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Efficacy of fecal microbiota transplantation in the treatment of infections caused by *Clostridioides. difficile*

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Efficacy of fecal microbiota transplantation in the treatment of infections caused by Clostridioides difficile

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ABSTRACT

Clostridioides difficile infection represents a significant public health problem, especially in hospitalized patients undergoing prolonged antibiotic use, due to high recurrence rates. In this context, fecal microbiota transplantation (FMT) has emerged as a promising therapeutic alternative for the treatment of recurrent infections.

This study aimed to analyze the effectiveness of fecal microbiota transplantation in the treatment of *C. difficile infections,* highlighting its advantages over conventional antibiotic therapies. This is an integrative literature review, composed of ten articles published between 2020 and 2025, obtained from the PubMed database. The results demonstrated that FMT presents clinical efficacy rates between 79% and 91%, especially in preventing infection recurrences. It was also observed that the therapy contributes to the restoration of intestinal microbial balance and to the improvement of clinical outcomes. Different routes of administration, such as colonoscopy and oral capsules, presented satisfactory results, although limitations related to the standardization of protocols and safety in immunocompromised patients still exist. It is concluded that fecal microbiota transplantation represents an effective alternative in the treatment of recurrent *C. difficile infections,* contributing to the reduction of recurrences and the improvement of patients' quality of life.

Keywords: Fecal microbiota transplantation; *Clostridioides difficile;* intestinal microbiota; antimicrobial resistance; recurrent infection.

ABSTRACT: *Clostridioides difficile* infection is an important public health problem, particularly among hospitalized patients receiving prolonged antibiotic therapy, due to high recurrence rates. In this context, fecal microbiota transplantation (FMT) has emerged as a promising therapeutic alternative for treating recurrent infections. This study aimed to assess the efficacy of fecal microbiota transplantation in treating C. difficile infections and to highlight its advantages over conventional antibiotic therapies. This is an integrative literature review comprising 10 articles published between 2020 and 2025, retrieved from PubMed. The results demonstrated that FMT achieves clinical efficacy ranging from 79% to 91%, particularly in preventing infection recurrence. The therapy also contributed to the restoration of intestinal microbial balance and to improvements in clinical outcomes. Different administration routes, such as colonoscopy and oral capsules, showed satisfactory results, although limitations related to protocol standardization and safety in immunocompromised patients still exist. It is concluded that fecal microbiota transplantation is an effective alternative for treating recurrent C. difficile infections, reducing recurrence and improving

patients' quality of life.
Keywords: *Fecal microbiota transplantation; Clostridioides difficile; intestinal microbiota; antimicrobial resistance; recurrent infection.*
DESCRIPTORS: *"Fecal Microbiota transplantation", "Clostridioides difficile infection" and*

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"Multidrug-Resistant Bacteria", as well as the Boolean connectors [title], AND, and OR.

INTRODUCTION

Clostridioides *difficile* is a Gram-positive, anaerobic, spore-forming bacterium.
recognized as one of the main causes of hospital-acquired intestinal infections. Its ability to
Forming highly resistant spores allows for prolonged survival on surfaces, in
Hospital equipment and healthcare professionals are using the virus, which facilitates its spread.
This resistance to conventional disinfection methods makes the microorganism a challenge.
important in the control of hospital infections. (Yadegar *et* al., 2023).
Clostridium difficile infection represents a significant public health problem, particularly in
immunocompromised patients, the elderly, and hospitalized patients—groups with higher morbidity rates and
Mortality (Markovska *et* al., 2023)—the disease is frequently associated with improper use.
antibiotics, which alters the balance of the intestinal microbiota.
Reduced microbial diversity promotes spore germination and the proliferation of *C.*
difficile. After multiplying, the bacteria release toxins that cause intestinal inflammation and lesions.
in the epithelium and symptoms such as diarrhea, abdominal pain, and colitis. In more severe cases, the infection can
evolve progressively and present with difficult clinical control (Di Bella *et* al., 2024; Da Cruz Silva
et al., 2024).
Conventional treatment is mainly based on the use of antibiotics, such as vancomycin.
fidaxomicin and metronidazole. However, these medications also eliminate microorganisms.
The beneficial effects of the gut microbiota worsen dysbiosis and promote recurrence of infection.
Continued use of these antimicrobials may also contribute to increased resistance.
bacterial (Markantonis *et* al., 2024; Da Cruz Silva *et* al., 2024).
Given these limitations, fecal microbiota transplantation (FMT) has shown promising results.
relevant as a therapeutic alternative, especially in recurrent cases of *C.* coli infection.
Difficulty. The procedure involves introducing fecal matter from a healthy donor into the digestive tract.
The patient's gastrointestinal system, with the goal of restoring the balance of the intestinal microbiota.
The reintroduction of beneficial microorganisms promotes the recovery of microbial diversity and reduces
the proliferation of pathogens, contributing to the reestablishment of intestinal homeostasis. (Pomares)
Bascuñana *et al.,* 2021; Vaughn *et* al., 2023).
The mechanisms of action of TMF involve intestinal recolonization by beneficial microorganisms.
which compete for nutrients and hinder the development of *C. difficile.* The procedure also
It promotes the production of metabolites important for strengthening the intestinal barrier and...

