## Developing a platform to investigate the heterogeneity of outcomes for patients with ovarian cancer

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## Abstract

**Background**

The geographical variation in treatment patterns for patients with ovarian cancer is profound, long standing, and worrying. Although these variations were highlighted in a recent UK registry audit, granular data to provide explanations for these variations have been lacking.

**Methods**

A consortium of six UK centres was generated to curate and submit data for all patients treated at their centre for a two year period. Descriptive statistics were combined with cox regression and Kaplan Meier analysis to confirm the findings from the national registry audit and identify possible drivers of the heterogeneity previously described.

**Results**

Records for 1117 patients treated in six centres in 2018 and 2019 were collated. Although there were differences in the clinical characteristics of patients between centres these were not enough to account for the significant variation in survival outcomes between centres (p<0.001). Treatment rates varied between centres with between 30% and 76% patients receiving combination therapy but in Cox models “treatment centre” remained a predictor of one year survival independent of patient, tumour factors, and treatment choice.

**Conclusion**

Variations in outcome seen between UK centres are not related solely to case mix but rather to the approach and ethos of each centre towards advanced ovarian cancer treatment options. Although important, differences in treatment patterns do not completely explain the variations seen and further work is required to understand the drivers of difference seen.

**Strengths & Limitations**

* This study uses data collected for all patients diagnosed with ovarian cancer presenting to six UK centres
* Data are retrospective so missing data were imputed
* The use of a data dictionary to collect data resulted in a uniform dataset

## Key messages

**What is already known on this topic**

Treatment patterns vary between centres in the UK and this is associated with worrying differences in outcomes
**What this study adds**

This variation in treatment is not explained by case mix and may therefore be related to the ethos of the centre

**How this study might affect research, practice or policy**

Women with ovarian cancer need better evidence to help them make treatment decisions

## Introduction

Outcomes for patients with ovarian cancer remain poor with five year survival rates of 34.6% [1]. One of the strongest determinants of outcome is mode of primary treatment [2]. Treatment with a combination of surgery and chemotherapy is associated with best outcomes, although not all patients are suitable for this approach. Guidance is lacking on how to select patients for treatment and consequently practice varies between centres, even within a centralised health service such as the UK. This variation was highlighted in the UK Ovarian Cancer Audit Feasibility Pilot (OCAFP) [1], which showed unacceptable levels of variation in treatment patterns, and overall survival, between Cancer Alliances, the geographical units of administration within England.

OCAFP was a registry study and was thus unable to capture potentially important data, including performance status and co morbidity data. As a result, it is difficult to interpret from OCAFP the underlying reasons for the variations in practice seen. To understand these differences a dataset is required which includes not only all known prognostic factors but also includes all patients diagnosed in a centre, thus ensuring the correct denominator [3]. Such datasets are not provided by clinical trial datasets which can often be highly selective.

Here we therefore wanted to assess the feasibility of generating a granular dataset from a consortium of UK centres before using these data to confirm the findings of the OCAFP and start to provide reasons for the variations that are seen in current treatment patterns.

## Methods

### Identification of centres

Six UK sites were carefully selected to include large and small centres, and centres from Cancer Alliances with high and low surgical resection rates, identified from the Ovarian Cancer Audit Feasibility Project (OCAFP) [1]. The participating centres were selected to reflect the full range of UK practice and included one centre which lies above the 99th centile for resection rates, and one centre lying below the 1st centile, with four centres representing mainstream practice.

A data dictionary was generated to define all clinical variables to be collected. Details of the dictionary have been previously described [4]. Briefly the data dictionary comprises (1) patient factor data which includes demographic, comorbidity using the validated ACE-27 system [5], and germline BRCA status, (2) tumour related data, including histological type, grade and stage, physiological response data and radiological distribution of disease, and (3) treatment related data including type and outcome of each treatment modality. Deprivation indices were generated from patient postcode using the Indices of Deprivation score [6]. Three year follow up data were also recorded.

