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HOLISTIC APPROACHES TO SMALL INTESTINAL BACTERIAL OVERGROWTH (SIBO): A REVIEW OF DIAGNOSTIC TOOLS AND COMBINED THERAPEUTIC STRATEGIES

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ABSTRACT

Background: Small Intestinal Bacterial Overgrowth (SIBO) is a complex gastrointestinal condition defined by excessive bacterial proliferation in the small intestine, often involving colonic species. Its prevalence is increasing, especially among individuals with irritable bowel syndrome, diabetes, or gastrointestinal motility disorders. SIBO presents with non-specific symptoms such as bloating, discomfort, and nutrient malabsorption, making diagnosis and treatment particularly challenging.
Methods: This review is based on a narrative synthesis of peer-reviewed literature from 2007 to 2025, retrieved through PubMed and Google Scholar. Inclusion criteria focused on diagnostic tools and integrative treatment strategies for SIBO, including antibiotics, diet, phytotherapy, and gut–brain axis modulation. Only high-quality studies were selected.
Results: SIBO is a multifactorial condition driven by motility disturbances, stress, dysbiosis, and anatomical abnormalities. While breath tests remain the most accessible diagnostic tools, their sensitivity is limited. Antibiotics such as rifaximin, metronidazole, and neomycin remain first-line therapy, yet symptom recurrence is common. Increasing attention is given to holistic management, including personalized low-FODMAP diets, herbal antimicrobials, digestive support, and gut–brain axis interventions. Patient-specific approaches, especially those addressing stress, sleep, and microbiota restoration, offer promising outcomes. However, implementation is challenged by inconsistent guidelines, insufficient follow-up, and varying patient adherence.
Conclusion: Effective SIBO management requires early diagnosis and multifaceted treatment strategies that extend beyond temporary microbial suppression. Personalized care integrating diet, microbiota modulation, psychological support, and long-term monitoring may improve outcomes and reduce recurrence. Further research is needed to validate holistic protocols and refine diagnostic criteria.

KEYWORDS

Small Intestinal Bacterial Overgrowth (SIBO), Rifaximin, Low-FODMAP Diet, Gut–Brain Axis, Probiotics, Microbiota Modulation, Herbal Antimicrobials, Breath Tests, Integrative Therapy

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Introduction

Small Intestinal Bacterial Overgrowth (SIBO) is a condition characterized by an excessive presence of bacteria in the small intestine, often involving species normally found in the colon. This unusual growth can cause symptoms like bloating, stomach pain, diarrhea, and poor nutrient absorption. SIBO is more common in people with irritable bowel syndrome, diabetes, liver disease, or problems with the structure or movement of the digestive system (Quigley, 2019).

Even though awareness of SIBO is increasing, it is still difficult to diagnose and treat. The most common diagnostic tools are breath tests, but their accuracy varies. The gold standard, jejunum aspirate culture, is rarely used because it is invasive and hard to perform (Losurdo et al., 2020). The main treatment is antibiotics like rifaximin, which can be effective, but many patients experience a return of symptoms, and the drug is not always available (Shah et al., 2013; Takakura et al., 2024).

Because of these difficulties, more people are turning to alternative and supportive treatments. These include dietary changes, probiotics, herbal antimicrobials, and behavioral methods that support gut health and microbial balance (Nickles et al., 2021). A combined approach that uses both medical and non-medical treatments may offer better, longer-lasting results, especially for people with chronic or hard-to-treat SIBO.

Aim of the Study

The aim of this review is to evaluate current diagnostic methods and therapeutic approaches for Small Intestinal Bacterial Overgrowth (SIBO), with special focus on the integration of standard pharmacological treatment and complementary strategies. By synthesizing available evidence, the study seeks to identify effective, patient-centered, and sustainable solutions for managing all forms of SIBO.

