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OPTIMIZATION OF TREATMENT OF BACTERIAL VAGINOSIS

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ABSTRACT

Bacterial vaginosis (BV) is one of the most common dysbioses among sexually active women (prevalence between 23-29%). It is characterized by reduction in the natural microflora of Lactobacillus and overgrowth of anaerobic bacteria, such as Gardnerella vaginalis. BV is an important risk factor for reproductive health complications, including higher incidence of sexual transmitted infections (STIs), preterm birth, and infertility. Standard treatment is based on antibiotics like metronidazole, which is highly effective for alleviating acute symptoms but carries a high recurrence risk (up to 60% within 12 months) due to biofilm formation on the vaginal epithelium, which prevents penetration of medicines and leads to antibiotic resistance. The primary goal of BV treatment is to ensure stable long-term eubiosis through rapid, accurate diagnosis and effective treatment. This review identifies optimization approaches, including alternative antibiotics regimens, biofilm management, and supportive therapies.

KEYWORDS

Bacterial Vaginosis, Antibiotic Treatment, Dysbiosis, Probiotics, Biofilm

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1. Introduction

The healthy vaginal microbiome maintains a symbiotic relationship with the host, influenced by factors such as hormone levels, physiological changes, pregnancy [1]. The predominant microorganism from the vaginal microbiome is Lactobacillus. These bacteria are able to control the growth of other bacteria thanks to the production of bioactive agents [2], and lactic acid which is crucial for maintaining a low pH. In effect, this makes the vaginal environment hostile to many pathogens. These mechanisms make Lactobacillus the main inhabitant of the vagina. Female sex hormones exert a strong influence on these bacteria; they increase the level of glycogen, which is essential for the proper function of Lactobacillus [3].

Bacterial vaginosis (BV) is one of the most common vaginal infections among sexually active women, with a prevalence between 23% and 29% [4]. BV is related to a reduction in the natural vaginal microbiota mainly consisting of Lactobacillus [5]; this decrease in lactobacilli leads to an overgrowth of predominantly anaerobic microorganisms [6]. One of the most frequently isolated bacteria are Gardnerella vaginalis, Atopobium vaginae, Prevotella spp. [7]. This dysbiosis causes increased vaginal discharge with a fishy odour. BV is not only a source of discomfort for the women but also a risk factor for many serious consequences such as higher rates of STIs, PID, and preterm labour [8]. Because of this, the treatment of bacterial vaginosis is crucial for maintaining healthy reproductive organs.

The purpose of this review paper is to summarize and compare information on the treatment of bacterial vaginosis and to investigate the evidence of its effectiveness as new medical strategies are emerging.

2. Research materials and methods

2.1. Data for this review were gathered through a systematic search across major scientific databases, such as Google Scholar and PubMed. The search strategy was based on keywords related to the subject matter (e.g., bacterial vaginosis, biofilm, dysbiosis, and probiotics). This review mainly focuses on synthesizing and comparing the statistical findings and reported conclusions.

2.2. AI was utilized for the linguistic refinement of this review to ensure proper English grammar and style. AI tools were used strictly for assistance, rather than to replace human interpretations and judgment.

3. Research results

3.1. Biofilm formation as a major therapeutic challenge.

A major therapeutic challenge in treating bacterial vaginosis is biofilm formation. This structure develops on vaginal epithelium when bacteria adhere to the surface, leading to colonization of tissues. Studies show that *Gardnerella* is crucial for the stage-setting of biofilm formation and also associated with treatment failure in BV [9]. The bacteria that make up this structure exhibit higher antibiotic resistance, which results in a higher chance of recurrence [10]. Other reasons pointed as an explanation for the high recurrence rates are the protective effect of some species which leads to a reduction in antibiotic bioavailability and the presence of biofilm that makes it harder to eradicate infection [11].

3.2. Recurrence rate and its impact on women

Standard treatment is effective in relieving symptoms of bacterial vaginosis but they are burdened with a recurrence rate of up to 60% within 12 months [12]. This leads not only to physical distress but also to a psychological burden for women experiencing BV. The study points to the negative impact on quality of female life, affecting both on social and personal aspects. Vaginal symptoms are associated with extreme anxiety and embarrassment, which lead to lowered self-esteem [13].

