UROGENITAL

Adnexal mass staging CT with a disease-specific structured report compared to simple structured report

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Abstract

Objectives To assess a disease-specific structured report (dsSR) for CT staging of ovarian malignancy compared to a simple structured report (sSR).

Methods This is a HIPAA-compliant, IRB-approved study with waiver of informed consent. An adnexal mass-specific structured reporting CT template was developed in collaboration between gynecologic oncologists and diagnostic radiologists. The study population included 24 consecutive women who had a staging CT prior to undergoing debulking surgery for a primary ovarian malignancy. Objective evaluation by radiologists for the presence of 19 key features and subjective evaluation by gynecologic oncologists were performed to assess the clarity and usefulness for procedural planning of dsSR and sSR. Accuracy, sensitivity, and specificity were assessed using operating room notes and pathology reports as the reference standard.

Results Fewer key features were missing from dsSR than sSR: 0.2 ± 0.8 (range 0–2) vs. 10.2 ± 1.7 (range 7–14), respectively ($p < 0.0001$). Compared to sSR, gynecologic oncologists deemed dsSR more helpful (4.3 ± 0.7 vs. 3.7 ± 0.8, $p < 0.0001$) and easier to understand (4.3 ± 0.6 vs. 3.9 ± 0.7, $p = 0.0057$) (on a scale 0–5, 0 not helpful/very difficult to understand; 5 extremely helpful/very clear to understand). Gynecologic oncologists reported a higher rate of potential to modify their surgical approach based on dsSR (33–42%) compared to sSR (13–17%), $p = 0.004$.

Conclusions Disease-specific structured reports were more reliable than simple structured reports in describing key features essential for procedural planning. dsSR was described as more helpful and easier to understand and more likely to lead to modification of the surgical approach by gynecologic oncologists compared to sSR.

Key Points
• *Disease-specific structured report is easier to understand and more helpful for planning gynecological surgery as compared with simple structured report.*
• *Disease-specific structured report for pre-operative evaluation of ovarian cancer provides better documentation of essential features required for surgical planning as compared with simple structured report.*
• *Disease-specific structured report has the potential to modify the surgical approach as assessed by gynecologic oncologists.*

Keywords Adnexal diseases · Structured reports · Cancer staging · Computed tomography · Patient-centered radiology

Abbreviations
dsSR Disease-specific structured reports
sSR   Simple structured reports

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Introduction

In 2008, the Radiological Society of North America (RSNA) introduced the radiology reporting initiative to develop standardization methods for imaging examinations [1–3]. Structured reporting of radiological examinations is performed using a predefined template instead of free style dictation to improve adherence to guidelines and increase consistency of the reports, thus simplifying and improving communication between radiologists and clinicians [4–7]. Despite multiple studies showing the benefits of structured reporting [5–9], its use is still limited in clinical practice, especially in

Europe [10]. Some studies credit this limited use to the constraints and rigidity of a structured template that impedes diagnostic accuracy and completeness in the complex cases [11, 12]. One of the solutions to this rigidity and lack of specificity is to tailor the structured reports to specific disease processes [13].

RSNA provides simple structured templates for computed tomography (CT) of the pelvis [1]. The template itemizes large structures with simple descriptors, such as "reproductive organs," "vessels," and "bones." However, it does not specify details required for staging such as the specific location and extent of lymphadenopathy or presence of omental disease, subcapsular liver, and spleen deposits. Simple structured reporting works well for routine evaluations since it serves as a simple but complete checklist for the interpreting radiologist. However, in the era of personalized medicine, when the same disease at different stages has very different clinical management, it is our opinion that tailored disease-specific templates are required.

Specifically, in cases of presumed advanced or metastatic ovarian cancer, there is a critical decision to be made at diagnosis: primary debulking surgery versus neoadjuvant chemotherapy [14–16]; therefore, standardizing the approach to imaging staging is highly important.

Benefits of disease-specific templates have been shown previously for pancreatic cancer staging, hepatocellular carcinoma, fibrosing lung disease, inflammatory bowel disease, uterine fibroids, and other diseases [8, 9, 17–19].

We believe that using disease-specific structured reporting for ovarian cancer may help to increase reporting of key features that are essential for clinical management decisions by gynecologic oncologists [20]. Our goal is to assess a disease-specific structured report for CT staging of ovarian malignancy compared to a simple structured report.

Materials and methods

Institutional review

This Health Insurance Portability and Accountability Act (HIPAA)-compliant retrospective study was conducted with the approval of the local institutional review board. The requirement for informed consent was waived due to the retrospective nature of the study.

