimicrobial resistance (Gammon et al., 2019). In this sense, an understanding of the magnitude of the phenomena is necessary in order to implement training and skills development measures for the prevention of HAIs.

All clinical cases are not immune to complications, especially infection. In each of these cases, activities aimed at preventing and controlling infection are carried out, including basic precautions such as hand hygiene, adequate use of personal protective equipment and environmental control. (Pina et al., 2010). In clinical practice, the preparation and administration of unsafe medication are included in these clinical actions and are most often the responsibility of nurses. In order to minimise the IACS related to the preparation of injectable medication, there is a growing interest in this subject and the need to understand the clinical practice of nurses, with the aim of, on the one hand, identifying conditionalities in the preparation of injectables that could jeopardise the safety of the patient and, on the other hand, contribute to improving the care provided by nurses.

BACKGROUND

Infection prevention and control is one of the areas of healthcare where the evolution of knowledge has been most marked. With the exponential increase in HAIs, particularly nosocomial bloodstream infections, there is a need to develop studies that promote the explanation of practices and awareness of the individual and collective role of nurses in providing safer and higher quality health care (Dolan et al., 2016).

The consequences of IACS are not only limited to health costs, but also lead to an inefficiency of human resources and materials, to an overload of hospital beds that could be allocated to other patients, to an increased risk for health professionals and to a decrease in the quality of life and productivity of patients and their families. (Silva, 2013).

Indisputably, there should be an investment by institutions to create a dialogical approach to knowledge construction. This should be adapted to the experiences of professionals and multifaceted interventions that also consider beliefs, values, and social behaviour, in addition to knowledge. (Jackson et al., 2014).

In clinical practice, the preparation of injectable medication is a part of the most frequently performed clinical procedures and, according to the Institute for Safe Medication Practices (ISMP), lacks improvement. Thus, it is thought that one of the ways to minimise IACS is related to the safe preparation and administration of medication, which has become an increasingly important area in health care. (Institute for Safe Medication Practices, 2021). On the other hand, although the issue is becoming more and more profound, it remains relevant to identify, inspire and

mobilise for the adoption of evidence-based practices, as there are still harmful and fatal errors for users. (Institute for Safe Medication Practices, 2021).

ISMP identifies several non-conformities in patient safety in the preparation of medicines (Institute for Safe Medication Practices, 2021). It is therefore essential to seek to understand the causes in order to prevent errors in medication preparation and administration. Strbova et al. (2015) allude to the deviations in the practice of professionals that affect patient safety, ranging from failures in the principles of assepsis during medication preparation (lack of hand and surface hygiene, failure to disinfect bottles and ampoules, etc.), to errors in its administration.

Thus, the objectives of the study were to understand the practice of preparing injectable medication performed by nurses, to assess the degree of importance that nurses attribute to the safe preparation of injectable medication and to analyse the association between the importance attributed to the safe preparation of injectables and the socio-professional variables (age, sex, length of service, speciality, training in infection control). The study is part of the research project "Controlo das Infeções Associadas aos Cuidados de Saúde", conducted by the research group Inovação e Desenvolvimento em Enfermagem (NursID) of the Centro de Investigação em Tecnologias e Serviços de Saúde (CINTESIS).

METHODOLOGY

An observational, descriptive and cross-sectional study was conducted, focusing on a quantitative approach. The study was carried out in the adult inpatient department of a hospital in the north of Portugal, and included all nurses who prepared injectable medication in the morning and afternoon shifts and agreed to participate in the study. Based on these criteria, the sampling process was non-probabilistic, of the accidental or convenience type.

As a data collection strategy, we chose to use an observation questionnaire and a questionnaire. The observation guideline allowed us to observe the practice of the nurses in the preparation of injectable medication and the questionnaire allowed us to evaluate the importance attributed by the nurses to the safe preparation of injectable medication.

The observation grid, created by Bastos & Barbieri (2020) and used with their permission, includes 14 items and records responses based on four options: i) "Yes" - for procedures performed correctly; ii) "No" - for procedures performed incorrectly; iii) "With flaws" - for procedures that are partially correct; iv) "Not Applicable" - when the described procedure does not apply to the type of preparation technique being performed.

The questionnaire was constructed from 11 of the items on the observation sheet, on a *Likert-type* scale, with three points, where "Not important at all" is 1, "Not very important" is 2, "Very important" is 3, "I have doubts" is zero. The questionnaire included the socio-professional variables (age, sex, length of service, speciality, training in infection control).