1. Diagnosis of Small Intestinal Bacterial Overgrowth (SIBO)

Patients with SIBO often experience common digestive symptoms such as bloating, abdominal discomfort, gas, diarrhea, or constipation. These symptoms are very similar to those found in functional gastrointestinal disorders, especially irritable bowel syndrome (IBS). SIBO appears to be more frequent in patients with diarrhea-predominant or mixed-type IBS, particularly when there is increased stool frequency, loose stool consistency, and excessive gas (Ghoshal et al., 2014).

The most common way to test for SIBO is through non-invasive breath tests that measure hydrogen and methane levels after consuming glucose or lactulose. Among these, glucose breath testing (GBT) is generally more accurate than lactulose breath testing (LBT). However, both tests have limitations. There is no standard method or universal cut-off value, and results can be affected by recent antibiotic use, diet, or oral bacteria. According to a recent meta-analysis, GBT showed a sensitivity of 54.5% and a specificity of 83.2%, while LBT had lower values (Losurdo et al., 2020).

LBT is especially prone to false positives due to rapid movement of the test sugar through the digestive tract. Methane levels, often included in breath test results, do not reliably indicate SIBO but may help identify cases of constipation-dominant IBS (Ghoshal et al., 2014).

The most accurate method to diagnose SIBO is still the culture of fluid from the small intestine (jejunal aspirate), which looks for bacterial counts of at least 10^5 CFU/mL. However, this test is rarely used because it is invasive, technically difficult, and may miss bacteria that cannot be cultured or that adhere to the intestinal wall (Miazga et al., 2015).

Notably, up to 45% of patients diagnosed with IBS based on the Rome criteria may actually have SIBO, which highlights the need for precise diagnosis (Esposito et al., 2007). Since symptoms often overlap between SIBO, IBS, and other gastrointestinal disorders, accurate testing is essential for choosing the right treatment and avoiding ineffective or unnecessary therapies.

2. Conventional Treatment Methods

Antibiotic Therapy

Antibiotics are the main treatment for Small Intestinal Bacterial Overgrowth (SIBO). Their goal is to reduce the number of bacteria in the small intestine and relieve symptoms. The most commonly use antibiotics include rifaximin, metronidazole, and neomycin. Their effectiveness and safety vary depending on the type of SIBO and individual patient characteristics.

Rifaximin is the best-studied antibiotic for SIBO. It works locally in the gut and is poorly absorbed, which reduces the risk of side effects. A large meta-analysis involving 1,331 patients showed that rifaximin achieved bacterial eradication in 70.8% of cases (intention-to-treat) and in 72.9% when only patients who completed treatment were considered (Gatta et al., 2017). In patients who cleared the bacterial overgrowth, 67.7% also reported symptom improvement. Higher doses and the use of rifaximin together with probiotics or prebiotics were associated with better outcomes. One randomized clinical trial showed that combining rifaximin with partially hydrolyzed guar gum (PHGG) increased the eradication rate to 87.1%, compared to 62.1% for rifaximin alone (Furnari et al., 2010).

Metronidazole is another option, although it is more likely to cause side effects because it is absorbed systemically. In a Chilean study, metronidazole had an eradication rate of 79%, compared to 59% for rifaximin. However, nearly 40% of patients taking metronidazole experienced side effects such as nausea or dizziness (von Muhlenbrock et al., 2024).

Neomycin is often used in cases of methane-dominant SIBO and may be combined with rifaximin to increase effectiveness against methane-producing bacteria. A systematic review found that 45.7% of patients treated with neomycin reported symptom improvement, compared to 14.9% in the placebo group (Takakura et al., 2024). However, due to the risk of serious side effects such as hearing or kidney damage, neomycin is usually reserved for selected cases.

Effectiveness Versus Recurrence

Although antibiotics often provide short-term improvement in SIBO, relapse is common. A meta-analysis showed that antibiotics increased the chance of breath test normalization (odds ratio: 2.55), but the actual symptom relief varied significantly between studies (Shah et al., 2013). In one study focusing only on rifaximin, the effect size was 1.97, but this result was not statistically significant ($p = 0.08$), suggesting that a normalized breath test does not always mean lasting symptom relief (Shah et al., 2013).