3.3. Current Standard Treatments

Current standard treatment for bacterial vaginosis is focused on stopping the proliferation of pathogens and restoring the physiological microbiome. It is based on antibiotic therapy against anaerobic bacteria and use of probiotics. The most common medication, and a drug of choice is metronidazole, administered orally or intravaginally [14]. Another used medication is tinidazole, which is structurally related to metronidazole; studies show that it has some benefits over the latter, such as reduced dosage or frequency of administration. However, the usage of tinidazole is not the primary treatment of choice, mostly because of a lack of compelling clinical comparisons [15].

The second-choice drug is clindamycin, recommended when there is failure in first-choice treatment, fast recurrence of BV, or metronidazole intolerance. The preferred usage is intravagina, in the form of a cream or globule. Clindamycin is more effective against certain pathogens and is better tolerated when used locally. On the other hand, there is greater risk of resistance development in comparison to nitroimidazoles, and likelihood of diarrhea related to *Clostridium difficile* [16]. Although antibiotics effectiveness is relatively high (up to 90%) [17][18], the biggest problem remains the recurrence of bacterial vaginosis.

The primary flaw of standard treatment is a very high recurrence rate, reaching up to 70% during the first year after medication [19]. This begs the question: is antibiotic therapy enough to fight bacterial vaginosis? While metronidazole and other antibiotics have great results against many pathogens, they also affect the natural microbiome. As a result, a weakened vaginal ecosystem is more likely to succumb to another infection. After treating BV with antibiotics, there are chances of developing persistent inflammation caused by immune protein disorders. This situation leads to subclinical dysbiosis [20].

Treating bacterial vaginosis with only antibiotics presents the risk of ineffective removal of the biofilm created by bacteria. These drugs have difficulty penetrating the organized bacterial structure, and as a result, some pathogens can be shielded from contact with medication [21]. Another crucial problem in treatment is the development of antibiotic resistance, not just for a single pathogen, but for the whole polymicrobial structure. Even though metronidazole is still a drug of first choice, many pathogens have developed decreased sensitivity to it, leading to incomplete therapeutic effectiveness. Many bacteria associated with BV are also resistant to clindamycin [22].

Behavioral factors are also important for the success of the treatment. Bacterial vaginosis is strongly related to social and sexual risk factors; therefore to achieve a positive outcome, some of these need to be modified. High frequency of intercourse, a large number of sexual partners, and lack of condom use can cause a “vicious circle” of treatment difficulties. These activities lead to constant disruption of the microbiome balance [23]. Finally, failure to follow medical recommendations, such as the early discontinuation of treatment, is a common reason why therapy is unsuccessful [24].

3.4. Strategies for Optimization of BV Treatment

3.4.1. Alternative antibiotic regimens

Failures in treating bacterial vaginosis using only standard protocols have forced a search for alternative BV therapies. For now, they are still based on nitroimidazole derivatives, but they include new substances or modified methods of administration. For example, secnidazole is a promising alternative to metronidazole. The advantage of this medication is its single-dose usage, which increases the likelihood of patient compliance [11]. Another alternative to oral metronidazole is prolonged-release metronidazole gel. Thanks to the local route of administration, it can achieve a higher concentration directly at the site of infection. It also has less systemic toxicity, minimizing the frequency of side effects and providing quick, noticeable results for many patients [25]. Combined therapy brings many advantages, as it involves the simultaneous administration of oral antibiotics, such as metronidazole or tinidazole, and intravaginal boric acid. This type of procedure allows for a comprehensive approach to the problem, directed at both combating bacteria and the destruction of the biofilm [26]. Other common practices rely on the oral use of antibiotics and subsequent administration of probiotics, either orally or vaginally.

3.4.2. Management of BV biofilms

Another way to approach the treatment of bacterial vaginosis is based on the management of biofilms. As studies show, they form a barrier to antibiotic penetration, therefore, for successful therapy, there is a need to break through it. Boric acid is one option; this weak acid has a disruptive effect on the biofilm structure. After the disorganization of the barrier, it allows antibiotics such as metronidazole to fight pathogens more effectively. Also, thanks to its acidic pH, it has an antibacterial effect, while creating favorable environmental conditions for the natural vaginal microbiome. Boric acid is recommended as a combined treatment and maintenance therapy for BV [27]. As Caliskan's 2025 research showed, the use of this acid brings significant improvement in women's health and a reduction in symptoms [28]. Besides boric acid, dequalinium chloride (DQC) is a promising disrupting factor for biofilm structure. It is particularly effective against *Gardnerella* spp. thanks to its ability to disrupt bacterial and fungal membranes [29]. Dequalinium chloride is recommended for recurrent bacterial vaginosis that is resistant to antibiotics. There is an ongoing study in which DQC is compared to standard antibiotics in order to determine if it could be used as a drug of choice in BV [30]. Other chemicals targeting biofilm disruption, such as amphoteric tensides, are also in the clinical research phase and show promising results in vitro [31].

