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REVIEW

Pharmacological Competencies in Nursing: Prevention of Medication Errors and Patient Safety in Intensive Care Units

Competencias Farmacológicas en Enfermería: Prevención de Errores de Medicación y Seguridad del Paciente en Unidades de Terapia Intensiva

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ABSTRACT

Introduction: Pharmacology focused on the study of the effects of chemical compounds on living organisms, consolidating itself as an essential discipline in health. Its evolution allowed significant advances in modern medicine, standing out in critical areas such as Intensive Care Units (ICU). In these environments, where patients require precise pharmacological care, medication errors (ME) were identified as one of the main causes of preventable adverse events. Institutions such as the World Health Organization (WHO) stressed the need to improve pharmacological competencies to ensure patient safety.
Development: Pharmacological training in nursing proved to be a major challenge. Although emphasis was placed on key areas such as pharmacodynamics and pharmacokinetics, deficiencies were observed in practical knowledge and the ability to prevent errors in drug administration. The problem was addressed from a systemic approach using tools such as Reason's model, which made it possible to identify structural and underlying failures in pharmacotherapeutic processes. In parallel, pharmacovigilance and pharmacoepidemiology stood out as pillars to monitor the safe use of medications, promoting an organizational culture oriented to learning and continuous improvement.
Conclusions: It was concluded that pharmacological competence in Nursing is fundamental to prevent medication errors and ensure patient safety. The integration of theoretical training, practical skills and ethical attitudes was key to address the challenges in critical contexts such as ICUs. In addition, it was recommended to strengthen continuous training systems and adopt interdisciplinary strategies to reduce medication-related risks and improve the quality of health care.

Keywords: Pharmacology; medication errors; patient safety; pharmacologic competencies; nursing.

RESUMEN

Introducción: La farmacología se enfocó en el estudio de los efectos de los compuestos químicos en los organismos vivos, consolidándose como una disciplina esencial en la salud. Su evolución permitió avances significativos en la medicina moderna, destacándose en áreas críticas como las Unidades de Terapia Intensiva (UTI). En estos entornos, donde los pacientes requieren cuidados farmacológicos precisos, los errores de medicación (EM) fueron identificados como una de las principales causas de eventos adversos prevenibles. Instituciones como la Organización Mundial de la Salud (OMS) subrayaron la necesidad de mejorar las competencias farmacológicas para garantizar la seguridad del paciente.
Desarrollo: La formación farmacológica en Enfermería demostró ser un desafío importante. Aunque se enfatizó en áreas clave como la farmacodinamia y farmacocinética, se observaron deficiencias en el conocimiento práctico y la capacidad de prevenir errores en la administración de medicamentos. La problemática se abordó desde un enfoque sistémico mediante herramientas como el modelo de Reason, que permitió identificar fallas estructurales y subyacentes en los procesos farmacoterapéuticos. Paralelamente, la farmacovigilancia y la farmacoepidemiología destacaron como pilares para monitorear el uso seguro de medicamentos, promoviendo una cultura organizacional orientada al aprendizaje y la mejora continua.
Conclusiones: Se concluyó que la competencia farmacológica en Enfermería es fundamental para prevenir errores de medicación y garantizar la seguridad del paciente. La integración de formación teórica, habilidades prácticas y actitudes éticas resultó clave para abordar los desafíos en contextos críticos como las UTI. Además, se recomendó fortalecer los sistemas de capacitación continua y adoptar estrategias interdisciplinarias para reducir los riesgos asociados a los medicamentos y mejorar la calidad de la atención sanitaria.

Palabras clave: Farmacología; errores de medicación; seguridad del paciente; competencias farmacológicas; enfermería.

INTRODUCTION

As a scientific discipline, pharmacology focuses on studying the properties, characteristics, and effects of chemical compounds on living organisms. Its relevance in the health field is reflected in its ability to address processes of cure, diagnosis, prevention, and relief of diseases in humans and animals, as defined by the World Health Organization (WHO). Since its origins, pharmacology has undergone remarkable development, going from rudimentary practices based on plant and animal extracts to establishing itself as one of the leading industries of the 20th century. This historical advance has allowed for the incorporation of techniques, knowledge, and discoveries essential to modern medicine, from the isolation of active ingredients such as morphine to the development of innovative drugs such as insulin and antibiotics.

