FDG PET/CT in Gynaecological Cancers

- Ovarian Cancer
- Cancer of the uterine cervix
- Endometrial Cancer
Gynaecological cancers

Guidelines (ESMO*)

Clinical examination
Routine biochemistry
CA-125 (ovarian cancer)

Ultrasound (US)
Abdominal-pelvic MR or CT

* European Society for Medical Oncology
• For ovarian and endometrial cancers treatment decisions are based on surgical staging of disease.
• Cervical cancer is staged clinically.

FDG-PET/CT provide information that can improve therapy decision making when used in the appropriate clinical setting.
Cervical cancer – introduction

Second most common malignancy in women worldwide and a major threat to women’s health globally

The incidence varies widely among countries; world age-standardized rates 1-50 cases per 100,000

Introduction of cervical cancer screening and human papilloma virus vaccination have dramatically reduced the incidence and mortality

Classification:
80-85% squamous cell carcinoma
15-20% adenocarcinoma and adenosquamous carcinoma (increasing incidences, worse prognosis)

In one third disease relapse, usually within the first 2 years after completion of primary treatment
Cervical cancer - staging

**Dissemination:**

**Direct extension**
- Vagina
- Parametrium
- Urinary bladder
- Ureters
- Rectum
- Paracervical tissue

**Through lymphatic channels**
- Pelvic, paraaortal,
- Periclavicular LN

**Hematogenous (rare)**

*Figure 1. Staging of uterine cervix carcinoma according to FIGO (2018).*
Cervical cancer - staging

FIGO is based on anatomic and compartmental spread.

Recent advances in imaging have influenced the staging of other malignancies,

The FIGO staging system has remained unchanged because of the unavailability of state-of-the-art imaging technology in developing nations, where the incidence is high.

Therefore LN status is not included in FIGO
Impact of nodal staging

**Aim:**
Lymph node involvement provide incremental prognostic value compared with FIGO stage.

**Staging**
Examination (anesthesia) MRI
FDG-PET

**Prognostic factors**
clinical (age, FIGO, clinical diameter, histology)
MRI (invasion, tumor volume)
PET (lymph node metastasis)

**Conclusion:**
Nodal status on PET was the major predictor of outcome and was superior to FIGO staging.

Retrospective, n=206
Locoregionally advanced cc

Naravan et al International Journal of Gynaecological Cancer 2009

**Outcome measures**
OOS, relapse free survival, time to failure, local failure, nodal failure, and distant failure.
FDG PET/CT is more accurate than conventional imaging (CT and MRI) for detection of pelvic and paraaortal metastases.

In early stage cervical cancer the sensitivity is low (micrometastases) and FDG PET/CT cannot replace lymphadenectomy in the setting of early stage disease.
Cervical cancer – nodal staging

Sironi S et al. 2006

Lymph Node Metastasis in Patients with Clinical Early-Stage Cervical Cancer: Detection with Integrated FDG PET/CT

N = 47 patients (1081 nodes), Histopathologic cancer positive: 15 patients (18 nodes)

Short axis diameter > 0.5 cm all 13 metastatic nodes
Five missed nodes ≤ 0.5 cm (micrometastasis)

PET/CT is less useful in the care of patients with disease in stage IB or lower because disease, particularly lymph node micrometastasis, can be missed.
Cervical cancer – nodal staging

Lymph Node Metastasis in Patients with Clinical Early-Stage Cervical Cancer: Detection with Integrated FDG PET/CT

Table 2. Overall Patient-based Accuracy of PET/CT

<table>
<thead>
<tr>
<th>Statistical Index</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sensitivity</td>
<td>73 (11/15)</td>
</tr>
<tr>
<td>Specificity</td>
<td>97 (31/32)</td>
</tr>
<tr>
<td>Positive predictive value</td>
<td>92 (11/12)</td>
</tr>
<tr>
<td>Negative predictive value</td>
<td>89 (31/35)</td>
</tr>
<tr>
<td>Accuracy</td>
<td>89 (42/47)</td>
</tr>
</tbody>
</table>

Note — Data are percentages of patients. The numbers used to calculate the percentages are in parentheses. There were 11 patients with true-positive findings, 31 patients with true-negative findings, four patients with false-negative findings, and one patient with false-positive findings.