Data collection took place in the months of May and June 2022. Observations of the preparation of injectable medication were carried out by the principal investigator during the morning (8-14 hours) and afternoon (14-21 hours) shifts. As the target of the observations was the preparation and not the nurse, this meant that some participants were observed more than once. After the period dedicated to observing the practice of preparing injections, the questionnaires

were left in the service so that the participants who agreed to participate in the study could answer according to their availability and interest. Subsequently, after answering, the participants left the questionnaire at the service, in the designated area.

In the analysis of the data, descriptive statistics were used, specifically, measures of central tendency (mean), measures of dispersion (standard deviation, minimum and maximum values) and frequencies were obtained. Subsequently, inferential statistics were used, which included tests of association (Chi-Square test and Spearman's Coefficient of Correlation) and the Mann-Whitney test of differences.

The ethical requirements were met, in particular, the authorisation of the study by the Ethics Committee of the institution, the letter of explanation of the study and the free and clear consent given to the participants of the study. The confidentiality and anonymity of the observations and the answers to the questionnaires was guaranteed, with the attribution of a numerical code, without the possibility of identifying the person who answered or was observed. All participants were informed about the moments of observation and that these would take place randomly and without prior marking.

RESULTS

Out of a total of 33 nurses who were preparing injectable medication in the context of the study, 28 agreed to participate in the study. In the first phase, these 28 patients were subjected to 45 observations. In the second phase, 71.3% (n=20) agreed to answer the questionnaire.

The results of the observations, presented in table 1, point to low adherence to relevant items to ensure safety in the preparation of injectable medication. In 93.3% of the observations, the medication preparation surface was not disinfected and bottles and various materials were deposited on this surface, which reduced the free space. Nearly 50% of the observations show that the nurses did not guarantee the opening of the syringe or gullet holes in the referenced area. In 19 cases in which it would be justified to proceed to the "disinfection of the ampoule's gullets", the participants did not do so. Finally, in about 90% of the observations, the participants did not previously disinfect the tray used to transport the medication to the patient. The results positively highlighted hand hygiene, where an adherence rate of 95.6% was observed, as well as the use of single-dose solvent for the 32 times when diluting or reconstituting the medication was recommended.

Table 1

Summary of the results obtained in the observations of the preparation of injectable medication

Procedure items	**N**	**%**
Preliminary disinfecting the preparation surface	3	6.7
Hand hygiene	43	95.6
Disinfecting the ampoule neck (*does not apply to 29 observations*)	0	0.0
Disinfecting the bottle cap (*not applicable in 18 observations*)	1	3.7
Opening the syringe/needle casings by the area indicated	21	46.7
Use of single dose solvent (*does not apply to 13 observations*)	32	100
Disinfecting the tray used to transport the medication	5	11.1

The 20 nurses who responded to the questionnaire were mainly female, with ages between 24 and 59 years (M=34.05; DP=8.04) and length of service between 2 and 34 years (M=10.50; DP=7.63). Most of the participants were general care nurses (n=13) and 35% were specialist nurses, in medical-surgical nursing (n=2) and rehabilitation nursing (n=5). Only 5 participants (25%) reported training in infection control.

The results obtained through the application of the questionnaires, with answers on a scale that evaluates the degree of importance that the participant attributed to each item, according to the following options: (0) "I have doubts", (1) "not at all important", (2) "not very important" and (3) "very important", report an average value of 2.76 (DP=0.194; Mn=2.36; Mx=3), i.e., the nurses attribute high importance to the safe preparation of injectable medication. The responses to each item are presented in table 2. The option "very important" was the most frequently stated, for example, when the nurses were questioned about the importance of prior surface disinfection (immediately before use), the majority answered "very important" (M=2.70; DP=0.73). Exceptions were found in the items "disinfecting the vial's thimble" and "in reconstitution and/or dilution of medicines, use multi-dose solvent", which were mostly answered as "not at all important".

Table 2

Summary of the results obtained in the answers to the questionnaires

Questionnaire items	**Mn - Mx**	**M (DP)**
Preliminary disinfection of the surface used in the preparation of the medicine	0 - 3	2.70 (0.73)
Hand hygiene	3 - 3	3.00 (0.00)
Disinfect the neck of the ampoule	1 - 3	2.60 (0.60)
Disinfect the bottle before inserting the bottle.	2 - 3	2.85 (0.37)
Open the screws of the syringe(s) in the referenced area.	2 - 3	2.95 (0.22)
Open the door(s) on the referenced area.	2 - 3	2.95 (0.22)
Comply with the principles of asepsis in the handling of the syringe(s), syringe(s) and flasks.	3 - 3	3.00 (0.00)
In reconstitution and/or dilution of medicines, use single-dose solvent.	2 - 3	2.60 (0.50)
In reconstitution and/or dilution, use a multi-dose solvent.	1 - 3	2.30 (0.57)
Use the tray to transport the medication to the patient.	2 - 3	2.75 (0.44)
Disinfecting the tray used to transport the medication	2 - 3	2.65 (0.49)

Subsequently, we proceeded to analyse the association between the importance attributed to the safe preparation of injectables and the socio-professional variables.