3.4.3. Adjunctive and supportive therapies

Besides directed action towards killing pathogens with antibiotics, measures should be taken to rebuild the natural vaginal microbiome. After antibiotic therapy, it is recommended to take probiotics containing *Lactobacillus*. Clinical research shows that probiotics are significant in lowering the risk of BV recurrence. Possible routes of administration are oral and vaginal, and a comparison of those two options indicates that both of them have similar outcomes [32][33]. Therefore, the choice of route can be based on patient preference. Preparations with *Lactobacillus crispatus* are particularly promising, not only do they restore stable vaginal microflora but, but they are exceptionally good at fast colonization after antibiotic therapy. They are great for preventing bacterial vaginosis and maintaining a state of eubiosis in the vagina [34]. To achieve this, the additional use of prebiotics is possible; their main role is to selectively support dominant strains of *Lactobacillus* and indirectly restore the acidic environment through increased production of lactic acid. The main prebiotic for the vagina is glycogen, but there are also other substances such as oligosaccharides or inulin [35].

3.4.4. Behavioral and lifestyle interventions

To prevent the recurrence of BV, the main focus should not only be on the use of medicines but also on behavioral and lifestyle interventions. Behavioral changes should include proper sexual hygiene and the use of condoms. This type of protection constitutes a physical barrier, which limits exposure to agents disrupting the vaginal microflora. It also prevents semen from increasing the pH level, which could otherwise allow for pathogen colonization [36]. Studies show that vaginal douching is associated with a higher risk of BV development by reducing the *Lactobacillus* population. Another important factor related to bacterial vaginosis is incorrect personal hygiene during the menstrual phase; the most crucial results concern the materials used as blood absorbents. Poorly washed, non-sterile reusable products lead to an increased risk of infection, but infrequent replacement of menstrual products presents the same outcome [37]. Both hormonal and non-

hormonal contraceptives affect the vaginal environment, which can cause changes in the composition of the microbiome and BV occurrence. This effect is especially common in women using intrauterine devices [36].

In recent years, attention has been drawn to the possibility of partner treatment in order to prevent the recurrence of BV. Most research indicates that antibiotic therapy for male partners does not bring the expected results, as the bacteria associated with BV that colonize the penis do not create biofilms, and treating them does not affect remission in female partners. However, in homosexual relationships, research suggests that treating both partners can lead to a reduced risk of BV recurrence [38]. In order to maintain long-term therapeutic success, there is a need for significant changes in sexual life, such as the use of condoms, better personal hygiene (especially during menstruation) or even dietary changes [36].

3.4.5. Novel and emerging therapies

As the current treatment of bacterial vaginosis is still not ideal and the recurrence rate is very high, research is being carried out to find more effective ways of fighting this problem. A new therapeutic approach includes vaginal microbiota transplantation (VMT); it involves the implantation of a whole, healthy microbiome from a donor. After selecting a healthy donor, material is taken from the vagina and transplanted to a female with recurrent bacterial vaginosis. This holistic approach allows for restoration of the whole ecosystem and the establishment of eubiosis, which is hoped to overcome antibiotic resistance and eradicate pathogens. VMT is perceived as a potential “last resort” treatment for recurrent and antibiotic-resistant BV [39]. Non-antibiotic antimicrobials are also used in BV therapy, such as lactic acid gels. Their mechanism of action is simple and is based on the quick acidification of the environment, which is toxic to many pathogens but supportive to endogenous *Lactobacillus*. This method should not be used as an alternative to standard treatment, but as an adjuvant to it [18].

3.5. Optimization of treatment in special populations

3.5.1. Pregnant women

The treatment of bacterial vaginosis in pregnant women depends on its course; if it is asymptomatic and the pregnancy is low-risk, treatment is not recommended. Clinical trials and meta-analyses have not shown that routine treatment brings any significant beneficial effects, such as impact on preventing preterm birth. If BV is symptomatic or pregnancy is high-risk, it is recommended to use standard antibiotic therapy, with the exception of using clindamycin in the first trimester, as it carries a potential higher risk of congenital defects [40]. Probiotics are also a safe intervention in bacterial vaginosis and bring a positive impact to the natural vaginal microbiome. They are recommended as a prevention and complementary strategy in treating BV in pregnant women [41].

