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# Common Prevention and Treatment Strategies for Gynecological Cancers

**Xuanhongyi Zhang***

Internatsschule Institut Lucius, 61209, Echzell, Germany
*Corresponding author: zhang.xuanhongyi@mygep.de

**Abstract:**

Breast cancer, ovarian cancer and cervical cancer pose a serious threat to women's health. Their initiation and progression are closely associated with multiple factors, including genetic susceptibility, abnormalities in DNA repair, viral infection and hormonal regulation. This review systematically summarizes the main preventive strategies and current treatment status of the three cancers. In terms of prevention, particular emphasis is placed on the roles of genetic screening, pharmacological interventions, HPV vaccination, and healthy lifestyle modifications in reducing cancer risk. Regarding treatment, the review outlines comprehensive therapeutic approaches based on surgery and radiotherapy/chemotherapy, combined with targeted therapy, immunotherapy, and maintenance therapy, and analyzes their advantages and limitations across different disease stages. Overall, precise screening and stage-adapted treatment strategies can significantly improve patient prognosis; however, the appropriate populations and long-term efficacy of emerging therapeutic approaches require further investigation and validation. Future efforts should integrate molecular subtyping and biomarkers to optimize precision prevention and comprehensive treatment strategies for gynecological malignancies.

**Keywords:** Cancer; Prevention; Treatment.

## 1. Introduction

Among women, breast cancer, ovarian cancer, and cervical cancer have received extensive attention due to the high incidence rates. According to data released by the WHO in 2022, breast cancer was the most common malignancy among the women globally, accounting for 23.8% of newly diagnosed cases that year, while cervical cancer and ovarian cancer accounted for 6.8% and 3.4%, respectively. Although the incidence of ovarian and cervical cancers is comparatively lower, they remain major causes of cancer-related mortality in certain low- and middle-income countries.

Gynecological cancers are influenced by multiple factors, like genetic predisposition, environmental exposure, behavioral factors, and infections. Current treatment strategies mainly consist of conventional approaches such as surgical resection, radiotherapy, and chemotherapy, as well as emerging therapies including targeted therapy and immunotherapy. Sur-

gical resection remains the primary curative option for patients diagnosed at an early stage; however, its effectiveness is limited in patients with advanced or recurrent disease. Meanwhile, radiotherapy and chemotherapy can delay disease progression but are often associated with significant adverse effects, and tumors may develop resistance to chemotherapeutic agents. Although targeted therapy and immunotherapy represent important technological breakthroughs in recent years, these approaches are not yet fully mature and are constrained by issues such as limited eligible populations, high costs, and interindividual variability. At present, they cannot completely replace traditional treatment modalities. Therefore, effective prevention has become a core issue of great necessity, urgency, and potential benefit.

Thus, this review seeks to comprehensively synthesize preventive strategies and recent treatment breakthroughs in breast, ovarian, and cervical cancers, and to scrutinize the advantages and limitations of existing preventive and therapeutic interventions, in order to provide references for diminishing the incidence of gynecological cancers.

## 2. Prevention

### 2.1 Breast Cancer and Ovarian Cancer

These patients often lack specific clinical symptoms in the early stages. Some patients may present only with mild or non-specific discomfort, making early detection difficult. Ovarian cancer in particular is frequently diagnosed at an intermediate or advanced stage, by which time the optimal window for treatment has often been missed. Therefore, compared with relying on symptom-based detection or routine screening alone, early prevention and intervention targeting high-risk populations are especially important.

Breast/ovarian cancers are largely associated with defects in DNA repair mechanisms. Accordingly, preventive strategies can be broadly divided into genetic screening and pharmacological intervention. At the molecular level, these two cancers share certain similarities in their pathogenesis, as their development and progression are closely linked to impaired DNA repair function, particularly abnormalities in the HRR pathway. Among the key regulatory factors in this pathway are the BRCA1 and BRCA2 genes, when pathogenic mutations occur in these genes, the cellular capacity to repair the DNA double-strand breaks is significantly reduced, leading to increased genomic instability and, consequently, tumorigenesis [1].