Each participating centre was funded to collect data, according to the data dictionary, for all patients registered with a diagnosis of ovarian cancer (ICD56), between the dates of 1/1/2018 and 31/12/2019.

Data were transferred to the University of Manchester and stored in a data repository in a pseudonymised fashion. Missing data were managed with median replacement. Data were analysed with Kaplan-Meier, cox proportional hazard, and multivariable cox models using Rstudios (4.2.3).

As part of the data collection process, sites were also asked to complete a resource requirements document, to better understand the time taken to obtain the data at each site. This information was not requested from the one centre, as data collection was complete prior to the commencement of this project.

Ethical approval was granted from the HRA and Health and Care Research Wales for data collection and storage (ref 22/HRA/3264).

## Results

### Data completeness

A total of 1,117 patient records were submitted, representing all cases registered with each centre for the two year period from 1/1/2018 to 31/12/2019. The numbers registered per centre were 94, 115, 123, 173, 304, 308 respectively. The numbers per centre varied, as expected, dependent upon the varying sizes of the local population.

Performance status, CA125, deprivation index, FIGO stage and grade were generally well recorded and available for analysis. In contrast, while ACE27 scores and ethnicity were well recorded in some centres, they were very poorly recorded in others, table 1. Although germline BRCA status was also heterogeneously recorded it should be noted that the study period coincided with the national roll out of germline BRCA testing with centres taking this on at various points during the study period, table 1.

### Data collection processes

The resource required to carry out retrospective data collection is rarely calculated. We wanted to generate an estimate of the time and resource required to generate a comprehensive data record, which often requires access to multiple IT systems. Data collectors therefore recorded the time taken to complete each record. Time taken to collect data for each patient varied across centres with a mean score of 27 minutes per patient, table 2. There was no evidence of time per record decreasing with increasing experience. There was also no correlation between number of patients and time taken to collect data. The number of data systems required to obtain the data (electronic and paper based) ranged from 2 to 7 in the five centres who submitted resource requirements information, table 2.

### Explaining Heterogeneity

Median follow up for the whole cohort was 36 months. However to explore heterogeneity we focussed on patients with FIGO stage 2-4 disease. Median survival for stage 2-4 patients was 27 months. Kaplan Meier analysis, stratified by treatment centre, showed marked survival differences between patients in each centre (p<0.001, long rank test), figure 1.

Demographics and clinical factors varied between centres. There were marked differences in indices of deprivation between the six centres, with two centres having large proportions of patients with low (1-3) deprivation scores, table 3 and figure 2a.

There were also differences between centres in age, WHO Performance Status, ACE27 co morbidity index [5], smoking status, ethnicity, body mass index, FIGO Stage and histological diagnosis, table 3.

However most notable was the heterogeneity seen within treatment patterns between the six centres, figure 3. For stage 2-4 disease the combination of surgery and chemotherapy, which can be delivered with surgery either prior to, or during, chemotherapy [7], is considered gold standard treatment for patients with advanced ovarian cancer. Median rates of gold standard treatment in this cohort were 64.2% but ranged from 29.4% in one centre to 75.9% in another. There were similar variations in rates of “no treatment” (median 12.0%, range 2.1-31.2%).

Cox proportional hazard modelling showed that the patient and tumour factors that impacted upon survival included age (HR for death 1.04), PS 3 or 4 (HR 2.06 and 16.5 respectively), FIGO stage 3 or 4 (3.13 and 4.30 respectively) and albumin level (HR 0.97).

When treatment was incorporated into the model, there was no effect of receiving neoadjuvant chemotherapy and interval surgery compared to primary cytoreductive surgery. Unsurprisingly, receiving chemotherapy alone without surgery (HR 3.03) was associated with shorter survival times (HR 4.0).

However when multivariable Cox models were generated, treatment centre remained a predictor of one year survival independent of patient, tumour factors, and treatment choice.

## Discussion

We have carried out a retrospective, observational, study to validate the findings first described in the UK Ovarian Cancer Audit Feasibility Pilot. The latter was a registry level study and detailed interpretation was limited by lack of data regarding patient demographics. Here we have carried out a “bottom up” study using clinical record data to confirm, and investigate, the findings from the OCAFP.