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Reduction of inflammation (Soveral *et al.,* 2022; Voziki *et al.,* 2024). Studies demonstrate that TMF
It exhibits high efficacy rates, ranging from 70% to 100%, especially in recurrent cases.
surpassing the results obtained with conventional therapies. The safety of the procedure is...
directly related to the careful selection of donors and rigorous screening protocols, the
which reduces the risks associated with the transmission of infectious agents (Baunwall *et* al., 2020; Peery *et*
al., 2024; Conover *et al.,* 2023).
The hypothesis is that fecal microbiota transplantation has greater therapeutic efficacy in
resolution and prevention of recurrence of *C. difficile* infection when compared to therapies
conventional antibiotics. Thus, the present study aims to analyze the effectiveness of
Fecal microbiota transplantation as a therapeutic alternative in the treatment of recurrent infections.
by *C. difficile,* highlighting its advantages over conventional antibiotic therapies.

METHODOLOGY

This study consisted of an integrative literature review, with the aim of gathering and
to analyze scientific publications on the effectiveness of fecal microbiota transplantation in the treatment of
C. difficile infections .
The literature review took place between September and December 2025, using a structured search.
The search was conducted in the PubMed database, without language restrictions, and articles published in [publication name] were selected.
last five years (2020–2025).
The following descriptors were used, obtained from a search in the Science Descriptors.
Health (DeCS/MeSH):
"Fecal Microbiota Transplantation", "Clostridioides difficile infection" and "Multidrug-Resistant
Bacteria", using the search field [Title] and the Boolean operators AND and OR.
The inclusion criteria adopted in this study were: articles published between 2020 and 2025.
available free of charge and written in Portuguese and/or English. Only studies that were included were considered.
They discussed fecal microbiota transplantation and its application in the treatment of *C.* coli infections.
difficile, especially in cases associated with antimicrobial resistance.
As exclusion criteria, duplicate articles across databases were disregarded.
publications prior to 2020, studies that did not directly address the proposed topic, and works
which addressed microorganisms other than *C. difficile.*

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RESULTS

Based on the structured search conducted in the databases, the following were initially identified: 3,356 studies. After applying the time filter, considering publications between 2020 and 2025, the The number was reduced to 2,885 articles. Then, with the use of Boolean connectors (AND and OR), associated with the descriptors *"Fecal Microbiota Transplantation", "Clostridioides difficile infection"* and *"Multidrug-Resistant Bacteria",* as well as the use of the [title] field for greater For specificity, the total number of studies was refined to 55.

From the 55 articles obtained, the titles and abstracts were read in order to verify the suitability to the proposed theme, which addresses the potential of fecal microbiota transplantation in Treatment of infections caused by *C. difficile.* In this stage, the inclusion criteria were applied. and previously established exclusion criteria, which allowed for a more thorough analysis of the studies. selected.

The inclusion criteria adopted in this study considered articles published between 2020 and 2025. freely available, written in Portuguese and/or English, that address the use of transplantation. of fecal microbiota in the treatment of *C. difficile infections,* with emphasis on cases associated with antimicrobial resistance.