Patients

Our institution's Gynecological Tumor Board database, which included 557 patients diagnosed with gynecological cancers between January 2015 and December 2015, was searched for consecutive adult subjects (≥ 18 years old) with primary ovarian malignancy with a staging CT and who underwent consequent debulking surgery (Fig. 1). Exclusion criteria included patients without a primary ovarian mass, without a staging CT and who did not undergo debulking surgery.

CT reporting template for adnexal tumors

In January 2016, a structured reporting template for abdominal and pelvic CT for staging adnexal cancer was developed in collaboration by gynecologic oncologists and diagnostic radiologists at our Institution, using the FIGO staging system [21] and guidelines for the development of disease-specific report templates [5]. The new template was designed to address specific surgery altering findings (such as the presence of mesenteric and porta hepatis deposits that elevate surgical complexity and thus increase risk for complications) and staging criteria specific for ovarian cancer patients (Fig. 2).

Simple structured report template used for reporting of CT of the abdomen and pelvis in our institution contains headings for different organs that are included in the CT examination such as liver, pancreas, spleen, and kidneys, with simple description (Appendix 1). The pelvic descriptors included "reproductive organs are within normal limits" and mention of the presence/absence of pelvic lymphadenopathy. Although this is sufficient description for most CT studies, in patients with ovarian cancer, much more detail is needed.

Study protocol

The study evaluated four types of reports for our patients: a simple structured interpretation interpreted by a trainee (resident or fellow on service) with a board-certified attending radiologist and three disease-specific structured reports (dsSR), each produced according to the disease-specific template (Fig. 2) by independent reinterpretation of the images by one of the three radiologists with different levels of experience, who did not participate to simple structured interpretation and who were blinded to the definitive pathological diagnosis, the original report, and patient outcomes (CW, diagnostic radiology resident with 3 years of radiology experience; MP, abdominal imaging fellow with 6 years of radiology experience; and ASB, abdominal imaging fellowship-trained attending radiologist with 3 years of post-fellowship experience).

Patients were scanned on multi-detector CT scanners (GE Lightspeed series, General Electric Healthcare; Aquilion series, Toshiba Medical Systems; SOMATOM series, Siemens Healthineers). Images were acquired helically at 120 kVp and reconstructed at 5-mm slice thickness in the axial, sagittal, and coronal planes. Patients were administered between 100 and 150 mL of intravenous nonionic iodide-based contrast (Omnipaque 350, Mallinckrodt Pharmaceuticals) based on their body mass index (BMI) and images were acquired at portal venous phase of imaging.

Fig. 1 STARD flow diagram. Patients with debulking surgery and pre-staging CT: objective, subjective, and accuracy evaluation
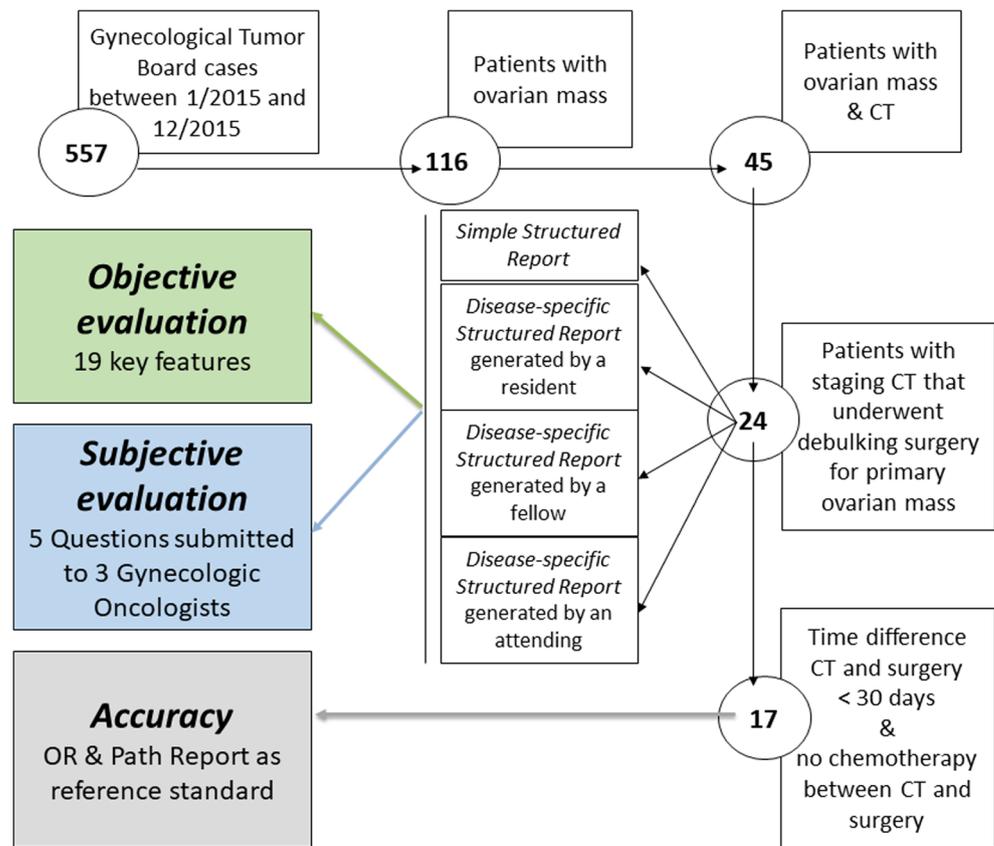
Objective evaluation of disease-specific structured vs simple structured reports