We have shown that granular datasets can be generated from routinely collected clinical records with acceptable levels of missing data within a centralised cancer care system. We have confirmed that the variations in treatment patterns seen in Cancer Alliances and reported in OCAFP are replicated in data from individual centres.

The variations in age, performance status and particularly deprivation seen between the cohorts in this study highlights the challenges faced by particular centres. These differences are rarely accounted for in commissioning of services but are likely to impact on resource requirements. More concerning are the variations in survival outcomes seen between the centres. These are not fully accounted for by the population and treatment differences between the centres. Given the comprehensive data collection that underpinned this study, it appears that variations in outcome are not fully driven by differences in casemix. Instead, these variations in outcome may be driven by more subtle differences between the centres; potentially including infrastructure, capacity or even an ethos and philosophy about treatment plans and overall treatment approach for patients with advanced ovarian cancer. Indeed, evidence is emerging that there is heterogeneity in the decision-making process for these patients between centres [8] and further work is required to understand these differences.

There has been extensive debate regarding the relative merits of primary versus delayed primary surgery for patients with advanced disease [9]. However the data presented here clearly indicate that key to survival benefit is the incorporation of surgical resection in the treatment algorithm of advanced ovarian cancer, independently of the timing ie upfront or delayed/ at interval. Hence, the focus for clinicians should move from discussions about timing of surgery to increasing the proportion of patients receiving this gold standard treatment [9], as reducing the inequity surrounding patient’s access to surgery could go some away to reducing the heterogeneity outcomes demonstrated here. Empowering patients in the decision-making process, using personalised decision aids as appropriate, may be a useful tool to enable this.

In summary we have confirmed here the findings that were first outlined in the Ovarian Cancer Feasibility Pilot. We have demonstrated that significant heterogeneity exists in treatment patterns, and outcomes, between centres in the UK. This heterogeneity cannot be explained by differences in casemix and further work is now required to understand why this is so, including whether this is related to the ethos and philosophy of the treating team. Perhaps more importantly, work needs to be carried out to show how this may be overcome.

## Rubric

**Funding**

Funding for this project was provided by Ovarian Cancer Action

**Patient and public involvement**

Members of our patient panel helped design the study and reviewed the data items being collected.

**Conflicts of Interest**

RJE has received honoraria from GSK and AstraZeneca

CF has received honoraria from Roche, GSK, Ethicon, Astra Zeneca/MSD, Oncoinvent.

No other authors declare any conflicts of interest

## Tables

**Table 1. Percentage missing data by centre**

|  | **0verall** |  |  | **Centre**  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Variable**  | n = 794*1* | **A**, n = 84*1* | **B**, n = 94*1* | **C**, n = 202*1* | **D**, n= 207*1* | **E**, n = 83*1* | **F**, n = 124*1* |
| **WHO Performance Status** | 9.6 | 7.1 | 43 | 13 | 0  | 3.6 | 0  |
|  |  |  |  |  |  |  |  |
| **ACE27** | 34 | 89 | 93 | 39 | 0  | 0  | 21 |
|  |  |  |  |  |  |  |  |
| **CA125** | 10.1 | 2.3 | 22 | 10.1 | 3.4 | 0 | 8.9 |
|  |  |  |  |  |  |  |  |
| **Ethnicity** | 42 | 9.5 | 64 | 18 | 11 | 99 | 100 |
|  |  |  |  |  |  |  |  |
| **Smoking status** | 35 | 76 | 20 | 28 | 50 | 4.8 | 23 |
|  |  |  |  |  |  |  |  |
| **Index of multiple deprivation** | 2.5 | 4.8 | 9.6 | 3.5 | 0 | 0 | 0 |
|  |  |  |  |  |  |  |  |
| **Body Mass Index** | 27 | 60 | 24 | 29 | 21 | 8.4 | 4 |
|  |  |  |  |  |  |  |  |
| **FIGO Stage** | 4.3 | 7.1 | 3.2 | 11 | 0.5 | 0 | 0.8 |
|  |  |  |  |  |  |  |  |
| **Histological grade** | 5.2 | 19 | 6.4 | 2.0 | 0 | 13 | 3.2 |
|  |  |  |  |  |  |  |  |
| **Histological diagnosis** | 12 | 14 | 9.6 | 17 | 17 | 7.2 | 0.8 |
|  |  |  |  |  |  |  |  |
| **BRCA mutation present** | 61 | 45 | 54 | 69 | 80 | 41 | 45 |
|  |  |  |  |  |  |  |  |

