Journal of Ecohumanism
2024
Volume: 3, No: 8, pp. 9328 – 9336
ISSN: 2752-6798 (Print) | ISSN 2752-6801 (Online)
https://ecohumanism.co.uk/joe/ecohumanism
DOI: https://doi.org/10.62754/joe.v3i8.5546

Ciprofloxacin: An Overview of Uses, Mechanism of Action, and Adverse Effects

Bader Awadh A Almutairi[1], Amjad Abdullrahman Almotawa[2], Masaad Awadh Mawadh Almutairi[3], Ranya Salem Baabbad[4], Alzahrani Ali Abdullah S[5], Hassan Shabi K Alagedi[6], Ebtisam Ali Hassan Aljaizani[7], Mohammed Ali Alahmar[8], Fatimah Ali Ahmad Shabi[9], Shaden Abdullah Alharbi[10], Ibrahim Suliman Ali Alaboudi[11], Ahmed Abdullah Kaabi[12], Alghamdi, Abdullah Saleh A[13]

Abstract

Ciprofloxacin, a fluoroquinolone antibiotic patented in 1983 and FDA-approved in 1987, is widely used for bacterial infections. It treats urinary tract infections (UTIs), pneumonia, and more, including off-label uses like Crohn's disease and cancer cell suppression.To provide an overview of ciprofloxacin's uses, mechanism of action, pharmacokinetics, administration, and associated adverse effects.A comprehensive review of literature and guidelines examined ciprofloxacin's therapeutic applications, effectiveness, resistance patterns, and patient-specific considerations.Ciprofloxacin demonstrates a broad antimicrobial spectrum, primarily by inhibiting DNA replication via DNA gyrase and topoisomerase. It exhibits high tissue penetration, reaching therapeutic levels in various fluids and tissues, including CSF under inflammation. Resistance mechanisms include DNA gyrase mutations and efflux pump activity, limiting efficacy in some settings. Ciprofloxacin is effective in oral, intravenous, and topical formulations, with renal excretion as the primary elimination pathway. However, adverse effects like tendonitis, QT prolongation, neuropsychiatric events, and rare severe dermatological reactions are reported. Use in neonates, pregnancy, and breastfeeding is restricted to specific indications.Ciprofloxacin remains a valuable antimicrobial agent despite resistance concerns and adverse effects. Its targeted use based on infection severity, patient comorbidities, and resistance patterns ensures optimized outcomes. Further research into resistance mitigation and alternative therapies is critical to preserve its efficacy.

Keywords: *Ciprofloxacin, Fluoroquinolone, Bacterial Infections, DNA Gyrase, Resistance, Pharmacokinetics, Adverse Effects.*

Introduction

Ciprofloxacin, a member of the fluoroquinolone class of antibiotics, was patented in 1983 by Bayer A.G. and subsequently approved by the United States Food and Drug Administration (USFDA) in 1987 [1]. This pharmacological agent is widely utilized to treat various bacterial infections, including urinary tract infections (UTIs) and pneumonia [2][3]. Ciprofloxacin has received FDA approval for the treatment of a broad spectrum of conditions such as sexually transmitted infections (e.g., gonorrhea and chancroid), skin and soft tissue infections, bone and joint infections, prostatitis, pneumonia, typhoid fever, gastrointestinal infections, lower respiratory tract infections, inhalation anthrax (as post-exposure prophylaxis), plague, and

[1] KSA, Ministry of Health
[2] KSA, Ministry of Health.
[3] KSA, Ministry of Health.
[4] KSA, Ministry of Health.
[5] KSA, Ministry of Health
[6] KSA, Ministry of Health
[7] KSA, Ministry of Health
[8] KSA, Ministry of Health
[9] KSA, Ministry of Health
[10] KSA, Ministry of Health
[11] KSA, Ministry of Health
[12] KSA, Ministry of Health
[13] KSA, Ministry of Health

Journal of Ecohumanism
2024
Volume: 3, No: 8, pp. 9328 – 9336
ISSN: 2752-6798 (Print) | ISSN 2752-6801 (Online)
https://ecohumanism.co.uk/joe/ecohumanism
DOI: https://doi.org/10.62754/joe.v3i8.5546

salmonellosis. Additionally, it is effective in managing acute bacterial exacerbations of chronic bronchitis [4][5][6]. Despite its extensive applications, resistance patterns, notably in *Neisseria gonorrhea*, limit its empirical use in specific cases [6].

Ciprofloxacin is unsuitable as a first-line treatment for respiratory infections where *Streptococcus pneumoniae* is identified as the primary pathogen, given the organism's susceptibility to penicillin. However, it remains an effective option for patients with mixed bacterial infections or those predisposed to Gram-negative infections. Guidelines from the American Academy of Family Physicians endorse ciprofloxacin for acute bacterial prostatitis [7], while chronic bacterial prostatitis requires prolonged therapy spanning approximately four weeks [8]. Moreover, ciprofloxacin is employed off-label for managing Crohn's disease with perianal fistula complications [9]. In ophthalmology, ciprofloxacin ophthalmic solutions are approved for treating corneal ulcers and conjunctivitis caused by susceptible bacterial strains [10][11]. Its otic formulations are authorized for acute otitis externa due to *Pseudomonas aeruginosa* or *Staphylococcus aureus*, while pediatric otitis media with effusion is addressed with ciprofloxacin suspension gel [12][13]. Though not officially indicated for neonates, ciprofloxacin serves as salvage therapy for life-threatening sepsis caused by multidrug-resistant pathogens, particularly in Europe and developing nations. Evidence from observational studies and case reports highlights positive clinical responses and minimal adverse events, including negligible joint toxicity, in neonates [14]. Beyond its antimicrobial utility, ciprofloxacin exhibits apoptotic and antiproliferative effects in several cancer cell lines, including carcinoma, osteosarcoma, and leukemia, mediated through dose- and time-dependent mechanisms [1][15]. Studies have also shown its promise in managing bladder cancer through inhibition of transitional cell carcinoma growth in vitro, although further clinical investigations are warranted [16].