Based on the information required for staging, surgical and clinical management, 19 key features were selected by a diagnostic radiologist who serves as consultant to the gynecology department (ORB, fellowship-trained abdominal radiologist with 6 years of post-fellowship experience) after consulting with the gynecologic oncologists that perform the oncological surgery for pelvic masses on a regular basis. These key features included pelvic mass location, pelvic mass size, bladder invasion, bowel invasion, largest omental deposit, cul-de-sac deposit, right and left paracolic gutter deposit, liver capsule deposit, spleen capsule deposit, mesenteric root deposit, pelvic lymphadenopathy, aortocaval lymphadenopathy, mesenteric root lymphadenopathy, porta hepatis lymphadenopathy, splenic hilum lymphadenopathy, diaphragmatic lymphadenopathy, distant metastasis, and ascites.

The absence of key features was assessed in both the simple structured reports and the disease-specific structured reports produced by the resident, fellow, and attending. The assessment was performed by a research fellow (AF, with 2 years of residency experience in radiology). Each key feature was considered to be absent if it was not mentioned in the report.

Subjective evaluation of disease-specific structured vs simple disease-specific structured reports by gynecologic oncologists

Three board-certified gynecologic oncologists with varying levels of experience (LF, 3 years of post-fellowship; KE, 3 years of post-fellowship experience; LG, 5 years of post-fellowship experience) evaluated (on a scale 0–5, 0 not helpful/very difficult to understand; 5 extremely helpful/very clear to understand) clarity, completeness, and usefulness for pre-operative staging purposes and for clinical management of disease-specific structured report and simple structured report, according to a 5-point questionnaire in an anonymized random fashion (Appendix 2).

Staging accuracy of disease-specific structured vs simple structured reports

Patients with a time interval of less than 30 days between CT and surgery were included in the subgroup analysis of staging accuracy evaluation of different types of reports as compared to surgical and pathological findings, serving as the reference standard.

PELVIC MASS: [RT/LT/BILAT] [x]cm [series_____]:[image_____]

INVASION:

BLADDER: none / [x   ] cm [series _____]:[image _____]

COLON: none / [x   ] cm [series _____]:[image _____]

PELVIC FLOOR MUSCULATURE: none / name and laterality of muscle _____[series _____]:[image _____]

VESSELS: none / name and laterality of vessel _____[series _____]:[image _____]

PERITONEAL METASTASES: NONE / ONLY BELOW RENAL ARTERIES / ABOVE AND BELOW RENAL ARTERIES

LARGEST OMENTAL DEPOSIT: none /[x   ] cm [series _____]:[image _____]

CUL DE SAC: none /[x   ] cm [series _____]:[image _____]

RIGHT PARACOLIC GUTTER: none /[x   ] cm [series _____]:[image _____]

LEFT PARACOLIC GUTTER: none /[x   ] cm [series _____]:[image _____]

LIVER CAPSULE: none / [x   ] cm [series _____]:[image _____]

SPLEEN CAPSULE: none / [x   ] cm [series _____]:[image _____]

GALLBLADDER: none / [x   ] cm [series _____]:[image _____]

LESSER SAC: none / [x   ] cm [series _____]:[image _____]

MESENTERIC ROOT: none / [x   ] cm [series _____]:[image _____]

LYMPHADENOPATHY:

Internal iliac   none /[x   ] cm [series _____]:[image _____]

External iliac   none /[x   ] cm [series _____]:[image _____]

Common iliac   none /[x   ] cm [series _____]:[image _____]

Aortocaval   none /[x   ] cm [series _____]:[image _____]

Mesenteric root   none /[x   ] cm [series _____]:[image _____]

Porta hepatis   none /[x   ] cm [series _____]:[image _____]

Splenic hilum   none /[x   ] cm [series _____]:[image _____]

Cardiophrenic   none /[x   ] cm [series _____]:[image _____]

DISTANT METASTASES: [none / liver / adrenal / bone / others _____]

Liver   [#_____][x   ] cm [series _____]:[image _____]

Adrenal [#_____][x   ] cm [series _____]:[image _____]

Others   [#_____][x   ] cm [series _____]:[image _____]

ASCITES: [none/small/moderate/large]

Fig. 2 Adnexal mass template that was developed in collaboration between gynecologic oncologists and diagnostic radiologists in our institution based on FIGO staging and guidelines on development of disease-specific structured reports

Assessment of distant metastasis was excluded from this evaluation due to inconsistent evaluation of distant sites during surgery, as some surgeries were performed for palliation with limited surgical field. A research fellow (AF, with 2 years of residency experience in radiology) went through the whole pathology report to find out the presence of each item present in the disease-specific structured report; where an item was not mentioned in the path report, it was assumed as not involved by disease.