**Table 2 effort required to collect data. Times were collected by each centre**

|  |  |  |
| --- | --- | --- |
| Site1 | **2018 Cohort** | **2019 Cohort** |
| Time taken to record all data for all patients (hours) | Time taken to complete 10th record (minutes) | Time taken to complete 50th record (minutes) | Time taken to record all data for all patients (hours) | Time taken to complete 10th record (minutes) | Time taken to complete 50th record (minutes) | number of IT systems required to collect data\* |
| A | 46 | 30 | 20 | 38 | 30 | 30 | 2 |
| B  | 60 | 60 | 30 | 60 | 60 | 40 | 3 |
| C  | 23.75 | 20 | 45 | 23.5 | 20 | 20 | 7 |
| D | 31 | 18 | 15 | 56 | 17 | 21 | 5 |
| E | 12.5 | 13 | 25 | 12.5 | 14 | 27 | 5 |

1 Site F not included in analysis as data had been pre collected

**Table 3: Clinical Data for patients with FIGO stage 2-4 ovarian cancer, stratified by centre (A-F)**

| **Variable** | **Overall**, N = 794*1* | **A**, n = 84*1* | **B**, n = 94*1* | **C**, n = 202*1* | **D**, n= 207*1* | **E**, n = 83*1* | **F**, n = 124*1* |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Age** | 68 (17-93) | 69 (17-91) | 65 (21-89) | 68 (21-90) | 71 (19-93) | 71 (23-93) | 62 (19-93) |
|     Not available | 23 | 10 | 12 | 0 | 0 | 1 | 0 |
| **WHO Performance Status** |  |  |  |  |  |  |  |
|     0 | 358 (45%) | 33 (39%) | 25 (27%) | 107 (53%) | 96 (46%) | 40 (48%) | 57 (46%) |
|     1 | 199 (25%) | 18 (21%) | 13 (14%) | 51 (25%) | 54 (26%) | 27 (33%) | 36 (29%) |
|     2 | 94 (12%) | 14 (17%) | 14 (15%) | 8 (4.0%) | 33 (16%) | 7 (8.4%) | 18 (15%) |
|     3 | 55 (6.9%) | 10 (12%) | 2 (2.1%) | 8 (4.0%) | 21 (10%) | 4 (4.8%) | 10 (8.1%) |
|     4 | 12 (1.5%) | 3 (3.6%) | 0 (0%) | 1 (0.5%) | 3 (1.4%) | 2 (2.4%) | 3 (2.4%) |
|     Not available | 76 (9.6%) | 6 (7.1%) | 40 (43%) | 27 (13%) | 0 (0%) | 3 (3.6%) | 0 (0%) |
| **ACE27** |  |  |  |  |  |  |  |
|     0 | 108 (14%) | 1 (1.2%) | 3 (3.2%) | 12 (5.9%) | 0 (0%) | 44 (53%) | 48 (39%) |
|     1 | 88 (11%) | 3 (3.6%) | 4 (4.3%) | 25 (12%) | 0 (0%) | 23 (28%) | 33 (27%) |
|     2 | 68 (8.6%) | 3 (3.6%) | 0 (0%) | 32 (16%) | 12 (5.8%) | 12 (14%) | 9 (7.3%) |
|     3 | 263 (33%) | 2 (2.4%) | 0 (0%) | 54 (27%) | 195 (94%) | 4 (4.8%) | 8 (6.5%) |
|     Not available | 267 (34%) | 75 (89%) | 87 (93%) | 79 (39%) | 0 (0%) | 0 (0%) | 26 (21%) |
| **Ca125** | 517 (5-49,031) | 366 (14-20,132) | 734 (16-12,866) | 524 (5-49,031) | 477 (6-13,575) | 716 (17-11,620) | 452 (9-32,305) |
|     Not available | 80 | 19 | 21 | 22 | 7 | 0 | 11 |
| **Ethnicity** |  |  |  |  |  |  |  |
