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MODERN DIAGNOSTIC AND THERAPEUTIC APPROACHES TO IRRITABLE BOWEL SYNDROME: AN INTEGRATIVE REVIEW

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ABSTRACT

Irritable bowel syndrome (IBS) is a highly prevalent functional gastrointestinal disorder characterized by recurrent abdominal pain, bloating, and altered bowel habits in the absence of detectable organic pathology. While not life-threatening, IBS significantly impairs patients' quality of life and imposes a substantial burden on global healthcare systems. This review aims to provide a comprehensive synthesis of modern diagnostic and therapeutic methods for IBS. The methodology involved a narrative review of scientific literature from major biomedical databases, including PubMed, Scopus, and Google Scholar. Key findings highlight the importance of the Rome IV criteria for diagnosis and classification based on predominant stool patterns. The pathophysiology is increasingly understood as a disorder of the gut-brain axis, involving visceral hypersensitivity, altered motility, immune activation, and microbiome dysbiosis. Consequently, treatment has shifted towards an individualized, integrative model. This includes dietary interventions like the low-FODMAP diet, evidence-based pharmacotherapies targeting specific symptoms and mechanisms, and psychological therapies such as cognitive-behavioral therapy (CBT) and gut-directed hypnotherapy. Emerging therapies based on microbiome modulation and digital medicine (e-health) show significant promise. The conclusion emphasizes that an integrated, patient-centered approach that considers the unique pathophysiological profile and personal needs of each individual is essential for effective IBS management.

KEYWORDS

Irritable Bowel Syndrome, IBS Treatment, FODMAP Diet, Microbiota, Gut-Brain Axis, Psychological Therapy

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Introduction

Irritable bowel syndrome (IBS) is one of the most common functional gastrointestinal disorders (FGIDs) diagnosed in clinical practice worldwide. It is defined by a constellation of chronic and recurrent symptoms, including abdominal pain, bloating, and abnormal bowel movements, for which no underlying organic, biochemical, or structural cause can be identified through standard diagnostic testing [1, 32]. Although IBS does not increase mortality risk, its impact is far from benign. The condition significantly diminishes patients' health-related quality of life (HRQoL), often to a degree comparable to or worse than that of chronic organic diseases like Crohn's disease or type 2 diabetes [9]. Furthermore, it places a considerable economic burden on healthcare systems through frequent physician visits, repetitive diagnostic testing, and lost productivity [2, 6].

The aim of this review is to present a comprehensive and current synthesis of modern diagnostic and therapeutic methods for irritable bowel syndrome. This includes an in-depth analysis of conventional treatments-spanning dietary, pharmacological, and psychological approaches-as well as emerging therapies grounded in recent advances in our understanding of the gut microbiota, neurogastroenterology, and digital medicine. This article seeks to highlight the critical importance of developing individualized, integrative treatment strategies tailored to the pathophysiological profile and personal needs of each patient, with a particular focus on the role of the gut-brain axis, microbiome modulation, and e-health solutions in contemporary management.

Materials and Methods

This narrative review was conducted to synthesize current knowledge on the diagnosis and treatment of irritable bowel syndrome (IBS), with a focus on modern and emerging therapeutic strategies. A targeted literature search was performed across major biomedical databases, including PubMed, Scopus, and Google Scholar, to collect relevant scientific articles. The search focused on identifying systematic reviews, meta-analyses, randomized controlled trials, and clinical guidelines related to the pathophysiology, diagnosis, and management of IBS. Key areas of focus included dietary interventions (e.g., the FODMAP diet), pharmacotherapy (e.g., rifaximin, linaclotide), psychological therapies (e.g., CBT, hypnotherapy), and novel approaches involving the gut microbiome and digital health platforms.

Definition, Classification, and Epidemiology of IBS

Definition and Diagnostic Criteria According to the current Rome IV criteria, which represent the globally accepted diagnostic standard, IBS is defined by the presence of recurrent abdominal pain experienced, on average, at least one day per week in the last three months. This pain must be associated with at least two of the following criteria: it is related to defecation, it is associated with a change in stool frequency, or it is associated with a change in stool form (appearance). For a formal diagnosis, these criteria must have been fulfilled for the last three months with symptom onset at least six months prior to diagnosis [1, 32].

Classification Given the heterogeneous clinical presentation of IBS, a classification system based on the predominant stool pattern is used in clinical practice to guide therapy. The Rome IV criteria delineate four primary subtypes [1]:

- **IBS with predominant constipation (IBS-C):** Characterized by ≥25% of bowel movements being hard or lumpy (Bristol Stool Scale types 1–2) and <25% being loose or watery (types 6–7). Patients often report a feeling of incomplete evacuation and bloating.
- **IBS with predominant diarrhea (IBS-D):** Diagnosed when ≥25% of bowel movements are loose or watery and <25% are hard or lumpy. Symptoms frequently include urgency, particularly in the morning or postprandially.
- **IBS with mixed bowel habits (IBS-M):** Defined by the occurrence of both hard/lumpy and loose/watery stools for ≥25% of bowel movements each. This subtype is often challenging to manage due to its unpredictable nature.
- **IBS-Unclassified (IBS-U):** Applies to patients who meet the diagnostic criteria for IBS but whose bowel habits do not fit into the C, D, or M categories.