3.5.2. Women undergoing IVF / fertility treatments.

Vaginal dysbiosis is found in approximately 18% of infertile women. It is associated with early pregnancy loss during IVF treatment and also negatively affects the clinical pregnancy rate [42]. The issue of treating bacterial vaginosis with antibiotics is not yet resolved, and there are no clear recommendations for it. Some studies suggest that even effective treatment of BV does not lead to higher chances of positive pregnancy outcome among women undergoing IVF [43]. That being said, the approach to treatment should be considered individually. If BV poses a potential risk to the pregnancy, it should be treated, while avoiding oral antibiotics due to potential negative effects on the vaginal microbiome. The aspect of rebuilding the natural vaginal ecosystem through the use of probiotics is crucial in this situation. All of these actions should be taken in advance of a potential embryo transfer.

3.5.3. Postmenopausal women.

Although bacterial vaginosis is more common among women of reproductive age, this dysbiosis is still a relevant problem in postmenopausal women. The main reasons for this are decline in the population of *Lactobacillus* and an increase in vaginal pH [44]. Treatment in this group should be aimed at dysbiosis prevention, such as using local products containing *Lactobacillus* (especially gels), and vaginal estrogen supplementation [45]. In acute, symptomatic BV, standard antibiotic treatment should be administered.

3.6. Future Directions

3.6.1. Need for standardized diagnostic methods.

Bacterial vaginosis is still an insufficiently explored topic and is in need of more specific diagnostic protocols. Diagnostic methods are not standardized enough, which leads to underdiagnosis and delayed treatment. Current diagnostic methods are limited by low sensitivity and specificity. Due to the polymicrobial character of BV, it is difficult to find the optimal pattern for confirming this dysbiosis. Future directions should be focused on new methods, such as molecular and biomarker tests [46].

3.6.2. Long-term microbiome stabilization

Regarding therapeutic goals, it should be possible to achieve long-term microbiome stabilization. Current available treatments are not fully efficient; therefore, further research should focus on the most accessible ways to achieve a more resilient microbiome [19].

3.6.3. Molecular profiling

Another promising method that is not yet widespread is molecular profiling, which provides detailed, quantitative data about the microbiome of an individual patient. With this knowledge, it would be possible to predict personal recurrence rates. For example, based on the size of the *Lactobacillus crispatus* population, we could assess the success of therapy and the likelihood of symptoms recurring. Molecular profiling could also be used for treatment monitoring and the identification of hidden dysbiosis [47].

4. Discussion

The findings of this review shows that while standard antibiotic therapy is effective for acute symptom relief, it fails to address the underlying complexity BV, leading to high recurrence rates. The ecosystem-centered approach is necessary to achieve long-term effects. The primary obstacle in current therapy is the vaginal biofilm, this structure acts as a physical barrier that prevents antibiotic penetration and fosters resistance. With this in mind, the use of biofilm-disrupting agents should be considered as a standard adjunct to antibiotic treatment, especially in recurrent cases. Given this context, the restoration of the *Lactobacillus* population is critical. While probiotics (particularly *L. crispatus*) show significant promise, their success depends on the rapid acidification of the vaginal pH. This highlights the importance of combined therapies, utilizing antibiotics to eliminate pathogens, acids to disrupt biofilms, and probiotics to rebuild the microflora. The review also emphasizes the need for personalized medicine. In special populations, such as pregnant women or those undergoing IVF, the management of BV must be carefully balanced to avoid unnecessary interventions while protecting reproductive outcomes. Tools like molecular profiling offer a path toward individualized diagnostics, allowing clinicians to identify asymptomatic dysbiosis and aim treatments to the specific patient. Finally, long-term success requires addressing behavioral and lifestyle factors. Without changes in sexual hygiene and a shift away from some practices the recurrence is likely to continue. Future research should prioritize standardizing non-antibiotic treatments and developing diagnostic protocols that reflect the polymicrobial nature of the disease.