From a preventive perspective, genetic screening has therefore become an important tool for identifying individuals at high risk. This primarily involves detecting carriers of pathogenic germline mutations in the BRCA1 and BRCA2. And other related genes, such as the PALB2 and ATM, may be included in multigene panel testing as complementary screening targets. Genetic counseling may benefit individuals with a strong family history—for example, multiple first-degree relatives affected by early-onset breast or ovarian cancer—or those identified as carriers of high-risk mutations. Taken together, these approaches enable the implementation of more targeted and individualized preventive strategies for high-risk populations.

### 2.2 Cervical Cancer

Cervical cancer is distinct from other gynecological malignancies in that its primary etiological factor is persistent infection with high-risk human papillomavirus (HPV). HPV promotes carcinogenesis mainly through the expression of its oncogenic proteins E6 and E7, which inhibit the tumor suppressor pathways mediated by p53 and the retinoblastoma protein (Rb). This disruption leads to dysregulate cell cycle control and increase genomic instability. Consequently, the prevention of cervical cancer primarily focuses on virological screening and intervention strategies [2].

With respect to pharmacological interventions in high-risk populations, existing studies have shown that tamoxifen and exemestane can significantly reduce the risk of breast cancer [3]. In the NSABP P-1 trial, tamoxifen reduced approximately 49–50% invasive breast cancer risk, compared with the placebo. Similarly, reduce approximately 65% in postmenopausal women at high risk when compared with the placebo [3]. For individuals at high risk of ovarian cancer, risk-reducing bilateral salpingo-oophorectomy (RRSO) remains the primary preventive intervention, while oral contraceptives may serve as an adjunctive measure. In addition, several studies have explored the potential role of SERMs in preventing breast cancer among BRCA mutation carriers [4].

For cervical cancer, prophylactic HPV vaccination can effectively prevent cervical cancer and its high-grade precancerous lesions, by reducing the incidence of cervical cancer by approximately 86% among individuals vaccinated at or before the age of 16, and by approximately 68% among those vaccinated between the ages of 17 and 19. A marked reduction in high-grade lesions, such as CIN2+, has also been observed, making HPV vaccination one of the most effective and well-established primary prevention strategies currently available [5]. In addition, regular HPV testing and cervical cytology screening enable early detection and intervention at the precancerous stage, thereby significantly reducing both the incidence and mortality.

Moreover, an increasing number of epidemiological stud-

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ies suggest that a healthy lifestyle also plays a protective role in cancer prevention. A balanced diet characterized by higher intake of leafy green vegetables, dietary fiber, flavonoids, and green tea has been associated with less risk of various cancers, whereas high intake of saturated fat, saturated fatty acids, cholesterol, and retinol has been linked to an increased cancer risk [6]. Aslo, maintaining a balanced diet, avoiding smoking, and minimizing exposure to exogenous mutagenic factors may help reduce the cumulative burden of cellular damage and, consequently, cancer risk.

## 3. Treatment

They are all primarily treated with surgery, radiotherapy, and systemic therapies, while emerging approaches such as targeted therapy and immunotherapy have been increasingly incorporated to enhance therapeutic efficacy and improve patients' quality of life. Nevertheless, the therapeutic focus and treatment selection differ substantially among these three malignancies.

Breast cancer is primarily treated through surgery, while adjuvant endocrine therapy and targeted therapy are key components of systemic treatment. Ovarian cancer treatment is mainly based on cytoreductive surgery and platinum-based chemotherapy, and in recent years, targeted therapies have significantly altered the recurrence. In contrast, treatment strategies for cervical cancer are highly stage-dependent, with concurrent chemoradiotherapy constituting the mainstay of treatment for intermediate-advanced disease patients, while immunotherapy has been gradually introduced to improve long-term outcomes.

### 3.1 Breast Cancer

Treatment decisions are based on an integrated assessment of clinical stage and tumor molecular subtype.