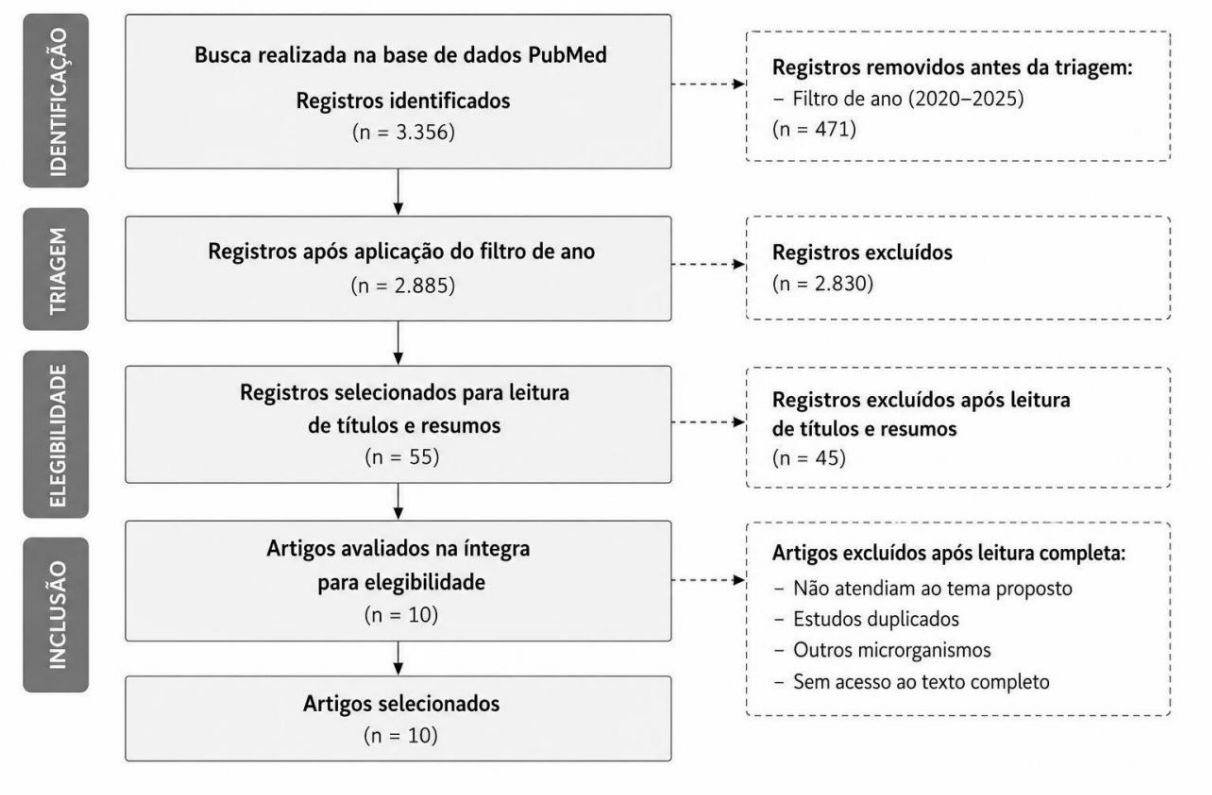
As exclusion criteria, duplicate articles across databases were disregarded. publications prior to 2020, studies not directly related to the proposed theme, as well as works which addressed other microorganisms. After applying these criteria, 10 were selected. articles to compose the final sample for this research. The selection of studies occurred in stages. including identification, screening, eligibility assessment and inclusion of articles, in accordance with the recommendations from the flowchart. Initially, the titles and abstracts were read, followed by... A complete reading of potentially eligible articles was conducted. Subsequently, the studies were analyzed. qualitatively, considering parameters related to therapeutic efficacy, rates of recurrence, procedural safety, and methodological limitations.

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FIGURE 1 – Flowchart of the article selection process for inclusion in the integrative review.



(Source: author's own work, 2026.)

Among the 10 articles selected for review, aspects related to the use of were analyzed.
fecal microbiota transplantation in the treatment of infections caused by *C. difficile,* with emphasis on therapeutic efficacy, infection recurrence rates, procedure safety, and its application in patients with antimicrobial resistance.

Furthermore, studies have evaluated the ability of fecal microbiota transplantation to restore the gut microbiota, reduce colonization by pathogenic microorganisms, and improve outcomes.

Clinical aspects of the patients were also considered. Factors such as study methodology and patient profile were also taken into account.
of the patients and the results obtained after the intervention.

