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Quality of surgery and treatment and its association with hospital volume: A population-based study in more than 5000 Belgian ovarian cancer patients

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ABSTRACT

Background: Different sets of quality indicators are used to identify areas for improvement in ovarian cancer care. This study reports transparently on how (surgical) indicators were measured and on the association between hospital volume and indicator results in Belgium, a country setting without any centralisation of ovarian cancer care.

Methods: From the population-based Belgian Cancer Registry, patients with a borderline malignant or invasive epithelial ovarian tumour diagnosed between 2014 and 2018 were selected and linked to health insurance and vital status data (n = 5119).

Thirteen quality indicators on diagnosis and treatment were assessed and the association with hospital volume was analysed using logistic regression adjusted for case-mix.

Results: The national results for most quality indicators on diagnosis and systemic therapy were around the predefined target value. Other indicators showed results below the benchmark: genetic testing, completeness of staging surgery, lymphadenectomy with at least 20 pelvic/para-aortic lymph nodes removed, and timely start of chemotherapy after surgery (within 42 days).

Ovarian cancer care in Belgium is dispersed over 100 hospitals. Lower volume hospitals showed poorer indicator results compared to higher volume hospitals for lymphadenectomy, staging, timely start of chemotherapy and genetic testing. In addition, surgery for advanced stage tumours was performed less often in lower volume hospitals.

Conclusions: The indicators that showed poorer results on a national level were also those with poorer results in lower-volume hospitals compared to higher-volume hospitals, consequently supporting centralisation. International benchmarking is hampered by different (surgical) definitions between countries and studies.

1. Introduction

In ovarian cancer the quality of care and, more specifically, quality of surgery are prognostic factors of survival [1]. Consequently, to identify and measure areas for quality improvement and to monitor progress, several organisations, including the European Society of Gynaecological

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Oncology developed quality indicators [2–7]. These indicators are tailored to data available in a hospital, and are not always possible to measure based on administrative data available on a national scale. Yet, to guide policy, several countries developed sets of quality indicators based on routinely available data and launched the quality cycle, including national audits [8–12].

In Belgium, national guidelines on diagnosis and treatment for ovarian cancer were published in 2016 [13]. The next step in the quality cycle involves selecting and implementing indicators, a step that has already been completed for several tumour types in Belgium [14,15]. This study reports on the findings of the first national, population-based quality assessment for ovarian cancer in Belgium, for the incidence years 2014–2018. The focus is on process indicators covering diagnosis and treatment. Importantly, there is no centralisation of ovarian cancer care in Belgium, and no required minimum caseload for hospitals or surgeons, resulting in a wide dispersion of care. This study therefore investigates the association between process indicator results and the hospital volume in terms of ovarian cancer patients treated.

