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Pharmacology and pharmacotherapy of antimicrobials

Dhiego Alves de Lacerda[1]
Larissa Luana Lopes Lima[1]
Pedro Fechine Honorato[1]
Renata Braga Vale[1]
Diego Formiga das Neves[1]
Claudenor Pinho de Sá Filho[1]
Thiago Quirino de Moura[1]
Vinícius Costa Figueiredo[1]
Anaylle Vieira Lacerda de Oliveira[1]
Ubiraídys de Andrade Isidório[2]

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1 INTRODUCTION

The history of medicine has witnessed a remarkable breakthrough with the discovery and development of antimicrobials, a group of essential drugs for the treatment of bacterial, fungal, viral and parasitic infections. From early antibiotics to modern antiviral and antifungal agents, these drugs have played a crucial role in reducing morbidity and mortality associated with infectious diseases. According to Goodman & Gilman (2021), "antimicrobials represent one of the most significant milestones in the history of medicine, radically transforming the treatment of previously fatal infections." Rang et al. (2019) corroborate, emphasizing that "the discovery and clinical use of antimicrobials are testaments to the ability of pharmaceutical science to positively impact global health."

The efficacy of antimicrobials lies in their ability to target specific targets in pathogenic microorganisms, blocking processes essential to their survival and replication. Katzung (2018) explains that "the mechanisms of action of antimicrobials vary according to the drug class, including inhibition of cell wall synthesis, interference with DNA replication, and blockade of bacterial protein synthesis." These precise modes of action not only fight infections but also minimize damage to host cells, resulting in a selective and relatively safe therapy.

However, the indiscriminate and inappropriate use of antimicrobials has generated growing global concern due to the development of antimicrobial resistance. This phenomenon, as highlighted by Souza (2020), "is a significant threat to the efficacy of treatments, becoming one of the greatest challenges faced by contemporary public health". Antimicrobial resistance occurs when microorganisms adapt to antimicrobials, becoming desensitized to the effects of available drugs.

[1] Undergraduate student in Medicine, UNIFSM, Cajazeiras, PB.
[2] Graduated in Physical Therapy, Centro Universitário de João Pessoa, João Pessoa, PB

Goodman & Gilman (2021) warn that "bacterial resistance is a clear example of biological evolution in action, requiring urgent action to preserve the therapeutic arsenal."

Faced with this complex scenario, the clinical application of antimicrobials requires a multifaceted approach, ranging from the judicious choice of drug based on microbiological susceptibility to strategies to prevent and control resistance. Lima et al. (2021) highlight that "antimicrobial pharmacotherapy should be individually adapted to each patient, considering factors such as age, comorbidities, and history of exposure to antimicrobials". Integration of up-to-date clinical guidelines and epidemiological surveillance are critical to ensure the continued efficacy of these vital medicines.

This work aims to explore in detail the main classes of antimicrobials, their mechanisms of action, pharmacokinetics, pharmacodynamics, and clinical implications, using an evidence-based approach and critical analysis of the main works of modern pharmacology, as described by Rang et al. (2019), Goodman & Gilman (2021), Katzung (2018), and other authors specialized in the field. In-depth understanding of these concepts not only enriches theoretical knowledge but also empowers healthcare professionals to make informed and effective therapeutic choices, contributing to evidence-based clinical practice and the preservation of antimicrobial efficacy in the global public health context.

2 METHODOLOGY

The methodology of this work is based on a detailed literature review of the main works of pharmacology, focusing on the renowned books "Rang & Dale Pharmacology" (Rang et al., 2019), "Goodman & Gilman The Pharmacological Bases of Therapeutics" (Goodman & Gilman, 2021), and "Basic and Clinical Pharmacology" (Katzung, 2018), in addition to other specialized sources. The approach adopted involved the systematic search of chapters related to antimicrobials, with emphasis on the following aspects: Investigation of the main classes of antimicrobials, their specific mechanisms of action and associated clinical implications, such as classification and mechanisms of action of antimicrobials. The impact of antimicrobials on contemporary clinical practice was analyzed, considering regulatory guidelines, scientific evidence, and strategies for the rational use of these therapeutic agents. In addition, pharmacokinetic characteristics of antimicrobials, including absorption, distribution, metabolism and excretion, were addressed, in addition to considering pharmacodynamic parameters that influence therapeutic efficacy. The mechanisms of antimicrobial resistance developed by microorganisms in response to the use of antimicrobials were also studied, with a focus on prevention and control strategies.

