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Analysis of the Impact of Pharmacological Intervention on the Outcome of High-Risk HPV Infections

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Abstract: This study aims to evaluate the clinical effectiveness of different drug treatment regimens for cervical high-risk human papillomavirus (HR-HPV) infection. Through literature review and randomized group experiment design, the study compares the HPV-DNA clearance rate, TCT results, and colposcopic biopsy findings among the control group, interferon group, and combination treatment group after six months of treatment. The results indicate that recombinant human interferon-2b vaginal effervescent tablets can effectively improve HPV clearance and reduce the risk of lesion progression, although individual responses to treatment vary. Combination therapy may enhance treatment efficacy by boosting immune response. The study also explores the relationship between drug treatment, viral load, cervical lesions, and vaginal microecology, providing scientific support for clinical medication decisions and offering a detailed analysis of the role of pharmacological intervention in the prognosis of HR-HPV infections.

Keywords: High-risk HPV infection; Pharmacological intervention; Viral clearance; Cervical lesions; Immune modulation

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1. Introduction

Persistent infection with high-risk human papillomavirus (HPV) is a major cause of cervical cancer and its precursor lesions, posing a significant threat to women's health. Although notable progress has been made in cervical cancer screening and prevention, the outcome of high-risk HPV (HR-HPV) infection remains a complex and unresolved issue. Currently, besides vaccination and routine screening, pharmacological intervention has garnered attention as a potential approach to improving the outcomes of HR-HPV infections. This study aims to analyze the impact of pharmacological intervention on the outcome of HR-HPV infections, investigating its possible efficacy and safety and potential applicability across different populations. By thoroughly analyzing existing clinical and basic research, this study seeks to broaden treatment options for

clinicians and provide scientific support for the advancement of future pharmacological intervention strategies.

2. Literature review

Before exploring the impact of pharmacological intervention on HR-HPV infection outcomes, this study conducted a thorough review of the epidemiological characteristics of HR-HPV infection, the impact of various interventions on HPV infection outcomes, and the role of drug treatment in influencing these outcomes. This review aims to provide a solid theoretical foundation and empirical basis for subsequent research.

2.1. Epidemiological characteristics of high-risk HPV infection

Human papillomavirus infection, particularly persistent HR-HPV types, is the primary cause of cervical cancer. Studies have shown that HPV infection is detectable in over 99% of cervical exfoliated cell samples from cervical cancer patients [1]. The infection rate is higher among young women and sexually active populations, decreasing with age. Certain HR-HPV types are closely associated with the onset of cervical cancer, particularly HPV types 16 and 18, which dominate globally.

High-grade squamous intraepithelial lesions (HSIL), including cervical intraepithelial neoplasia (CIN) grade 2/3, have the potential to progress to invasive cervical cancer. If left untreated, approximately one-third of CIN 2/3 cases may develop into malignant cervical tumors over a 30-year period. Therefore, developing appropriate treatment protocols for cervical HSIL is crucial in effectively controlling the incidence and mortality rates of cervical cancer [2].

2.2. Impact of different interventions on HPV outcomes

The outcome of HR-HPV infection is influenced by multiple interventions, including vaccination, screening, pharmacological treatment, and lifestyle changes. Vaccination, as a primary preventive measure, has been shown to effectively reduce the incidence of HR-HPV infection and related lesions [3]. However, for individuals already infected with HR-HPV, screening and monitoring become critical, allowing for timely detection and management of CIN. The role of drug treatment, including antiviral agents, immunomodulators, and chemotherapeutic drugs, in improving HPV infection outcomes is still under investigation. These various interventions differ in their effects on viral clearance, lesion regression, and reduction in cervical cancer risk. Therefore, a comprehensive assessment of these intervention strategies' benefits is essential to devising personalized treatment plans.

2.3. Role of drug treatment in HPV infection outcomes

The role of drug treatment in the outcomes of HR-HPV infection is receiving increasing attention, although no definitive treatment has been established to completely clear the virus. Studies suggest that certain drugs may influence infection outcomes by inhibiting viral replication, enhancing the host immune response, or directly targeting cervical lesions. Antiviral drugs such as imiquimod and interferon-α have been used to treat HR-HPV infection, but their efficacy and safety require further validation. The application of immunomodulators offers a new perspective on improving HPV infection outcomes by promoting viral clearance through modulation of the host immune system [4]. Additionally, chemopreventive agents like aspirin and other antioxidants are being explored for their potential role in intervening in the natural course of HPV infection. However, the

effectiveness, tolerability, and long-term impact of pharmacological treatment still need to be evaluated through large-scale randomized controlled trials to provide robust evidence for clinical practice.