The details of the analyzed articles, including title, authors, year of publication, objectives, and main points.
The results are presented in Table 1.

TABLE 1 – Characterization of selected studies on fecal microbiota transplantation in the treatment of C. difficile infection.

Title	Authors:	Year	Objective	Results
Efficacy of Fecal Microbiota Transplantation (FMT) versus	RAY *et al.*	2025	Evaluate the therapeutic performance and safety of fecal microbiota transplantation in	Recurrence rates were 16% in the group treated with TMF, compared to 42% in the group treated with

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Standard Antibiotic Therapy in Recurrent Clostridioides difficile			comparison with Standard antibiotic treatment for recurrent ICD.	antibiotics. Subgroup analysis indicated that TMF exhibits consistent efficacy regardless of the route of administration used.
AGA Clinical Practice Guideline on Fecal Microbiota-Based Therapies for Select Gastrointestinal Diseases	PEERY *et al.*	2024	To provide evidence-based clinical recommendations on the use of fecal microbiota therapies in adults with recurrent Clostridioides difficile infection, including severe cases and other gastrointestinal diseases.	The panel issued seven recommendations, suggesting the use of TMF after standard antibiotic therapy to prevent CDI recurrences, as well as to assist in the treatment of severe and fulminant cases in patients unresponsive to antimicrobials.
The use of fecal microbiota transplant as treatment for recurrent or refractory Clostridioides difficile infection	MULLISH *et al.*	2024	Establish Recommendations and best practices for the safe and effective performance of fecal microbiota transplantation in adults with recurrent or refractory CDI.	Fecal microtransplantation (FMT) is recommended for patients with multiple recurrences of intravascular coagulation (ICD), with the use of frozen fecal material being particularly noteworthy due to its greater safety and practicality.
Clostridioides difficile infection: history, epidemiology, risk factors, prevention, clinical manifestations, treatment, and future options	DI BELLA *et al.*	2024	To provide a comprehensive overview of the epidemiological aspects, risk factors, clinical manifestations, diagnostic tools, and current and future options for prophylaxis and treatment of Clostridioides difficile infection (CDI).	TMF stands out as one of the most effective approaches for recurrent CDI, promoting the restoration of the intestinal microbiota and significantly reducing recurrence rates. Among the main risk factors are antibiotic use and advanced age.
Effectiveness and Safety of Colonic and Fecal Capsule Microbiota Transplantation for Recurrent Clostridioides difficile Infection	VAUGHN *et al.*	2023	Evaluate the effectiveness and safety of colonic routes (colonoscopy) and TMF capsules in the treatment of ICD. recurring.	Both routes of administration showed high cure rates: 91% with colonoscopy and 84% with After one month, the capsules showed no statistically significant difference. The capsules proved to be a safe and less invasive alternative to colonoscopy.
Fecal Microbiota Transplantation for Clostridioides difficile Infection in Immunocompromised Pediatric Patients	CONOVER *et al.*	2023	To evaluate the efficacy and safety of fecal microbiota transplantation in immunocompromised children with recurrent Clostridioides difficile infection.	The success rate was 79% after the first procedure and 86% after multiple interventions, demonstrating good clinical results. However, serious adverse events occurred in 9.5% of cases, highlighting the need for a careful risk-benefit assessment in this population.
Beneficial effects of fecal microbiota transplantation in	YADEGAR *et al.*	2023	Provide an overview of the pathogenesis of recurrent CDI and discuss the	TMF works by restoring the gut microbiota and promoting changes.

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recurrent Clostridioides difficile infection			Mechanisms of action of TMF, including microbial, metabolic, immunological, and epigenetic aspects.	metabolic processes, such as the recovery of secondary bile acids and... Valerate. In addition, it promotes immune modulation, with an increase in IL-25 and IL-33, which contributes to intestinal balance.
Immunological mechanisms of fecal microbiota transplantation in recurrent Clostridioides difficile infection	SOVERAL *et al.*	2022	Analyze the main immunological mechanisms involved in the effectiveness of fecal microbiota transplantation in the treatment of recurrent CDI.	The effectiveness of TMF is related to the production of secondary bile acids, which favors regulatory T cells, reduces intestinal inflammation, and restores immune homeostasis.
Effectiveness of fecal microbiota transplant for the treatment of Clostridioides difficile diarrhea	POMARES BASCUÑANA *et al.*	2021	Evaluate the overall effectiveness and safety of TMF, as well as any differences between routes of administration.	The treatment showed an average efficacy of 82%, with oral capsules standing out as more effective than colonoscopy. Patients undergoing FMT via colonoscopy experienced a higher frequency of adverse effects.
Fecal microbiota transplantation for recurrent Clostridioides difficile infection: an updated systematic review and meta-analysis	BAUNWALL *et al.*	2020	Establishing evidence This study aims to assess the effectiveness of TMF in the treatment of recurrent CDI, considering different administration methods and therapeutic regimens, and to compare it to standard antibiotic therapy.	TMF showed an overall efficacy of 91% in repeat transplants and 84% in single-dose transplants, demonstrating superior results to vancomycin. Administration via colonoscopy proved superior to other methods.