In our sample, whether or not the nurses had specific training in infection control was not shown to be relevant in the importance attributed by the nurses to the preparation of injectable medication. In this follow-up, there was no statistically significant difference between nurses with and without training in infection control. On the other hand, it was the nurses with a speciality who attributed greater importance to the safe preparation of injectable medication (Md=33; n=7); U=16.000, *p=0.*018.

In more detail, the *Mann-Whitney test* reveals a statistically significant difference between nurses with

a speciality (Md=33; n=7) and nurses without a speciality (*Md=30*; n=13) in terms of the level of importance attributed to the items in the questionnaire, U=16.000, *p=0.*018. Thus, specialist nurses attribute greater importance to the items in the questionnaire than non-specialist nurses.

In the study of the association between the importance attributed to the items in the questionnaire and the variables age and length of service, *Spearman's* correlation coefficient did not produce statistically significant results for age (rs = -0.003; p =0.891), nor for length of service (rs = 0.063; p =0.793).

DISCUSSION

The majority of our sample was female, with an average age of 34.5 years, which reflects the reality in Portugal (Ordem dos Enfermeiros, 2018). This will probably be the reality in other countries, given that the same has happened in other research, for example, the studies by Anwar et al. (2019) and Bhatia et al. (2018).

The results of the study reveal deviations from the recommendations that guarantee the safety of the procedure, particularly observed in the non-compliance of the disinfection of the surfaces used for the preparation of the medication and of the tablets used in its transport to the patient. Also to highlight the low adherence to the disinfection of the vials' beads and the diaphragm of the vials, and to the opening of the sterile vials through the area referenced for this purpose, putting the procedure's aseptic technique at risk.

Indeed, the impact of environmental contamination and the lack of surface disinfection on the transmission of multidrug-resistant microorganisms has been extensively researched (Hausemann et al., 2018).. Studies show that most nosocomial pathogens can survive for months on work surfaces and can be a source of transmission if they are not properly disinfected, jeopardising patient safety (Hausemann et al., 2018).. Taking into account this evidence, our results show that, in most of the observations of injectable medication preparation, there was a high risk of microbial contamination.

Paradoxically, when questioned, the nurses attribute importance to surface disinfection, so it is important to reflect on the reason for this dispersion, i.e., the degree of importance attributed to surface removal is not in accordance with the observed practice. These results reflect the *gap* between the evidence, the existing standards and the practice, reporting a professional practice that is far from the recommendations and policies defined (Jackson et al., 2014).

With respect to the disinfection of the glass ampoule clusters and bottle diaphragms, the results of low adherence to this item translate into non-compliance with recommendations (Dolan et al., 2016). Once again, there is a discrepancy between the model presented and the model in use. This is because the lack of adherence to a safe practice is not consistent with the level of importance attributed to it. Dolan et al. (2016) warns of the need to disinfect the diaphragms of the vials and the vial chambers with 70% alcohol immediately before the insertion of the needle, with a view to the inactivation of some vegetative forms of bacteria, most viruses and fungi.

In relation to the opening of the gullet and syringe holes in the referenced area, more than half of the participants did not do so, distancing themselves from

the recommendations that point to the importance of the aseptic norm in the preparation of injectable medication, avoiding any contact with the non-sterile environment (Dolan et al., 2016). The importance attributed by the participants to these items again reflects a discrepancy with the observed practice.

A frequently equated issue in medication preparation is the use of solvent from multi-dose vials. According to studies by Bhatia et al. (2018) and Dolan et al. (2016), the use of this type of solvent increases the risk of contamination of solutions by pathogenic microorganisms, resulting in an increased risk of nosocomial infection of the bloodstream, so its use is discouraged. The results of our study are in line with this recommendation, since the 32 times that it was recommended to dilute or reconstitute the medication, the professionals opted to use the single-dose solvent. However, it should be noted that in the context under study, few medications required reconstitution and/or dilution, which may facilitate adherence to safe practice, Compared to other contexts where the amount of medication is higher and the nurses share 100 cc bottles of physiological saline solution or sterile water for the preparation of several doses of medication, even at different times and with more or less long periods of time.