FDG PET/CT
FDG-positive = cancer positive
TP = 11/15

FDG-negative = cancer negative
TN = 31/32
Positive findings on FDG PET/CT correlates with disease stage and tumor volume.

Sensitivity of PET PET/CT for detection of metastases in advanced-stage disease is 95%.

Extrapelvic lymphadenopathy may alter therapy choice (but not the stage).
**Important prognostic factors:**
- Tumor size and volume
- Histologic grade
- Lymphovascular involvement
- **Local or retroperitoneal lymph node status** (especially paraaortic nodal metastasis)

SUVmax is a predictive biomarker of lymph node status, distant metastasis, and overall survival.
Cervical cancer – M-staging


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Abstract

PURPOSE: To assess the accuracy of positron emission tomography (PET) with 2-deoxy-2-[(18)F]fluoro-D-glucose (FDG) for evaluating local and distant disease in patients with cervical cancer.

METHODS: The PET imaging database maintained at our institution was used to identify patients who received FDG-PET scans for the clinical indication of cervical cancer for the past four years. Patients were followed for a minimum of six months following the PET study. Results of the FDG-PET studies were correlated with surgical pathology, biopsy results, and/or clinical follow up to assess the accuracy of FDG-PET in evaluating local and distant disease.

RESULTS: A total of 61 FDG-PET studies performed in 41 patients were included in this retrospective study. Nine FDG-PET studies were performed for initial staging of cervical cancer, and 52 PET scans were performed in 35 different patients as restaging studies following therapy. For the initial staging, the local primary disease was identified in all nine FDG-PET studies, and PET distinguished the patients which had localized disease (four patients) from those with distant metastases on follow-up (five patients) with 100% accuracy. For restaging cervical cancer, FDG-PET had a sensitivity of 0.82 and specificity of 0.97 (accuracy 0.92) for evaluation of local recurrence. For evaluating distant disease in these patients, PET had a sensitivity of 1.0 and specificity of 0.90 (accuracy 0.94). In the evaluation of local disease, focal rectal activity caused false-positive results in two cases. Three false-positive studies for distant disease were caused by inflammatory adenopathy.

CONCLUSION: FDG-PET is an accurate modality both for initial staging and restaging of patients with cervical cancer. PET is particularly sensitive for detecting distant metastases, allowing stratification of patients into those with locally confined disease and those with distant disease. These results were achieved by using a standardized PET imaging protocol without the use of bowel preparations, laxix administration, or Foley catheter drainage. Evaluation of local disease can be challenging due to adjacent rectal and bladder activity, and the use of hybrid PET/computed tomography (CT) scanners in the future may further improve evaluation of local disease.

PET had sensitivity of 100%, specificity of 90%, and accuracy of 94% for evaluating distant disease.
Cervical cancer – recurrence

Relapse occurs within the first 2 years

**Posttherapy protocols (5 years)**
- Physical examination
- Cervical and vaginal cytology
- Chest radiograph

NCCN guidelines for surveillance include FDG-PET/CT for high risk patients for loco-regional failure

Sensitivity: 86-100%
**Cervical cancer – relapse**

<table>
<thead>
<tr>
<th>Study</th>
<th>No. of patients</th>
<th>Sensitivity (%)</th>
<th>Specificity (%)</th>
<th>Treatment modification (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unger et al., 2004 [7]</td>
<td>44</td>
<td>80(^a)</td>
<td>100(^a)</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td></td>
<td>100(^b)</td>
<td>86(^b)</td>
<td></td>
</tr>
<tr>
<td>Sun et al., 2001 [8]</td>
<td>20</td>
<td>90.0</td>
<td>100</td>
<td>–</td>
</tr>
<tr>
<td>Havrilesky et al., 2003 [10]</td>
<td>28</td>
<td>85.7</td>
<td>86.7</td>
<td>–</td>
</tr>
<tr>
<td>Chang et al., 2004 [11]</td>
<td>27</td>
<td>94.4</td>
<td>77.8</td>
<td>25.9</td>
</tr>
<tr>
<td>Ryu et al., 2003 [18]</td>
<td>249</td>
<td>90.3</td>
<td>76.1</td>
<td>–</td>
</tr>
<tr>
<td>Lai et al., 2003 [19]</td>
<td>40</td>
<td>91.0</td>
<td>98.0</td>
<td>55.0</td>
</tr>
</tbody>
</table>