Sensitivity and specificity of each feature were calculated for simple structured report and for disease-specific structured report for each interpreter (resident, fellow, and attending). Overall average sensitivity and specificity were also provided.

Statistical analysis

The Student's *t* test was used to compare the mean number of key features present in disease-specific structured reports and simple structured reports for objective evaluation of the reports. The Fisher exact test was used to evaluate the frequencies of the 19 key features in the disease-specific structured reports and simple structured reports. The McNemar test was utilized to evaluate staging accuracy, sensitivity, and specificity of disease-specific structured reports and simple structured reports. Sensitivity, specificity, and 95% confidence intervals for disease-specific structured reports and simple structured reports were assessed. Wilcoxon signed-rank test and paired Student's *t* test were used to compare the difference between

disease-specific structured report and simple structured report for grading of usefulness and clarity by gynecologists in the subjective analysis. A p value less than 0.05 was considered to indicate a significant difference.

Results

Objective evaluation of disease-specific structured vs simple structured reports: 19 key features

After application of exclusion criteria, 24 consecutive patients with primary ovarian malignancy with a staging CT who underwent debulking surgery afterwards were included in the study. The average age of patients in our cohort was 57 $\pm$ 15 years (range 28–83 years).

On average, only 0.2 $\pm$ 0.8 (range 0–2) key features were absent in the disease-specific structured reports whereas 10.2 $\pm$ 1.7 (range 7–14) key features were absent from the simple structured reports ($p < 0.0001$) (Fig. 3). For all, but three (out of 19) key features (bladder, bowel involvement, and distant metastases), disease-specific structured reports provided more consistent assessment than simple structured reports (Table 1).

Subjective evaluation by gynecologic oncologists of disease-specific structured vs simple structured reports

The disease-specific structured reports improved the provided information for pre-operative staging purpose and more often led to modification of the surgical approach as assessed by the three gynecologic oncologists. However, both types of reports provided sufficient information for making clinical management decisions (Table 2).

Gynecologic oncologists graded disease-specific structured report as more helpful for surgical planning compared to simple structured report with an average score of 4.3 $\pm$ 0.7 (range

4–5) for disease-specific structured report compared to 3.7 $\pm$ 0.8 (range 3–4) for simple structured report, ($p = 0.00016$).

Similarly, disease-specific structured reports were graded as easier to understand than simple structured reports with an average score of 4.3 $\pm$ 0.6 (range 4–5) for disease-specific structured report vs. 3.9 $\pm$ 0.7 (range 3–5) for simple structured report, ($p = 0.00512$).

Staging accuracy disease-specific structured vs simple structured reports

After exclusion of 7 out of 24 (29.2%) patients from the cohort due to neoadjuvant chemotherapy treatment between CT and surgery and/or time interval greater than 30 days between CT and surgery, a subanalysis of staging accuracy of simple vs disease-specific structured templates was performed on 17 remaining patients.

Disease-specific structured reporting as compared to simple structured reporting improved overall sensitivity (46 $\pm$ 38.6 of dsSR vs 35 $\pm$ 34.7 of sSR) for detection and characterization of specific features needed for ovarian cancer debulking (Table 3) with the bowel involvement and largest omental deposit responsible for most of the difference.

Overall specificity (90.4 $\pm$ 11 of dsSR vs 96.2 $\pm$ 6.4 of sSR), on the other hand, decreased with disease-specific structured reporting compared to simple structured reporting. This was due to increased false positives (Table 4), most prominently in the bowel involvement category.