A very positive result that emerged in our study was hand hygiene before medication preparation, which resulted in an adherence rate of 95.6%. There is consensus in the literature that hand hygiene is one of the fundamental practices with proven efficacy in reducing HAIs. (Centers for Disease Control and Prevention, 2002). The result of our study distances itself from the research of Mendes et al. (2018)in which an adherence rate of only 29.7% was observed. We would like to highlight two facilitating factors of adherence in our study. On the one hand, the existence of conditions for hand hygiene, namely, a toilet with water and neutral soap, and a device with an alcohol-based antiseptic solution (SABA); on the other hand, the study was conducted during a pandemic situation, which seems to us to have contributed to encourage this practice. The participants in the study attribute the utmost importance to hand hygiene, which is consistent with the observed practice.

Nurses, by virtue of the nature of their work, with direct and permanent intervention alongside the patient, are crucial in identifying practices that compromise the safety of health care and also in guaranteeing this safety. Sometimes professionals perceive their own failures as small and minor, but studies show that these can lead to the transmission of cross-infection and risks that are not always detectable (Anwar et al., 2019).

In the study of the association of variables, it can only be said that specialist nurses attribute greater importance to each of the stages of the safe preparation of injectable medication, compared to non-specialist nurses. However, it is not possible to perceive whether this tendency is maintained in terms of their performance, since, given the nature of the study and to ensure the anonymity of the participants during the observation of the practices, it was not possible to study the association of the practice of medication preparation with socio-professional variables. On the other hand, the literature points out that there may be discrepancies between the level of knowledge and the rigour in the performance of clinical procedures, since the behaviour of nurses is multifaceted and not always the failures in practice have their origin in knowledge deficit (Jackson et al., 2014). In this sense, having a speciality, which is

supposed to result in a higher level of knowledge, may not translate directly into adherence to safety recommendations for medication preparation.

The results of our study reinforce the conclusions of other studies regarding deviations from safe practice in the preparation of injectable medication. We can equate possible reasons for these results, such as individual factors, such as the interest and involvement of professionals, access to credible information and training, or organisational factors, such as work overload, supervision and team management, and promotion of training/continuing education opportunities in the professional context itself. It should be noted that 75% of the participants in our study reported having no training in infection control, which is, in fact, alarming.

In view of the results presented, it seems imperative to reflect on the most appropriate strategies for raising awareness among professionals in order to change the practices in use. On the other hand, there is a categorical need to rethink issues related to training, auditing of practices and feedback to professionals. For example, the presence of an infection control professional, assuming the role of a *coach*, who audited central vascular access maintenance practices and provided direct and timely feedback to nurses through timely and non-punitive conversations, proved to be an effective complement to infection prevention in the intensive care setting. (Buchanan et al., 2019)..

Although globally the results found are not discouraging, because they show a performance in accordance with some of the recommendations, they also point to the need to promote moments of discussion and reflection in the team under study, on some discrepancies between the importance attributed to the steps of the procedure of preparation of injectable medication and the practices in use. These moments of reflection are opportunities that, in our view, can facilitate awareness of a practice that is frequently rotated and which is rarely questioned or analysed.

According to different studies, intervening in the field of prevention and control of infestation requires the implementation of multifaceted strategies, which, in addition to the acquisition of knowledge, also include the acquisition of competencies focused on behavioural change, relying on social sciences and psychology. (Borg, 2014).

In the context of the safe practice of injectable medication and taking into account the results of our study, it is considered useful to plan a multimodal intervention that can combine training and educational strategies with strategies for behavioural change, taking into account the psychological and social determinants that can facilitate the adoption of safe practices, benefiting users, healthcare institutions and the professionals themselves.

CONCLUSION

The results of the study positively emphasise the importance of hand hygiene and the use of single-dose solvents in the reconstitution and/or dilution of injectable medication. However, the results also point to deviations from the evidence of safe injection preparation practices, particularly in relation to environmental contamination, surface disinfection failures, ampoule disinfection and opening of the involute. On the other hand, across the board, professionals attach great importance to the stages of safe practice. Thus, there is a gap between the

evidence, the existing standards, the importance attributed by the participants to safety and the practice carried out. It is important to share these results with study participants, providing an opportunity for analysis and reflection on practices, and the possibility of implementing a multifaceted intervention, which could include regular peer audits, with feedback on performance, with the ultimate goal of improving injectable medication preparation practices and patient safety.

The limitation of this study is the small size of the sample, which does not make it possible to generalise the results. However, these results may be transferable to other contexts and may help to equate the practices in use. It is evident that there is a need to continue the research work initiated, with large-scale replication of the study and possible national representativeness, making it possible to raise awareness among nurses of the problem of low adherence to recommendations for the preparation of injectable medication and the need for change with a focus on patient safety, in the perspective of continuous improvement of nursing care.