Sironi et al 2007 25 92.9 100
Kitajima K et al 2008 25 92.0 92.6
Mitra E et al 2009 30 93.0 93.0
Yen TC et al 2004 55 65
Chung 2007 52 90.3 81.0 23.1

**Conclusion:** FDG PET/CT provides good anatomic and functional localization of suspicious lesions in CC patients.
FDG PET/CT has an impact not only on clinical management and treatment planning of patients, but also on disease-free survival.

Kaplan-Meir survival graph of 2-year disease-free survival rate of patients with negative PET/CT and positive PET/CT in 52 patients with suspected cervical cancer recurrence (Chung HH et al. Gynaec Oncol 2007)
Cervical cancer – recurrence

Recurrent CCU (55 y female)

**Indication:**
Biopsy from bladder wall with recurrence of CCU.

LN in mediastinum, paraaortal and in the pelvis
Carcinosis

One lesion in bone
Detection of Hematogenous Bone Metastasis in Cervical Cancer

18F-Fluorodeoxyglucose-Positron Emission Tomography Versus Computed Tomography and Magnetic Resonance Imaging

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BACKGROUND: In this large-scale, retrospective study, the authors evaluated the diagnostic performances of computed tomography (CT), magnetic resonance (MR) imaging, and 18F-fluorodeoxyglucose-positron emission tomography (18F-FDG-PET) in detecting hematogenous bone metastasis in patients with cervical cancer. The associated risk factors also were analyzed. METHODS: Patients with invasive cervical cancer who had both 18F-FDG-PET studies and CT or MR imaging studies were selected. Patients who had either International Federation of Gynecology and Obstetrics (FIGO) stage III/IV disease or positive lymph node metastasis at the time of primary staging and patients who had suspected recurrent disease were included in the analyses. The diagnostic performances of PET were compared with the performance of CT and MR imaging by using the area under the receiver-operating-characteristic curve (AUC). Both univariate and multivariate analyses were applied to assess the risk factors for hematogenous bone metastasis at primary staging. RESULTS: PET was more sensitive than CT (P = .004) and was more specific than MR imaging (P = .04). The diagnostic performance of PET was significantly superior to the performance CT (AUC, 0.964 vs 0.662; P < .001) and MR (AUC, 0.966 vs 0.833; P = .035). Both FIGO stage and the extent of lymph node metastases were associated with hematogenous bone metastasis in univariate analysis. However, the extent of lymph node metastases was the only significant risk factor in multivariate analysis (P = .025). CONCLUSIONS: The current study demonstrated the superiority of 18F-FDG-PET over CT and MR imaging for detecting hematogenous bone metastasis in patients with advanced cervical cancer. Hematogenous bone metastasis in cervical cancer was associated with the extent of lymph node metastases rather than with FIGO stage. Cancer 2009;115:5470-80. © 2009 American Cancer Society.
Summary
For locally advanced cervical cancer, the current literature supports the use of 18F-FDG PET for assessing treatment response 3 mo after the completion of concurrent chemoradiation.

18F-FDG PET can provide reliable longterm prognostic information for these patients and, in the future, may be used to guide additional therapy.

Investigational areas: monitoring response during radiotherapy and chemotherapy in the metastatic and neoadjuvant settings.

Schwart JK et al. The role of 18F-FDG PET in Assessing Therapy Response in Cancer of the Cervix and Ovaries JNM 2009
### Conclusions and further use