Discussion

Our study showed that disease-specific structured reporting of ovarian cancer staging CT was rated as more useful for surgical planning and was easier to understand by surgeons. Disease-specific structured reports consistently reported all key features required for pre-operative evaluation as seen on objective analysis, while simple structured reports missed on average 10
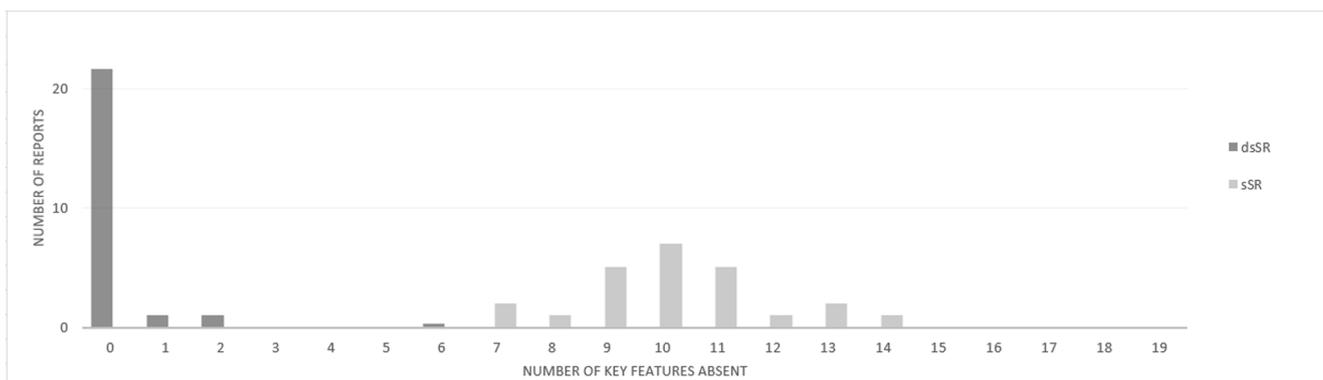

Fig. 3 Number of key features absent in all reports: disease-specific structured report (dsSR) vs. simple structured report (sSR). For disease-specific structured reports (dsSR), the average absent features of separate reports provided by resident, fellow, and attending are provided per patient

Table 1 The presence of key features in the disease-specific structured and simple structured reports. The number of total possible responses is given by 24 CT scans × 3 radiologists = 72 for dsSR and 24 CT scans × 1 radiologist = 24 for sSR. Not all features were relevant to all exams; therefore, the number of total possible responses varies for different types of features. p value of less than 0.05 is presented in italics

	Disease-specific structured reports			Simple structured reports			p value
	n	Possible responses	%	n	Possible responses	%	
Pelvic mass location	72	72	100.0	21	24	87.5	*0.0142*
Pelvic mass size	70	70	100.0	20	23	87.0	*0.0136*
Bladder involvement	70	72	97.2	23	24	95.8	> 0.9999
Bowel involvement	68	72	94.4	24	24	100.0	0.5691
Largest omental deposits	72	72	100.0	9	24	37.5	*< 0.0001*
Cul-de-sac deposits	71	72	98.6	14	24	58.3	*< 0.0001*
Right paracolic gutter deposits	72	72	100.0	1	24	4.2	*< 0.0001*
Left paracolic gutter deposits	72	72	100.0	2	24	8.3	*< 0.0001*
Liver capsule deposits	72	72	100.0	5	24	20.8	*< 0.0001*
Spleen capsule deposits	72	72	100.0	1	24	4.2	*< 0.0001*
Mesenteric root deposits	71	72	98.6	2	24	8.3	*< 0.0001*
Pelvic lymphadenopathy	71	72	98.6	17	24	70.8	*< 0.0001*
Aortocaval lymphadenopathy	71	72	98.6	19	24	79.2	*0.0067*
Mesenteric root lymphadenopathy	71	72	98.6	17	24	70.8	*0.0002*
Porta hepatis lymphadenopathy	71	72	98.6	0	24	0.0	*< 0.0001*
Splenic hilum lymphadenopathy	71	72	98.6	0	24	0.0	*< 0.0001*
Diaphragmatic lymphadenopathy	71	72	98.6	1	24	4.2	*< 0.0001*
Distant metastasis	72	72	100.0	23	23	100.0	> 0.9999
Ascites	71	72	98.6	11	24	45.8	*< 0.0001*
Absent key features from the report	0.2 ± 0.8			10.2 ± 1.7			*< 0.0001*

descriptors, essential for ovarian cancer staging and pre-operative evaluation for debulking surgery. Subjectively, gynecologic oncologists stated that, based on the information from disease-specific reports, they would alter their surgical strategy at a higher rate compared to simple structured reports.

Results of our study confirmed that disease-specific structured reports are more useful for surgical planning and easier to understand by surgeons, in agreement with multiple prior studies that showed the benefits of disease-specific templates. Structured rectal MRI reporting systems in patients with primary rectal cancer facilitated surgical planning and led to higher satisfaction among referring surgeons compared to narrative reports [22]. Structured reporting improved interobserver agreement in regard to the number of significant stenotic vessels in a coronary CT angiography report [23]. Structured chest radiograph reports were more detailed and more useful for management than unstructured chest

Table 2 Positive responses for the ability to perform pre-operative staging and pre-procedural planning by gynecologic oncologists based on disease-specific structured report (dsSR) and simple structured reports (sSR). p value was assessed summing three attendings' scores and p value of less than 0.05 is presented in italics