|     Asian or Asian British | 27 (3.4%) | 10 (12%) | 7 (7.4%) | 7 (3.5%) | 3 (1.4%) | 0 (0%) | 0 (0%) |
|     Black, Black British, Caribbean or African | 8 (1.0%) | 5 (6.0%) | 2 (2.1%) | 0 (0%) | 1 (0.5%) | 0 (0%) | 0 (0%) |
|     Mixed or multiple ethnic groups | 1 (0.1%) | 1 (1.2%) | 0 (0%) | 0 (0%) | 0 (0%) | 0 (0%) | 0 (0%) |
|     Other ethnic group | 8 (1.0%) | 1 (1.2%) | 5 (5.3%) | 0 (0%) | 2 (1.0%) | 0 (0%) | 0 (0%) |
|     White | 417 (53%) | 59 (70%) | 20 (21%) | 158 (78%) | 179 (86%) | 1 (1.2%) | 0 (0%) |
|     Not available | 333 (42%) | 8 (9.5%) | 60 (64%) | 37 (18%) | 22 (11%) | 82 (99%) | 124 (100%) |
| **Smoking status** |  |  |  |  |  |  |  |
|     Smoker | 55 (6.9%) | 0 (0%) | 4 (4.3%) | 15 (7.4%) | 18 (8.7%) | 6 (7.2%) | 12 (9.7%) |
|     Ex-smoker | 65 (8.2%) | 6 (7.1%) | 6 (6.4%) | 10 (5.0%) | 15 (7.2%) | 9 (11%) | 19 (15%) |
|     Never smoked | 398 (50%) | 14 (17%) | 65 (69%) | 121 (60%) | 70 (34%) | 64 (77%) | 64 (52%) |
|     Not available | 276 (35%) | 64 (76%) | 19 (20%) | 56 (28%) | 104 (50%) | 4 (4.8%) | 29 (23%) |
| **Index of multiple deprivation** |  |  |  |  |  |  |  |
|     1 | 111 (14%) | 22 (26%) | 4 (4.3%) | 25 (12%) | 24 (12%) | 1 (1.2%) | 35 (28%) |
|     2 | 85 (11%) | 13 (15%) | 8 (8.5%) | 23 (11%) | 25 (12%) | 2 (2.4%) | 14 (11%) |
|     3 | 76 (9.6%) | 9 (11%) | 5 (5.3%) | 13 (6.4%) | 27 (13%) | 9 (11%) | 13 (10%) |
|     4 | 90 (11%) | 9 (11%) | 9 (9.6%) | 28 (14%) | 20 (9.7%) | 13 (16%) | 11 (8.9%) |
|     5 | 75 (9.4%) | 9 (11%) | 11 (12%) | 11 (5.4%) | 15 (7.2%) | 13 (16%) | 16 (13%) |
|     6 | 76 (9.6%) | 9 (11%) | 13 (14%) | 16 (7.9%) | 19 (9.2%) | 9 (11%) | 10 (8.1%) |
|     7 | 81 (10%) | 2 (2.4%) | 10 (11%) | 26 (13%) | 23 (11%) | 15 (18%) | 5 (4.0%) |
|     8 | 78 (9.8%) | 2 (2.4%) | 9 (9.6%) | 23 (11%) | 20 (9.7%) | 17 (20%) | 7 (5.6%) |
|     9 | 57 (7.2%) | 3 (3.6%) | 9 (9.6%) | 15 (7.4%) | 21 (10%) | 2 (2.4%) | 7 (5.6%) |
|     10 | 45 (5.7%) | 2 (2.4%) | 7 (7.4%) | 15 (7.4%) | 13 (6.3%) | 2 (2.4%) | 6 (4.8%) |
|     Not available | 20 (2.5%) | 4 (4.8%) | 9 (9.6%) | 7 (3.5%) | 0 (0%) | 0 (0%) | 0 (0%) |
| **Body Mass Index** | 26.6 (16.0-58.0) | 30.0 (19.0-44.0) | 25.2 (16.0-50.7) | 26.0 (16.0-46.0) | 26.0 (16.0-46.0) | 26.7 (16.0-58.0) | 26.8 (16.4-51.2) |
|     Not available | 189 | 51 | 23 | 59 | 44 | 7 | 5 |
| **FIGO Stage** |  |  |  |  |  |  |  |
|     2 | 72 (9.1%) | 8 (9.5%) | 11 (12%) | 16 (7.9%) | 11 (5.3%) | 10 (12%) | 16 (13%) |
|     3 | 507 (64%) | 49 (58%) | 51 (54%) | 126 (62%) | 161 (78%) | 46 (55%) | 74 (60%) |