Mechanism of Action

Ciprofloxacin belongs to the fluoroquinolone class of bactericidal antibiotics. It exerts its antimicrobial effects by inhibiting bacterial DNA replication, targeting essential enzymes such as DNA topoisomerase and DNA gyrase. This mechanism is particularly effective against Gram-negative bacilli, including members of the *Enterobacteriaceae* family such as *Escherichia coli*, *Salmonella spp.*, *Shigella spp.*, and *Neisseria spp.* [17]. Additionally, ciprofloxacin demonstrates efficacy against specific Gram-positive bacteria. Among fluoroquinolones, ciprofloxacin is the most potent against *Pseudomonas aeruginosa*, a feature that distinguishes it within this drug class [18]. However, reduced susceptibility to ciprofloxacin among *P. aeruginosa* has been reported, particularly in healthcare settings such as hospitals and nursing homes, where risk factors are prevalent [19]. Resistance mechanisms to ciprofloxacin include mutations in DNA gyrase, plasmid-mediated resistance, and efflux pump activity. For *Escherichia coli*, resistance typically involves alterations in the GyrA subunit of DNA gyrase [20][21]. Despite these challenges, ciprofloxacin remains a cost-effective alternative to traditional parenteral regimens in specific clinical scenarios when used appropriately. However, resistance trends, particularly in hospital-acquired *E. coli* urinary tract infections, necessitate careful evaluation of ciprofloxacin as an empirical therapy on a case-by-case basis [22].

Pharmacokinetics

Ciprofloxacin is rapidly absorbed following oral administration, although its absorption is incomplete. The bioavailability of orally administered ciprofloxacin ranges between 70% and 80%, with peak plasma concentrations (Tmax) occurring within 1 to 1.5 hours. However, co-administration with dairy products or calcium-fortified juices can significantly impair its absorption, necessitating dietary precautions during therapy [23]. The drug exhibits a high volume of distribution (2 to 3 L/kg) and is extensively distributed throughout body tissues after oral administration. Tissue concentrations frequently surpass plasma concentrations, ensuring therapeutic levels in saliva, bronchial secretions, lymph, bile, prostate, and urine. Although ciprofloxacin's cerebrospinal fluid (CSF) concentrations are typically lower than plasma levels, active meningeal inflammation can enhance CSF penetration. Furthermore, topically applied ciprofloxacin achieves measurable concentrations in the aqueous humor of the eye, making it effective for ophthalmic applications [24][25][26][27][28]. Ciprofloxacin acts as an inhibitor of cytochrome P450 1A2 (CYP1A2), potentially increasing plasma concentrations of co-administered drugs metabolized by this pathway. This interaction necessitates caution to avoid toxicity [29]. The elimination half-life of ciprofloxacin is

Journal of Ecohumanism
2024
Volume: 3, No: 8, pp. 9328 – 9336
ISSN: 2752-6798 (Print) | ISSN 2752-6801 (Online)
https://ecohumanism.co.uk/joe/ecohumanism
DOI: https://doi.org/10.62754/joe.v3i8.5546

approximately four hours. Renal excretion is the primary elimination route, with 40% to 50% of the drug excreted unchanged in urine. The renal clearance rate (approximately 300 mL/min) exceeds the glomerular filtration rate, indicating active tubular secretion. Additionally, 20% to 35% of orally administered ciprofloxacin is recovered in feces, reflecting significant biliary and transintestinal elimination pathways [30].

Administration

Ciprofloxacin is a versatile antibiotic available in various formulations, including oral, intravenous, ophthalmic, and otic preparations. The standard oral dosage involves twice-daily administration for a period ranging from 7 to 14 days or continuing for at least two days after infection symptoms have resolved. The recommended regimen for mild to moderate urinary tract infections (UTIs) is 250 mg administered twice daily, while severe or complicated cases necessitate a dosage of 500 mg twice daily. For respiratory tract or soft-tissue infections, mild to moderate cases require a 500 mg dose administered twice daily, whereas severe conditions demand 750 mg twice daily. To reduce gastrointestinal discomfort, ciprofloxacin should ideally be taken with food. Intravenous administration is prescribed at 200 to 400 mg twice daily for mild to moderate infections, escalating to 400 mg every eight hours for severe, life-threatening conditions [31]. A dose reduction of 50% is recommended in patients with severe renal impairment (creatinine clearance = 1.2 L/hour). Intravenous administration involves a slow infusion over 60 minutes to ensure optimal safety and efficacy. Adequate hydration and urine output are critical during therapy, and the simultaneous use of antacids should be avoided. Ciprofloxacin should be taken at least two hours before or six hours after antacid use for both immediate-release and extended-release formulations. The oral suspension is contraindicated for administration through feeding tubes due to its propensity to adhere to tubing surfaces. Otic formulations of ciprofloxacin have proven to be a safe and effective therapeutic option for treating chronic otitis media, with superior tolerability and targeted efficacy compared to oral ciprofloxacin tablets [32]. The appropriate selection of formulation and route of administration is contingent on the severity of the infection and patient-specific factors such as renal and hepatic function.