Relapse is likely when the root causes of SIBO, such as poor gut motility or structural problems, are not addressed. This is especially noticeable in children, where rifaximin normalized breath tests in only 20% of cases, even though it was well tolerated (Collins & Lin, 2011). In studies with adults, long-term follow-up is often missing, which makes it hard to fully evaluate the lasting effects of treatment (Majewski et al., 2007).

Limitations of the Standard Approach

Antibiotic treatment for SIBO has several important limitations. Although it helps reduce bacterial overgrowth, it does not restore a healthy microbiota or fix underlying problems such as impaired motility or structural abnormalities. As a result, symptoms often return, and repeated antibiotic use may lead to gut dysbiosis (Shah et al., 2013).

Rifaximin is usually well tolerated, but side effects can occur in a small number of cases (4.6%), including digestive discomfort and rare instances of Clostridioides difficile infection (Gatta et al., 2017). Moreover, rifaximin has limited effect on methane-producing organisms, which may require combination therapy with drugs like neomycin (Majewski et al., 2007).

Importantly, a normalized breath test does not always mean that symptoms improve, suggesting that other factors besides bacteria may contribute to SIBO symptoms (Furnari et al., 2010).

3. Diet in the Treatment of SIBO

Low-FODMAP Diet

The low-FODMAP diet (low in fermentable oligosaccharides, disaccharides, monosaccharides, and polyols) is one of the most commonly use dietary strategies for managing SIBO. By limiting certain carbohydrates that feed gas-producing bacteria, the diet helps reduce bloating, gas, diarrhea, and abdominal discomfort, symptoms common to both SIBO and irritable bowel syndrome (IBS).

A randomized trial by Eswaran et al. found that personalized low-FODMAP dietary guidance significantly reduced abdominal pain and bloating and lowered hydrogen gas levels in IBS patients, compared to standard dietary advice (Patcharatrakul et al., 2019). Although the study focused on IBS, the mechanisms of gas production are similar in SIBO.

In a clinical trial involving SIBO patients, Redondo-Cuevas et al. reported that 78.4% of those on a personalized low-FODMAP plan experienced symptom resolution, compared to 60.0% in the control group, supporting its benefit in managing SIBO symptoms (Redondo-Cuevas et al., 2024).

However, concerns exist regarding long-term use. Nickles et al. warned that the diet can reduce beneficial gut bacteria, such as Bifidobacterium, and lower microbial diversity (Wielgosz-Grochowska et al., 2022). Another paper also noted the risk of nutrient deficiencies, especially iron, calcium, and folate, when the diet is followed without proper guidance (Souza et al., 2022). Similar concerns were raised by Hersko, who found that patients often restrict foods out of fear of symptoms, leading to poor nutrition and reduced quality of life (Hersko, 2024).

The Role of Elimination and Reintroduction

A step-by-step dietary approach, including elimination, reintroduction, and personalization, is key to managing SIBO while maintaining proper nutrition. In the study by Redondo-Cuevas et al., patients first followed a strict low-FODMAP diet for four weeks, then gradually reintroduced foods over eight weeks with dietitian support. This helped identify triggers while preserving dietary variety (Redondo-Cuevas et al., 2024).

Similarly, another study showed that individualized reintroduction improved patient adherence and reduced hydrogen gas production more effectively than general dietary advice (Patcharatrakul et al., 2019). In contrast, some authors warned that prolonged elimination without supervision can lead to nutrient deficiencies, dysbiosis, and psychological stress (Wielgosz-Grochowska et al., 2022; Hersko, 2024).

Importance of Individualization

Dietary needs vary across SIBO subtypes. Wielgosz-Grochowska et al. found that hydrogen-dominant patients consumed less lactose and fat, likely due to intolerance, while methane- and mixed-type patients had lower fiber intake and higher fat consumption (Wielgosz-Grochowska et al., 2024). These patterns may worsen

motility and microbial imbalance, especially in constipation-related SIBO. The same study also noted vitamin D and ferritin deficiencies, particularly in mixed-type cases, suggesting malabsorption and restrictive eating.