The research was conducted by consulting scientific databases such as PubMed, ScienceDirect and Scopus, using keywords such as "antimicrobial pharmacology", "mechanism of action",

"pharmacokinetics", "pharmacodynamics", "antimicrobial resistance", among other relevant keywords.

A careful selection of bibliographic references was carried out to ensure the inclusion of up-to-date and pertinent studies in the area of antimicrobial pharmacology.

3 DEVELOPMENT

Antimicrobials are classified according to their specific spectrum and mechanisms of action, and are essential in contemporary antimicrobial therapy. The main classes include beta-lactams, such as penicillins (penicillin G, amoxicillin, penicillin V) and cephalosporins (cephalexin, ceftriaxone, cefepime), which inhibit bacterial cell wall synthesis (Rang et al., 2019; Goodman & Gilman, 2021). Carbapenems, such as imipenem, meropenem, and ertapenem, are potent inhibitors used against serious infections (Katzung, 2018).

Aminoglycosides, such as gentamycin, amicacin, and tobramycin, interfere in bacterial protein synthesis by ligarem themselves to ribossomo (Goodman & Gilman, 2021). Tetracyclines such as tetracycline, doxycycline, and minocycline, atuam similarly, inibinating bacterial protein synthesis (Rang et al., 2019). Quinolones such as ciprofloxacin, levofloxacin, and moxifloxacin, inibem the replication of bacterial DNA (Katzung, 2018).

Macrolids (erythromycin, azithromycin, clarithromycin) inibem bacterial protein synthesis (Goodman & Gilman, 2021). Glycopeptids such as vancomycin and teicoplanin inibem the synthesis of the bacterial cell wall (Rang et al., 2019). Sulfonamides and trimethoprim (co-trimoxazole) interfere in the synthesis of bacterial folic acid, while Azóis (fluconazole, itraconazole, voriconazole) and Equinocandins (caspofungin, micafungin, anidulafungine) inibem the synthesis of essential components of fungal cell walls (Goodman & Gilman, 2021; Katzung, 2018).

Antivirals, such as reverse transcriptase inhibitors (zidovudine, lamivudine, efavirenz) and protease inhibitors (ritonavir, lopinavir, atazanavir), play a crucial role in the treatment of viral infections by interfering with viral replication processes (Rang et al., 2019; Goodman & Gilman, 2021).

Antiparasitics such as antimalarials (chloroquine, artemisinin, mefloquine) and antiprotozoa (metronidazole, tinidazole) are also fundamental, acting on specific mechanisms to combat parasites (Katzung, 2018; Goodman & Gilman, 2021).

4 PHARMACOKINETICS AND PHARMACODYNAMICS

The pharmacokinetics of antimicrobials involve the absorption, distribution, metabolism and excretion of drugs. Each class of antimicrobial has unique pharmacokinetic characteristics that influence its administration and dosage. For example, penicillins and cephalosporins are often

administered intravenously to ensure adequate therapeutic concentrations at the site of infection (Rang et al., 2019).

Pharmacodynamics, on the other hand, refers to the biochemical and physiological effects of drugs on pathogenic microorganisms and the underlying mechanisms of action. Goodman & Gilman (2021) highlight that understanding dose-response relationships and pharmacodynamic parameters, such as minimum inhibitory concentration (MIC) and minimum bactericidal concentration (MBC), is crucial to optimize therapeutic efficacy and minimize resistance.

5 ANTIMICROBIAL RESISTANCE

Antimicrobial resistance poses a significant challenge to modern clinical practice. Microorganisms develop resistance through various strategies, including genetic mutations and acquisition of resistance genes through plasmids. Souza (2020) observes that the indiscriminate use of antimicrobials directly contributes to the increase in bacterial resistance, making rational use strategies and continuous surveillance necessary.

6 CONCLUSION

Antimicrobial pharmacology and pharmacotherapy are fundamental to contemporary medical practice, offering essential therapeutic solutions in the fight against infections. It is crucial that health professionals are up-to-date with the latest regulatory guidelines and scientific evidence, such as those outlined by renowned authors and regulations such as ANVISA (2017), to ensure the safe and effective use of these therapeutic agents. Effective antimicrobial resistance control strategies are needed to preserve the efficacy of antimicrobials and ensure better clinical outcomes for patients.

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