		Disease-specific structured reports			Simple structured reports			p value
		N = yes	tot	%	N = yes	tot	%	
"Does this report provide sufficient information for pre-operative staging purpose?"	Attending 1	23	24	95.8	7	24	29.2	*< 0.0001*
	Attending 2	22	24	91.7	16	24	66.7	
	Attending 3	22	24	91.7	23	24	95.8	
"Does this report provide sufficient information to make next clinical management decision?"	Attending 1	23	24	95.8	23	24	95.8	0.057
	Attending 2	22	24	91.7	21	24	87.5	
	Attending 3	21	24	87.5	13	24	54.2	
Based on this report, if you decide to operate, would you modify your surgical approach?"	Attending 1	10	24	41.7	3	24	12.5	*0.0035*
	Attending 2	8	24	33.3	3	24	12.5	
	Attending 3	8	24	33.3	4	24	16.7	

Table 3 Sensitivity for detection of various features by different level of experience with disease-specific structured reporting compared to simple structured reporting. Mean sensitivity of dsSR vs sSR was compared. *p* value of less than 0.05 is presented in italics. *Data provided per location (right/left/bilateral)

Sensitivity (%)	Disease-specific structured reports									Mean	Simple structured reports			*p* value
	Resident			Clinical fellow			Attending							
	TP	FN	Sensitivity	TP	FN	Sensitivity	TP	FN	Sensitivity		TP	FN	Sensitivity	
Pelvic mass location*	20	2	90.9	18	4	81.8	19	3	86.4	86.4	16	6	72.7	0.24
Bladder involvement	0	4	0.0	0	4	0.0	2	2	50.0	16.7	0	4	0.0	0.08
Bowel involvement	1	5	16.7	1	5	16.7	3	3	50.0	27.8	0	6	0.0	*0.02*
Largest omental deposits	4	1	80.0	4	1	80.0	5	0	100.0	86.7	2	3	40.0	*0.005*
Cul-de-sac deposits	2	4	33.3	0	6	0.0	0	6	0.0%	11.1	1	5	16.7	0.64
Right paracolic gutter deposits	2	0	100.0	1	1	50.0	1	1	50.0	66.7	1	1	50.0	0.33
Left paracolic gutter deposits	0	0	/	0	0	/	0	0	/	NA	0	0	/	NA
Liver capsule deposits	2	4	33.3	3	3	50.0	3	3	50.0	44.4	3	3	50.0	0.74
Spleen capsule deposits	0	0	/	0	0	/	0	0	/	NA	0	0	/	NA
Lesser sac deposits	0	3	0.0	0	3	0.0	0	3	0.0	0	0	3	0.0	1
Mesenteric root deposits	0	3	0.0	0	3	0.0	0	3	0.0	0	0	3	0.0	1
Pelvic lymphadenopathy	1	0	100.0	1	0	100.0	1	0	100.0	100	1	0	100.0	1
Aortocaval lymphadenopathy	1	1	50.0	1	1	50.0	2	0	100.0	66.7	1	1	50.0	0.33
Mesenteric root lymphadenopathy	0	1	0.0	0	1	0.0	0	1	0.0	0	0	1	0.0	1
Porta hepatis lymphadenopathy	0	0	/	0	0	/	0	0	/	NA	0	0	/	NA
Splenic hilum lymphadenopathy	0	0	/	0	0	/	0	0	/	0	0	0	/	NA
Diaphragmatic lymphadenopathy	0	0	/	0	0	/	0	0	/	0	0	0	/	NA
Ascites	4	0	100.0	4	0	100.0	3	1	75.0	91.7	3	1	75.0	0.20
Average ± SD			46.8 ± 42.4			40.7 ± 40.2			50.9 ± 40.2	46 ± 38.6			35 ± 34.7	*0.02*

radiograph reports [24]. Brook et al [8] showed improvement in staging and surgical planning of pancreatic cancer with the implementation of a structured report.

One major difference between our studies and all the studies listed above is that we have compared disease-specific structured reports to simple but structured reports, not to free text reporting as was usually used in previous studies. This study confirms that using "catch all" simple structured reports is not sufficient for complex cases that require specialized, disease-specific reports. In the case in point, in patients with initial presentation of ovarian cancer, specific CT findings altered patient course from surgical to medical treatment and the type and extent of surgery. In the era of personalized medicine, the requirement for disease-specific results is more of the norm rather than exception. Therefore, further research is needed to build, test, implement, and improve disease-specific structured reports for various indications.

Interestingly, all three-attending gynecologic oncologists reported a higher rate of potential to modify their surgical approach based on disease-specific structured reports (33–42%), as compared to simple structured reports (13–17%). This shows the potential of disease-specific structured reporting to impact surgical planning and as a result, patient outcomes, as these responses were based on the same CT studies with the only difference being in the level of detail provided and clarity of the report.