REFERENCES

Anwar, M. M., Mohamed Lotfy, A. A., & Alrashidy, A. A. (2019). Safe injection awareness and practices among nursing staff in an Egyptian and a Saudi hospital. *Journal of the Egyptian Public Health Association*, *94*(1). https://doi.org/10.1186/s42506-019-0018-5

Bastos, C., & Barbieri, M. do C. (2020, dezembro, 14-18). *Preparação de medicação injetável em contexto hospitalar: resultados de estudo piloto* [Poster]. NursID Winter School 2020 – Semana de Investigação em Enfermagem, Escola Superior de Enfermagem do Porto, Porto.

Bhatia, M., Mishra, B., Sood Loomba, P., & Dogra, V. (2018). A pilot study for evaluation of knowledge and common practises of nursing staff regarding use of multidose injection vials and their microbial contamination rate in a super-specialty hospital, *Journal of Education and Health Promotion*, *7*(1), 120. https://doi.org/10.4103/jehp.jehp_73_18

Borg, M. A. (2014). Cultural determinants of infection control behaviour: Understanding drivers and implementing effective change. *Journal of Hospital Infection* 86(3), 161–168. https://doi.org/10.1016/j.jhin.2013.12.006

Buchanan, M. O., Summerlin-Long, S. K., DiBiase, L. M., Sickbert-Bennett, E. E., & Weber, D. J. (2019). The compliance coach: A bedside observer, auditor, and educator as part of an infection prevention department's team approach for improving central line care and reducing central line-associated bloodstream infection risk. *American Journal of Infection Control*, *47*(1), 109–111. https://doi.org/10.1016/j.ajic.2018.06.005

Centers for Disease Control and Prevention (2002). *Hand Hygiene Guidance*. https://www.cdc.gov/infection-control/media/pdfs/Guideline-Hand-Hygiene-P.pdf

Dolan, S. A., Arias, K. M., Felizardo, G., Barnes, S., Kraska, S., Patrick, M., & Bumsted, A. (2016). APIC position paper: Safe injection, infusion, and medication vial practices in health care. *American Journal of Infection Control*, *44*(7), 750–757. https://doi.org/10.1016/j.ajic.2016.02.033

Gammon, J., Hunt, J., Williams, S., Daniel, S., Rees, S., & Matthewson, S. (2019). Infection prevention control and organisational patient safety culture within the context of isolation: Study protocol. *BMC Health Services Research*, *19*(1), 1–8. https://doi.org/10.1186/s12913-019-4126-x

Hausemann, A., Grünewald, M., Otto, U., & Heudorf, U. (2018). Cleaning and disinfection of surfaces in hospitals. Improvement in quality of structure, process and outcome in the hospitals in Frankfurt/Main, Germany, in 2016 compared to 2014, *GMS Hygiene and Infection Control*, *13*. https://doi.org/10.3205/dgkh000312

Institute for Safe Medication Practices. (2021). *2020-2021 Targeted Medication Safety Best Practices for Hospitals*.https://www.ismp.org/sites/default/files/attachments/2020-02/2020-2021%20TMSBP-%20FINAL_1.pdf

Jackson, C., Lowton, K., & Griffiths, P. (2014). Infection prevention as "a show": A qualitative study of nurses' infection prevention behaviours. *International Journal*

of Nursing Studies, *51*(3), 400–408. https://doi.org/10.1016/j.ijnurstu.2013.07.002

Mendes, J. R., Lopes, M. C., Vancini-Campanharo, C. R., Okuno, M. F., & Batista, R. E. (2018). Types and frequency of errors in the preparation and administration of drugs. *einstein (São Paulo)*, *16*(3). https://doi.org/10.1590/S1679-45082018AO4146

Ordem dos Enfermeiros. (2018). *Membros activos*.

Pina, E., Ferreira, E., Marques, A., & Matos, B. (2010). Infecções associadas aos cuidados de saúde e segurança do doente. *Revista Portuguesa de Saúde Pública*, *Temático* (10), 27–39.

Silva, M. G. D. G. M. Da. (2013). Controlo de infeção em Portugal: evolução e atualidade. *Salutis Scientia - Revista de Ciências da Saúde da ESSCVP*, *5*, 2-8.

Strbova, P., Mackova, S., Miksova, Z., & Urbanek, K. (2015). Medication Errors in Intravenous Drug Preparation and Administration: A Brief Review. *Journal of Nursing & Care*, *4*(5). https://doi.org/10.4172/2167-1168.1000285