(Source: author's own work, 2026.)

DISCUSSION

Analysis of the selected studies demonstrates that fecal microbiota transplantation (FMT) presents high efficacy in the treatment of recurrent *C. difficile infection,* especially in the prevention of new episodes in patients with treatment failure to conventional antibiotic therapy. In order Overall, the literature points to a positive answer to the research question, indicating that TMF It has demonstrated greater effectiveness in preventing recurrences in certain patient groups. especially in recurrent cases associated with the failure of conventional therapy.

In this context, Baunwall *et al.* (2020) highlight high clinical success rates, with overall efficacy. 91% in repeat transplants and 84% in a single dose, in addition to a number needed to treat (NNT) of only 1.5 compared to vancomycin. These findings are corroborated by Ray *et al.*

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(2025), which demonstrate a significant reduction in the recurrence rate, of 16% in the group submitted to TMF, in contrast to 42% in the group treated with conventional antibiotics. These data They reinforce the therapeutic potential of TMF in resolving the infection and reducing new episodes. in patients with recurrence

Despite consensus regarding overall effectiveness, there are disagreements in the literature about the best route of administration. administration of TMF. Baunwall *et al.* (2020) argue that administration via colonoscopy It presents better clinical results when compared to other approaches. On the other hand, Bascuñana *et al.* (2021) report that administration via oral capsules demonstrated greater efficacy. statistics in their analyses. Vaughn *et al.* (2023), in a real-world study, did not observe statistically significant differences were found between the routes of administration, suggesting that both may... to be considered viable alternatives in clinical practice. These divergences highlight the need standardization of protocols and new comparative studies.

The effectiveness of TMF can be explained by mechanisms that go beyond simple bacterial replacement. including the restoration of intestinal eubiosis. According to Soveral *et al.* (2022) and Yadegar *et al.* (2023), The procedure restores the ability of the gut microbiota to convert bile acids. primary to secondary. These compounds inhibit the germination of *C. difficile spores.* In addition Furthermore, there is evidence that TMF acts in immune modulation. Soveral *et al.* (2022) demonstrate that transplantation promotes the expansion of regulatory T cells and increased production of IL-10, contributing to the reduction of intestinal inflammation. Furthermore, Yadegar *et al.* (2023) highlight the importance of restoring metabolites, such as short-chain fatty acids, including the valerate, essential for maintaining the integrity of the intestinal barrier.

Despite the promising results, the studies analyzed present significant limitations. Among the One of the main limitations is the difficulty of blinding in clinical trials involving TMF. as pointed out by Ray *et al.* (2025) and Peery *et al.* (2024). This factor may compromise the The reliability of the results can lead to an overestimation of the observed effects. Furthermore, Mullish *et al.* (2024) highlight the heterogeneity in material preparation protocols. fecal, including differences in processing time, storage and use of Cryoprotectants. These variations can directly impact the therapeutic effectiveness of the procedure.

Another important aspect concerns the safety of fecal microbiota transplantation, especially in Vulnerable populations, such as immunocompromised patients. According to Conover et al. (2023), Serious adverse events can occur in these individuals, highlighting the need for a A thorough assessment of the risk-benefit ratio before performing the procedure.

Biosecurity issues also represent significant challenges for the consolidation of TMF. in clinical practice. The possibility of transmission of multidrug-resistant microorganisms reinforces the

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need for rigorous donor screening protocols, microbiological control and
Laboratory monitoring of the fecal material used.