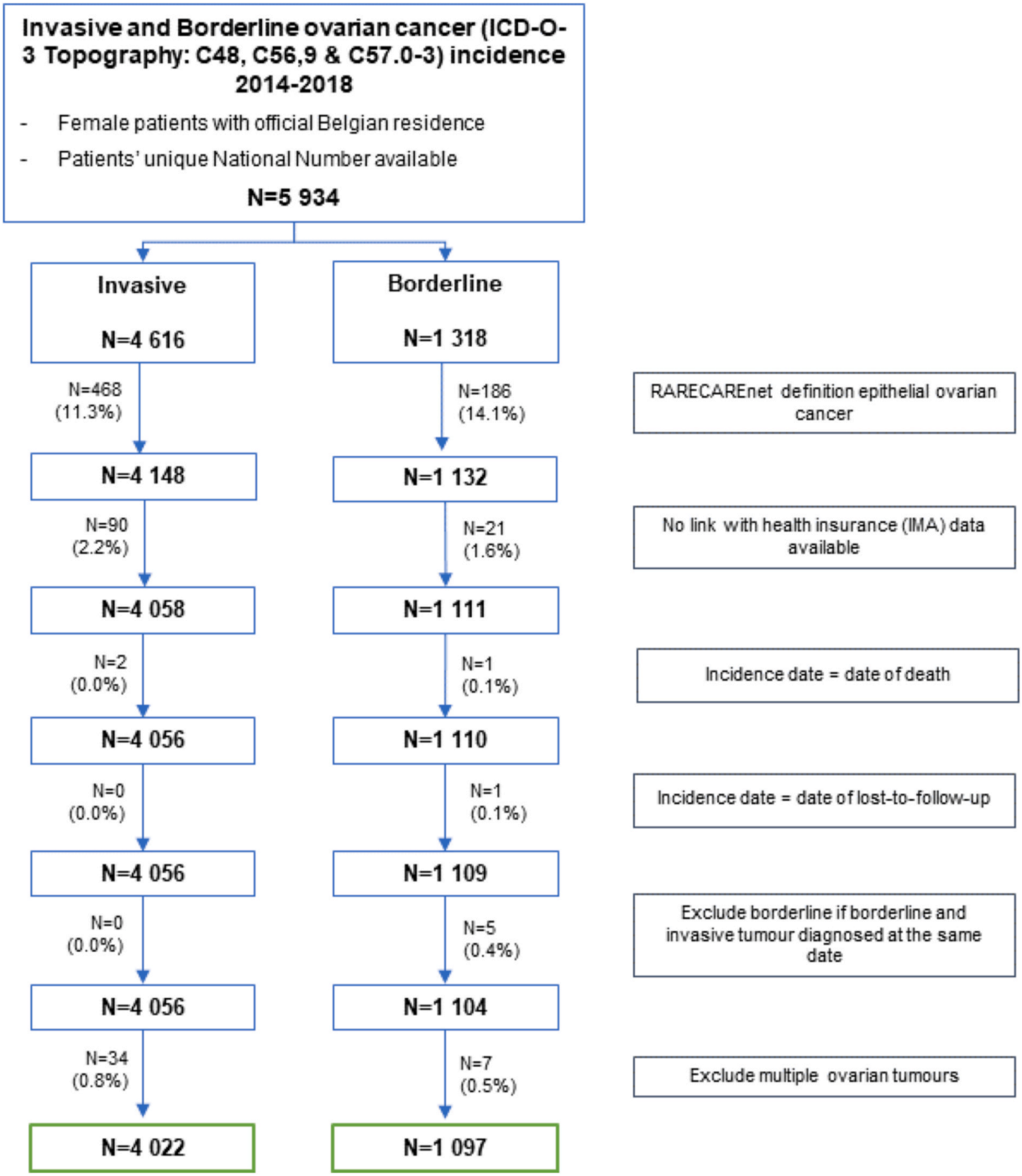

Fig. 1. Flowchart – Selection of the study population (N = 5119). The RARECAREnet definition of Epithelial Tumours of Ovary and Fallopian Tube ICD-O-3 topography and morphology codes was used for the selection of "ovarian tumours": ovary (C56.9), fallopian tube (C57.0-C57.3) and primary peritoneum (C48.0-C48.9). The exclusion of respectively 11.3 % in the invasive tumours and 14.1 % in the borderline tumours is due to another, non-epithelial histological type. Patients with multiple ovarian tumours (epithelial or non-epithelial) registered with incidence date during the study period were excluded, except if a borderline and invasive tumour were diagnosed on the same date; then only the invasive tumour was retained and the patient included.

2. Material and methods

2.1. Data sources

Population-based cancer registration data from the nationwide Belgian Cancer Registry were used [16]. For this study, the database was linked with billing data from the Intermutualistic Agency, which contains the medical procedures and pharmaceuticals reimbursed by the national health insurance from one year prior to cancer incidence until five years after incidence; and with vital status data from the Crossroad Bank of Social Security (available until December 1, 2021). The linkage was based on the patients' unique social security number.

Stage at diagnosis was determined based on the International Federation of Gynecology and Obstetrics (FIGO) 2013 guidelines, and/or clinical (c)TNM and pathological (p)TNM information. For patients receiving primary surgery, FIGO stage was given preference while for patients starting with neoadjuvant therapy or not undergoing surgery, cTNM was given priority. TNM 7 was used for incidence years 2014–2016, and TNM 8 for 2017–2018 [17,18].

2.2. Study cohort

The cohort included patients, newly diagnosed with invasive or borderline epithelial ovarian cancer, including invasive epithelial fallopian tube or primary peritoneal cancer in 2014–2018. The flowchart (Fig. 1) illustrates the selection process.

2.3. Selection of quality indicators

Relevant quality indicators were identified in peer reviewed and grey literature, discussed with a multidisciplinary panel of twelve clinical experts (gynecological oncologists, pathologists) and checked for measurability with the available clinical and administrative data (details on the methods for selection in supplement section 1 [19]). Thirteen process indicators covering diagnosis and treatment were retained (see Table 3). When applicable, a target value was defined based on literature or by expert consensus before the analysis [7].

2.4. Building blocks of the quality indicators

For every indicator, the denominator and numerator were defined, and where applicable a target value (supplement section 2) [19].