#### 3.1.1 Early-stage

In the early stage, tumors are typically confined to the breast and adjacent regions without extensive metastasis. The primary treatment goals are curative intent and reduction of recurrence risk. Surgical resection remains the cornerstone management. For eligible patients, BCS has become a widely adopted standard approach when tumor size, location, and breast volume permit. In terms of survival benefit, BCS has been shown to be comparable to mastectomy. A15-year follow-up has demonstrated no significant difference in the overall survival between patients (BCS vs. mastectomy) [7]. When combined with adjuvant radiotherapy, BCS can effectively reduce the risk of cancer cell dissemination and decrease both local and distant recurrence rates, thereby improving survival outcomes [8].

In addition to surgery and radiotherapy, systemic adjuvant therapy also plays a crucial role. For patients with hormone receptor–positive early-stage breast cancer, it is a standard treatment option. Commonly used agents include SERMs, such as the tamoxifen and the aromatase inhibitors. Tamoxifen is effective in both premenopausal and postmenopausal patients, and studies have shown that itcan reduce the risk of recurrence by approximately 50% [9].

Overall, the treatment remains primarily based on conventional local therapies and endocrine therapy, with newer treatment modalities serving mainly as adjunctive options for specific molecular subtypes and high-risk patient populations.

#### 3.1.2 Intermediate-stage

Intermediate-stage refers to disease with regional or locoregional spread but without distant metastasis. The primary treatment goals at this stage are to achieve effective local control, reduce the distant metastasis risk and improve overall survival. Treatment strategies are typically based on a multidisciplinary approach, incorporating surgery, adjuvant radiotherapy, chemotherapy, endocrine therapy, and, in selected cases, targeted therapy. Treatment regimens are individualized according to patient characteristics and disease-related risk factors to optimize survival outcomes and quality of life.

From a surgical perspective, breast-conserving surgery (BCS) remains a common treatment option, particularly when tumor size and location are appropriate. However, evidence indicates that BCS achieves outcomes comparable to mastectomy only when combined with postoperative radiotherapy. For patients with multifocal disease or large tumors, mastectomy may be a more appropriate option. Postoperatively, lymph node assessment and dissection are often required, especially in patients with axillary lymph node involvement, given the relatively high incidence of axillary metastasis. In such cases, axillary lymph node dissection is a standard component of treatment. When lymph node metastases are identified, additional axillary radiotherapy is typically recommended to reduce the risk of local recurrence.

For patients with intermediate-stage breast cancer, adjuvant radiotherapy plays a critical role in local disease control by eliminating residual microscopic disease and preventing locoregional recurrence. Postoperative radiotherapy generally involves comprehensive irradiation of the remaining breast tissue or chest wall, as well as regional lymphatic areas including the supraclavicular and axillary lymph nodes, to ensure adequate eradication of potential residual tumor cells. Evidence from the Early Breast Cancer Trialists' Collaborative Group (EBCTCG)

indicates that postoperative radiotherapy can reduce the risk of local recurrence by approximately 50–60%, with particularly pronounced benefits observed beyond five years of follow-up [10]. Similar to radiotherapy, chemotherapy and endocrine therapy can improve disease-free survival and overall survival in appropriately selected patient populations.

In addition, targeted therapy has become a standard component of treatment for patients with intermediate-stage HER2-positive breast cancer. Trastuzumab, a monoclonal antibody targeting the HER2 protein, has been shown to significantly improve survival outcomes, with an approximate 15% increase in 5-year survival rates [11].

#### 3.1.3 Advanced-stage

Advanced-stage refers to disease with distant metastases or locally advanced, unresectable tumors, including extensive regional lymph node involvement. The primary goals of treatment at this stage are to control disease progression and prolong survival. Treatment strategies must be highly individualized and depend on tumor molecular characteristics, the patient's overall health status, and responses to prior therapies. Systemic therapies, including chemotherapy, targeted therapy, and endocrine therapy, form the mainstay of treatment, with immunotherapy and other hormonal strategies serving as adjunctive options in selected cases.

For patients with triple-negative breast cancer (TNBC), chemotherapy and immunotherapy constitute the primary treatment approaches in this subgroup. In contrast, for HER2-positive breast cancer, chemotherapy is commonly combined with HER2-targeted agents to achieve optimal disease control. Patients with advanced breast cancer often require multiple lines of chemotherapy to manage disease progression.