The difference between the performance of the two report types may be due to providing more detail regarding the extent of the disease or potential organ involvement, such as bowel and bladder. When we compared sensitivity and specificity of the identification and characterization of specific features, it appeared that sensitivity was improved, at the cost of a mild decrease in specificity. In particular, sensitivity of disease-specific structured report resulted in significantly higher detection of bowel involvement and largest omental deposits, at the cost, for the latter, of a significantly lowering in specificity when compared to simple structured report. These results are very preliminary and need to be confirmed in larger studies, as small numbers precluded statistically significant evaluation for this subanalysis. However, it is understandable that using a specific checklist would improve sensitivity for detecting an easy to miss lesion but would reduce specificity because previously there was not much attention paid to some subtle findings that are easy to overcall.

Some discrepancy between the radiology and surgical/pathological report that resulted in suboptimal staging accuracy can be ascribed to rapid changes of the amount of ascites within few days and to the limited resolution of CT images that can miss small lesions or rapid disease progression.

The importance of a consistent lexicon to improve communication with referring physicians, reproducibility in research, and time consumption has been shown previously [24–26];

Table 4 Specificity of detection of various features by different level of experience with diseasespecific structured reporting compared to simple structured reporting. Mean specificity of dsSR vs sSR were compared. *p* value of less than 0.05 is presented in italics. *Data provided per location (right/left/bilateral)

Specificity (%)	Disease-specific structured reports										Mean	Simple structured reports			*p* value
	Resident			Clinical fellow			Attending								
	FP	TN	Specificity	FP	TN	Specificity	FP	TN	Specificity			FP	TN	Specificity	
Pelvic mass location*	3	9	75.0	5	7	58.3	6	6	50.0		61.1	3	9	75.0	0.31
Bladder involvement	0	13	100.0	0	13	100.0	2	11	84.6		94.9	0	13	100.0	0.35
Bowel involvement	1	10	90.9	1	10	90.9	5	6	54.5		78.8	0	11	100.0	*0.05*
Largest omental deposits	0	12	100.0	2	10	83.3	0	12	100.0		94.4	1	11	91.7	0.76
Cul-de-sac deposits	1	10	90.9	0	11	100.0	1	10	90.9		93.9	1	10	90.9	0.75
Right paracolic gutter deposits	1	14	93.3	3	12	80.0	1	14	93.3		88.9	0	15	100.0	0.16
Left paracolic gutter deposits	4	13	76.5	4	13	76.5	2	15	88.2		80.4	1	16	94.1	0.24
Liver capsule deposits	0	11	100.0	1	10	90.9	0	11	100.0		97	0	11	100.0	0.48
Spleen capsule deposits	0	17	100.0	0	17	100.0	0	17	100.0		100	1	16	94.1	0.32
Lesser sac deposits	0	14	100.0	0	14	100.0	0	14	100.0		100	0	14	100.0	1
Mesenteric root deposits	0	14	100.0	0	14	100.0	0	14	100.0		100	0	14	100.0	1
Pelvic lymphadenopathy	1	15	93.8	0	16	100.0	2	14	87.5		93.8	0	16	100.0	0.30
Aortocaval lymphadenopathy	0	15	100.0	3	12	80.0	3	12	80.0		86.7	1	14	93.3	0.53
Mesenteric root lymphadenopathy	0	16	100.0	0	16	100.0	1	15	93.8		97.9	0	16	100.0	0.55
Porta hepatis lymphadenopathy	0	17	100.0	1	16	94.1	0	17	100.0		98	0	17	100.0	0.56
Splenic hilum lymphadenopathy	0	17	100.0	0	17	100.0	0	17	100.0		100	0	17	100.0	1
Diaphragmatic lymphadenopathy	1	16	94.1	0	17	100.0	4	13	76.5		90.2	0	17	100.0	0.19
Ascites	4	9	69.2	4	9	69.2	3	10	76.9		71.8	1	12	92.3	0.13
Average ± SD			93.5 ± 9.9			90.1 ± 12.8			87.6 ± 15.3	90.4 ± 11				96.2 ± 6.4	*0.006*

the International Ovarian Tumor Analysis (IOTA) consensus largely helped in a better homogenous description of adnexal masses sonographic features, underlined the need for a standardized nomenclature [27]. However, while analyzing the reports, we noticed a lack of uniform language in the radiologists' reports, operation room reports, and pathology reports. Language inconsistency was also noticed among three radiologists, even with disease-specific structured templates. For example, attending radiologist frequently added "abut" instead of "no invasion/invasion" option. Rigidity and simplification in the structured reports requires a definitive interpretation, which at times is difficult to provide in borderline cases [10, 12]. Therefore, based on the results of our study, we have modified our template by adding "abutting" to the features describing invasion of the distant organs.