Personalization is further supported by findings by Hersko, where patients reported varied reactions to specific foods and behaviors. Methane-dominant individuals were more likely to avoid fiber, while hydrogen-dominant patients often restricted lactose or gluten, sometimes unnecessarily (Hersko, 2024).

Other Dietary Approaches

Alternative diets, such as elemental diets, may help selected patients. Nickles et al. reported that a 14-day elemental diet normalized breath tests in up to 85% of SIBO cases (Nickles et al., 2021). However, cost, poor taste, and low adherence limit its use.

Experts also caution against unverified "SIBO diets" promoted online, many of which lack scientific backing and may harm gut health (Souza et al., 2022).

4. Phytotherapy and Supplementation

Herbal Antimicrobials

Herbal treatments are increasingly used as alternatives or additions to antibiotics in SIBO therapy, especially due to rising antibiotic resistance and frequent relapses. Botanical agents like oregano oil, berberine, garlic extract, and thyme act through multiple mechanisms, including disrupting bacterial membranes, inhibiting biofilms, and supporting immune responses (Min et al., 2024).

In an open-label study, a protocol using Biocidin (a broad-spectrum botanical formula with antimicrobial and biofilm-disrupting properties) and GI Detox+ (a binder containing activated charcoal, zeolite, and other ingredients aimed at absorbing microbial toxins) led to breath test normalization in 66.7% of hydrogen-dominant SIBO patients and 42.8% of hydrogen-sulfide-dominant cases, along with improved microbial diversity and reduced facial redness. Methane-dominant SIBO showed weaker response, likely due to resistance of methane-producing microbes (Min et al., 2024).

Earlier studies suggest that herbal regimens can match the effectiveness of rifaximin, especially in patients who failed antibiotic therapy (Zhong et al., 2017).

Comparison with Antibiotics

In direct comparisons, herbal treatments combined with probiotics performed better than antibiotics alone in methane-dominant SIBO (Redondo-Cuevas et al., 2024). Meta-analyses also showed herbal and probiotic strategies achieving similar or better outcomes than metronidazole, especially when combined with antibiotics (up to 85.8% success rate) (Zhong et al., 2017). However, breath test normalization after herbal therapy does not always match symptom relief, pointing to the need for broader treatment goals (Redondo-Cuevas et al., 2024).

Probiotics and Prebiotics – To Use or Not to Use?

The role of probiotics in SIBO is debated, as they may worsen overgrowth in some cases. Yet, several studies suggest benefits when properly selected and combined with antimicrobials. For example, co-administration of Saccharomyces boulardii with rifaximin improved outcomes in methane-dominant SIBO (Redondo-Cuevas et al., 2024). A trial with Lactobacillus casei Shirota showed breath test normalization in 64% of patients and a 55% reduction in symptoms (Barrett et al., 2008).

In another clinical trial involving pregnant women with SIBO and subclinical hypothyroidism, a 21-day synbiotic protocol with probiotics and polysaccharide-based prebiotics significantly reduced methane production and improved systemic markers such as TSH and lipid levels (Ouyang et al., 2024).

Still, not all patients tolerate probiotics equally. Some patients report worsening of bloating or brain fog, especially in the presence of motility disorders (Rao & Bhagatwala, 2019).

Prebiotics are usually avoided during active SIBO due to fermentation risk. However, partially hydrolyzed guar gum (PHGG) has been well tolerated during post-treatment recovery, supporting mucosal healing and microbial diversity (Redondo-Cuevas et al., 2024).

Other Supplements

Digestive support is often needed in SIBO. Low stomach acid (hypochlorhydria), sometimes caused by long-term use of proton pump inhibitors, can promote overgrowth. Though data are limited, HCl supplementation may help restore gut acidity (Rao & Bhagatwala, 2019; Velasco-Aburto et al., 2025).