As it was not possible to identify the surgical procedure from billing data, and no surgical reports were available, pathology reports (from 1 month before to 9 months after diagnosis) were reviewed to extract an overview of the surgical procedures performed (Table 1). Patients for whom one or more billed surgical procedures were found but one or more pathology reports were not available (n = 419) were excluded from the analysis for surgical indicators.

The objective of debulking/cytoreductive surgery for advanced disease (stage IIB-IV) is the removal of all macroscopic disease. However, pathology reports did not contain information on residual disease. Therefore, the indicator on debulking is more general and focuses on which patients underwent a surgery. A more detailed analysis aimed to identify patients who underwent a more extensive surgery based on a list of procedures (Table 1).

Considering that older age is associated with being not or less fit for chemotherapy, the clinical experts focused on the age group younger than 75 years for the chemotherapy indicators.

2.5. Volume – process indicator association

Each patient was assigned to one hospital, even if the patient received care in more than one hospital. Depending on the indicator under study, this was either the hospital of diagnosis, chemotherapy or surgery (see supplement [19]).

Table 1
Procedures for surgery definitions.

Type of surgery	Definition
Staging[a]	For invasive tumours: - Complete or partial removal of **both ovaries** - And complete or partial removal of **both fallopian tubes** - And partial or complete removal of **omentum** - And biopsies of the peritoneum or, as a proxy, complete/partial **removal or biopsies of at least one the following organs**: (sigmoid) colon, cecum, small intestine, spleen, liver, gallbladder, bladder, stomach, diaphragm - abdominal **cytology** For borderline tumours: - Complete or partial removal of at least **one ovary** - And complete or partial removal of at least **one fallopian tube** - And partial or complete removal of **omentum** - And biopsies of the peritoneum or, as a proxy, complete/partial **removal or biopsies of at least one the following organs**: (sigmoid) colon, cecum, small intestine, spleen, liver, gallbladder, bladder, stomach, diaphragm - abdominal **cytology** **Lymphadenectomy was not included** in the definition of complete staging surgery but evaluated in separate quality indicators. To account for fertility sparing surgery, **hysterectomy is not required** in the definition of staging surgery and a single-sided ovariectomy/salpingectomy is permitted in borderline disease.
Extensive debulking surgery	- Complete or partial removal of **both ovaries** - And complete or partial removal of **both fallopian tubes** - And complete removal of **uterus** (or coded as already removed) - And partial or complete removal of **omentum** (or coded as already removed) - complete/partial **removal or biopsies of at least one the following organs**: peritoneum, (sigmoid) colon, cecum, small intestine, spleen, liver, gallbladder, bladder, stomach, diaphragm

[a] It is not possible to reliably distinguish a staging laparoscopy from a staging laparotomy based on pathology reports.

The treatment volume for each hospital was calculated as the number of newly diagnosed borderline or invasive epithelial ovarian cancer patients in the period 2014–2018 who received their treatment in that particular hospital. To be able to assign a patient to one treatment hospital, even if parts of their treatment was performed in different hospitals, an algorithm was developed where surgery location takes prescience over chemotherapy location (see supplement section 3).

The accuracy of the hospital allocation algorithm and the methodology used to identify diagnostic and therapeutic procedures were validated in eight Belgian hospitals. This showed that 99 % of patients were correctly allocated.

The association between hospital treatment volume and process indicator results was evaluated using logistic regression models using a categorical (based on the quartiles) volume variable. Lower volume hospitals refer to the lowest quartile, and higher volume hospitals refer to the highest quartile. Clustering of patients into hospital was taken into account in all analyses, and some process indicators were adjusted for age at diagnosis, tumour stage and World Health Organisation (WHO) performance status.

All statistical analyses were performed with Statistical Analysis System version 9.4 (SAS Institute, Cary, NC, USA).

3. Results

Overall, 5119 patients with a borderline tumour or an epithelial carcinoma of the ovary (90.2 %), fallopian tube (7.0 %) or peritoneum (2.8 %) were included. Patient and tumour characteristics are shown in Table 2.

Table 2
Baseline patient and tumour characteristics at the time of diagnosis (N = 5119).