3. Research methods

This study aims to evaluate the clinical efficacy of different medication regimens for cervical HR-HPV infection.

3.1. Subject selection and grouping

The inclusion criteria were women diagnosed with HR-HPV infection at the Gynecology Outpatient Department of the First Affiliated Hospital of Zhengzhou University. Exclusion criteria included pregnant or breastfeeding women, those with malignancies of the reproductive system or other gynecological diseases, those allergic to treatment drugs, and those who did not complete the prescribed treatment regimen.

In this study, to ensure scientific rigor and objectivity, patients meeting the inclusion criteria were randomly assigned to one of three treatment groups. The control group (Group A) received only regular follow-up without any intervention; the interferon group (Group B) received local treatment with recombinant human interferon α2b vaginal effervescent tablets administered every other day (one tablet each time, placed at the cervical opening after cleaning the vulva, with a break during menstruation). This regimen was administered for three months, followed by a three-month break, and then a follow-up at six months. The combination treatment group (Group C) received the same treatment as Group B but also added thymosin injections for systemic treatment (1.6 mg via subcutaneous injection twice weekly), following the same three-month on-treatment, three-month off-treatment cycle, with a six-month follow-up.

The clinical efficacy of the different medication regimens for cervical HR-HPV infection was evaluated by comparing HPV-DNA conversion rates, TCT outcomes, and colposcopy biopsy results among the three groups at six months post-treatment, providing a basis for clinical drug selection.

3.2. Drug intervention protocol

In treating cervical HR-HPV infection, treatment selection requires comprehensive consideration of factors such as infection severity, lesion status, age, reproductive needs, and patient preferences to create individualized treatment plans.

The initial steps in cervical cancer screening and treatment include performing an HPV-DNA test via cervical swab to determine the infection subtype and viral load. Subsequently, liquid-based cytology testing (TCT) is used to assess morphological changes in cervical cells and preliminarily evaluate lesion severity. For patients with single HPV infections and minor lesions, observation and follow-up are recommended, with cervical cancer screening every 6–12 months (including HPV-DNA and TCT testing) to monitor viral clearance and lesion progression. For patients with single infections but more severe lesions, drug treatment is recommended, including a combination of recombinant human interferon α2b vaginal effervescent tablets (Jinshuxi) and thymosin injections (Maipuxin) [5]. Jinshuxi is administered vaginally to locally modulate the immune status, enhancing viral clearance [6]; Maipuxin is administered via subcutaneous injection to comprehensively modulate the immune response, boost immunity, and reduce lesion progression risk. Combined treatment aims to achieve synergistic effects, enhancing immune action, accelerating HPV clearance,

improving therapeutic efficacy, and reducing the risk of cervical cancer.

During treatment, patients should have regular follow-ups, with cervical cancer screening every 6–12 months to assess treatment efficacy and lesion status. Patients should also be closely monitored for symptoms, such as abnormal vaginal bleeding or discharge, to detect and address lesion progression promptly, ensuring treatment efficacy and patient safety.

3.3. Observation indicators and testing methods

The primary indicators of this study include HPV conversion rate, clinical efficacy, and safety. Hybrid Capture II testing is used to detect high-risk HPV-DNA, assessing the HPV conversion status post-treatment. Colposcopy and histopathological assessments evaluate improvement in cervical lesions, including epithelial morphology and pathological changes, to determine treatment efficacy. Adverse effects during treatment are recorded to evaluate safety. Based on these comprehensive indicators, this study evaluates the clinical efficacy of different drug treatment regimens for cervical HR-HPV infection, providing evidence for clinical drug decision-making.

3.4. Efficacy analysis of different drug interventions

3.4.1. Impact of cervical conization on high-risk HPV infection outcomes

Cervical conization, an essential surgical method for treating CIN and early-stage cervical cancer, has the primary advantage of accurately removing cervical lesion tissue and providing sufficient pathological samples for detailed pathological evaluation [7]. This process not only aids in confirming the diagnosis but also provides critical guidance for developing subsequent treatment plans. Clinical studies have shown that cervical conization significantly reduces the risk of cervical lesion progression to invasive cervical cancer by effectively clearing cervical HR-HPV infection.