In recent years, the treatment landscape for advanced breast cancer has continued to evolve, with novel agents and combination regimens being actively evaluated in clinical trials. Future therapeutic options may include additional targeted therapies, novel immunotherapeutic approaches, and poly(ADP-ribose) polymerase (PARP) inhibitors for patients with BRCA-mutated breast cancer.

### 3.2 Ovarian Cancer

Early-stage generally refers to FIGO stage I–II disease, characterized by localized tumors with high resect ability. The primary treatment goals are long-term survival with maximal reduction of recurrence risk and improvement of survival outcomes. Comprehensive surgical staging remains the cornerstone of treatment.

#### 3.2.1 Early-stage

For selected patients with FIGO stage IA–IB low-grade epithelial ovarian cancer, adequate surgical staging alone may achieve favorable outcomes, with reported 5-year survival rates exceeding 90% in low-risk groups [12]. However, patients with high-risk features—such as FIGO stage IC–II disease, poor tumor differentiation, or aggressive histological subtypes—require postoperative adjuvant platinum-based chemotherapy. The most commonly used regimen consists of paclitaxel combined with carboplatin. Clinical studies have demonstrated that adjuvant chemotherapy reduces the death risk (approximately 29%) and decreases the recurrence risk or disease progression by approximately 33% within five years [13].

#### 3.2.2 Intermediate-stage

Intermediate-stage typically refers to FIGO stage II–III disease, in which tumors extend beyond the ovaries to involve pelvic structures or the peritoneal cavity but without distant metastasis. Compared with early-stage disease, intermediate-stage ovarian cancer is associated with increased tumor burden and a significantly higher risk of recurrence. Accordingly, treatment goals shift from curative intent alone to maximal tumor burden reduction and prolongation of progression-free survival (PFS) and overall survival (OS).

For patients with good performance status, manageable comorbidities, and tumors primarily confined to the pelvis or abdominal cavity, primary debulking surgery (PDS) is preferred, with the aim of achieving no gross residual disease or minimal residual disease. This is followed by platinum-based chemotherapy, which has been shown to significantly improve survival outcomes. Data indicate that the 3-year survival rate reaches approximately 72.4% in patients with no residual disease, 65.8% in those with the minimal residual disease (≤1 cm), and 45.2% in patients with the substantial residual disease (>1 cm) [14]. These findings underscore residual tumor volume as a key prognostic factor, with greater survival benefit observed as the extent of cytoreduction improves.

For patients with extensive tumor burden, in whom optimal cytoreduction via PDS is unlikely, or for those with significant comorbidities and elevated surgical risk, neoadjuvant chemotherapy (NACT) followed by interval debulking surgery may be considered. Evidence suggests that, in appropriately selected patients, NACT-based strategies are not inferior to PDS in terms of survival outcomes while being associated with reduced perioperative morbidity.

#### 3.2.3 Advanced-stage

Advanced-stage ovarian cancer generally refers to FIGO stage III–IV disease, characterized by widespread intraperitoneal dissemination or distant metastasis. This stage is associated with high tumor burden, frequent recurrence,

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and represents the leading cause of ovarian cancer–related mortality. Management is centered on systemic therapy, with an emphasis on the integrated application of surgery, chemotherapy, and targeted therapy.

In the neoadjuvant and first-line treatment setting, platinum-based chemotherapy combined with taxanes remains the standard regimen. In recent years, clinical studies have demonstrated that, for patients harboring BRCA1/2 mutations, maintenance therapy with poly(ADP-ribose) polymerase (PARP) inhibitors following completion of first-line chemotherapy—such as olaparib—can reduce the risk of disease progression by approximately 70% compared with placebo [15]. Taken together, the treatment paradigm for advanced ovarian cancer is gradually shifting from traditional surgery followed by adjuvant chemotherapy toward a strategy integrating neoadjuvant chemotherapy with biomarker-driven maintenance therapy.

### 3.3 Cervical Cancer

The treatment is primarily determined by the FIGO stage, tumor size, and depth of invasion. In contrast, prognosis assessment and treatment selection for advanced disease increasingly emphasize tumor molecular characteristics.

