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TREATMENT OF DYSBIOSIS DURING ANTIBIOTIC THERAPY FOR ACUTE INTESTINAL INFECTIONS

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Abstract: Acute intestinal infections (AIIs) remain one of the most frequent causes of morbidity across various age groups, particularly among children and immunocompromised patients. Bacterial or mixed etiology infections often require antibiotic therapy, which can significantly disrupt the gut microbiota. This dysbiosis may manifest clinically and lead to prolonged gastrointestinal symptoms, malabsorption, and increased susceptibility to secondary infections. This article reviews current knowledge regarding the pathophysiology of dysbiosis induced by antibiotic treatment of AIIs and presents evidence-based strategies for restoring a balanced gut microbiota. Key approaches include using probiotics, prebiotics, and synbiotics, alongside antibiotic stewardship and careful monitoring of gastrointestinal function.

Keywords: acute intestinal infections, antibiotics, dysbiosis, probiotics, gut microbiota, antibiotic stewardship

ЛЕЧЕНИЕ ДИСБАКТЕРИОЗА ВО ВРЕМЯ АНТИБИОТИКОТЕРАПИИ ОСТРЫХ КИШЕЧНЫХ ИНФЕКЦИЙ

Аннотация: Острые кишечные инфекции (ОКИ) остаются одной из наиболее частых причин заболеваемости в различных возрастных группах, особенно среди детей и пациентов с ослабленным иммунитетом. Бактериальные или смешанные инфекции часто требуют антибактериальной терапии, которая может значительно нарушить микробиоту кишечника. Этот дисбактериоз может проявляться клинически и приводить к длительным желудочно-кишечным симптомам, мальабсорбции и повышенной восприимчивости к вторичным инфекциям. В этой статье рассматриваются современные знания о патофизиологии дисбактериоза, вызванного антибиотикотерапией ОКИ, и представлены научно обоснованные стратегии восстановления сбалансированной микробиоты кишечника. Ключевые подходы включают использование пробиотиков, пребиотиков и синбиотиков, а также рациональное использование антибиотиков и тщательный мониторинг функции желудочно-кишечного тракта.

Ключевые слова: острые кишечные инфекции, антибиотики, дисбактериоз, пробиотики, микробиота кишечника, рациональное использование антибиотиков

INTRODUCTION

Acute intestinal infections (AIIs) are among the most common causes of acute gastroenteritis worldwide, leading to significant morbidity and, in certain regions, elevated mortality, especially in pediatric populations 111. Their etiological agents include bacteria

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(e.g., *Salmonella spp.*, *Shigella spp.*, pathogenic *Escherichia coli*), viruses (rotavirus, norovirus), and protozoa [1]. Depending on the severity and cause, bacterial AIIs frequently necessitate antibiotic therapy. While antibiotics can be lifesaving, they often disrupt the gut microbiome's natural balance, resulting in dysbiosis and associated complications 222.

The present article provides an overview of how antibiotic therapy contributes to dysbiosis during AIIs, the clinical implications of this dysbiosis, and current evidence-based interventions that aim to restore a healthy gut microbiota [2].

Etiology and pathogenesis of aii-related dysbiosis

Mechanisms of Antibiotic-Induced Dysbiosis - Antibiotics work by targeting bacterial pathogens, but they also non-selectively impact commensal flora in the gut. Key mechanisms include: Reduced Microbial Diversity: Broad-spectrum antibiotics can eradicate beneficial bacteria (e.g., *Bifidobacterium* spp., *Lactobacillus* spp.), diminishing overall richness and diversity of the microbiome 333. Overgrowth of Resistant Strains: With commensals depleted, antibiotic-resistant organisms (e.g., *Clostridioides difficile*) can proliferate, leading to secondary infections and inflammation. Metabolic Shifts: Loss of beneficial bacteria impairs short-chain fatty acid (SCFA) production, influencing gut pH and epithelial integrity [3].

Clinical Manifestations - Prolonged Diarrhea: Antibiotic-associated diarrhea can be exacerbated in an environment of ongoing intestinal infection. Malabsorption: Dysbiosis reduces the capacity of the gut to digest and absorb nutrients. Recurrence or Persistence of Infection: An imbalanced microbiota may fail to outcompete remaining pathogens [4]. Risk of Secondary Infections: The prevalence of opportunistic pathogens (e.g., *C. difficile*) increases under dysbiotic conditions.