Epidemiology IBS is a global health issue. A landmark meta-analysis by Sperber et al. (2021) reported a global average prevalence of approximately 10–12% [2]. However, these figures exhibit significant regional variation, with prevalence estimated at 4–9% in Asia, 11–15% in North America and Europe, and as high as 21% in South America [2]. In Poland, the prevalence is estimated to be between 9% and 13%, though many cases likely remain undiagnosed [8]. A study by Wojcik et al. (2018) found that while 70% of primary care patients reported symptoms suggestive of IBS, only about 20% had received a formal diagnosis [8]. Key

epidemiological risk factors include female sex (2:1 ratio), age of onset between 20 and 40 years, a history of infectious gastroenteritis (post-infectious IBS), and the presence of psychological comorbidities such as anxiety and depression.

Pathophysiology: The Central Role of the Gut-Brain Axis

The pathogenesis of IBS is increasingly understood as a disorder of the gut-brain axis, a complex bidirectional communication network linking the central nervous system (CNS) and the gastrointestinal tract. This system integrates the autonomic nervous system, the hypothalamic-pituitary-adrenal (HPA) axis, the enteric nervous system, the immune system, and the gut microbiota [3, 12].

Disruptions in this axis are a key mechanism underlying IBS symptoms. Stress and emotional states are potent modulators of this network. In many IBS patients, psychological stress triggers or exacerbates symptoms through excessive activation of the HPA axis. This leads to increased cortisol levels, which in turn alters intestinal motility, increases visceral pain perception, and compromises the integrity of the intestinal epithelial barrier ("leaky gut") [3, 12, 28]. Functional brain imaging studies have revealed that IBS patients exhibit altered activity in brain regions involved in pain processing, such as the cingulate cortex and insula, leading to a state of visceral hypersensitivity where normal gut sensations are perceived as painful [3, 12, 23].

Neurotransmitters, particularly serotonin (5-HT), play a crucial role. Over 90% of the body's serotonin is produced in the gut, where it regulates motility, secretion, and sensation [9]. Imbalances in serotonin signaling are implicated in both IBS-C and IBS-D. The gut microbiota is another pivotal player, interacting extensively with the gut-brain axis. Dysbiosis—an imbalance in the composition and function of gut bacteria—is commonly observed in IBS patients. This can alter the production of key metabolites, such as short-chain fatty acids (SCFAs) and neurotransmitters, which can directly influence gut function and send aberrant signals to the CNS, perpetuating the cycle of symptoms [12].

Modern Therapeutic Strategies

The multifaceted pathophysiology of IBS necessitates an individualized and multi-pronged therapeutic approach. Treatment is typically layered, beginning with non-pharmacological interventions and escalating to pharmacotherapy and more specialized treatments as needed.

Non-Pharmacological Treatment

- **Dietary Modification:** Diet is a cornerstone of IBS management. The most well-researched and effective dietary intervention is the **low-FODMAP diet** [22]. FODMAPs (Fermentable Oligosaccharides, Disaccharides, Monosaccharides, and Polyols) are short-chain carbohydrates that are poorly absorbed and rapidly fermented by gut bacteria, leading to gas, bloating, and pain. The diet involves a temporary elimination phase (2–6 weeks), followed by a structured reintroduction phase to identify individual trigger foods, culminating in a personalized long-term diet. Meta-analyses show that up to 70% of IBS patients experience significant symptom improvement, particularly in bloating, pain, and diarrhea [22]. Emerging research suggests that a patient's gut microbiota profile may predict their response to the diet, opening avenues for more personalized application [4].
- **Probiotics and Prebiotics:** Given the role of dysbiosis, modulating the gut microbiome is a logical therapeutic target. Probiotics are live microorganisms that can confer a health benefit. Specific strains, such as *Bifidobacterium infantis 35624* and *Lactobacillus plantarum 299v*, have shown efficacy in reducing global IBS symptoms, particularly bloating and pain [13, 30]. Meta-analyses indicate that multi-strain formulations may be more effective, though effects are strain-specific and modest [13]. Prebiotics, which are fermentable fibers that promote the growth of beneficial bacteria, may be helpful in low doses but can also exacerbate symptoms in some patients.
- **Psychological Support:** The profound influence of the gut-brain axis provides a strong rationale for psychological therapies, especially for patients with moderate-to-severe symptoms or significant stress-related symptom exacerbation. **Cognitive-behavioral therapy (CBT)** is the most established approach, helping patients reframe their interpretation of symptoms, reduce catastrophizing, and develop effective coping strategies. Clinical trials demonstrate symptom improvement in 60–70% of patients [15]. **Gut-directed hypnotherapy** has also proven effective in reducing visceral hypersensitivity and pain. Increasingly, these therapies are being delivered via digital platforms and mobile apps, improving accessibility and scalability [15, 16, 17].