Pharmacology covers various fields of study, from pharmacodynamics, which analyzes the mechanisms of action of drugs in biological processes, to pharmacokinetics, which deals with aspects such as the absorption, distribution, metabolism, and excretion of drugs. These fundamentals are essential for the professional nursing practice, particularly in critical areas such as Intensive Care Units (ICUs), where patients require precise and safe drug administration. However, this practice is subject to errors that can have significant consequences for patient safety, as the Institute for Safe Medication Practices (ISMP) pointed out.

Medication-related problems, including medication errors (MEs), are one of the leading causes of preventable adverse events in healthcare systems. These errors, which range from incorrect patient identification to medication administration errors, can cause significant harm, such as delays in medical discharge, increased hospital costs, and even mortality. The WHO has identified medication errors as one of the ten leading causes of disability and death worldwide, highlighting the need for safer health systems and standardized procedures to reduce their incidence.

In this context, pharmacovigilance and pharmacoepidemiology emerge as key tools for evaluating and improving the safety of medication use based on identifying and analyzing adverse events. These disciplines emphasize the importance of adequate and continuous training in pharmacological skills, particularly in Nursing, where medication administration constitutes the last line of defense to avoid errors.

Pharmacology training for nurses must go beyond the simple acquisition of theoretical knowledge, integrating practical skills and ethical attitudes that enable them to face the challenges of professional practice. According to the WHO, the “10 rights” in medication administration are essential standards to guarantee patient safety, highlighting aspects such as precise identification, correct dosage, information to the patient, and evaluation of therapeutic responses. However, recent studies highlight deficits in the pharmacological training of nurses, which highlights the need to reinforce teaching and training to prevent errors and optimize the quality of care in critical contexts.

General objective

To evaluate pharmacological competencies and their relationship with medication-related problems in the field of nursing in an intensive care unit, to identify areas for improvement and propose strategies to optimize safety in the administration of medication and guarantee quality patient-centered care.

DEVELOPMENT

Pharmacology

Pharmacology is the basic science that deals with drugs and chemical compounds' characteristics, properties, and actions in biological systems. The term comes from the Greek words pharmacon—medicine or poison—and logos—treatise.

Therefore, a pharmaceutical or medicine is a chemical substance that can act on living beings. The World Health Organization specifies the definition of its use for the "cure, diagnosis, prevention or relief of disease in humans and animals."" Usually, drugs can be named by the trade or patent name by which an organization has presented them in the pharmaceutical industry; the generic, official, or INN (international nonproprietary name) name, which is the name used in international publications; and the chemical name that corresponds to its formulation constituents (Vergel Rivera, 2009).

The acceleration of pharmacology in the 20th century, with such a boom that it led to one of the biggest industries of our time, has historical precedents (Osinachi, 2004) that go back to the Sumerians and the use of opium around 5000 BC; in 3500 the appearance of records of alcohol distillation in Egypt and around 1600 the discovery of the Egyptian Ebers papyri that mention an extensive pharmacopeia. In the Christian era, in 1493, Christopher Columbus introduced tobacco obtained in America to Europe, and in 1525, Paracelsus began to use laudanum or tincture of opium in medical practice. Valerius Cordus discovered ether in 1540 and 1762; Thomas Dover produced a preparation of opium powder for the treatment of gout that was used for the next 150 years. In 1776, Priestley synthesized nitrous oxide, which would take 20 years to demonstrate its usefulness as an anesthetic. In 1805, Friedrich Serturner isolated morphine, and in 1841, Jacques Moreau used hashish (a type of cannabis) in the treatment of psychiatric patients. In 1842, Crawford Long used ether as an inhalation anesthetic in neck surgery. Two years later, cocaine was isolated in its pure form and became the first local anesthetic to be used. In 1846, Sobrero synthesized nitroglycerine, and in 1846, dentist William Morton demonstrated the anesthetic effects of ether to a skeptical audience, thus ushering in the era of surgical anesthesia; the