**TABLE 2: Value of PET/CT in Evaluation of Cervical Cancer**

<table>
<thead>
<tr>
<th>Purpose</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Staging</strong></td>
<td>FDG PET/CT is effective in lymph node staging particularly of locally advanced cervical carcinoma (stage ≥ IB2).</td>
</tr>
<tr>
<td><strong>Therapy planning</strong></td>
<td>PET staging affects management by extending the radiation field and administered dose to the involved nodes.</td>
</tr>
<tr>
<td><strong>Therapy response assessment</strong></td>
<td>PET/CT has a high accuracy in the assessment of locally recurrent and distant metastatic disease.</td>
</tr>
<tr>
<td><strong>Prognosis</strong></td>
<td>Posttherapy standardized uptake value (SUV) and qualitative assessment (positive versus negative) help in identifying recurrence and residual disease after therapy and help in assessment of disease status.</td>
</tr>
<tr>
<td></td>
<td>The maximum SUV of the primary cervical tumor is predictive of disease outcome.</td>
</tr>
<tr>
<td></td>
<td>Metabolic tumor volume and total lesion glycolysis, which are volume-based metabolic parameters, and lymph node status on PET images are significant independent prognostic factors.</td>
</tr>
<tr>
<td></td>
<td>Posttherapy FDG uptake, as detected with whole-body PET, is predictive of survival.</td>
</tr>
<tr>
<td></td>
<td>Studies of $^{68}$Cu-diacetyl-bis(N$^\text{4}$-methylthiosemicarbazone) ($^{68}$Cu-ATSM), which has a high affinity for hypoxic tissue, show that the pretreatment oxygenation status of tumors can be predictive of overall survival, disease-free survival, local tumor control, or any or a combination of these features.</td>
</tr>
</tbody>
</table>
Ovarian cancer

- Occur in any age (>65 y)
- Nonspecific symptomatology
- Lack of accurate screening
- 75% present at stage III or IV
- Metastatic spread is serosal and undetected by morphologic imaging until tumor bulk is sufficient to present as macroscopic foci greater than 0.5 mm
Ovarian cancer

Type I tumors (25%)
confined to the ovary at diagnosis
indolent course.
Low-grade serous, low-grade endometrioid, clear
cell, and mucinous tumors.

Type II tumors (75%)
present in advanced-stage
responsible for 90% of ovarian cancer deaths
high-grade serous and undifferentiated carcinomas
and mixed mesodermal tumors.

Best survival: Early diagnosis, optimized debulking.
FIGO stage for treatment and prognosis

Treatment is primary surgery and staging (FIGO)

Table 1: FIGO staging of ovarian cancer

<table>
<thead>
<tr>
<th>Stage</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Limited to ovaries</td>
</tr>
<tr>
<td>IA</td>
<td>1 ovary, capsule intact</td>
</tr>
<tr>
<td>IB</td>
<td>Both ovaries, capsules intact</td>
</tr>
<tr>
<td>IC</td>
<td>1 or both ovaries with capsule rupture, serosal tumor, ascites</td>
</tr>
<tr>
<td>II</td>
<td>1 or both ovaries with pelvic extension</td>
</tr>
<tr>
<td>IIA</td>
<td>Extension to uterus or tubes</td>
</tr>
<tr>
<td>IIB</td>
<td>Extension to other pelvic organs</td>
</tr>
<tr>
<td>IIC</td>
<td>Pelvic extension and malignant ascites</td>
</tr>
<tr>
<td>III</td>
<td>1 or both ovaries with microscopic peritoneal disease</td>
</tr>
<tr>
<td>IIIA</td>
<td>Microscopic peritoneal spread beyond pelvis</td>
</tr>
<tr>
<td>IIIB</td>
<td>Macroscopic peritoneal spread ≤2 cm</td>
</tr>
<tr>
<td>IIIC</td>
<td>Macroscopic peritoneal spread &gt;2 cm or regional nodes</td>
</tr>
<tr>
<td>IV</td>
<td>Distant metastases (excluding peritoneal metastases)</td>
</tr>
</tbody>
</table>

FIGO allocates to treatment and divides patients into groups with similar prognostic outlook.

Prognosis is strongly related to the stage of disease at initial diagnosis.

5-year survival:
Stage I: 75%
Stage II-III: 20-40%
Stage IV: <10%
Ovarian cancer – treatment planning

The clinical impact of imaging is limited to the ability to discover and localize peritoneal implants giving indications to the surgeons to perform a complete debulking and to identify other sites of metastatic disease preventing surgery.