DIAGNOSTIC CONSIDERATIONS

Microbiological Testing - Stool Culture: Useful for identifying primary pathogenic bacteria, as well as any emerging resistant flora. Molecular Methods (PCR): Can detect low levels of pathogenic bacteria or viruses, and sometimes quantify pathogenic or beneficial strains.

Microbiota Profiling - 16S rRNA Gene Sequencing: Provides insights into microbial community composition. Although more common in research settings, next-generation sequencing techniques are increasingly being used clinically to assess the extent of dysbiosis. Metabolomic Analysis: Evaluates functional changes (e.g., SCFA production). Still largely in the research phase but offers a deeper understanding of metabolic alterations [5].

Clinical markers - Inflammatory Markers: Elevated C-reactive protein (CRP) or fecal calprotectin can indicate intestinal inflammation [6]. Symptom Assessment: Frequency of diarrhea, abdominal pain, bloating, and presence of systemic symptoms help evaluate the severity of dysbiosis.

TREATMENT STRATEGIES

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Rational Antibiotic Therapy - Narrow-Spectrum Agents: Whenever possible, select agents that specifically target the identified pathogen. Reducing the use of broad-spectrum antibiotics helps preserve beneficial gut flora. Antibiotic Stewardship: Includes de-escalating therapy based on pathogen sensitivities, limiting treatment duration, and avoiding inappropriate antibiotic use.

Probiotic Supplementation - Single-Strain Probiotics: *Lactobacillus rhamnosus GG*, *Saccharomyces boulardii*, and *Bifidobacterium* species are commonly used. Studies show they can reduce the incidence and severity of antibiotic-associated diarrhea 444. Multi-Strain Formulations: Combining different species may broaden the coverage and enhance resilience against multiple pathogens [7]. Timing and Dosage: Probiotics are most effective when initiated early in therapy and continued for at least 1–2 weeks post-antibiotic course. Dosages typically range from 10^7 to 10^10 CFU/day, though optimal levels depend on specific strains.

Prebiotics and Synbiotics - Prebiotics: Non-digestible food ingredients (e.g., fructooligosaccharides, inulin) that selectively feed beneficial gut bacteria. Synbiotics: Formulations that combine probiotics and prebiotics, aiming to improve probiotic survival and colonization [8]. Dietary Fiber: Encouraging whole-grain foods, fruits, and vegetables can enhance gut flora recovery.

Adjunctive Therapies - Enterosorbents (e.g., activated charcoal, smectite) can help bind bacterial toxins, though their role in dysbiosis remains under investigation. Zinc Supplementation: Particularly beneficial in pediatric populations, as zinc supports epithelial integrity and immune function. Rehydration Therapy: Oral rehydration solutions are key to preventing dehydration in patients with ongoing diarrheal symptoms.

Prevention and Long-Term Management

Vaccination - Preventing primary infections (e.g., rotavirus vaccine, COVID-19 vaccine, influenza vaccine) can reduce the need for antibiotics and, hence, lower the risk of dysbiosis.

Infection control - Hand Hygiene and Sanitation: Reduces the transmission of pathogenic bacteria and viruses. Isolation Precautions: In hospital settings, adherence to infection control protocols can prevent healthcare-associated infections that complicate the patient's gastrointestinal condition.

Ongoing Microbiome Monitoring - In cases of severe or recurrent dysbiosis, periodic stool analyses or other emerging diagnostics may guide personalized interventions, including targeted probiotic use or dietary modifications.

DISCUSSION

Antibiotic-induced dysbiosis can prolong or worsen the clinical course of acute intestinal infections, resulting in additional morbidity and extended convalescence. The gut microbiota plays a critical protective role, acting as a barrier to pathogen colonization and contributing to immune function. When antibiotics are necessary for life-threatening infections, the

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judicious selection of agents and the concurrent or subsequent use of microbiome-supportive measures can mitigate the negative impact on the gut ecosystem.

Challenges persist in identifying optimal probiotic strains, dosages, and durations for different patient populations. Moreover, while current evidence supports the efficacy of many commercially available products, further large-scale, randomized clinical trials are needed to standardize best practices, especially in pediatric and immunocompromised individuals.

CONCLUSION

The management of dysbiosis during antibiotic therapy for acute intestinal infections necessitates a multifaceted approach. Central to this is the rational use of antibiotics guided by precise microbiological diagnoses, combined with probiotic supplementation, prebiotics, and synbiotics to help restore intestinal homeostasis. Emphasizing antibiotic stewardship, promoting preventive measures (e.g., vaccination), and advancing diagnostic techniques will contribute to improved patient outcomes and a reduced burden of antibiotic-associated dysbiosis.

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