Digestive enzymes may aid absorption and reduce fermentable residues, particularly in patients with pancreatic insufficiency or slow motility (Velasco-Aburto et al., 2025).

Fiber needs vary. Insoluble fiber can worsen symptoms during active SIBO, but soluble, low-fermenting types like PHGG can support motility and gut recovery afterward. In methane-dominant SIBO, carefully balanced fiber intake may help relieve constipation without increasing fermentation (Velasco-Aburto et al., 2025).

5. Gut–Brain Axis and Psychophysiological Factors

The gut–brain axis (GBA) is a two-way communication system linking the gut and central nervous system through neural, hormonal, immune, and microbial pathways. In SIBO, disturbances in this axis may worsen symptoms and contribute to chronicity, especially via stress, altered motility, and neuroinflammatory responses driven by the microbiota.

Stress and Its Impact on Motility

Stress is a key factor in gut–brain imbalance. In patients with IBS, commonly overlapping with SIBO, higher levels of anxiety, depression, and stress are frequently reported (Chu et al., 2016). Stress likely disrupts intestinal motility by affecting the hypothalamic–pituitary–adrenal (HPA) axis and autonomic balance, leading to bacterial overgrowth.

Chronic stress can also alter the gut microbiota and weaken the intestinal barrier, increasing permeability and promoting inflammation and bacterial translocation (Almeida et al., 2020).

Sleep, Physical Activity, and Relaxation Techniques

Lifestyle habits such as sleep, exercise, and relaxation significantly affect gut–brain signaling. While direct data in SIBO are limited, broader studies show that poor sleep quality is linked to dysbiosis and inflammation. In animal models, sleep deprivation changed the gut microbiota, reducing beneficial butyrate-producing bacteria and increasing pro-inflammatory species like Aeromonas (Wang et al., 2023).

Butyrate, a key short-chain fatty acid (SCFA), has anti-inflammatory and neuroprotective properties. In sleep-deprived mice, butyrate supplementation reduced brain inflammation and improved cognition by modulating microglial activity and inhibiting HDAC3 (Wang et al., 2023).

Relaxation techniques such as yoga and breathwork may also modulate autonomic tone, enhance vagal activation, and indirectly stabilize microbial populations (Almeida et al., 2020).

Emotional Regulation and Neuropsychological Factors

Emotional and cognitive processes influence gut function via brain circuits that control vagal output. Studies in IBS show that emotional dysregulation affects both gut physiology and microbiota. Cognitive-behavioral therapy (CBT) has been shown to improve symptoms by modifying brain activity and microbial composition, reducing Prevotella and increasing Bacteroides (Jacobs et al., 2021).

Similarly, sleep disturbances can also increase neuroinflammation and alter microbiota, effects that may be reversed through microbiome-targeted interventions, highlighting the bidirectional influence of emotions and microbiota (Wang et al., 2023).

Additionally, personality and emotional traits appear to modulate SIBO outcomes. In a Polish study, SIBO patients exhibited significantly higher neuroticism and stress scores, while greater extroversion was linked to lower emotional tension, suggesting a psychosomatic dimension to SIBO vulnerability (Kossewska et al., 2023).

Wider research also connects gut dysbiosis with mental health disorders like depression and anxiety. Altered microbiota may contribute to neuroinflammation and disrupted brain signaling. SCFAs and tryptophan metabolites play a role in modulating serotonin, brain plasticity, and microglial activity, linking gut and emotional health (Góralczyk-Bińkowska et al., 2022).

6. Holistic and Integrative Approach

The Functional Medicine Model

Functional medicine offers a personalized, system-based approach to SIBO that addresses deeper causes such as impaired motility, dysbiosis, inflammation, nutritional deficiencies, and psychosocial stress. This model is well suited to the multifactorial nature of SIBO, as shown in clinical, dietary, and psychological studies.