5. Conclusions

Current bacterial vaginosis management is not ideal and most often consists of two phases at most; it is focused on the eradication of common BV pathogens and the attempt to reconstruct the vaginal microbiome. This approach is not as effective as it should be, as confirmed by the high recurrence rate of BV [12]. Currently, metronidazole as a targeted treatment and the preventive use of probiotics after antibiotic therapy constitute the standard procedure. Effective ways to improve this treatment include the more frequent use of biofilm-disrupting agents and ensuring an individual approach for women with frequently recurring BV. Molecular profiling could make a significant difference in this group, which would also likely reduce expenses related to long-term treatment.

REFERENCES

1. Chen, X., Lu, Y., Chen, T., & Li, R. (2021). The female vaginal microbiome in health and bacterial vaginosis. *Front Cell Infect Microbiol*, 11, 631972. <https://doi.org/10.3389/fcimb.2021.631972>
2. Prabburajeshwar, C., & Chandrakanth, R. K. (2017). Probiotic potential of lactobacilli with antagonistic activity against pathogenic strains: An in vitro validation for the production of inhibitory substances. *Biomed J*, 40(5), 270–283. <https://doi.org/10.1016/j.bj.2017.06.008>
3. Kwon, M. S., & Lee, H. K. (2022). Host and microbiome interplay shapes the vaginal microenvironment. *Front Immunol*, 13, 919728. <https://doi.org/10.3389/fimmu.2022.919728>
4. Peebles, K., Velloza, J., Balkus, J. E., McClelland, R. S., & Barnabas, R. V. (2019). High global burden and costs of bacterial vaginosis: A systematic review and meta-analysis. *Sexually Transmitted Diseases*, 46(5), 304–311. <https://doi.org/10.1097/OLQ.0000000000000972>
5. Smith, S. B., & Ravel, J. (2017). The vaginal microbiota, host defence and reproductive physiology. *J Physiol*, 595(2), 451–463. <https://doi.org/10.1113/JP271694>
6. Turovskiy, Y., Sutyak Noll, K., & Chikindas, M. L. (2011). The aetiology of bacterial vaginosis. *J Appl Microbiol*, 110(5), 1105–28. <https://doi.org/10.1111/j.1365-2672.2011.04977.x>
7. Hardy, L., Cerca, N., Jespers, V., Vaneechoutte, M., & Crucitti, T. (2017). Bacterial biofilms in the vagina. *Res Microbiol*, 168(9–10), 865–874. <https://doi.org/10.1016/j.resmic.2017.02.001>
8. Chee, W. J. Y., Chew, S. Y., & Than, L. T. L. (2020). Vaginal microbiota and the potential of Lactobacillus derivatives in maintaining vaginal health. *Microb Cell Fact*, 19(1), 203. <https://doi.org/10.1186/s12934-020-01464-4>
9. Bradshaw, C. S., Morton, A. N., Hocking, J., Garland, S. M., Morris, M. B., Moss, L. M., Horvath, L. B., Kuzevska, I., & Fairley, C. K. (2006). High recurrence rates of bacterial vaginosis over the course of 12 months after oral metronidazole therapy and factors associated with recurrence. *J Infect Dis*, 193(11), 1478–86. <https://doi.org/10.1086/503780>
10. Swidsinski, S., Moll, W. M., & Swidsinski, A. (2023). Bacterial vaginosis-vaginal polymicrobial biofilms and dysbiosis. *Dtsch Arztebl Int*, 120(20), 347–354. <https://doi.org/10.3238/arztebl.m2023.0090>
11. Sousa, L. G. V., Pereira, S. A., & Cerca, N. (2023). Fighting polymicrobial biofilms in bacterial vaginosis. *Microb Biotechnol*, 16(7), 1423–1437. <https://doi.org/10.1111/1751-7915.14261>
12. Bradshaw, C. S., Morton, A. N., Hocking, J., Garland, S. M., Morris, M. B., Moss, L. M., Horvath, L. B., Kuzevska, I., & Fairley, C. K. (2006). High recurrence rates of bacterial vaginosis over the course of 12 months after oral metronidazole therapy and factors associated with recurrence. *J Infect Dis*, 193(11), 1478–86. <https://doi.org/10.1086/503780>
13. Bilardi, J. E., Walker, S., Temple-Smith, M., McNair, R., Mooney-Somers, J., Bellhouse, C., Fairley, C. K., Chen, M. Y., & Bradshaw, C. (2013). The burden of bacterial vaginosis: Women's experience of the physical, emotional, sexual and social impact of living with recurrent bacterial vaginosis. *PLoS One*, 8(9), e74378. <https://doi.org/10.1371/journal.pone.0074378>
14. Kumar, N., Behera, B., Sagiri, S. S., Pal, K., Ray, S. S., & Roy, S. (2011). Bacterial vaginosis: Etiology and modalities of treatment-A brief note. *J Pharm Bioallied Sci*, 3(4), 496–503. <https://doi.org/10.4103/0975-7406.90102>
15. Dickey, L. J., Nailor, M. D., & Sobel, J. D. (2009). Guidelines for the treatment of bacterial vaginosis: Focus on tinidazole. *Ther Clin Risk Manag*, 5(3), 485–9. <https://doi.org/10.2147/tcrm.s3777>
16. Petrina, M. A. B., Cosentino, L. A., Rabe, L. K., & Hillier, S. L. (2017). Susceptibility of bacterial vaginosis (BV)-associated bacteria to secnidazole compared to metronidazole, tinidazole and clindamycin. *Anaerobe*, 47, 115–119. <https://doi.org/10.1016/j.anaerobe.2017.05.005>
17. Mauck, C., Hillier, S. L., Gendreau, J., Dart, C., Chavoustie, S., Sorkin-Wells, V., Nicholson-Uhl, C., Perez, B., Jacobs, M., Zack, N., & Friend, D. (2022). Single-dose, bioadhesive clindamycin 2% gel for bacterial vaginosis: A randomized controlled trial. *Obstet Gynecol*, 139(6), 1092–1102. <https://doi.org/10.1097/AOG.0000000000004805>