Specific Patient Populations

Hepatic Impairment: In patients with liver cirrhosis, ciprofloxacin's pharmacokinetics remain largely unchanged. However, limited research exists on its pharmacokinetics in patients with acute hepatic insufficiency. Notably, ciprofloxacin has a potential risk of hepatotoxicity, necessitating cautious use in individuals with compromised liver function [33].

Renal Impairment: As ciprofloxacin undergoes primary elimination via renal pathways, dosage adjustments are essential in patients with reduced renal function. For patients with a creatinine clearance exceeding 50 mL/min/1.73m², no dose modification is required. Those with creatinine clearance values between 30-49 mL/min/1.73m² should receive 250 to 500 mg every 12 hours, while individuals with clearance values between 5-29 mL/min/1.73m² are advised to take 250 to 500 mg every 18 hours. Hemodialysis and peritoneal dialysis patients require a dosage of 250 to 500 mg every 24 hours, administered post-dialysis. For sepsis patients undergoing continuous renal replacement therapy (CRRT), a dose of 200 to 400 mg every 8 to 12 hours is recommended [34].

Pregnancy Considerations: Ciprofloxacin and other fluoroquinolones are traditionally contraindicated during pregnancy due to concerns regarding cartilage and bone damage. However, current evidence does not indicate a significant risk of congenital disabilities, adverse pregnancy outcomes, or miscarriages associated with ciprofloxacin use [35][36]. It may be considered during early pregnancy in cases of antimicrobial resistance or intolerance to first-line antibiotics, with restricted use for severe indications such as inhalation anthrax or refractory Crohn's disease with perianal involvement. In these scenarios, ciprofloxacin is recommended only under compelling circumstances, such as when alternative therapies are ineffective [37].

Breastfeeding Considerations: While ciprofloxacin use during lactation has been discouraged due to potential adverse effects on joint development, limited absorption of fluoroquinolones in breast milk mitigates this concern. Ciprofloxacin may be safely used by nursing mothers for critical indications, with

Journal of Ecohumanism
2024
Volume: 3, No: 8, pp. 9328 – 9336
ISSN: 2752-6798 (Print) | ISSN 2752-6801 (Online)
https://ecohumanism.co.uk/joe/ecohumanism
DOI: https://doi.org/10.62754/joe.v3i8.5546

vigilant monitoring of the infant for possible adverse reactions such as diarrhea or candidiasis. To further reduce exposure, nursing mothers may consider withholding breastfeeding for 3 to 4 hours post-dosage [38].

Adverse Effects

Ciprofloxacin is generally well-tolerated at therapeutic doses, with the majority of adverse reactions confined to mild gastrointestinal disturbances, including nausea and diarrhea. However, serious adverse events are well-documented, including QT interval prolongation, dysglycemia, and photosensitivity [39]. Rare but significant dermatological reactions, such as drug-induced bullous pemphigoid, have also been reported [40]. The FDA has issued boxed warnings highlighting risks of tendinitis, tendon rupture, peripheral neuropathy, neuropsychiatric events, and exacerbation of myasthenia gravis. Tendon injuries primarily involve the Achilles tendon but have also been observed in other tendons, including gluteal and triceps tendons. Risk factors for tendinopathy include corticosteroid use and advanced age, with a potential mechanism involving the upregulation of matrix metalloproteinases leading to collagen degradation [41][42][43]. Peripheral neuropathy risk correlates with cumulative fluoroquinolone doses, evidenced by small fiber nerve damage detectable via biopsy [44]. Neuropsychiatric adverse events include agitation, hallucinations, tremors, psychosis, and seizures [45]. Fluoroquinolones, including ciprofloxacin, have been linked to aortic aneurysm and dissection, with prolonged therapy and advanced age identified as risk factors. Discontinuation of ciprofloxacin is advised upon suspicion of aortic dissection [46].

Contraindications

Ciprofloxacin is strictly contraindicated in individuals with a known hypersensitivity to the drug or any of its components, as severe allergic reactions, including life-threatening anaphylaxis, have been reported even after initial doses [47][48]. Due to its inhibitory effect on cytochrome P450 1A2 (CYP1A2), ciprofloxacin should not be co-administered with tizanidine. This interaction significantly increases tizanidine levels in the bloodstream, leading to severe adverse effects such as psychomotor impairment, marked hypotension, and bradycardia, which can pose serious risks to patient safety [31][49]. Additionally, ciprofloxacin and other fluoroquinolones are contraindicated in patients with myasthenia gravis. This is due to their potential to aggravate the underlying condition by further weakening skeletal muscles, which could result in life-threatening complications such as respiratory failure. Clinicians must exercise caution and thoroughly evaluate the patient's medical history to identify these contraindications before prescribing ciprofloxacin. The safety profile of the drug requires meticulous patient selection and monitoring to prevent severe adverse effects and ensure optimal therapeutic outcomes.