	N	%
Age group		
Mean, SD (years)	64.5 (15.0)	
<40 years	318	6.2
40–49 years	477	9.3
50–59 years	938	18.3
60–69 years	1279	25.0
70–79 years	1241	24.2
80+ years	866	16.9
Stage[a]		
I	1448	32.9
II (NOS)/IIA	113	2.6
IIB/IIC	149	3.4
III	1561	35.5
IV	1124	25.6
Unknown	724	14.1
Grade		
Well differentiated	684	13.4
Moderately differentiated	293	5.7
Poorly differentiated or undifferentiated	2756	53.8
Unknown	1386	27.1
Behaviour		
Borderline	1097	21.4
Invasive	4022	78.6
Histological type		
Serous	3376	66.0
Mucinous	741	14.5
Endometrioid	293	5.7
Clear cell	181	3.5
Brenner	24	0.5
Other or non specified	504	9.8
Multiple tumours (other than ovarian tumours)[b]		
No	4557	89.0
Yes	562	11.0

NOS: Not otherwise specified; SD: Standard deviation.
[a] Percentages for stages I, II, III, and IV were computed excluding the category unknown.
[b] Patients with multiple ovarian tumours were excluded, except if a borderline and invasive tumour were diagnosed on the same date; then only the invasive tumour was retained.

3.1. National results

The 13 quality indicators, their target values, and the results at national level are presented in Table 3.

Most diagnostic indicators were close to the target value. Genetic testing for patients with invasive tumours increased over the years from 25.9 % for patients diagnosed in 2014 to 68.7 % in 2018, though this still remained below the target (90 %).

Staging surgery in invasive early stage (I-IIA) disease was well below target (95 %), as it was only performed in 29.1 % of patients and this was even lower in borderline ovarian tumours (19.5 %). A more in-depth analysis showed that the most frequently omitted procedures were peritoneal biopsies and cytology. The results stratified per age group showed that 28 % of the patients aged 70–79 years had a staging surgery, and this dropped to 9.6 % in those aged 80 or older.

Lymphadenectomy, defined as the removal of at least 20 pelvic/para-aortic lymph nodes in operated patients with invasive stage I-IIA disease, was performed for 27.3 % of patients for whom pathology report data were complete (no target was defined). In 51 % of patients, no lymph nodes were removed while 17.8 % had at least 30 lymph nodes removed. Conversely, for patients with borderline stage I-IIA tumours, 93.0 % of patients had no lymph nodes removed.

The median waiting time was 21 days (IQR: 10–37) when surgery was the first treatment, while it was 25 days (IQR: 16–36) for chemotherapy as first treatment (no target was defined). For patients who received their first treatment in the same centre as their diagnosis, the median time to treatment was 20 days (IQR: 11–34) while in those who had their first treatment in a different centre it was 27 days (IQR:

Table 3
National results on thirteen quality indicators.

Quality indicator	n/N	Result (%)	Target (%)
Diagnosis and staging			
1) Proportion of patients with epithelial ovarian cancer who were discussed at a **multidisciplinary team meeting**	4638/5119	90.6	95
2) Proportion of patients with invasive epithelial ovarian cancer who underwent **genetic testing**	1666/3254	51.2	90
3) Proportion of patients with epithelial ovarian cancer having a **histological or cytological diagnosis** prior to starting chemotherapy	3147/3170	99.3	100
4) Proportion of patients with epithelial ovarian cancer having an **abdomino-pelvic imaging** prior to starting treatment	4179/4736	88.2	95
5) A: Proportion of patients with I-IIA invasive ovarian cancer who received a **staging** surgery	176/604	29.1[a]	95
B: Proportion of patients with a I-IIA borderline ovarian tumour who received a **staging** surgery	105/538	19.5	95
6) Proportion of operated patients with invasive I-IIA epithelial ovarian cancer, in whom at least 20 **lymph nodes** were removed	130/477	27.3	–
7) Proportion of patients with a borderline ovarian tumour who were operated, in whom **no lymphadenectomy** was performed	739/795	93.0	–
Treatment			
8) **Median time** between diagnosis (by medical imaging) and start of first treatment	N = 4410	22 days (IQR: 12–37)	–
9) Proportion of patients with stage IIB-IV epithelial ovarian cancer who received surgery	2181/2834	77.0[b]	
10) A: Proportion of patients <75 y with invasive high grade serous I-IIA epithelial ovarian cancer who received **platinum-based chemotherapy**, either in combination or as a single agent	176/234	86.9	90
B: Proportion of patients <75 y with invasive IIB-IV epithelial ovarian cancer who received **platinum-based chemotherapy**, either in combination or as a single agent	2378/2730	95.6	90
11) A: Proportion of patients <75 y with invasive high grade serous I-IIA epithelial ovarian cancer who received **at least 9 weeks (≈ 3 cycles)** of platinum-based chemotherapy	157/172	90.3	90
B: Proportion of patients <75 y with invasive IIB-IV epithelial ovarian cancer who received at **least 18 weeks (≈ 6 cycles)** of platinum-based	1569/1924	82.8	90

(continued on next page)

Table 3 (*continued*)

Quality indicator	n/N	Result (%)	Target (%)
neo-adjuvant (NACT) and/or adjuvant (ACT)			
12) Proportion of patients with invasive epithelial ovarian cancer who started their chemotherapy **within 42 days** following surgery[c]	1850/2470	74.9	90
13) Proportion of deceased patients with epithelial ovarian cancer who received systemic therapy[d] within 14 days prior to death	170/1547	11.0 *of whom 87.6 % received a chemotherapeutic agent and 7.6 % received targeted or immunotherapy*	–

The details on the numerator and denominator can be found in Supplement Table 2.