18. Armstrong-Buisseret, L., Brittain, C., Kai, J., David, M., Anstey Watkins, J., Ozolins, M., Jackson, L., Abdali, Z., Hepburn, T., Griffiths, F., Montgomery, A., Daniels, J., Manley, A., Dean, G., & Ross, J. D. (2022). Lactic acid gel versus metronidazole for recurrent bacterial vaginosis in women aged 16 years and over: The VITA RCT. *Health Technol Assess*, 26(2), 1–170. <https://doi.org/10.3310/ZZKH4176>
19. Heczko, P. B., Tomusiak, A., Adamski, P., Jakimiuk, A. J., Stefański, G., Mikołajczyk-Cichońska, A., Suda-Szczurek, M., & Strus, M. (2015). Supplementation of standard antibiotic therapy with oral probiotics for bacterial vaginosis and aerobic vaginitis: A randomised, double-blind, placebo-controlled trial. *BMC Womens Health*, 15, 115. <https://doi.org/10.1186/s12905-015-0246-6>
20. Mtshali, A., San, J. E., Osman, F., Garrett, N., Balle, C., Giandhari, J., Onywera, H., Mngomezulu, K., Mzobe, G., de Oliveira, T., Rompalo, A., Mindel, A., Abdool Karim, S. S., Ravel, J., Passmore, J. S., Abdool Karim, Q., Jaspan, H. B., Liebenberg, L. J. P., & Ngcapu, S. (2021). Temporal changes in vaginal microbiota and genital tract cytokines among South African women treated for bacterial vaginosis. *Front Immunol*, 12, 730986. <https://doi.org/10.3389/fimmu.2021.730986>
21. Gottschick, C., Deng, Z. L., Vital, M., Masur, C., Abels, C., Pieper, D. H., Rohde, M., Mendling, W., & Wagner-Döbler, I. (2017). Treatment of biofilms in bacterial vaginosis by an amphoteric tenside pessary-clinical study and microbiota analysis. *Microbiome*, 5(1), 119. <https://doi.org/10.1186/s40168-017-0326-y>
22. Bitew, A., Mengist, A., Belew, H., Aschale, Y., & Reta, A. (2021). The prevalence, antibiotic resistance pattern, and associated factors of bacterial vaginosis among women of the reproductive age group from Felege Hiwot Referral Hospital, Ethiopia. *Infect Drug Resist*, 14, 2685–2696. <https://doi.org/10.2147/IDR.S305329>
23. Smart, S., Singal, A., & Mindel, A. (2004). Social and sexual risk factors for bacterial vaginosis. *Sex Transm Infect*, 80(1), 58–62. <https://doi.org/10.1136/sti.2003.004978>
24. Muzny, C. A., & Kardas, P. (2020). A narrative review of current challenges in the diagnosis and management of bacterial vaginosis. *Sex Transm Dis*, 47(7), 441–446. <https://doi.org/10.1097/OLQ.0000000000001178>