3.4.2. Postoperative HPV conversion rate and cervical lesion recurrence rate

In evaluating the efficacy of cervical conization, the postoperative HR-HPV conversion rate and cervical lesion recurrence rate are two key indicators [8]. Studies indicate that factors such as patient age, lesion severity, HPV subtype, and treatment methods influence postoperative HPV conversion rates. Additionally, there is a close correlation between lesion recurrence rates and postoperative HPV conversion, as persistent HPV positivity after surgery is considered a significant risk factor for cervical lesion recurrence.

3.4.3. Efficacy of recombinant human interferon-2b vaginal effervescent tablets in treating cervical precancerous lesions with HR-HPV infection

Recombinant human interferon-2b vaginal effervescent tablets, a locally applied immunomodulator, have dual antiviral and immune-modulating effects [9]. Clinical studies have demonstrated its significant efficacy in treating CIN and HPV infection, effectively improving HPV conversion rates and reducing lesion progression risk. Compared to other treatments, the advantage of interferon-2b vaginal effervescent tablets lies in their local administration, reducing systemic side effects, with simple use and easy patient acceptance. Multiple studies have confirmed its safety and efficacy in treating CIN and HPV infections [10]. However, certain limitations exist, such as the long treatment cycle requiring several months of continuous administration, and the therapeutic efficacy varies across individuals, with some patients potentially needing additional treatments

to enhance efficacy.

4. Impact of drug interventions on the outcome of high-risk HPV infection

This section explores the impact of drug interventions on the outcome of high-risk HPV infection, including the relationship between drug treatment and HPV viral load, the effect of drug treatment on the progression of cervical lesions, and the correlation between drug treatment and vaginal microecology.

4.1. Relationship between drug treatment and HPV viral load

Studies have shown that drug treatments can effectively reduce HPV viral load and promote viral clearance. Recombinant human interferon-2b vaginal effervescent tablets, a locally applied immunomodulator, enhance the function of phagocytes, lymphocytes, and natural killer cells, thereby modulating immune function to inhibit HPV replication and transcription and reduce viral load. Additionally, thymosin α1, another immunomodulator, promotes the maturation and function of T cells, enhancing immune capacity and reducing HPV viral load.

4.2. Effect of drug treatment on the progression of cervical lesions

Drug treatment effectively inhibits the progression of cervical lesions. Recombinant human interferon-2b vaginal effervescent tablets, as an antiviral medication, can modulate local immune status in the cervix through local application. This enhances the ability of immune cells to clear viruses, such as HPV, thus preventing the occurrence and progression of cervical lesions. Furthermore, thymosin α1, as an immunomodulator, strengthens the body's immune function, improving the capacity of immune cells to recognize and eliminate lesion cells. This reduces the risk of lesion progression, offering multifaceted support for cervical lesion treatment.

4.3. Correlation between drug treatment and vaginal microecology

Vaginal microecology is crucial for maintaining vaginal health and is closely related to the occurrence and progression of HPV infection and cervical lesions. Drug treatment can influence vaginal microecology, thereby impacting the outcome of HPV infection and cervical lesions. Recombinant human interferon-2b vaginal effervescent tablets can modulate the local immune status in the vagina, promoting the growth of normal vaginal flora and thereby improving vaginal microecology. Thymosin α1 can also enhance immune function and regulate vaginal microecology, reducing the risk of HPV infection and cervical lesions.

5. Conclusion

This study conducted an in-depth analysis of the impact of drug interventions on the outcome of HR-HPV infection and evaluated the clinical effectiveness of different medication regimens. The findings highlight the importance of drug therapy in the prognosis of HPV infection, especially the significant efficacy of recombinant human interferon-2b vaginal effervescent tablets in promoting viral clearance and reducing the risk of lesion progression, despite challenges such as individual variability in efficacy and longer treatment duration. Combination therapy may enhance effectiveness through synergistic mechanisms. Additionally, the study explored the relationships between drug therapy, viral load, cervical lesions, and vaginal microecology. These results provide theoretical support for clinical medication decisions; however, further large-scale randomized

controlled trials are needed to verify the effectiveness, tolerability, and long-term outcomes of the drugs. Future research should focus on optimizing medication regimens, improving patient adherence, and developing new therapeutic methods and medications to provide better treatment options for patients with high-risk HPV infections.

Disclosure statement

The author declares no conflict of interest.

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