Pharmacological Treatment

Pharmacotherapy is reserved for patients with persistent symptoms despite non-pharmacological interventions. The choice of agent is guided by the patient's IBS subtype and predominant symptoms [7].

- **For IBS-D: Rifaximin**, a non-absorbable antibiotic, can provide symptom relief by modulating the gut microbiota and reducing bacterial fermentation [7]. **Eluxadoline**, an opioid receptor agonist, reduces motility and visceral pain but is contraindicated in certain patients.
- **For IBS-C: Linaclotide** and **Lubiprostone** are secretagogues that increase fluid secretion into the intestinal lumen, thereby accelerating transit and improving stool consistency [7].
- **For Abdominal Pain and Neuromodulation:** Low-dose **tricyclic antidepressants (TCAs)**, such as amitriptyline, are highly effective central neuromodulators that reduce visceral pain independently of their antidepressant effects [21]. **Selective serotonin reuptake inhibitors (SSRIs)** may be used for patients with co-existing depression or anxiety, particularly in IBS-C [20]. Antispasmodics like mebeverine or drotaverine can be used for acute symptomatic relief of cramps.

New and Emerging Therapeutic Approaches

Research into the pathophysiology of IBS is paving the way for innovative therapeutic strategies that promise greater personalization and efficacy.

- **Microbiota-Targeted Therapies: Fecal microbiota transplantation (FMT)**, while highly effective for *C. difficile* infection, has shown mixed and inconclusive results for IBS and is currently not recommended outside of clinical trials. The future likely lies in **precision probiotics** and therapies based on specific microbial metabolites like SCFAs.
- **Digital Therapeutics (DTx):** Mobile applications delivering structured CBT, gut-directed hypnotherapy (e.g., Nerva), and symptom tracking are gaining regulatory approval and becoming an important part of the therapeutic toolkit. These e-health solutions offer scalable, accessible, and cost-effective care [19, 27].
- **Biomarker-Guided Therapy:** The ultimate goal is a shift from empirical treatment to precision medicine. Ongoing research aims to identify reliable biomarkers (e.g., inflammatory markers, fecal metabolites, genetic profiles) that can predict a patient's response to a specific therapy, allowing for targeted treatment selection from the outset [18, 29].

Discussion and Future Directions

The management of IBS is undergoing a paradigm shift, moving away from a one-size-fits-all, symptom-suppression model towards a personalized, mechanism-based approach. The recognition of IBS as a disorder of the gut-brain axis has been central to this evolution, validating the integration of dietary, psychological, and pharmacological interventions. The low-FODMAP diet and gut-directed psychotherapies represent major advances in non-pharmacological management, offering significant relief to a large proportion of patients.

The future of IBS treatment lies in harnessing technology and molecular medicine to further personalize care. Artificial intelligence and machine learning algorithms are being developed to predict treatment responses based on complex patient data, including symptoms, genetics, and microbiome composition [18, 26]. The development of new drug classes and biological therapies targeting specific receptors or inflammatory pathways continues. Digital therapeutics are set to become a standard component of care, providing continuous support and remote monitoring that can empower patients and optimize treatment outcomes [16, 27].

Despite these advances, significant challenges remain. The heterogeneity of the IBS population makes clinical trials difficult to interpret, and there is a need for more long-term data on the efficacy and safety of new interventions. A key direction for future research is the identification and validation of biomarkers that can reliably stratify patients into distinct pathophysiological endotypes, allowing for truly targeted and effective therapy.

Conclusions

In conclusion, irritable bowel syndrome is a complex and challenging disorder rooted in disruptions of the gut-brain axis. Modern management has evolved to embrace a personalized, multimodal strategy that integrates dietary modification, psychological support, and targeted pharmacotherapy. The low-FODMAP diet and CBT have emerged as evidence-based cornerstones of non-pharmacological care, while newer drugs and microbiome-modulating agents offer valuable options for specific patient profiles. The future of IBS therapy is bright, with the promise of precision medicine, digital therapeutics, and novel biological treatments poised to transform patient care. This continued evolution towards an integrated and individualized approach should markedly enhance patients' quality of life and reduce the substantial personal and societal burden of IBS [3, 12, 18].

Authors' contributions:
Conceptualisation: SK
Methodology: ZK
Software: JK,NS
Check: ZK, NS
Formal analysis: SK
Investigation: JK
Resources: SK
Data curation: SK,NS
Writing-rough preparation: ZK
Writing-review and editing: JK
Visualization: SK,JK
Project administration: NS, ZK
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