- **Stage I**: Limited to Ovaries
  - 1c – surface/rupture/+ve cytology
- **Stage II**: Limited to pelvic structures
- **Stage III**: Limited to abdominal cavity
  - incl. peritoneal spread, para-aortic lymphadenopathy, liver capsule
- **Stage IV**: Beyond abdominal cavity

- **Advanced stage ovarian cancer**
  - Debulking surgery
  - The complete resection is related to the best survival rates.
  - Post-operative residual tumor is one of the most important negative prognostic factors

- **Systemic therapy**
Ovarian cancer – primary lesion

**Diagnostic work up**

Transvaginal ultrasound examinations
CA-125 level in blood
Menopausal status

RMI

Exploratory laparotomy/laparoscropy is performed when the pelvic tumor is suspected to be malignant.

It is still necessary to perform 8–9 benign ovarian cyst operations for the detection of one cancer patient

Co morbidity in the elderly
The diagnostic value of PET/CT for primary ovarian cancer—A prospective study

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Received 16 August 2006
Available online 16 January 2007

97 patients, RMI>150 (US, CA125, meopausal status)
57/57 TP (sensitivity = 100%)
37/40 TN (specificity 92.5%)
3 FP (fibroma ovarii, leiomyoma uteri, endometriosis)

Conclusion:
FDG-PET/CT is the image modality of choice when US shows a pelvic tumour, and additional information prior to surgery is needed.
Ovarian cancer – primary lesion

Table 1 Results of the studies using FDG-PET/CT in evaluation of differentiation between malignant and benign ovarian tumors

<table>
<thead>
<tr>
<th>Authors</th>
<th>Year</th>
<th>No. of patients</th>
<th>Sen (%)</th>
<th>Spe (%)</th>
<th>Acc (%)</th>
<th>Modality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Castelluci et al. [9]</td>
<td>2007</td>
<td>50 (M:32, B:18)</td>
<td>87</td>
<td>100</td>
<td>92</td>
<td>PET/CT</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>90</td>
<td>61</td>
<td>80</td>
<td>TVUS</td>
</tr>
<tr>
<td>Nam et al. [10]</td>
<td>2009</td>
<td>133 (M:108, B:25)</td>
<td>98</td>
<td>74</td>
<td>90</td>
<td>PET/ceCT</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>95</td>
<td>46</td>
<td>53</td>
<td>Enhanced MRI</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>TVUS</td>
</tr>
</tbody>
</table>

M malignant ovarian tumor (ovarian cancer), B benign ovarian tumor, Sen sensitivity, Spe specificity, Acc accuracy, TVUS transvaginal sonography, PET/ceCT PET/contrast-enhanced CT

False negative
Low-grade and early adenocarcinomas
Borderline tumors with small volume or low cellular density

False-positive
Serous cystadenoma
Endometrioma
Teratoma
Fibroma
Physiological ovarian uptake; ovulation and during early luteal phase
Surgery could be postponed/cancelled in asymptomatic patients with a pelvic tumor suspected to be benign after PET/CT.

Especially in patients in poor performance status where the estimated risk of complications to surgery is high.

The patients need follow-up to make sure that a future malignant transformation in a benign tumor is detected.
Staging is done by exploratory laparotomy (FIGO)

MRI of the pelvis for invasion to surrounding organs

CT chest/abdomen for lymph nodes and peritoneal implants
Peritoneal carcinomatosis from ovarian cancer: the role of CT and $^{[18]}\text{F}^{18}$FDG-PET/CT

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Abstract

Purpose: The diagnosis of peritoneal carcinomatosis secondary to ovarian cancer is a real challenge in the cancer imaging field. In this retrospective study, we evaluated the accuracy of Single Detector Computed Tomography (SDCT), Multi Detector Computed Tomography (MDCT), and Positron Emission Tomography-Computed Tomography (PET/CT) for the detection of peritoneal carcinomatosis in patients with ovarian cancer primary or secondary to ovarian cancer.

Materials and methods: A total of 228 cases (91 SDCT, 89 MDCT, and 48 $^{[18]}\text{F}^{18}$FDG-PET/CT) of patients with peritoneal carcinomatosis secondary to ovarian cancer were selected and reviewed by two independent radiologists with a significant experience in abdominal imaging.