Individualized diet is central to this approach. Low-FODMAP and elimination diets are effective in reducing symptoms, especially when followed by supervised reintroduction (Redondo-Cuevas et al., 2024; Patcharatrakul et al., 2019). However, overly strict diets may lower beneficial bacteria like Bifidobacterium and increase the risk of nutrient deficiencies (Souza et al., 2022).

Phytotherapeutic agents such as berberine, garlic extract, and oregano oil are also commonly used. In some cases, they have shown similar effectiveness to rifaximin and may be helpful in rifaximin-resistant or methane-dominant SIBO (Min et al., 2024; (Zhong et al., 2017).

Other supportive therapies include prebiotics like partially hydrolyzed guar gum (PHGG), digestive enzymes, and betaine HCl, used to restore normal digestive function rather than only reduce bacteria (Velasco-Aburto et al., 2025).

This model also integrates gut–brain axis support, acknowledging that stress, poor sleep, and emotional dysregulation affect motility and immune balance. Studies support the relevance of lifestyle and neuropsychological interventions in symptom management (Kossewska et al., 2023; Jacobs et al., 2021).

Challenges and Controversies in the Integrative Approach

Despite its potential, integrative SIBO care faces challenges. Evidence for certain therapies, like herbal antimicrobials, psychobiotics, or elemental diets, is often based on small or open-label trials (Nickles et al., 2021; Redondo-Cuevas et al., 2024).

Additionally, many patients follow complex diets or use supplements without professional guidance, risking over-restriction, fear of food, and further microbial imbalance (Hersko, 2024).

Diagnosis remains inconsistent. While jejunal aspirate culture is the gold standard, it is rarely used due to its invasiveness. Breath tests are more common but vary in accuracy and interpretation, especially lactulose-based tests.

Probiotic use is another area of debate. Some avoid it during active SIBO, while others report better outcomes with targeted strains like Saccharomyces boulardii or Lactobacillus casei (Redondo-Cuevas et al., 2024).

Recurrence also remains a major issue. Even after rifaximin treatment, relapse rates often exceed 40%, pointing to the need for long-term, cause-focused strategies (Shah et al., 2013).

The Role of Patient Education and Interdisciplinary Collaboration

A key strength of the integrative model is its emphasis on patient education and teamwork among healthcare professionals. Patients benefit from understanding how diet, chewing habits, physical activity, and emotional health affect gut function (Hersko, 2024).

Dietitians are essential for guiding safe, personalized nutrition and ensuring that reintroduction phases are nutritionally sound (Wielgosz-Grochowska et al., 2022). Gastroenterologists are needed to monitor symptoms and manage medications. Psychologists or therapists can address emotional factors using techniques such as gut-directed cognitive behavioral therapy.

Personality traits like high neuroticism or low stress resilience may influence SIBO outcomes and broader psychiatric research highlights the link between microbiota imbalance and mental health (Kossewska et al., 2023) (Góralczyk-Bińkowska et al., 2022).

Conclusions

Small Intestinal Bacterial Overgrowth (SIBO) is a multifaceted condition that extends beyond a purely infectious paradigm. This review demonstrates that addressing SIBO requires not only symptom control through antibiotics or diet but also a broader understanding of its physiological, nutritional, and psychological underpinnings.

Evidence suggests that recurrence and treatment resistance often reflect overlooked drivers such as impaired motility, chronic stress, and disrupted microbial ecology. Diagnostic and therapeutic decisions should therefore be guided by individual profiles, not uniform protocols.

While holistic and integrative strategies, ranging from personalized nutrition to microbiota modulation and gut–brain axis interventions, offer encouraging results, their application must be grounded in clinical expertise and supported by further research.

Ultimately, the most effective management of SIBO will depend on shifting from reactive treatment to proactive, individualized care. This demands interdisciplinary collaboration, careful monitoring, and a long-term strategy that recognizes the complexity of both the condition and the patient.

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