#### 3.3.1 Early-stage

Early-stage generally refers to FIGO stages IA–IB1. For patients with FIGO stage IA disease without lymphovascular space invasion, cervical conization or simple hysterectomy may be considered, achieving effective tumor control while minimizing treatment-related morbidity. For patients with IB1, radical hysterectomy combined with pelvic lymph node dissection constituting the standard approach. In patients with fertility preservation desires and tumor diameters ≤2 cm, fertility-sparing radical trachelectomy may be considered.

Postoperatively, recurrence risk and high-risk pathological features—including the lymph node metastasis, positive surgical margins, and parametrial invasion—are evaluated. Patients with high-risk factors typically require adjuvant concurrent chemoradiotherapy, while those with intermediate-risk features may be considered for adjuvant radiotherapy alone. According to statistics from the National Cancer Institute (NCI) based on the SEER program, the 5-year relative survival rate is approximately 91%.

#### 3.3.2 Intermediate-stage

Intermediate-stage typically refers to tumors larger than 4 cm or with local parametrial invasion but without distant metastasis, corresponding to FIGO stages IB2–IIA/II. Standard treatment remains based on surgery combined with radiotherapy and chemotherapy, with greater emphasis on preoperative or postoperative risk stratification compared with the early-stage disease.

For operable patients, radical hysterectomy with pelvic lymph node dissection remains the main treatment option, followed by adjuvant chemoradiotherapy in the presence of high-risk pathological features. For those who are not suitable for surgical candidates, or those with bulky tumors and significant local invasion, neoadjuvant chemotherapy followed by the surgery or definitive concurrent chemoradiotherapy may be preferred to improve local control and survival outcomes. According to NCI data, patients who receive standardized multimodal treatment achieve a 5-year survival rate of approximately 60%. Although lower than that observed in early-stage disease, a substantial proportion of patients can still attain long-term survival. In recent years, advances in imaging techniques, molecular biomarkers, and lymph node assessment have increasingly contributed to treatment decision-making in intermediate-stage cervical cancer, providing a more precise basis for individualized therapy.

#### 3.3.3 Advanced-stage

Advanced-stage cervical cancer generally includes FIGO stages IIB–IVA through IVB, characterized by extensive local invasion or distant metastasis. Treatment in this stage is primarily systemic and multimodal in nature.

For patients with distant metastases or recurrent disease, systemic therapy becomes the cornerstone of management. Treatment options include platinum-based chemotherapy combined with targeted agents or immune checkpoint inhibitors, with therapeutic regimens selected according to tumor molecular characteristics and relevant biomarkers. Surgical intervention in advanced-stage disease is generally limited to palliative resection or management of complications. According to NCI statistics, the 5-year survival rate declines to approximately 15%, markedly lower than that of early- and intermediate-stage disease. Nevertheless, standardized concurrent chemoradiotherapy and the incorporation of targeted and immunotherapeutic approaches can prolong survival and improve life quality.

## 4. Conclusion

Breast/ovarian/cervical cancer, as the three major malignancies posing serious threats to women's health, have seen substantial improvements in prevention and treatment strategies. In terms of prevention, genetic screening combined with pharmacologic interventions can reduce the risk of breast and ovarian cancer, whereas primary prevention of cervical cancer relies primarily on HPV vaccination and regular screening. Adopting a healthy lifestyle has also been shown to confer broad protective effects.

Therapeutically, all three cancers follow precision-guided strategies based on disease stage and molecular subtype. Early-stage patients are typically managed with curative-intent surgery. In intermediate-stage disease, multimodal treatment is emphasized to control local progression and reduce the risk of metastasis. For the advanced-stage disease, systemic management—including targeted therapies and immune checkpoint inhibitors—is prioritized to prolong survival and improve life quality.

Although novel therapies such as the immunotherapy and maintenance strategies have significantly enhanced outcomes for certain patient subgroups, their applicability, long-term survival benefit, and potential for resistance remain under investigation. Future efforts should focus on integrating molecular biomarkers with individualized treatment approaches and optimizing continuum-of-care management, which will be pivotal for further improving the overall prevention and treatment of gynecologic malignancies.

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