following year, James Simpson would demonstrate the anesthetic effect of chloroform. In 1860, Andean Niemann isolated cocaine from the Erythroxylon coca plant, and in 1864, Adolfo Von Baeyer synthesized the first barbiturate. In 1867, Baeyer synthesized acetylcholine, and in 1895, Oliver & Schafer demonstrated the effect of adrenal gland extracts; 4 years later, they named this active principle Adrenaline. Felix Hoffman synthesized acetylsalicylic acid in 1897, but it was not until 1971 that John Vane won the Nobel Prize in Medicine for describing its mechanism of action. In 1898, diacetylmorphine (heroin) was synthesized in Germany, and in 1903, the Coca-Cola company replaced cocaine with caffeine in its drinks. In 1912, phenobarbital was introduced for medical use under the name luminal. In 1921, Frederick G. Banting - a young Canadian surgeon - and Charles H. Best - a medical student - obtained dog pancreas extract and treated a 14-year-old diabetic patient, reducing his blood glucose from 500 mg/% to 75 mg/%, and in 1923 they were awarded the Nobel Prize in Medicine for the discovery of insulin. In 1931, Butenandt synthesized 15 mg of androsterone from 25,000 liters of male urine. In 1936, the antibacterial effect of sulfonamides was discovered, and in 1938, Hoffman synthesized LSD. Penicillin was identified and isolated in 1940 and began to be used as an antibacterial a year later; in 1943, Waksman discovered Streptomycin. In France, in 1950, chlorpromazine was synthesized, and two years later, Laborit and his colleagues recognized its pharmacological effects and began to use it on patients as a neuroleptic. In 1951, Erythromycin was discovered, and in 1958, Janssen discovered the antipsychotic effects of haloperidol.

Given that pharmacology is a comprehensive science, Morón Rodríguez and Levy Rodríguez (2002) define the various fields that comprise the study of Pharmacology; some of these fields have less direct impact on the problems of professional practice, such as Pharmacognosy, which is dedicated to the origin, characteristics, chemical compositions and constituents in their natural state of drugs, allowing their identification; Pharmacogenetics, which studies hereditary alterations that affect the activity of drugs in therapeutic doses; Molecular Pharmacology, which deals with the chemical structure of a drug and its biological activity; Biopharmacy, which deals with the design of formulations; and Pharmacoeconomics, which considers the economic analysis of the field of medicines in terms of efficacy, effectiveness, availability, and affordability. Other fields of Pharmacology have a direct application, such as Pharmacodynamics, which explains the action and mechanism of the active ingredients on the physiological and biochemical processes of living beings, and Pharmacokinetics, which deals with the study of the absorption, distribution, metabolism, or biotransformation and excretion of drugs.

Pharmacodynamics and Pharmacokinetics are the foundations for understanding Pharmacotherapy, which aims to achieve particular effects in treatment.

Toxicology is a vast discipline that deals with diagnosing and treating poisoning. Although it is associated with legal medicine and industrial medicine, a drug administered - even correctly - can have adverse or undesirable reactions. Pharmacoepidemiology is the field dedicated to measuring the impact of drugs on populations using the epidemiological method and constituting a cross between two disciplines. It is a field that emerged from pharmacovigilance, which is a set of methods widely used in the post-marketing stage for "the identification and quantitative assessment of the risk represented by the use of a drug in the population as a whole or specific subgroup thereof" (Morón Rodríguez & Levy Rodríguez, 2002).

Medication-related problems

Medication errors (MEs) have become one of the leading causes of preventable harm and have promoted the concept of patient safety as a priority objective of health systems worldwide. "Preventable MEs in hospitals even outnumber deaths attributable to vehicle accidents, breast cancer, and AIDS." This situation is a source of loss of life and of patients' trust in the healthcare team and the healthcare system. Thus, the problem with the use of medicines includes - in addition to the intrinsic risk of adverse and secondary reactions typical of active ingredients - numerous adverse events caused by failures or errors that can arise during the process known as the Medicines Utilization System (Encina Contreras & Rodríguez

Galán, 2016). Before addressing the definition of this system, it is worth defining an adverse event (AE) - in terms of Parra et al. (2012)- as "the involuntary injuries or complications that occur during healthcare, which are more attributable to it than to the underlying disease and which can lead to death, disability or deterioration in the patient's state of health, delayed discharge, prolongation of the time spent in hospital and an increase in non-quality costs."