[a] If patients with one or more missing pathology reports were included in the calculation and assumed to have achieved staging ("best case scenario"), still only 49.4 % of invasive tumours and 39.4 % of borderline tumours would be appropriately staged.

[b] When looking at the organs/tissues removed, 44.7 % underwent a more extensive surgery.

[c] The median time between surgery and adjuvant chemotherapy was 33 days (IQR: 25–43).

[d] Systemic therapy includes chemotherapy, targeted/immunotherapy, endocrine therapy; IQR: interquartile range; "-" indicates that no predefined target was set.

17–43).

Indicators related to chemotherapy (choice of chemotherapy and duration) showed results around the target value (90 %).

Among operated patients who received adjuvant chemotherapy, 74.9 % of patients started chemotherapy within 42 days after surgery (target 90 %).

3.2. Association between hospital volume and quality of care

Over the 5-year study period, 5079 ovarian cancer patients (invasive and borderline malignant) were treated in 100 Belgian hospitals (for 40 patients a centre of main treatment could not be assigned), with a median hospital volume of 34 (range 3–458), corresponding to seven patients per year (range 1–92).

For several process indicators a clear association with hospital volume was seen (see odds ratio's in Table 4). In particular compared to the highest volume group (i.e. treating more than 63 patients in 5 years which translates to treating around 13 patients per year), the indicator results decrease with descending volume group: the odds for having undergone genetic testing was 33–77 % lower ($p < 0.001$) and the odds to receive a surgery in advanced stage was 68–36 % lower ($p = 0.0002$). The odds for receiving staging surgery, lymphadenectomy and timely start of chemotherapy were also lower in the lowest volume hospitals compared to the highest volume.

4. Discussion

4.1. Summary of main results

In this first nationwide study on quality of care for ovarian cancer in Belgium, the indicator results on diagnosis and systemic treatment were near target, while those on surgery (in particular minimal staging and lymphadenectomies in early stage disease), genetic testing and timeliness of starting adjuvant chemotherapy were below the benchmark. The lower volume hospitals showed poorer indicator results.

4.2. Results in the context of published literature

With staging surgery performed in less than 30 % of patients, our

Table 4
Association between 5 year hospital volume (quartiles) and quality indicator results.

Quality indicator	Number of patients	Adjusted[a] OR (95 % CI)		Global type III p-value
Proportion of patients with invasive epithelial ovarian cancer who underwent **genetic testing**				<0.0001
o 1–18 vs 63+ patients	164 vs 1966	0.23	[0.14, 0.39]	
o 19–33 vs 63+ patients	405 vs 1966	0.50	[0.33, 0.75]	
o 34–62 vs 63+ patients	695 vs 1966	0.67	[0.46, 0.98]	
Proportion of patients with epithelial ovarian cancer having an abdomino-pelvic imaging prior to starting treatment				0.4912
o 1–18 vs 63+ patients	231 vs 2849	0.75	[0.47, 1.21]	
o 19–33 vs 63+ patients	618 vs 2849	0.95	[0.65, 1.39]	
o 34–62 vs 63+ patients	1031 vs 2849	1.11	[0.78, 1.58]	
Proportion of patients with I-IIA invasive ovarian cancer who received a **staging** surgery				0.0629[b]
o 1–18 vs 63+ patients	37 vs 334	0.16	[0.04, 0.66]	
o 19–33 vs 63+ patients	80 vs 334	0.59	[0.26, 1.33]	
o 34–62 vs 63+ patients	153 vs 334	0.70	[0.35, 1.41]	
Proportion of patients with a I-IIA borderline ovarian tumour who received a **staging** surgery				0.0570[b]
o 1–18 vs 63+ patients	37 vs 324	0.36	[0.09, 1.39]	
o 19–33 vs 63+ patients	76 vs 324	0.44	[0.16, 1.23]	
o 34–62 vs 63+ patients	100 vs 324	0.29	[0.11, 0.78]	
Proportion of operated patients with invasive I-IIA epithelial ovarian cancer, in whom at least 20 lymph nodes were removed				0.0027[b]
o 1–18 vs 63+ patients	26 vs 277	0.12	[0.02, 0.69]	
o 19–33 vs 63+ patients	62 vs 277	0.16	[0.05, 0.50]	
o 34–62 vs 63+ patients	112 vs 277	0.45	[0.20, 1.03]	
Proportion of patients with stage IIB-IV epithelial ovarian cancer who received surgery				0.0002[b]
o 1–18 vs 63+ patients	129 vs 1749	0.32	[0.19, 0.55]	
o 19–33 vs 63+ patients	353 vs 1749	0.63	[0.42, 0.95]	
o 34–62 vs 63+ patients	590 vs 1749	0.64	[0.44, 0.93]	
Proportion of patients with invasive epithelial ovarian cancer who started their chemotherapy within 42 days following surgery				0.0241[b]
o 1–18 vs 63+ patients	73 vs 1616	0.49	[0.25, 0.93]	
o 19–33 vs 63+ patients	271 vs 1616	0.54	[0.34, 0.86]	
o 34–62 vs 63+ patients	510 vs 1616	0.67	[0.44, 1.02]	
Proportion of deceased patients with epithelial ovarian cancer who received systemic therapy within 14 days prior to death				0.8124[b]
o 1–18 vs 63+ patients	116 vs 788	1.32	[0.72, 2.41]	
o 19–33 vs 63+ patients	247 vs 788	0.95	[0.58, 1.54]	
o 34–62 vs 63+ patients	364 vs 788	1.04	[0.69, 1.55]	