Monitoring

Clinicians must vigilantly monitor patients on ciprofloxacin therapy for several potential complications. This includes observing for signs of tendinitis and altered mental status, as well as conducting routine assessments of complete blood count (CBC), and renal and hepatic functions, particularly in cases requiring prolonged treatment. Ciprofloxacin interacts with various medications, notably theophylline, especially when combined with caffeine, as it inhibits CYP1A2, resulting in increased theophylline levels [31]. Additionally, it has been reported to elevate cyclosporine serum levels, necessitating close monitoring in patients prescribed both agents. The co-administration of antacids containing aluminum or magnesium significantly reduces ciprofloxacin's oral bioavailability, emphasizing the need for timing adjustments. Patients should also be monitored for Clostridioides difficile-associated diarrhea, a potential adverse effect linked to ciprofloxacin [50]. Another critical aspect of monitoring involves serum glucose levels, especially in diabetic patients undergoing insulin therapy, as dysglycemia is a recognized adverse reaction of fluoroquinolones, including ciprofloxacin [47][51][52]. Maintaining vigilant surveillance for these interactions and adverse effects is essential to optimize therapeutic outcomes and minimize risks associated with ciprofloxacin therapy.

Journal of Ecohumanism
2024
Volume: 3, No: 8, pp. 9328 – 9336
ISSN: 2752-6798 (Print) | ISSN 2752-6801 (Online)
https://ecohumanism.co.uk/joe/ecohumanism
DOI: https://doi.org/10.62754/joe.v3i8.5546

Toxicity

Ciprofloxacin's elimination half-life ranges between 3.3 to 6.8 hours in elderly patients compared to three to four hours in younger adults, demonstrating an age-related variation in its pharmacokinetics [53]. Although limited data exists, the excretion of ciprofloxacin in breast milk has been observed to be minimal [54]. Clinical evidence suggests no significant osteoarticular toxicity in neonates or children, even when exposed to higher doses in clinical studies compared to the minimal exposure through breastfeeding [14]. However, instances of acute kidney injury following ciprofloxacin overdose have been documented. Currently, no specific antidote is available for such overdoses. Administering magnesium or calcium-containing antacids may help mitigate oral absorption of ciprofloxacin in overdose scenarios. In cases of ciprofloxacin-induced nephrotoxicity, intermittent hemodialysis can be considered as a supportive measure [55][56]. Healthcare providers must remain vigilant in recognizing toxicity symptoms early and implementing appropriate interventions to ensure patient safety.

Photosensitivity of Ciprofloxacin

Ciprofloxacin, a widely used fluoroquinolone antibiotic, is associated with photosensitivity as a notable adverse effect. Photosensitivity occurs due to the drug's ability to absorb ultraviolet (UV) light, leading to the generation of reactive oxygen species (ROS) that can cause cellular damage in the skin upon exposure to sunlight or artificial UV radiation. This reaction typically manifests as phototoxicity, characterized by erythema, edema, and blistering in sun-exposed areas, resembling an exaggerated sunburn. In rare cases, photoallergic reactions, which involve delayed hypersensitivity mediated by the immune system, may also occur. The phototoxic effects of ciprofloxacin are dose-dependent and influenced by factors such as the intensity of UV exposure and individual patient susceptibility. Research indicates that UVA light plays a significant role in ciprofloxacin-induced phototoxicity, as the drug's molecular structure facilitates absorption in this wavelength range. The clinical presentation of photosensitivity may vary from mild skin irritation to severe dermatological damage, requiring prompt medical intervention. Preventive measures are crucial for minimizing the risk of photosensitivity in patients taking ciprofloxacin. Patients should be advised to avoid prolonged exposure to sunlight and artificial UV sources, such as tanning beds, during treatment. The use of broad-spectrum sunscreens with a high sun protection factor (SPF) and protective clothing can further reduce the likelihood of adverse skin reactions. Healthcare providers should educate patients about this potential side effect, especially those with a history of photosensitivity or extensive sun exposure. Early recognition of symptoms and discontinuation of ciprofloxacin when necessary are essential to prevent complications. In cases of severe phototoxicity, supportive care, including the use of topical corticosteroids and emollients, may be required to manage symptoms effectively. The phototoxic potential of ciprofloxacin underscores the importance of patient education and monitoring in clinical practice.

Enhancing Healthcare Team Outcomes

Ciprofloxacin has proven to be a cost-effective alternative to traditional parenteral antimicrobial regimens in appropriately selected clinical cases. Nonetheless, increasing ciprofloxacin resistance, particularly in E. coli-associated urinary tract infections, has been noted, with higher resistance rates observed in hospital settings compared to the community [22]. Therefore, its use as empiric therapy requires careful evaluation tailored to individual cases. Ciprofloxacin is widely prescribed and generally well-tolerated, but its optimal utilization demands a coordinated, interprofessional healthcare approach. Clinicians must consider pharmacokinetic alterations in patients with renal or hepatic dysfunction and order relevant diagnostic tests during prolonged therapy. Pharmacists play a pivotal role in reviewing antibiograms, verifying appropriate dosing, and determining the duration of treatment. Nurses are essential in counseling patients, monitoring compliance, assessing therapeutic effectiveness, and promptly reporting concerns to prescribers. Effective ciprofloxacin therapy necessitates collaboration among infectious disease specialists, physicians, pharmacists, and nurses to achieve favorable patient outcomes. A recent study highlights that hospital-based antimicrobial stewardship programs are effective in reducing the prescription of fluoroquinolones, including ciprofloxacin, during hospitalization, demonstrating the critical role of coordinated healthcare

Journal of Ecohumanism
2024
Volume: 3, No: 8, pp. 9328 – 9336
ISSN: 2752-6798 (Print) | ISSN 2752-6801 (Online)
https://ecohumanism.co.uk/joe/ecohumanism
DOI: https://doi.org/10.62754/joe.v3i8.5546

efforts in combating antibiotic resistance [57-58]. This underscores the importance of vigilance, teamwork, and judicious use of antibiotics within healthcare teams.