The NCC MERP presented the first attempt at an error taxonomy in the justification section of this study in 1998; the different health offices adapted this taxonomy to their realities to obtain operational tools to address the problem.

The Institute for Safe Medication Practices, the Spanish Delegation of the ISMP, presents a document on medication errors reported in 2021 (ISMP Bulletin No. 51, June 2022), representing the most significant risk or serious patient consequences. Healthcare professionals communicated this information to the ISMP-Spain Medication Error Reporting and Learning System and to the Patient Safety Reporting and Learning System (SiNASP).

The bulletin, as mentioned above, lists the following errors reported as recurring incidents and appends to each section a summary of recommended practices to avoid them:

1. Errors due to incorrect identification of patients.
2. Errors due to omission or delay of medication.
3. Errors in patients with known allergies or adverse effects of medications.
4. Errors in the reconciliation of medication in care transitions.
5. Errors due to the patient taking their medication in the hospital.
6. Errors in verbal prescriptions.
7. Errors associated with the failure to use intelligent infusion pumps.
8. Errors due to the administration of high doses of IV paracetamol in children.
9. Errors due to similarity in the name or appearance of medicines.
10. Wrong administration of liquid oral medicines by IV route.

Medication error (ME) is an event with the possibility of harm that can be avoided with proper medication use, given that it is an activity under the control of healthcare personnel or the patient or consumer. Meanwhile, adverse drug events (ADE) are those damages that occur due to the use or lack of use of a medication. ADEs can be preventable when they originate from medication errors and presuppose harm and error; ADEs are unpreventable when they occur despite the appropriate use of medicines and presuppose harm without error in correspondence with so-called adverse drug reactions. Adverse drug reaction (ADR) will be assigned where the reaction appears as "a response to a drug that is noxious and unintended, and that occurs at doses normally used in humans." A potential adverse event (potential PAME) is defined as a medication error with the potential for serious harm that did not occur, either for an unexplained reason or because the error was noticed and corrected. Therefore, analyzing the occurrence of ADEs allows us to identify the points where the medication use system fails and the points where errors could be identified and corrected (Encina Contreras & Rodríguez Galán, 2016).

Pharmacotherapeutic process and ADE

ADEs tend to respond to a multifactorial cause as they are related to various factors present in the medication use system. Escrivá Gracia (2017) presents Parry's (2015) triad of determinism, which depicts professionals, the environment, and behaviors as the main and interacting protagonists in the phenomenon.

Encina Contreras and Rodríguez Galán (2016) consider MEs to be multidisciplinary events because they involve a chain of different healthcare actors and processes, and therefore, recommend that the medication use process be integrated into a system with the capacity for coordination and teamwork. On this point, they state that there is a bias that most adverse drug events are the result of individual negligent behavior. Still, they are known to occur due to the complexity and functioning of a working

system. This system includes various actors involved in selection, prescription, validation, dispensing, administration, and monitoring.

The World Health Organization (2019) explains this using a systemic approach; specifically, it asserts a correlation between the maturity of the healthcare system and the consideration of the increased complexity of healthcare environments. This complexity exposes professionals to be more prone to making mistakes: when a hospitalized patient receives the wrong medication, for example, due to confusion with another medication with a similar presentation, the prescription has gone through more than one professional - minimally through the prescribing doctor and ending with the nurse who administers the wrong medication to the patient. In a mature system, safety assurance processes are organized by levels that allow the error to be quickly identified and corrected. "In this situation, the lack of standardized procedures for storing similar medications, poor communication between different providers, lack of verification before medication administration, and lack of patient participation in their care could be underlying factors that led to the error." The WHO adds that adverse events originating from unsafe systems are probably one of the 10 leading causes of death and disability in the world.

The Reason or Swiss cheese model (1990), presented by Escrivá Gracia (2017), explains that an accident is the final consequence of an overlap of failures from the last line of defense, through the unsafe act, the unsafe condition, the failure of supervision, the failure of advice (safety) and, finally, the failure of the organization. When the pharmacological event is approached as a system, the error can be understood as an explainable and evaluable result.