25. Simoes, J. A., Bahamondes, L. G., Camargo, R. P., Alves, V. M., Zaneveld, L. J., Waller, D. P., Schwartz, J., Callahan, M. M., & Mauck, C. K. (2006). A pilot clinical trial comparing an acid-buffering formulation (ACIDFORM gel) with metronidazole gel for the treatment of symptomatic bacterial vaginosis. *Br J Clin Pharmacol*, 61(2), 211–7. <https://doi.org/10.1111/j.1365-2125.2005.02550.x>
26. Surapaneni, S., Akins, R., & Sobel, J. D. (2021). Recurrent bacterial vaginosis: An unmet therapeutic challenge. Experience with a combination pharmacotherapy long-term suppressive regimen. *Sex Transm Dis*, 48(10), 761–765. <https://doi.org/10.1097/OLQ.0000000000001420>
27. Powell, A., Ghanem, K. G., Rogers, L., Zinalabedini, A., Brotman, R. M., Zenilman, J., & Tuddenham, S. (2019). Clinicians' use of intravaginal boric acid maintenance therapy for recurrent vulvovaginal candidiasis and bacterial vaginosis. *Sex Transm Dis*, 46(12), 810–812. <https://doi.org/10.1097/OLQ.0000000000001063>
28. Caliskan, M., Karadeniz, O., Goksu, M., & Cetin, A. (2025). Intravaginal boric acid treatment for recurrent bacterial vaginosis: Short-term effects on vaginal health parameters and patient satisfaction. *BMC Womens Health*, 25(1), 536. <https://doi.org/10.1186/s12905-025-04084-5>
29. Gaspar, C., Rolo, J., Cerca, N., Palmeira-de-Oliveira, R., Martinez-de-Oliveira, J., & Palmeira-de-Oliveira, A. (2021). Dequalinium chloride effectively disrupts bacterial vaginosis (BV) *Gardnerella* spp. Biofilms. *Pathogens*, 10(3), 261. <https://doi.org/10.3390/pathogens10030261>
30. Haydock, R., Hepburn, T., Ross, J., Daniels, J., Brittain, C., Jackson, L., Ozolins, M., & Wilson, J. (2022). The DEVA trial: Protocol for a randomised controlled trial of dequalinium chloride versus usual care antibiotics for the treatment of bacterial vaginosis. *Trials*, 23(1), 1040. <https://doi.org/10.1186/s13063-022-06954-x>
31. Hay, P. (2017). Bacterial vaginosis. *F1000Res*, 6, 1761. <https://doi.org/10.12688/f1000research.11417.1>
32. Rezazadeh, M. B., Zanganeh, M., Jarahi, L., & Fatehi, Z. (2024). Comparative efficacy of oral and vaginal probiotics in reducing the recurrence of bacterial vaginosis: A double-blind clinical trial. *BMC Womens Health*, 24(1), 575. <https://doi.org/10.1186/s12905-024-03418-z>
33. Chen, R., Li, R., Qing, W., Zhang, Y., Zhou, Z., Hou, Y., Shi, Y., Zhou, H., & Chen, M. (2022). Probiotics are a good choice for the treatment of bacterial vaginosis: A meta-analysis of randomized controlled trial. *Reprod Health*, 19(1), 137. <https://doi.org/10.1186/s12978-022-01449-z>