40 patients could not be assigned to a centre of main treatment and are not included in the analysis. The 5-year hospital volume was categorised into quartiles (1–18 patients, 19–33 patients, 34–62 patients, 63+ patients).

[a] All analyses are adjusted for clustering of patients into the hospital of main treatment, however not all indicators were adjusted for case-mix variables.

[b] Indicates that case-mix variables were taken into account: age at diagnosis, tumour stage and WHO performance status.

national result lies within the wide variation reported in the international literature. Scotland reported staging surgery performed in above 80 % of patients, a German study reported 61 % and in a Danish study only 2 % of patients underwent complete staging [10,20,21]. Much of the variation can be explained by the differences in 'staging surgery' definitions. For example some guidelines do not recommend omentectomy for all early-stage borderline tumours, while in our staging definition omentectomy for borderline is a requirement. This might explain the even lower proportion of staging surgery in patients with borderline ovarian cancer (19.5 %) [22]. Nevertheless, most studies conclude staging is below par. The fact that several studies, including ours, showed that a lack of peritoneal biopsies was one of the criteria upon which the majority of surgeries fell short, could be explained by the ongoing debate whether biopsies of the peritoneum are relevant when no macroscopic disease is noted [20,21]. For example the Scottish definition requires only peritoneal washings and no biopsies [10]. In addition to missing peritoneal biopsies, the absence of para-aortic and pelvic lymphadenectomies is frequently observed [20]. In our study lymphadenectomy was considered a separate indicator, which, in theory, made it easier to comply to the requirements of the staging definition. In our study optimal lymphadenectomy was defined as the removal of at least 20 lymph nodes, though only half of the early stage epithelial ovarian cancer patients received any lymphadenectomy regardless of the number of resected lymph nodes. Another issue complicating the comparison with international results is the different inclusion criteria to determine who should undergo staging. Some studies exclude unoperated patients from assessment of surgical quality, and some are able to exclude fertility sparing surgery, whereas the Belgian denominator is set for all patients with a confirmed I-IIA stage ovarian cancer [10,11,21]. The aim of including lymphadenectomy in the definition of 'complete staging' is to optimise the choice and dosage of chemotherapy, particularly in patients with apparent early stage disease [23,24]. However, the lower indicator result could be attributed to clinicians hesitating to undertake a comprehensive staging when they perceive a high surgical risk (e.g. older age) or if the therapeutic decisions are already clear before surgery (e.g. no chemotherapy planned in frail or older patients or decision to give chemotherapy already made in case of a high grade cancer). As evident from our results, the staging decreased to 9.6 % in the group of patients aged 80 or older. Nevertheless, the fact that there was a clear difference in odds ratio between the lower and higher volume hospitals, even when corrected for age, performance status and tumour stage, means that experience and know-how might also play a role.

The marked increase in genetic testing during the study period can be explained by the launch of new guidelines broadening the indications for genetic testing and by the market introduction and reimbursement of polyADPribose polymerase inhibitors end 2015 [25,26]. An explanation for not reaching the target is that there might be genetic tests performed outside the timeframe of the available database, i.e. patients with familial breast and ovarian cancer may have undergone testing more than 1 year prior to incidence.