In this model, the holes represent the system failures; the environment elements presented in Parry's triad are latent situations that underlie the system and favor the occurrence of human error. Active errors are the elements of the triad composed of the professionals who work in the pharmacotherapeutic system; the coincidence between the active error and the underlying situation produces the incident. The model also shows the spaces and moments in which systems can and "should be shielded against these threats, building fail-safe systems." The point is to detect and solve underlying problems and organize teams to constitute filters capable of detecting and correcting potential ME throughout the pharmacotherapeutic process. This cannot be done if the healthcare team does not have sufficient knowledge and training (Escrivá Gracia, 2017).

According to Encina Contreras and Rodríguez Galán (2016), setting up a committee for the safe use of medicines is the first step towards intervention in preventing medication-related errors in healthcare systems. The committee must include the voices of all the professionals and institutional actors involved in the pharmacotherapeutic process, from the acquisition of the medication to the evolution of its effects. Its function will be establishing protocols, controls, supervisions, and evaluations; that is, ensuring the system's shielding in permanent consideration of the patient safety standard. This way of intervening in the solution of the problem requires a premise: understanding medical errors as a systemic event, "recognizing that medical errors are inherent to human nature, that is to say, that independently of the training and care of people, errors can occur in any human process" and this is the basis for resorting to a system and abandoning the exclusive basis of individual action. "This approach also means focusing the analysis of errors from the perspective that they occur because there are failures in the system (system approach) and not because of incompetence or failures of individuals (person approach), as has been the traditional approach until now." When a non-punitive patient safety culture is built, errors are accepted and learned from: they are detected, corrected, and prevented. In short, when an AE occurs, it is not the center that caused it but rather the analysis of the error to identify how and why it happened.

Pharmacovigilance and Pharmacoepidemiology

Determining who was involved in an AE is not a question of individualizing a person but instead of detecting the point where that event occurred. Patient safety standards in the healthcare system cannot be considered unless an organizational culture is built that exercises the detection and notification of ADEs. "To this end, it is necessary to create a non-punitive professional environment that rejects the idea

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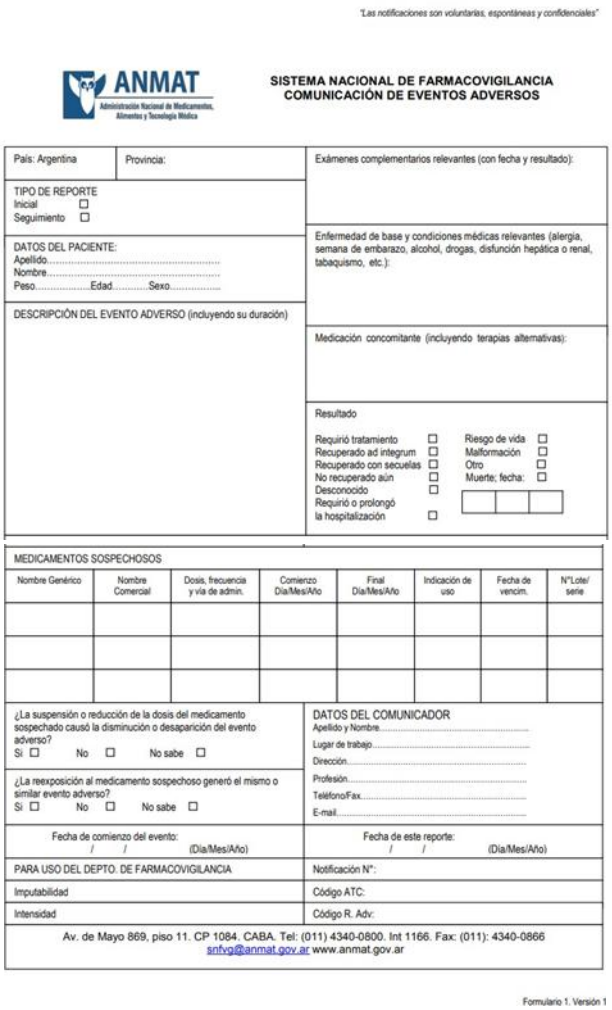
of guilt and favors the communication of errors that occur, the analysis of their causes, and the discussion of the strategies necessary to avoid them." From this concept, it is not the individual who is detected but the latent error and the need for consolidation of the system of medication use (Encina Contreras & Rodríguez Galán, 2016).