Pharmacists and Ciprofloxacin Monitoring

Pharmacists play a pivotal role in ensuring the safe and effective use of ciprofloxacin through vigilant monitoring and patient education. As medication experts, pharmacists are uniquely positioned to assess the appropriateness of ciprofloxacin therapy, verify dosing accuracy, and evaluate potential drug interactions. Their involvement is particularly crucial given ciprofloxacin's complex pharmacokinetic profile and its associated risks, including adverse effects such as tendinopathy, dysglycemia, and Clostridioides difficile-associated diarrhea. One key aspect of pharmacists' responsibilities is identifying contraindications and precautions in patients prescribed ciprofloxacin. For instance, pharmacists must recognize patients with a history of hypersensitivity to fluoroquinolones or those concurrently taking medications such as tizanidine, which may result in harmful interactions due to cytochrome P450 1A2 inhibition. Pharmacists also assess renal and hepatic function to adjust dosages in individuals with organ dysfunction, mitigating the risk of drug accumulation and toxicity. Pharmacists actively monitor for signs of ciprofloxacin-induced adverse reactions. This includes educating patients about symptoms of tendinitis, such as localized pain or swelling, and the importance of reporting any changes in mental status. They are instrumental in preventing phototoxic reactions by advising patients on sun exposure precautions and the use of sunscreen. Monitoring serum glucose levels in diabetic patients on ciprofloxacin is another critical function, given the potential for dysglycemia. Furthermore, pharmacists contribute to antimicrobial stewardship by reviewing antibiograms to ensure ciprofloxacin is used appropriately and not as empiric therapy in cases where resistance patterns suggest limited efficacy. They collaborate with healthcare teams to optimize ciprofloxacin use, reducing unnecessary prescriptions and minimizing resistance development. Through comprehensive monitoring and collaboration with other healthcare professionals, pharmacists enhance the therapeutic outcomes of ciprofloxacin while safeguarding patient safety. Their proactive role underscores the importance of interprofessional approaches to antimicrobial management.

Conclusion

Ciprofloxacin, as a fluoroquinolone antibiotic, offers broad-spectrum efficacy against various bacterial infections, including UTIs, pneumonia, and anthrax. Its mechanism of action—targeting DNA replication via DNA gyrase and topoisomerase inhibition—makes it particularly potent against Gram-negative bacteria. However, resistance patterns, notably in healthcare-associated pathogens like *Escherichia coli* and *Pseudomonas aeruginosa,* challenge its empirical use in specific clinical scenarios. The drug's pharmacokinetics underscore its utility, with high tissue distribution and effective penetration into fluids, despite limited bioavailability in certain environments like CSF. While its therapeutic applications span oral, intravenous, ophthalmic, and otic formulations, careful attention to dosage adjustments for renal and hepatic impairments is imperative. The drug's potential for off-label uses, including neonatal sepsis and cancer treatment, highlights its versatile clinical impact, though further research is warranted. Despite its benefits, ciprofloxacin's adverse effects, including tendon rupture, QT interval prolongation, and neuropsychiatric disturbances, require vigilance. Boxed FDA warnings emphasize risks, particularly for older adults and corticosteroid users. Additionally, considerations during pregnancy and lactation restrict its use to critical indications where benefits outweigh risks. In conclusion, ciprofloxacin remains a cornerstone in antimicrobial therapy but demands judicious use. Optimizing its application requires ongoing monitoring of resistance trends, patient-specific factors, and adverse effect profiles. Future research should prioritize mitigating resistance mechanisms and exploring alternative treatments to sustain its clinical relevance in combating bacterial infections.

References

Sharma PC, Jain A, Jain S, Pahwa R, Yar MS. Ciprofloxacin: review on developments in synthetic, analytical, and medicinal aspects. J Enzyme Inhib Med Chem. 2010 Aug;25(4):577-89.