In the field of biomedicine, these findings reinforce the importance of standardizing processes.
Laboratory and quality control aspects in the development and application of TMF. The transition from
The use of raw fecal material for living biotherapeutic products requires technical and scientific rigor;
Performing TMF involves rigorous laboratory biosafety criteria, including screening.
Clinical and microbiological examination of donors, screening for intestinal pathogens, viruses, and bacteria.
multidrug-resistant and other potentially transmissible microorganisms. In this context, the
Biomedical professionals play a fundamental role in performing microbiological tests and in analysis.
laboratory sample processing and quality monitoring of the biological material used.
In Brazil, the use of fecal microbiota transplantation still requires further regulatory consolidation.
The Brazilian National Health Surveillance Agency (ANVISA) establishes guidelines for sanitary control.
The handling of human biological material and microbiological safety are essential aspects for
to minimize the risks associated with the transmission of infectious agents during the procedure. In this
In this context, the safe implementation of TMF depends not only on its clinical effectiveness, but also
strengthening biosafety standards, laboratory standardization, and regulation.
sanitary, which ensures greater therapeutic safety for patients.
In this sense, Bascuñana *et al.* (2021) and Vaughn *et al.* (2023) highlight that the development of
Standardized encapsulated formulations represent a significant advance by facilitating application.
clinical aspects and reduce the risks associated with the procedure. Therefore, the biomedical professional plays a crucial role.
fundamental in donor screening and microbiological surveillance, especially with regard to
Prevention of the transmission of multidrug-resistant microorganisms, as advised by guidelines.
such as those of the *American Gastroenterological Association* (AGA) and the *British Society of*
Gastroenterology/ Healthcare Infection Society (BSG/HIS)
Finally, future prospects indicate promising advances in the area. AGA guidelines (2024)
They suggest the use of TMF as a preventive strategy in high-risk patients, even before...
occurrence of new infection episodes. Di Bella et al. (2024) point to the development of
live biotherapeutic products approved by the *Food and Drug Administration* (FDA), such as Rebyota
Vowst. These products offer more standardized and safer alternatives compared to...
Conventional TMF. Consequently, Yadegar *et al.* (2023) highlight the need to further explore
studies on epigenetic mechanisms, including the role of microRNAs in the regulation of
Inflammatory response, which may pave the way for more specific and innovative therapies in the future.
Thus, the analysis of the studies shows that fecal microbiota transplantation represents a
An effective and promising therapeutic approach in the treatment of Clostridioides difficile infection .

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especially in reducing recurrences. However, further progress is still needed in standardization of protocols, in the evaluation of long-term safety and in the development of new therapeutic strategies, in order to consolidate their application in clinical practice.

FINAL CONSIDERATIONS

The present study aimed to analyze the effectiveness of fecal microbiota transplantation in treatment of recurrent infections caused by *C. difficile,* highlighting its advantages compared to to conventional antibiotic therapies. The research made it possible to understand the limitations of conventional treatment, especially given the high recurrence rates and the impact of antimicrobial resistance, as well as the mechanisms involved in the restoration of the microbiota intestinal transplantation promoted by fecal transplantation.

Based on the bibliographic analyses carried out, it was observed that fecal microbiota transplantation It exhibits high efficacy in resolving the infection and preventing recurrences, demonstrating The results were superior to those of conventional therapies in most of the studies analyzed. The procedure has also shown potential to restore the balance of the gut microbiota. contributing to the reduction of intestinal inflammation and to the improvement of the quality of life of patients affected by the infection.

Despite the observed benefits, the studies also highlighted important limitations. related to the standardization of protocols, the choice of administration route, and the selection of donors. and to the assessment of long-term safety, especially in immunocompromised patients. Challenges related to the potential risk of transmission were also identified. pathogenic microorganisms and genes associated with antimicrobial resistance. It is worth highlighting that The need for new clinical research aimed at expanding knowledge about the effects of fecal microbiota transplantation, in order to improve its applicability and ensure greater safety. therapy.

This review contributes to a deeper understanding of therapeutic strategies. more effective in combating C. difficile infections , especially in light of the increase in cases recurrent infections and antimicrobial resistance. In the context of Biomedicine, the study reinforces the The importance of the biomedical professional's role in microbiological control, donor screening, and... biosecurity and in the development of more effective and individualized therapeutic approaches, aiming to promote health and improve patient care.

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