

Cervical Cancer: Epidemiology Molecular Pathogenesis Clinical Management and Prevention Strategies

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Abstract

Cervical cancer is a major global health concern and ranks among the leading causes of cancer-related deaths in women, particularly in low- and middle-income countries. Persistent infection with high-risk human papillomavirus (HPV) types is the primary etiological factor. Despite the availability of effective screening methods and prophylactic vaccines, the burden of cervical cancer remains high due to inadequate healthcare infrastructure and limited awareness. This paper provides a comprehensive review of cervical cancer, focusing on its epidemiology, risk factors, molecular pathogenesis, clinical presentation, diagnostic approaches, treatment modalities, and prevention strategies. Emphasis is placed on the importance of early detection and vaccination in reducing disease incidence and mortality.

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Introduction

Cervical cancer originates from the transformation zone of the cervix and develops through a series of precancerous lesions known as cervical intraepithelial neoplasia (CIN). It is a preventable disease due to the long latency period between initial HPV infection and invasive cancer. However, disparities in access to screening and vaccination programs continue to pose challenges in disease control, especially in developing countries like India.

Epidemiology

Cervical cancer is the fourth most common cancer among women worldwide. According to global estimates, it accounts for significant morbidity and mortality, particularly in resource-limited settings. India contributes a substantial proportion of global cases due to population size and gaps in organized screening.

The highest incidence is observed in women aged 30–50 years. Mortality rates remain high in underserved populations due to late-stage diagnosis and limited access to treatment [1].

Etiology and Risk Factors

Persistent infection with high-risk HPV types, especially HPV-16 and HPV-18, is responsible for approximately 70% of cervical cancer cases. HPV is transmitted primarily through sexual contact. Early onset of sexual activity, Multiple sexual partners, Smoking,

Long-term use of oral contraceptives, Immunosuppression (e.g., HIV infection), Poor socioeconomic conditions.

Pathogenesis

The development of cervical cancer involves a multistep process beginning with HPV infection and progressing to CIN and invasive carcinoma. HPV oncoproteins E6 and E7 play a central role by inactivating tumor suppressor proteins p53 and retinoblastoma (Rb), leading to uncontrolled cellular proliferation, inhibition of apoptosis, and genomic instability. Accumulation of genetic mutations over time results in malignant transformation [2].

Histological Classification

Cervical cancer is classified into:

Squamous Cell Carcinoma: The most common type (70–80%).

Adenocarcinoma: Accounts for 10–20% of cases.

Other rare types: Including adenosquamous carcinoma and neuroendocrine tumors

Clinical Presentation

Early cervical cancer is typically asymptomatic, highlighting the importance of screening. As the disease progresses, symptoms may include: Abnormal vaginal bleeding (postcoital, intermenstrual, or postmenopausal), Persistent vaginal discharge,

Pelvic pain, Dyspareunia. Advanced disease may present with urinary or bowel symptoms and systemic manifestations [3].

Diagnostic Evaluation

Pap smear test: Detects precancerous cellular changes

HPV DNA testing: Identifies high-risk viral strains

Visual Inspection with Acetic Acid (VIA): Cost-effective method in low-resource settings

Colposcopic examination, Cervical biopsy for histopathological confirmation

MRI, CT, and PET scans are utilized for staging and assessing disease spread.

Staging

The International Federation of Gynecology and Obstetrics (FIGO) staging system is used to classify cervical cancer. It ranges from Stage I (confined to the cervix) to Stage IV (spread to distant organs). Accurate staging is essential for determining treatment strategies and prognosis [4].

Prevention

HPV vaccination (recommended for adolescents before sexual debut)

Health education and safe sexual practices, Regular cervical cancer screening programs, Awareness campaigns, Strengthening healthcare infrastructure, Integration of vaccination and screening services [5].

Conclusion

Cervical cancer is a preventable and treatable disease when detected early. Persistent HPV infection remains the primary cause, but effective interventions such as vaccination and screening have significantly reduced disease burden in developed regions. However, challenges persist in low-resource settings due to limited access to healthcare and lack of awareness. Strengthening public health strategies, promoting vaccination, and expanding screening coverage are critical for reducing incidence and mortality. Continued research into molecular mechanisms and innovative therapies offers hope for improved outcomes and eventual elimination of cervical cancer as a public health threat.

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