Journal of Ecohumanism
2024
Volume: 3, No: 8, pp. 9328 – 9336
ISSN: 2752-6798 (Print) | ISSN 2752-6801 (Online)
https://ecohumanism.co.uk/joe/ecohumanism
DOI: https://doi.org/10.62754/joe.v3i8.5546
Zhang HL, Tan M, Qiu AM, Tao Z, Wang CH. Antibiotics for treatment of acute exacerbation of chronic obstructive pulmonary disease: a network meta-analysis. BMC Pulm Med. 2017 Dec 12;17(1):196.
Bartolomé-Álvarez J, Solves-Ferriz V. [Increase in methicillin-resistant and ciprofloxacin-susceptible Staphylococcus aureus in osteoarticular, skin and soft tissue infections]. Rev Esp Quimioter. 2020 Apr;33(2):143-144.
Meyerhoff A, Albrecht R, Meyer JM, Dionne P, Higgins K, Murphy D. US Food and Drug Administration approval of ciprofloxacin hydrochloride for management of postexposure inhalational anthrax. Clin Infect Dis. 2004 Aug 01;39(3):303-8.
Apangu T, Griffith K, Abaru J, Candini G, Apio H, Okoth F, Okello R, Kaggwa J, Acayo S, Ezama G, Yockey B, Sexton C, Schriefer M, Mbidde EK, Mead P. Successful Treatment of Human Plague with Oral Ciprofloxacin. Emerg Infect Dis. 2017 Mar;23(3):553-5.
Unemo M, Lahra MM, Cole M, Galarza P, Ndowa F, Martin I, Dillon JR, Ramon-Pardo P, Bolan G, Wi T. World Health Organization Global Gonococcal Antimicrobial Surveillance Program (WHO GASP): review of new data and evidence to inform international collaborative actions and research efforts. Sex Health. 2019 Sep;16(5):412-425.
Coker TJ, Dierfeldt DM. Acute Bacterial Prostatitis: Diagnosis and Management. Am Fam Physician. 2016 Jan 15;93(2):114-20.
Heras-Cañas V, Gutiérrez-Soto B, Almonte-Fernández H, Lara-Oya A, Navarro-Marí JM, Garrido-Frenich A, Vázquez-Alonso F, Gutiérrez-Fernández J. Antibiotic activity and concentrations in clinical samples from patients with chronic bacterial prostatitis. Actas Urol Esp. 2017 Dec;41(10):631-638.
Wu XW, Ji HZ, Wang FY. Meta-analysis of ciprofloxacin in treatment of Crohn's disease. Biomed Rep. 2015 Jan;3(1):70-74.
McDonald EM, Ram FS, Patel DV, McGhee CN. Topical antibiotics for the management of bacterial keratitis: an evidence-based review of high quality randomised controlled trials. Br J Ophthalmol. 2014 Nov;98(11):1470-7.
Mohamed S, Elmohamady MN, Abdelrahman S, Amer MM, Abdelhamid AG. Antibacterial effects of antibiotics and cell-free preparations of probiotics against Staphylococcus aureus and Staphylococcus epidermidis associated with conjunctivitis. Saudi Pharm J. 2020 Dec;28(12):1558-1565.
Wiegand S, Berner R, Schneider A, Lundershausen E, Dietz A. Otitis Externa. Dtsch Arztebl Int. 2019 Mar 29;116(13):224-234.
Edmunds AL. Otiprio: An FDA-Approved Ciprofloxacin Suspension Gel for Pediatric Otitis Media With Effusion. P T. 2017 May;42(5):307-311.
Kaguelidou F, Turner MA, Choonara I, Jacqz-Aigrain E. Ciprofloxacin use in neonates: a systematic review of the literature. Pediatr Infect Dis J. 2011 Feb;30(2):e29-37.
Herold C, Ocker M, Ganslmayer M, Gerauer H, Hahn EG, Schuppan D. Ciprofloxacin induces apoptosis and inhibits proliferation of human colorectal carcinoma cells. Br J Cancer. 2002 Feb 01;86(3):443-8.
Aranha O, Wood DP, Sarkar FH. Ciprofloxacin mediated cell growth inhibition, S/G2-M cell cycle arrest, and apoptosis in a human transitional cell carcinoma of the bladder cell line. Clin Cancer Res. 2000 Mar;6(3):891-900.
Campoli-Richards DM, Monk JP, Price A, Benfield P, Todd PA, Ward A. Ciprofloxacin. A review of its antibacterial activity, pharmacokinetic properties and therapeutic use. Drugs. 1988 Apr;35(4):373-447.
LeBel M. Ciprofloxacin: chemistry, mechanism of action, resistance, antimicrobial spectrum, pharmacokinetics, clinical trials, and adverse reactions. Pharmacotherapy. 1988;8(1):3-33.
Rehman A, Patrick WM, Lamont IL. Mechanisms of ciprofloxacin resistance in Pseudomonas aeruginosa: new approaches to an old problem. J Med Microbiol. 2019 Jan;68(1):1-10.
Güler G, Eraç B. [Investigation of fluoroquinolone resistance mechanisms in clinical Acinetobacter baumannii isolates]. Mikrobiyol Bul. 2016 Apr;50(2):278-86.
Chang MX, Zhang JF, Sun YH, Li RS, Lin XL, Yang L, Webber MA, Jiang HX. Contribution of Different Mechanisms to Ciprofloxacin Resistance in Salmonella spp. Front Microbiol. 2021;12:663731.
Fasugba O, Gardner A, Mitchell BG, Mnatzaganian G. Ciprofloxacin resistance in community- and hospital-acquired Escherichia coli urinary tract infections: a systematic review and meta-analysis of observational studies. BMC Infect Dis. 2015 Nov 25;15:545.
El-Sabawi D, Abu-Dahab R, Zalloum WA, Ijbara F, Hamdan II. The effect of ferrous ions, calcium ions and citric acid on absorption of ciprofloxacin across caco-2 cells: practical and structural approach. Drug Dev Ind Pharm. 2019 Feb;45(2):292-303.
Radovanovic M, Dushenkovska T, Cvorovic I, Radovanovic N, Ramasamy V, Milosavljevic K, Surla J, Jecmenica M, Radulovic M, Milovanovic T, Dumic I. Idiosyncratic Drug-Induced Liver Injury Due to Ciprofloxacin: A Report of Two Cases and Review of the Literature. Am J Case Rep. 2018 Sep 29;19:1152-1161.
Schlender JF, Teutonico D, Coboeken K, Schnizler K, Eissing T, Willmann S, Jaehde U, Stass H. A Physiologically-Based Pharmacokinetic Model to Describe Ciprofloxacin Pharmacokinetics Over the Entire Span of Life. Clin Pharmacokinet. 2018 Dec;57(12):1613-1634
Eyler RF, Shvets K. Clinical Pharmacology of Antibiotics. Clin J Am Soc Nephrol. 2019 Jul 05;14(7):1080-1090.
Nau R, Sörgel F, Eiffert H. Penetration of drugs through the blood-cerebrospinal fluid/blood-brain barrier for treatment of central nervous system infections. Clin Microbiol Rev. 2010 Oct;23(4):858-83.
Silva GCM, Jabor VAP, Bonato PS, Martinez EZ, Faria-E-Sousa SJ. Penetration of 0.3% ciprofloxacin, 0.3% ofloxacin, and 0.5% moxifloxacin into the cornea and aqueous humor of enucleated human eyes. Braz J Med Biol Res. 2017 Jul 03;50(7):e5901.
Rudolph A, Dahmke H, Kupferschmidt H, Burden A, Weiler S. Coadministration of tizanidine and ciprofloxacin: a retrospective analysis of the WHO pharmacovigilance database. Eur J Clin Pharmacol. 2021 Jun;77(6):895-902.