Waiting time targets have been integrated as indicators of quality of cancer care. Both the guidelines of England and EORTC define this as starting treatment within 31 days, while in the Netherlands it should be within 28 days [4,12,27]. International comparison is hampered because different starting points are used (e.g. decision to treat, consultation with the gynaecologist-oncologist). With a median time of 22 days and an interquartile range of 12–37 days, more than a quarter of Belgian patients must wait unacceptably long for treatment.

Cut-offs to define a timely start of chemotherapy after surgery range from 28 to 42 days, and are either based on the median result in a study or based on guidelines [28,29]. Similar to the Society of Gynaecologic Oncology, the Belgian experts considered 42 days after surgery a timely start of adjuvant chemotherapy; though this was not achieved for approximately 25 % of patients [5]. Shortcomings in the timely start of chemotherapy can be partly explained by the extent of the surgery, post-operative recovery, complications and comorbidities [30].

Could the large dispersion of care and expertise explain the poor indicator results? In countries where concentration of ovarian cancer care was implemented, quality of care and guideline adherence increased [31–33]. In Belgium, patients with ovarian cancer are still treated in almost every hospital in the country. The analysis of the process indicator results according to hospital volume, showed that there was a volume-association for those indicators with suboptimal national results: lower volume hospitals performed less genetic testing, less lymphadenectomies, less staging surgery, and took longer to start chemotherapy. In addition, lower volume hospitals performed fewer operations in advanced stage patients, even after adjusting for age, stage and performance status of the patients.

4.3. Strengths and weaknesses

Oftentimes presentation of quality indicator data is limited to a single hospital, or a subset of hospitals [20,34], introducing selection bias, and limiting the policy relevance at a national level. A strength of this Belgian study is the availability of data from an exhaustive population-based database covering more than 98 % of all cancer cases in Belgium [16]. The linkage with pathology reports and billing data permits assessment of the entire care trajectory, even if the patient changed hospital. This renders the data representative of the entire Belgian population, enabling national policy guidance and international comparison.

A limitation is the retrospective nature of the data, and the reliance on existing, most often administrative information (e.g. billing data). Assessment of the quality of debulking surgery was hampered by the lack of data on residual disease. Examining the pathology reports provided additional information on procedures and organs/tissue removed but was insufficient to assess complete debulking. The exclusion of patients for whom we lacked pathology reports might underestimated the result of surgery indicators as it might be that in those missing pathology reports all relevant procedures were executed, but no malignant tissue was found, and therefore not reported to the national cancer registry. However, assuming these patients with missing pathology reports had a correct staging, still only 49.4 % of invasive tumours and 39.4 % of borderline tumours would have been appropriately staged.

The hospital volume is used as a proxy for experience in the treatment of patients diagnosed with epithelial ovarian cancer. For defining the hospital volume, a patient was assigned to the hospital where the main treatment was provided (according to an algorithm), assuming that hospital was responsible for the treatment decisions. Consequently, when a patient underwent parts of their treatment (e.g. multiple surgeries) at different hospitals, the patient was assigned to only one hospital, which could have introduced some bias in the actual volume of the other hospital. Unfortunately, in Belgium there are no reliable data on the activity of the surgeon or the entire treating team to account for experience.

For systemic therapy, there is a risk of underreporting as experimental therapy in clinical trial settings is not (always) captured in the administrative data; however a validation study suggested that the impact of clinical trials is very limited for this cohort. Data on patient reported outcomes, patient values and preferences, though important factors to guide treatment decisions, were not available in this study [10].

4.4. Implications for practice and future research

Given that many Belgian hospitals treat very few patients per year and the lower-volume hospitals score lower on process indicators, this study is a plea for centralising ovarian cancer care in reference centres with adequately trained and certified physicians. Our study shows there is statistical evidence that treating more patients per year shows better results on the quality indicators. However, the required minimum caseload for a reference centre should also take into account impact on survival and other outcomes, evidence from the international literature and experience from abroad. This includes data on the minimal caseload per surgeon, access to supportive care such as lymphoedema clinics, onco-fertility treatment, access to clinical trials, and the collective clinical experience of the entire care team, including pathologists [35]. The ESGO guidelines recommend a minimum of 20 cytoreductive surgeries for advanced stage invasive ovarian cancer per centre and per surgeon per year, though they put 50 and 100 surgeries per centre forward as the intermediate and optimal targets, respectively [7]. However, centralisation as such, without careful monitoring is no guarantee that ovarian cancer patients will receive optimal quality of care [34]. A particular concern, for example, is to avoid extending waiting times. Therefore, these Belgian indicator results should be seen as a baseline measurement, and monitoring should be set up to track the impact of centralisation and quality improvement.