Results: MDCT showed 81% of true positives, SDCT 72.5%, and $^{[18]}\text{F}^{18}$FDG-PET/CT 77%. False negatives were 19% for MDCT, 27.5% for SDCT, and 23% for $^{[18]}\text{F}^{18}$FDG-PET/CT.

Conclusions: From our results, we concluded that MDCT is the technique of choice in the diagnosis of peritoneal seeding, while $^{[18]}\text{F}^{18}$FDG-PET/CT, though showing higher accuracy, remains the most accurate technique for monitoring therapeutic response and disease recurrence. MDCT could play a key role in the planning of the surgical procedure, allowing for the precise definition of the extent of disease.

Keywords: Ovarian cancer – Peritoneal carcinomatosis – MDCT – Positron emission tomography – Magnetic resonance imaging – Single Detector CT

Results:

MDCT: 81%
SDCT: 72.5%
$^{[18]}\text{F}^{18}$FDG-PET/CT: 77%

True positives

MDCT: 81%
SDCT: 72.5%
$^{[18]}\text{F}^{18}$FDG-PET/CT: 77%

False negatives

MDCT: 19%
SDCT: 27.5%
$^{[18]}\text{F}^{18}$FDG-PET/CT: 23%
Ovarian cancer – staging

Does the use of diagnostic PET/CT cause stage migration in patients with primary advanced ovarian cancer?

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b Department of Oncology, Aarhus University Hospital, Aarhus University, Denmark

ABSTRACT

Objectives: To investigate if the use of diagnostic PET/CT leads to stage migration in patients with primary advanced ovarian cancer.

Materials and Methods: A retrospective study was performed on all patients with primary advanced ovarian cancer referred for initial staging PET/CT at a tertiary cancer center between January 2016 and December 2018. A total of 125 patients were included in the study. The characteristics of patients with and without stage migration were compared. All patients underwent a subsequent surgery and were staged according to the International Federation of Gynecology and Obstetrics (FIGO) classification.

Results: Of the 125 patients included, 26% (n=32) showed stage migration. The median age of the patients was 60 years (range: 22-86) and the median body mass index was 27.5 kg/m² (range: 16.5-38). The most common histological type was serous adenocarcinoma (51%, n=64), followed by mucinous adenocarcinoma (29%, n=36) and endometrioid adenocarcinoma (15%, n=19). The overall survival of patients with stage migration was significantly lower than in patients without migration (median survival: 37 months vs. not reached, p=0.01).

Conclusion: The use of diagnostic PET/CT in patients with primary advanced ovarian cancer may lead to stage migration, and further studies are needed to evaluate the impact of this on patient outcomes.

Histological diagnosis | FIGO stage | PET/CT stage
--- | --- | ---
Serous adenocarcinoma | 58 | 58
Mucinous adenocarcinoma | 3 | 3
Endometrioid adenocarcinoma | 2 | 2
Carcinoma | 2 | 2

Stage IV: Beyond abdominal cavity
Surgery has no value

![PET/CT stage III](image)

Stage IV and IIIA

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Fig. 1. Overall survival of 39 patients with PET/CT stage III, 27 patients with PET/CT stage IV, and 64 patients with FIGO stage III.
Ovarian cancer – treatment planning

• PET/CT is more accurate than CT and MRI identification of extra-abdominal metastatic lymphadenopathy adenopathy

• Mediastinal metastatic lymphadenopathy on PET/CT is associated with higher mortality.

• A preoperative PET/CT in patients with advanced ovarian cancer may alter therapy, direct surgery, and provide a baseline for subsequent treatment monitoring
Ovarian cancer
Ovarian cancer
The incidence of relapse:
Early stage disease: 20-30%
Advanced stage: 50-75%

Risk is highest the first 2 years after primary treatment

Few formal guidelines exist on surveillance.

Strict follow-up by gynaecologic examination and CA-125 serum level monitoring and imaging (CT or MRI) is the common practice to detect early relapse.
Ovarian cancer - relapse

Small local recurrence, LN metastasis, small dissemination, bone/muscle metastasis are difficult to detect with CT and MRI.