Journal of Ecohumanism
2024
Volume: 3, No: 8, pp. 9328 – 9336
ISSN: 2752-6798 (Print) | ISSN 2752-6801 (Online)
https://ecohumanism.co.uk/joe/ecohumanism
DOI: https://doi.org/10.62754/joe.v3i8.5546

Begg EJ, Robson RA, Saunders DA, Graham GG, Buttimore RC, Neill AM, Town GI. The pharmacokinetics of oral fleroxacin and ciprofloxacin in plasma and sputum during acute and chronic dosing. Br J Clin Pharmacol. 2000 Jan;49(1):32-8.

Davis R, Markham A, Balfour JA. Ciprofloxacin. An updated review of its pharmacology, therapeutic efficacy and tolerability. Drugs. 1996 Jun;51(6):1019-74.

Samarei R. Comparison of local and systemic ciprofloxacin ototoxicity in the treatment of chronic media otitis. Glob J Health Sci. 2014 Sep 18;6(7 Spec No):144-9.

LiverTox: Clinical and Research Information on Drug-Induced Liver Injury [Internet]. National Institute of Diabetes and Digestive and Kidney Diseases; Bethesda (MD): Feb 28, 2020. Ciprofloxacin.

Roger C, Wallis SC, Louart B, Lefrant JY, Lipman J, Muller L, Roberts JA. Comparison of equal doses of continuous venovenous haemofiltration and haemodiafiltration on ciprofloxacin population pharmacokinetics in critically ill patients. J Antimicrob Chemother. 2016 Jun;71(6):1643-50.

Padberg S, Wacker E, Meister R, Panse M, Weber-Schoendorfer C, Oppermann M, Schaefer C. Observational cohort study of pregnancy outcome after first-trimester exposure to fluoroquinolones. Antimicrob Agents Chemother. 2014 Aug;58(8):4392-8.

Yefet E, Schwartz N, Chazan B, Salim R, Romano S, Nachum Z. The safety of quinolones and fluoroquinolones in pregnancy: a meta-analysis. BJOG. 2018 Aug;125(9):1069-1076.

Mahadevan U, Robinson C, Bernasko N, Boland B, Chambers C, Dubinsky M, Friedman S, Kane S, Manthey J, Sauberan J, Stone J, Jain R. Inflammatory Bowel Disease in Pregnancy Clinical Care Pathway: A Report From the American Gastroenterological Association IBD Parenthood Project Working Group. Gastroenterology. 2019 Apr;156(5):1508-1524.

Drugs and Lactation Database (LactMed®) [Internet]. National Institute of Child Health and Human Development; Bethesda (MD): Dec 20, 2021. Ciprofloxacin.

Blondeau JM. Expanded activity and utility of the new fluoroquinolones: a review. Clin Ther. 1999 Jan;21(1):3-40; discussion 1-2.

Cozzani E, Chinazzo C, Burlando M, Romagnoli M, Parodi A. Ciprofloxacin as a Trigger for Bullous Pemphigoid: The Second Case in the Literature. Am J Ther. 2016 Sep-Oct;23(5):e1202-4.

Shimatsu K, Subramaniam S, Sim H, Aronowitz P. Ciprofloxacin-induced tendinopathy of the gluteal tendons. J Gen Intern Med. 2014 Nov;29(11):1559-62.

Smith N, Fackrell R, Henderson E. Ciprofloxacin-associated bilateral iliopsoas tendon rupture: a case report. Age Ageing. 2016 Sep;45(5):737-8.

Shybut TB, Puckett ER. Triceps Ruptures After Fluoroquinolone Antibiotics: A Report of 2 Cases. Sports Health. 2017 Sep/Oct;9(5):474-476.

Morales D, Pacurariu A, Slattery J, Pinheiro L, McGettigan P, Kurz X. Association Between Peripheral Neuropathy and Exposure to Oral Fluoroquinolone or Amoxicillin-Clavulanate Therapy. JAMA Neurol. 2019 Jul 01;76(7):827-833.

Baggio D, Ananda-Rajah MR. Fluoroquinolone antibiotics and adverse events. Aust Prescr. 2021 Oct;44(5):161-164.

Dai XC, Yang XX, Ma L, Tang GM, Pan YY, Hu HL. Relationship between fluoroquinolones and the risk of aortic diseases: a meta-analysis of observational studies. BMC Cardiovasc Disord. 2020 Feb 03;20(1):49.

Tang W, Rao E. Anaphylaxis to Ciprofloxacin Requiring Emergent Surgical Cricothyrotomy. Eur J Case Rep Intern Med. 2022;9(2):003180.

Kelesidis T, Fleisher J, Tsiodras S. Anaphylactoid reaction considered ciprofloxacin related: a case report and literature review. Clin Ther. 2010 Mar;32(3):515-26.

Abd-Elsayed A, Elsharkawy H, Sakr W. A severe interaction between Tizanidine and Ciprofloxacin. J Clin Anesth. 2015 Dec;27(8):698.