34. Hemmerling, A., Wierzbicki, M. R., Armstrong, E., & Cohen, C. R. (2024). Response to antibiotic treatment of bacterial vaginosis predicts the effectiveness of LACTIN-V (*Lactobacillus crispatus* CTV-05) in the prevention of recurrent disease. *Sex Transm Dis*, 51(6), 437–440. <https://doi.org/10.1097/OLQ.0000000000001962>
35. Pagar, R., Deshkar, S., Mahore, J., Patole, V., Deshpande, H., Gandham, N., Mirza, S., Junnarkar, M., & Nawani, N. (2024). The microbial revolution: Unveiling the benefits of vaginal probiotics and prebiotics. *Microbiol Res*, 286, 127787. <https://doi.org/10.1016/j.micres.2024.127787>
36. Abbe, C., & Mitchell, C. M. (2023). Bacterial vaginosis: A review of approaches to treatment and prevention. *Front Reprod Health*, 5, 1100029. <https://doi.org/10.3389/frph.2023.1100029>
37. Samantaray, S. R., Parida, S., & Mohapatra, I. (2024). Connecting the dots: Exploring the relationship between menstrual hygiene and bacterial vaginosis in eastern India. *J Family Med Prim Care*, 13(10), 4451–4456. https://doi.org/10.4103/jfmpe.jfmpe_431_24
38. Vodstrcil, L. A., Muzny, C. A., Plummer, E. L., Sobel, J. D., & Bradshaw, C. S. (2021). Bacterial vaginosis: Drivers of recurrence and challenges and opportunities in partner treatment. *BMC Med*, 19(1), 194. <https://doi.org/10.1186/s12916-021-02077-3>
39. Tuniyazi, M., & Zhang, N. (2023). Possible therapeutic mechanisms and future perspectives of vaginal microbiota transplantation. *Microorganisms*, 11(6), 1427. <https://doi.org/10.3390/microorganisms11061427>
40. Haahr, T., Ersbøll, A. S., Karlsen, M. A., Svare, J., Sneider, K., Hee, L., Weile, L. K., Ziobrowska-Bech, A., Østergaard, C., Jensen, J. S., Helmig, R. B., & Uldbjerg, N. (2016). Treatment of bacterial vaginosis in pregnancy in order to reduce the risk of spontaneous preterm delivery - a clinical recommendation. *Acta Obstet Gynecol Scand*, 95(8), 850–60. <https://doi.org/10.1111/aogs.12933>
41. Yang, S., Reid, G., Challis, J. R. G., Gloor, G. B., Asztalos, E., Money, D., Seney, S., & Bocking, A. D. (2020). Effect of oral probiotic *Lactobacillus rhamnosus* GR-1 and *Lactobacillus reuteri* RC-14 on the vaginal microbiota, cytokines and chemokines in pregnant women. *Nutrients*, 12(2), 368. <https://doi.org/10.3390/nu12020368>
42. Skafte-Holm, A., Humaidan, P., Bernabeu, A., Lledo, B., Jensen, J. S., & Haahr, T. (2021). The association between vaginal dysbiosis and reproductive outcomes in sub-fertile women undergoing IVF-treatment: A systematic PRISMA review and meta-analysis. *Pathogens*, 10(3), 295. <https://doi.org/10.3390/pathogens10030295>
43. Haahr, T., Elbaek, H. O., Laursen, R. J., Alsbjerg, B., Jensen, J. S., & Humaidan, P. (2017). Treatment of abnormal vaginal microbiota before frozen embryo transfer: Case-report and minireview to discuss the longitudinal treatment efficacy of oral clindamycin. *Front Physiol*, 8, 415. <https://doi.org/10.3389/fphys.2017.00415>
44. Cauci, S., Driussi, S., De Santo, D., Penacchioni, P., Iannicelli, T., Lanzafame, P., De Seta, F., Quadrifoglio, F., de Aloysio, D., & Guaschino, S. (2002). Prevalence of bacterial vaginosis and vaginal flora changes in peri- and postmenopausal women. *J Clin Microbiol*, 40(6), 2147–52. <https://doi.org/10.1128/JCM.40.6.2147-2152.2002>
45. Yoshikata, R., Yamaguchi, M., Mase, Y., Tatsuyuki, A., Myint, K. Z. Y., & Ohta, H. (2022). Evaluation of the efficacy of *Lactobacillus*-containing feminine hygiene products on vaginal microbiome and genitourinary symptoms in pre- and postmenopausal women: A pilot randomized controlled trial. *PLoS One*, 17(12), e0270242. <https://doi.org/10.1371/journal.pone.0270242>
46. Redelinghuys, M. J., Geldenhuys, J., Jung, H., & Kock, M. M. (2020). Bacterial vaginosis: Current diagnostic avenues and future opportunities. *Front Cell Infect Microbiol*, 10, 354. <https://doi.org/10.3389/fcimb.2020.00354>
47. Savicheva, A. M., Krysanova, A. A., Budilovskaya, O. V., Spasibova, E. V., Khusnutdinova, T. A., Shalepo, K. V., Beliaeva, N. R., Safarian, G. K., Sapozhnikov, K. V., Tapilskaya, N. I., & Kogan, I. Y. (2023). Vaginal microbiota molecular profiling in women with bacterial vaginosis: A novel diagnostic tool. *Int J Mol Sci*, 24(21), 15880. <https://doi.org/10.3390/ijms242115880>