Today FDG PET/CT has the best diagnostic accuracy in these clinical situations

Gu P et al. Ca125, PET alone, PET-CT, CT and MRI in diagnosing recurrent ovarian carcinoma: a systematic review and meta-analysis
Eur J Radion 2009;27:294-23
Results
34 studies (meta-analysis)
CA 125 had the highest pooled specificity, 0.93 (95% CI: 0.89–0.95)
PET–CT had highest pooled sensitivity, 0.91 (95% CI: 0.88–0.94)

Conclusion
PET–CT might be a useful supplement to current surveillance techniques, particularly for those patients with an increasing CA 125 level and negative CT or MR imaging.
PET/CT may have the greatest utility in the situation in which CA-125 levels are rising and conventional imaging studies show negative or equivocal findings.

**Table 2** Indications for PET/CT scan, the number of positive PET/CT studies and the number of confirmed recurrences in patients with suspected recurrent ovarian cancer

<table>
<thead>
<tr>
<th>Reason for PET/CT scan</th>
<th>No. of patients</th>
<th>PET/CT positive</th>
<th>Confirmed recurrence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elevated serum tumour marker</td>
<td>42</td>
<td>31</td>
<td>33</td>
</tr>
<tr>
<td>Abnormal imaging study</td>
<td>29</td>
<td>10</td>
<td>9</td>
</tr>
<tr>
<td>Abnormal physical examination</td>
<td>4</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Abnormal histology</td>
<td>2</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Total</td>
<td>77</td>
<td>43</td>
<td>45</td>
</tr>
</tbody>
</table>

Chung HH et al Role of 18FFDG PET/CT in the assessment of suspected recurrent ovarian cancer  
Eur J Nucl Mol Imaging 2007
## Ovarian cancer - relapse

**Table 2** Results of the studies using FDG-PET/CT in evaluation of recurrence/metastases in patients with ovarian cancer with clinical follow-up including radiological imaging findings as the standard reference

<table>
<thead>
<tr>
<th>Authors</th>
<th>Year</th>
<th>N</th>
<th>Location</th>
<th>Contrast medium</th>
<th>Sen (%)</th>
<th>Spe (%)</th>
<th>Acc (%)</th>
<th>Modality</th>
<th>Management (%)</th>
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<tr>
<td>Hauth et al. [19]</td>
<td>2005</td>
<td>19</td>
<td>Whole</td>
<td>Oral + IV</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>PET/ceCT</td>
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<td>100</td>
<td>100</td>
<td>100</td>
<td>Enhanced CT</td>
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<td>73</td>
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<td>Nanni et al. [20]</td>
<td>2005</td>
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<td>85</td>
<td>PET/CT</td>
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<td>Simcock et al. [21]</td>
<td>2006</td>
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<td>NA</td>
<td>NA</td>
<td>PET/CT</td>
<td>57</td>
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<tr>
<td>Chung et al. [22]</td>
<td>2007</td>
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<td>Oral</td>
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<td>97</td>
<td>95</td>
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<td>Mangili et al. [23]</td>
<td>2007</td>
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<td>Abd</td>
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<td>NA</td>
<td>NA</td>
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<tr>
<td>Thrall et al. [24]</td>
<td>2007</td>
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<td>Kim et al. [25]</td>
<td>2007</td>
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<td>NA</td>
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<td>81</td>
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<tr>
<td>Sebastian et al. [26]</td>
<td>2008</td>
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<td>Whole</td>
<td>Oral + IV</td>
<td>97</td>
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<td>92</td>
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<td>Enhanced CT</td>
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<tr>
<td>Iagaru et al. [27]</td>
<td>2008</td>
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<td>Soussan et al. [28]</td>
<td>2008</td>
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<td>Enhanced CT</td>
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<tr>
<td>Kitajima et al. [18]</td>
<td>2008</td>
<td>132</td>
<td>Whole</td>
<td>IV</td>
<td>79</td>
<td>91</td>
<td>85</td>
<td>PET/ceCT</td>
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<td>PET/CT</td>
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<td>85</td>
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<td>Enhanced CT</td>
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<td>Fulham et al. [29]</td>
<td>2009</td>
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<td>NA</td>
<td>PET/CT</td>
<td>59</td>
</tr>
</tbody>
</table>

*Note: Number of patients, NA not available, Whole whole body was assessed, Abd abdomen and pelvis was assessed, IV intravenous contrast material is used for CT portion of PET/CT, Oral oral material is used for CT portion of PET/CT, Sen sensitivity, Spe specificity, Acc accuracy, PET/ceCT PET/contrast-enhanced CT*
Ovarian cancer – conclusions

FDG PET/CT can postpone/cancel surgery in asymptomatic patients with a FDG-negative pelvic tumor.

provide an accurate depiction of the sites of abnormal disease.

help to perform optimal primary cytoreductive surgery.