|     4 | 181 (23%) | 21 (25%) | 29 (31%) | 37 (18%) | 34 (16%) | 27 (33%) | 33 (27%) |
|     Unstaged | 34 (4.3%) | 6 (7.1%) | 3 (3.2%) | 23 (11%) | 1 (0.5%) | 0 (0%) | 1 (0.8%) |
| **Histological grade** |  |  |  |  |  |  |  |
|     1 | 59 (7.4%) | 4 (4.8%) | 3 (3.2%) | 20 (9.9%) | 12 (5.8%) | 10 (12%) | 10 (8.1%) |
|     2 | 11 (1.4%) | 1 (1.2%) | 7 (7.4%) | 0 (0%) | 2 (1.0%) | 0 (0%) | 1 (0.8%) |
|     3 | 683 (86%) | 63 (75%) | 78 (83%) | 178 (88%) | 193 (93%) | 62 (75%) | 109 (88%) |
|     Not available | 41 (5.2%) | 16 (19%) | 6 (6.4%) | 4 (2.0%) | 0 (0%) | 11 (13%) | 4 (3.2%) |
| **Histological diagnosis** |  |  |  |  |  |  |  |
|     Carcinosarcoma | 10 (1.3%) | 1 (1.2%) | 0 (0%) | 2 (1.0%) | 0 (0%) | 1 (1.2%) | 6 (4.8%) |
|     Clear cell | 33 (4.2%) | 2 (2.4%) | 4 (4.3%) | 8 (4.0%) | 7 (3.4%) | 3 (3.6%) | 9 (7.3%) |
|     Endometrioid | 26 (3.3%) | 1 (1.2%) | 5 (5.3%) | 4 (2.0%) | 7 (3.4%) | 5 (6.0%) | 4 (3.2%) |
|     High grade serous | 565 (71%) | 62 (74%) | 72 (77%) | 138 (68%) | 144 (70%) | 59 (71%) | 90 (73%) |
|     Low grade serous | 41 (5.2%) | 3 (3.6%) | 2 (2.1%) | 14 (6.9%) | 7 (3.4%) | 9 (11%) | 6 (4.8%) |
|     Mucinous | 10 (1.3%) | 0 (0%) | 0 (0%) | 2 (1.0%) | 5 (2.4%) | 0 (0%) | 3 (2.4%) |
|     Germ cell tumour | 6 (0.8%) | 2 (2.4%) | 2 (2.1%) | 0 (0%) | 0 (0%) | 0 (0%) | 2 (1.6%) |
|     Sex cord stromal tumour | 5 (0.6%) | 1 (1.2%) | 0 (0%) | 0 (0%) | 1 (0.5%) | 0 (0%) | 3 (2.4%) |
|     Not available | 98 (12%) | 12 (14%) | 9 (9.6%) | 34 (17%) | 36 (17%) | 6 (7.2%) | 1 (0.8%) |
| **BRCA mutation present** |  |  |  |  |  |  |  |
|     Yes | 55 (6.9%) | 7 (8.3%) | 8 (8.5%) | 7 (3.5%) | 11 (5.3%) | 5 (6.0%) | 17 (14%) |
|     No | 254 (32%) | 39 (46%) | 35 (37%) | 55 (27%) | 30 (14%) | 44 (53%) | 51 (41%) |
|     Not tested | 485 (61%) | 38 (45%) | 51 (54%) | 140 (69%) | 166 (80%) | 34 (41%) | 56 (45%) |
| **Treatment received** |  |  |  |  |  |  |  |
|     Primary debulking surgery and chemotherapy | 204 (26%) | 28 (33%) | 23 (24%) | 45 (22%) | 28 (14%) | 29 (35%) | 51 (41%) |
|     Neo-adjuvant chemotherapy and interval debulking surgery | 235 (30%) | 21 (25%) | 43 (46%) | 65 (32%) | 33 (16%) | 34 (41%) | 39 (31%) |
|     Chemotherapy only | 140 (18%) | 18 (21%) | 18 (19%) | 0 (0%) | 80 (39%) | 10 (12%) | 14 (11%) |
|     Surgery only | 68 (9%) | 5 (6.0%) | 8 (8.5%) | 29 (14%) | 15 (7.2%) | 2 (2.4%) | 9 (7.3%) |
|     None | 147 (19%) | 12 (14%) | 2 (2.1%) | 63 (31%) | 51 (25%) | 8 (9.6%) | 11 (8.9%) |
| *1*Median (Minimum-Maximum); n (%) |