Brown KA, Langford B, Schwartz KL, Diong C, Garber G, Daneman N. Antibiotic Prescribing Choices and Their Comparative C. Difficile Infection Risks: A Longitudinal Case-Cohort Study. Clin Infect Dis. 2021 Mar 01;72(5):836-844.

Berhe A, Russom M, Bahran F, Hagos G. Ciprofloxacin and risk of hypolycemia in non-diabetic patients. J Med Case Rep. 2019 May 12;13(1):142.

Chou HW, Wang JL, Chang CH, Lee JJ, Shau WY, Lai MS. Risk of severe dysglycemia among diabetic patients receiving levofloxacin, ciprofloxacin, or moxifloxacin in Taiwan. Clin Infect Dis. 2013 Oct;57(7):971-80.

Wiseman LR, Balfour JA. Ciprofloxacin. A review of its pharmacological profile and therapeutic use in the elderly. Drugs Aging. 1994 Feb;4(2):145-73.

Kaplan YC, Koren G. Use of ciprofloxacin during breastfeeding. Can Fam Physician. 2015 Apr;61(4):343-4.

Walden DM, Khotimchenko M, Hou H, Chakravarty K, Varshney J. Effects of Magnesium, Calcium, and Aluminum Chelation on Fluoroquinolone Absorption Rate and Bioavailability: A Computational Study. Pharmaceutics. 2021 Apr 21;13(5)

Hajji M, Jebali H, Mrad A, Blel Y, Brahmi N, Kheder R, Beji S, Fatma LB, Smaoui W, Krid M, Hmida FB, Rais L, Zouaghi MK. Nephrotoxicity of Ciprofloxacin: Five Cases and a Review of the Literature. Drug Saf Case Rep. 2018 Apr 18;5(1):17.

Vaughn VM, Gandhi T, Conlon A, Chopra V, Malani AN, Flanders SA. The Association of Antibiotic Stewardship With Fluoroquinolone Prescribing in Michigan Hospitals: A Multi-hospital Cohort Study. Clin Infect Dis. 2019 Sep 27;69(8):1269-1277.

Thai, T., Salisbury, B. H., & Zito, P. M. (2023). Ciprofloxacin. In StatPearls [internet]. StatPearls Publishing.

Journal of Ecohumanism
2024
Volume: 3, No: 8, pp. 9328 – 9336
ISSN: 2752-6798 (Print) | ISSN 2752-6801 (Online)
https://ecohumanism.co.uk/joe/ecohumanism
DOI: https://doi.org/10.62754/joe.v3i8.5546

سيبروفلوكساسين: نظرة عامة على الاستخدامات وآلية العمل والآثار الجانبية

الملخص:

الخلفية :سيبروفلوكساسين هو مضاد حيوي من عائلة الفلوروكينولونات تم تسجيل براءة اختراعه عام 1983 وحصل على موافقة إدارة الغذاء والدواء الأمريكية (FDA) في عام 1987. يُستخدم على نطاق واسع لعلاج العدوى البكتيرية مثل التهابات المسالك البولية (UTIs)والالتهاب الرئوي، بالإضافة إلى استخدامات غير مصرح بها مثل مرض كرون وكبح الخلايا السرطانية.

الهدف :تقديم نظرة شاملة حول استخدامات سيبروفلوكساسين وآلية عمله وحركية الدواء وطرق الإعطاء والآثار الجانبية المرتبطة به.

الطرق :تم إجراء مراجعة شاملة للأدبيات والإرشادات لفحص التطبيقات العلاجية للسيبروفلوكساسين، وفعاليته، وأنماط المقاومة، والاعتبارات الخاصة بالمرضى.

النتائج :يظهر سيبروفلوكساسين طيفًا واسعًا من النشاط المضاد للميكروبات، حيث يعمل بشكل أساسي على تثبيط تكرار الحمض النووي من خلال إنزيم الجيراز (DNA gyrase) وتوبويزوميراز .(topoisomerase) يتمتع بقدرة عالية على اختراق الأنسجة والوصول إلى مستويات علاجية في سوائل وأنسجة مختلفة، بما في ذلك السائل الدماغي الشوكي (CSF) أثناء الالتهاب. تشمل آليات المقاومة الطفرات في إنزيم الجيراز ونشاط مضخات التدفق الخارجي، مما يحد من فعاليته في بعض الحالات. يتوفر السيبروفلوكساسين في أشكال فموية، ووريدية، وموضعية، مع كون الإخراج الكلوي هو المسار الأساسي للتخلص منه. ومع ذلك، تم الإبلاغ عن آثار جانبية مثل التهاب الأوتار، وإطالة فترةQT ، والأحداث النفسية العصبية، وردود الفعل الجلدية النادرة والشديدة. يُقيّد استخدامه لدى حديثي الولادة والحوامل والمرضعات بحالات محددة.

الخلاصة :لا يزال سيبروفلوكساسين عاملًا مضادًا للميكروبات ذا قيمة على الرغم من مخاوف المقاومة والآثار الجانبية. يضمن الاستخدام الموجه بناءً على شدة العدوى، وأمراض المريض المصاحبة، وأنماط المقاومة تحقيق أفضل النتائج. تعد الأبحاث الإضافية حول تقليل المقاومة واستكشاف العلاجات البديلة أمرًا بالغ الأهمية للحفاظ على فعاليته.

الكلمات المفتاحية :سيبروفلوكساسين، فلوروكينولون، العدوى البكتيرية، إنزيم الجيراز، المقاومة، حركية الدواء، الآثار الجانبية.