The methodology and results of this Belgian study highlight the importance of transparent reporting of in- and exclusion criteria. Often only patients undergoing surgery are included in quality indicators, whereas the quality of care should be reported for all diagnosed patients [9]. Harmonizing and standardizing the way indicators are measured will facilitate international comparison [36].

Important for the surgical indicators is the need for structured, complete surgical and pathology reports, including information on residual disease, that can be accessed in a national database. The ESGO indicators also insist on having complete, structured operative and pathology reports available for at least 90 % of operated patients [7]. Initiatives such as the Dutch Palga with standardized synoptic pathology reports on a national level already show that it improves a patient's treatment allocation and interpretation of national quality indicators [37].

5. Conclusion

The Belgian indicator results on diagnosis and systemic treatment were near target, while those on surgery (in particular staging surgery and lymphadenectomies in early stage disease) were below target. Treatment of ovarian cancer is very dispersed with lower volume hospitals scoring lower on several process indicators, supporting the need for centralisation. Future monitoring of indicators on national level can aid assessment of the impact of centralisation efforts. Improving international benchmarking can be achieved by implementing more standardized and transparent methods for measuring indicators and (surgical) definitions.

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Ethics approval

Given the retrospective non-interventional nature of this study, it is exempted of Ethic Committee approval by the Belgian law (Art. 3 § Law of 7 May 2004 on medical experiments in human beings, Official Journal 18 May 2004). Furthermore, The Belgian Cancer Registry is authorised by Belgian law (Art. 39 of the law of 13 December 2006 on diverse health related provisions, Official Journal 22 December 2006) to collect, validate, codify, link and analyse the data relating to the compulsory cancer registry.

Data availability statement

The cancer cohort data used and analysed during the study are available from the Belgian Cancer Registry upon reasonable request. The pseudonymized data can be provided within the secured environment of the Belgian Cancer Registry after having been guaranteed that the applicable General Data Protection Regulation is applied.

CRediT authorship contribution statement

Jolyce Bourgeois: Study concepts, Study design, Quality control of data and algorithms, Data, Formal analysis, Interpretation, Manuscript preparation, Manuscript editing, Manuscript review. **Hanna M. Peacock:** Study concepts, Study design, Data curation, Funding acquisition, Quality control of data and algorithms, Data, Formal analysis, and interpretation, Statistical analysis, Manuscript editing, Manuscript review. **Isabelle Savoye:** Study concepts, Study design, Quality control of data and algorithms, Data, Formal analysis, Interpretation, Manuscript editing, Manuscript review. **Cindy De Gendt:** Study concepts, Study design, Data curation, Funding acquisition, Quality control of data and algorithms, Data, Formal analysis, Interpretation, Statistical analysis, Manuscript editing, Manuscript review. **Roos Leroy:** Study concepts, Study design, Quality control of data and algorithms, Data, Formal analysis, Interpretation, Manuscript editing, Manuscript review. **Geert Silversmit:** Study concepts, Study design, Data curation, Funding acquisition, Quality control of data and algorithms, Data, Formal analysis, Interpretation, Statistical analysis, Manuscript editing. **Sabine Stordeur:** Study concepts, Study design, Data, Formal analysis, Interpretation, Manuscript editing, Manuscript review. **Philippe de Sutter:** Study concepts, Study design, Quality control of data and algorithms, Data, Formal analysis, Interpretation, Manuscript editing. **Frédéric Goffin:** Study concepts, Study design, Quality control of data and algorithms, Data, Formal analysis, Interpretation, Manuscript editing. **Mathieu Luyckx:** Study concepts, Study design, Quality control of data and algorithms, Data, Formal analysis, Interpretation, Manuscript editing. **Guy Orye:** Study concepts, Study design, Quality control of data and algorithms, Data, Formal analysis, Interpretation, Manuscript editing. **Peter Van Dam:** Study concepts, Study design, Quality control of data and algorithms, Data, Formal analysis, Interpretation, Manuscript editing. **Toon Van Gorp:** Study concepts, Study design, Quality control of data and algorithms, Data, Formal analysis, Interpretation, Manuscript editing. **Leen Verleye:** Study concepts, Study design, Quality control of data and algorithms, Data, Formal analysis, Interpretation, Manuscript editing, Manuscript review.

Declaration of competing interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ejso.2024.107978.

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