The Institute for Safe Medication Practices (ISMP) is the only non-profit organization dedicated to preventing medication errors. It has been in operation for 25 years and is known and respected as the gold standard for information on medication safety. It is estimated that it has helped to "make a difference in the lives of millions of patients and the healthcare professionals who care for them." The ISMP promotes necessary changes in clinical practice, public policy, and the labeling and packaging of medicines (ISMP, 2022). The Institute for Safe Medication Practices is the Spanish Delegation of the ISMP, which disseminates up-to-date information for permanent consultation for those services and professionals with web connectivity. On its institutional homepage, you can find information such as bulletins on the highest-risk medication errors reported for the previous period, infographics and a guide for healthcare professionals on key moments for the safe use of medicines, the updated list of names and packaging of drugs that are prone to confusion, the publication of current research papers, and updates on emerging issues such as recommendations for preventing errors with the new COVID-19 vaccines. Its various navigation tabs on the page propose specific problems and an institutional self-assessment questionnaire regarding the Safety of its Medication Use System. Institutions can access complementary information about the tool and enter the self-assessment document with a username and password; previously completed assessment guides can also be consulted. Individuals can also access the tool to consult information about the problem (Institute for the Safe Use of Medicines, 2022).

In the Argentine Republic, the National Administration of Medicines, Food and Medical Technology (ANMAT) is an agency under the Ministry of Health. It is responsible for "protecting the population by guaranteeing that health products are effective, safe, and of high quality" (Argentina.gob.ar/ANMAT, 2022). The Pharmacovigilance System, which is part of ANMAT, provides professionals and patients with a link to the website for reporting adverse events (Argentina.gob.ar/Sistema Nacional de Farmacovigilancia, 2022).

Figure 1. ANMAT Pharmacovigilance System. Adverse Event Reporting Form.



"Las notificaciones son voluntarias, espontáneas y confidenciales"

ANMAT
Administración Nacional de Medicamentos, Alimentos y Tecnología Médica

SISTEMA NACIONAL DE FARMACOVIGILANCIA
COMUNICACIÓN DE EVENTOS ADVERSOS

País: Argentina — Provincia:	Exámenes complementarios relevantes (con fecha y resultado):
TIPO DE REPORTE Inicial ☐ Seguimiento ☐	Enfermedad de base y condiciones médicas relevantes (alergia, semana de embarazo, alcohol, drogas, disfunción hepática o renal, tabaquismo, etc.):
DATOS DEL PACIENTE: Apellido..... Nombre..... Peso.....Edad.....Sexo.....	Medicación concomitante (incluyendo terapias alternativas):
DESCRIPCIÓN DEL EVENTO ADVERSO (incluyendo su duración)	Resultado Requirió tratamiento ☐ Riesgo de vida ☐ Recuperado ad integrum ☐ Malformación ☐ Recuperado con secuelas ☐ Otro ☐ No recuperado aún ☐ Muerte; fecha: ☐ Desconocido ☐ Requirió o prolongó la hospitalización ☐

MEDICAMENTOS SOSPECHOSOS

Nombre Genérico	Nombre Comercial	Dosis, frecuencia y vía de admin.	Comienzo Día/Mes/Año	Final Día/Mes/Año	Indicación de uso	Fecha de vencim.	N°Lote/ serie

¿La suspensión o reducción de la dosis del medicamento sospechado causó la disminución o desaparición del evento adverso? Si ☐ No ☐ No sabe ☐	DATOS DEL COMUNICADOR Apellido y Nombre..... Lugar de trabajo..... Dirección..... Profesión..... Teléfono/Fax..... E-mail.....
¿La reexposición al medicamento sospechoso generó el mismo o similar evento adverso? Si ☐ No ☐ No sabe ☐	
Fecha de comienzo del evento: / / (Día/Mes/Año)	Fecha de este reporte: / / (Día/Mes/Año)
PARA USO DEL DEPTO. DE FARMACOVIGILANCIA	Notificación N°:
Imputabilidad	Código ATC:
Intensidad	Código R. Adv:

Av. de Mayo 869, piso 11. CP 1084. CABA. Tel: (011) 4340-0800. Int 1166. Fax: (011): 4340-0866
snfvg@anmat.gov.ar www.anmat.gov.ar

Formulario 1. Versión 1

Source: National Administration of Drugs, Food and Medical Technology (2022). Adverse event reporting form.