FDG PET/CT is useful in follow-up (CA 125 increase).
Two histologic subtypes:
Type 1: 75-80% estrogen-associated carcinoma
Well differentiated endometrioid adenocarcinoma

Type 2:
Estrogen independent
Aggressive, undifferentiated of serous or clear cell type
Occur in the elderly

Most patients are postmenopausal 20-25% present in the premenopausal group
# Endometrial Cancer

## Endometrial CA: by HPE

<table>
<thead>
<tr>
<th>STAGE</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>I</td>
<td>Confined to Corpus Uteri</td>
</tr>
<tr>
<td>IA</td>
<td>Limit to Endometrium</td>
</tr>
<tr>
<td>IB</td>
<td>Invade $&lt; \frac{1}{3}$ Myometrium</td>
</tr>
<tr>
<td>IC</td>
<td>Invade $&gt; \frac{1}{3}$ Myometrium</td>
</tr>
<tr>
<td>II</td>
<td>Invade Cervix; Not beyond Uterus</td>
</tr>
<tr>
<td>IIA</td>
<td>+ Endocervical</td>
</tr>
<tr>
<td>IIB</td>
<td>+ Ectocervical</td>
</tr>
<tr>
<td>III</td>
<td>Beyond Uterus; Not beyond True Pelvis</td>
</tr>
<tr>
<td>IIIA</td>
<td>Invade Serosa, Adnexae, Peritoreum</td>
</tr>
<tr>
<td>IIIB</td>
<td>+ Vagina</td>
</tr>
<tr>
<td>IV</td>
<td>Beyond True Pelvis/ + Bladder/ + Rectum</td>
</tr>
<tr>
<td>IVA</td>
<td>Invade Bladder/ Bowel Mucosa</td>
</tr>
<tr>
<td>IVC</td>
<td>Distant Mets (including Inguinal Nodes)</td>
</tr>
</tbody>
</table>

**Staging:** surgically (hysterectomy, bilateral salpingo-oophrectomy, pelvic and para-aortic lymphadenectomy)
Most endometrial cancers are FDG-avid: Sensitivity for detection of nodal metastases is 57-63%, specificity is 100%.

Even patients with locally advanced disease benefit from surgical debulking and positive findings on FDG PET/CT before therapy does not alter surgical intervention.

In selected high-risk patients FDG-PET/CT may identify distant metastases that obviate surgical staging.
Endometrial cancer - restaging

Most recurrences occur within first 3 years.

**Routine surveillance:**
- Physical examination
- Vaginal cytology
- CT or MRI as clinically indicated

Asymptomatic metastatic disease: 20%

FDG PET/CT is not included in the international guidelines but have high sensitivity and specificity in detection of local recurrence and distant metastatic disease and is potentially a better surveillance tool for high-risk patients.
Endometrioid cancer stage IIIb. Recurrence in vagina
Uterine sarcomas

Rare cancer
Poor prognosis
Early metastatic spread
Risk of distant spread
Usually very FDG-avid
FDG-PET is excellent in relapse

- Sensitivity: 92.9%
- Specificity: 100%
- PPV: 100%
- NPV: 84%

*Park JY et al. Role of OET or PET/CT in the post-therapy surveillance of uterine sarcoma. Gynecol Oncol 2008*
Choriocarcinoma is a malignant FDG-avid, trophoblastic cancer, usually of the placenta. Characterized by early hematogenous spread.

Gestational choriocarcinoma is sensitive to chemotherapy (metotrexate)

Intense combination regimens: intermediate or high-risk.

Hysterectomy: uncontrolled bleeding, patients > 40 y or those for whom sterilisation is not an obstacle.
Choriocarcinoma