## Figure Legends

**Figure 1: Survival analysis for all FIGO stage 2-4 ovarian cancers, stratified by centre. Follow up was shorter for patients at one centre resulting in early censoring. Survival differed between the cohorts (p<0.001, long rank test)**

**Figure 2: Clinical characteristics of cohort by centre. (a) Deprivation index was calculated for each patient using the index of multiple deprivation. Age (b) and BMI (c) also both showed significant differences between centres.**

**Figure 3: Stacked bar chart showing treatment patterns for patients with advanced ovarian cancer for each centre. Centres are shown in ascending order of “gold standard” treatment rate, defined as the combination of surgery and chemotherapy (red and orange bars).**

## References

1. NCRAS. *Ovarian Cancer Audit Feasibility Pilot*. 2020.

2. Lheureux, S., et al., *Epithelial ovarian cancer.* Lancet, 2019. **393**(10177): p. 1240-1253.

3. Phillips, A., et al., *Reporting 'Denominator' data is essential for benchmarking and quality standards in ovarian cancer.* Gynecol Oncol, 2017. **146**(1): p. 94-100.

4. Russell, B., et al., *Propensity score matching confirms that primary surgery or neoadjuvant chemotherapy result in equivalent survival within a comprehensive cohort of patients with high-grade serous ovarian cancer.* Gynecologic Oncology, 2020.

5. Kallogjeri, D., et al., *Comparison of Scoring Methods for ACE-27: Simpler Is Better.* J Geriatr Oncol, 2012. **3**(3): p. 238-245.

6. Gov, U., *The English Indices of Deprivation 2019 - Statistical Release*, C.L.G. Ministry of Housing, Editor. 2019.

7. Coleridge, S.L., et al., *Neoadjuvant chemotherapy before surgery versus surgery followed by chemotherapy for initial treatment in advanced ovarian epithelial cancer.* Cochrane Database Syst Rev, 2021. **7**(7): p. Cd005343.

8. Khassan, T., et al., *MDT practice determines treatment pathway for patients with advanced ovarian cancer: A multi-centre observational study.* Eur J Surg Oncol, 2023.

9. Morrison, J., *Neoadjuvant chemotherapy for ovarian cancer: Avoiding 'needless hurt'?* Bjog, 2023.