Pharmacological training and competence in nursing

Pharmacology has been presented as both a basic science and an applied science. It finds its purpose when knowledge allows practical problems to be solved, in this case, the problems of professional nursing practice. Nurses must be trained to possess this knowledge—as a basic science—and to be able to apply it to problem solving—as an applied science.

The word competence - from the Latin competent - has meanings such as ability, skill, and aptitude, and there is debate among experts as to whether to accept a single definition. Perhaps the most representative is "a set of knowledge, qualities, and behaviors brought into play to resolve specific work situations." In this author's proposal, it can be inferred that the sphere of knowledge of basic science is exceeded in raising the need for a domain that includes the integration of knowledge, skills, and attitudes that allow for the resolution of situations arising from the area of medication problems in the professional practice of Nursing (Vera Carrasco, 2014).

Therefore, pharmacological competence in nursing integrates knowledge, skills, and attitudes to resolve medication-related problems in specific situations in professional practice. Now, Bunk (1994) makes explicit the idea that - if we consider that a competent professional is someone who possesses the knowledge, abilities, skills, attitudes, and values needed to fulfill their role - it can be said: "that a

person's professional competencies are made up of a combination of values and beliefs (knowing how to be), knowledge (knowing or knowing how to know), skills (knowing how to do) and attitudes (knowing how to be).”

This opening by Bunk introduces a fundamental element that leads Tobón Tobón - a current reference in competency-based training - to state that competency building seeks to develop people's full potential to "act with competence and ethics" in the face of problems, with a high impact on social problems (Aldana de Becerra and Ruiz 2010). Incorporating Tobón Tobón's ethical concept is fundamental because it expands the concept of domain, expertise, or skill, and it is no longer enough to have expertise or even expertise. Suitable and ethical professional competence constitutes a distinct, high, and pertinent standard.

An important and valuable distinction is to classify competencies as specific or cross-disciplinary. Specific competencies distinguish a profession and correspond exclusively to it, while cross-disciplinary competencies are shared by two or more professions (Bunk, 1994).

The specific competencies of the different disciplines that make up the health team are specified in the Professional Practice Law of each one and Article 43 of the Higher Education Law, which establishes the need to determine activities reserved for the degree of those careers included therein. It is common knowledge and practice that the prescription of active ingredients is a specific competence of Medicine. In contrast, pharmacological competence is a transversal competence of several disciplines, such as Medicine, Nursing, Pharmacy, and Veterinary Medicine, among others.

The Resolution of the Ministry of Education of Argentina -ME 2721/2015- approves the activities reserved for the Bachelor's Degree in Nursing and determines its scope (Argentina Presidency/Official Gazette, 2022):

1. Define, establish, and participate in policies of care, administration, education, and research in their professional practice.
2. Manage hospital health services at different levels of complexity and community services, making decisions in any areas of their professional performance based on their capacity for observation, reflective analysis, and critical judgment.
3. Plan, organize, coordinate, develop, and evaluate nursing education programs at the different levels and modalities provided for by current legislation for the sector.
4. Promote and participate in research in the field of health.
5. Integrate competent national and international organizations related to developing health professionals.

Law 24004 on the Professional Practice of Nursing states in Article 2 that "the practice of nursing includes the functions of health promotion, recovery, and rehabilitation, as well as the prevention of disease, carried out autonomously within the limits of competence derived from the responsibilities of the respective qualifications. Likewise, the nursing practice shall include teaching, research, and advice on matters within its competence and the administration of services when carried out by persons authorized by this law to practice nursing. It is pertinent to add the wording of the third article that legislates for the professional level (undergraduate and degree) "the application of a systematic body of knowledge for the identification and resolution of health-disease situations within the scope of their competence" and in the article 10 -section e- "maintaining professional suitability through permanent updating" (Argentina Honorable Congreso de la Nación (2022).

The discussion of the workload for learning Pharmacology and the pedagogical approach to conducting training by achieving objectives or training by competencies is an attribute of higher education. Minimum and standardized competencies in nursing must be established at the individual level as institutions build their systems to use medicines.

The 10 rights in medication administration are standards proposed worldwide by the WHO on March 29, 2017, as a proposal to halve serious and preventable medication-related harm in all countries in the

next 5 years. The proposal covers different phases in the medication use system and includes respecting a series of steps to improve patient safety during an adverse event. These fundamental competencies are (Aimacaña Guayta, 2019):

1. Correct medication: This consists of verifying that the medication to be administered is the one that has been prescribed, that it is not past its expiry date and that it is not in the patient's allergy history.

2. Correct patient: This involves verifying the patient's identity—the name on the armband, the bed number, and verbal identification if the patient is conscious.

3. Correct dose: This is to check the pharmacological dose present with the dose about to be administered.

4. Correct time: Many drugs' therapeutic blood concentrations depend on the administration times' regularity.

5. Reconstitution and dilution: The drug is prepared using an aseptic technique, and the stability of the resulting compound is checked.

6. Correct route of administration: Medicines have specific indications according to their presentation and composition (tablets, pills, ampoules, ointments, etc.). There are medications for parenteral or enteral use, and the choice may depend on the effect to be achieved in a given period of time since pharmacokinetics change in relation to each route of administration.

7. Information for the patient: The patient has the right to know what medication is being administered, how it is to be used, and what the side effects are. This enables them to collaborate in evaluating the medication's effects.

8. Speed of administration: The speed of administration—especially the parenteral route—requires a set time that must be strictly adhered to. Related desired effects include the administration of boluses in a short period of time and continuous infusions. The calculation of drips per minute is much more precise in Intensive Care Units, where infusion pumps allow for exact doses.

9. Recording: The medication administration must be recorded in the institutionally designated instruments to ensure the information is shared with the rest of the team.

10. Observation and evaluation of the response: It is vital to monitor the response to the medication administered, to evaluate and record all the information that allows us to know the effects produced.

CONCLUSIONS

Pharmacology plays a crucial role in healthcare, providing the scientific and practical basis for the safe and effective use of medicines. Its historical evolution, from rudimentary practices to becoming a complex discipline, has been essential for the development of modern medicine. In this context, advances in pharmacodynamics and pharmacokinetics have allowed for a better understanding of the mechanisms of action and metabolism of drugs and the establishment of standards for their correct administration, contributing significantly to patient safety.

In Intensive Care Units (ICUs), where patients are subjected to complex pharmacological treatments, the adequate pharmacological competence of nursing staff becomes a determining factor in preventing medication errors (MEs). These errors, which can range from incorrect dosage to the administration of medication to the wrong patients, represent one of the leading causes of preventable adverse events in healthcare systems. As the WHO points out, these incidents compromise the quality of care and significantly impact morbidity, mortality, and hospital costs.

The medication problem understood as a systemic phenomenon, must be addressed from an interdisciplinary approach that integrates scientific knowledge, practical skills, and ethical attitudes at all levels of the pharmacotherapeutic process. Implementing tools such as Reason's model and Parry's triad have proven effective in identifying and mitigating the underlying failures in medication use

systems. Likewise, pharmacovigilance and pharmacoepidemiology are essential for monitoring the impact of medications on populations and guaranteeing their safe use.

In this sense, the "10 rights" proposed by the WHO represent a fundamental guide to reducing the risks associated with medication administration. Correct patient identification, compliance with doses, schedules, routes of administration, and constant evaluation of therapeutic responses are essential skills that nursing staff must master. However, recent studies have revealed deficiencies in nurses' pharmacological training, which underlines the need to reinforce initial education and continuous training in this area.

Finally, it is concluded that creating a non-punitive organizational culture oriented towards learning and continuous improvement is indispensable for effectively addressing medication errors. This implies strengthening the pharmacological competencies of healthcare personnel and implementing standardized systems and protocols that promote patient safety as a priority objective. The integration of ethical and technical approaches in nursing training and practice is key to guaranteeing quality care in highly complex environments such as ICUs.

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CONFLICT OF INTEREST

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