Implementation of structured reporting is also a move in the direction set by the ACR Imaging 3.0 campaign [28], which aims at maximizing radiologists' value, in term of completeness, time efficiency, user acceptance, and greater collaboration with other physicians [7, 29]. In the scenario of multidisciplinary conferences, all these tools have the aim to feed the discussion between radiologists and physicians in the complicated decision-making process of the clinical practice. We showed as disease-specific structured report lets a structured interaction

that may alter gynecological oncologists' surgical decisions, provides a useful reference for comparing response on serial imaging, and so may be thought as a valuable guide in the setting of the multidisciplinary discussion. Other studies underscored the goal of a structured report in achieving quality improvement through reduction in variability [25], and better adherence to guidelines [5]. In 2009, to facilitate communication between radiologists and referring clinicians and to strengthen recommendations for management, the Gynecology Imaging Reporting and Data System (GI-RADS) for reporting ultrasound findings of adnexal masses was developed [30].

Our study has a number of limitations. First, due to stringent inclusion and exclusion criteria, subanalysis for staging accuracy was performed in a relatively small number of patients (n = 17), likely underpowered to detect significant differences. Future studies should address this in a larger group of patients. Second, the retrospective nature, inability to blind readers to the study purpose, and gynecologic oncologists' awareness of the type of report could have introduced a bias for the subjective assessment. Third, disease-specific structured reports were produced specifically for the study, while simple structured reports were produced during routine clinical work, with potential of increased bias towards structured reporting in the study setting. Future studies should evaluate real life

implementation of disease-specific structured reporting to see if the benefits persist during routine clinical work.

In conclusion, our study showed that disease-specific structured report for pre-operative evaluation of ovarian cancer provides better documentation of essential features required for surgical planning, improves reports clarity, and has the potential to modify the surgical approach as assessed by gynecologic oncologists.

Compliance with ethical standards

Appendix 1: Sample of a simple structured report at our Institution

EXAMINATION: CT abdomen pelvis with contrast

INDICATION: 38 year old woman with bilateral ovarian masses, elevated CA125. Patient with bilateral ovarian masses worrisome for ovarian carcinoma seen on pelvic ultrasound dated 7/24/2015, elevated CA125 of 388, please evaluate formets.

COMPARISON: None.

FINDINGS:

LOWER CHEST: Visualized lung fields are within normal limits. There is no evidence of pleural or pericardial effusion.

ABDOMEN:

HEPATOBILIARY: The liver demonstrates homogenous attenuation throughout. There is no evidence of focal lesionsThere is no evidence of intrahepatic or extrahepatic biliary dilatation. The gallbladder is within normal limits, without stones or gallbladder wall thickening.

PANCREAS: The pancreas has normal attenuation throughout, without evidence of focal lesions or pancreatic ductal dilatation. There is no peripancreatic stranding.

SPLEEN: The spleen shows normal size and attenuation throughout, without evidence of focal lesions.

ADRENALS: The right and left adrenal glands are normal in size and shape.

URINARY: The kidneys are of normal and symmetric size with normal nephrogram.

There is no evidence of stones, focal renal lesions, or hydronephrosis. There are no urothelial lesions in the kidneys or ureters. There is no perinephric abnormality.

GASTROINTESTINAL: Small bowel loops demonstrate normal caliber, wall thickness and enhancement throughout. The colon and rectum are within normal limits. The appendix is not visualized. There is no evidence of mesenteric lymphadenopathy.

RETROPERITONEUM: There is no evidence of retroperitoneal lymphadenopathy.

VASCULAR: There is no abdominal aortic aneurysm. There is no calcium burden in the abdominal aorta and great abdominal arteries.

PELVIS: The urinary bladder and distal ureters are unremarkable. There is no evidence of pelvic or inguinal lymphadenopathy. There is no free fluid in the pelvis.

REPRODUCTIVE ORGANS: A heterogeneously enhancing soft tissue mass measuring 7.7 × 3.9 × 9.5 cm arises from the left adnexa (series 6, image 101, and series 9, image 20). On the right, heterogeneous soft tissue mass measures 3.5 × 2.4 × 3.8 cm (series 6, image 101, and series 9, image 21). Endometrial stripe measures 6 mm.

BONES AND SOFT TISSUES: There is no evidence of worrisome osseous lesions. The abdominal and pelvic wall is within normal limits.

IMPRESSION: 1. No evidence of metastatic disease.

2. Heterogeneously enhancing masses arising from bilateral adnexa measures 7.7 × 3.9 × 9.5 cm on the left and on the right, 3.5 × 2.4 × 3.8 cm.

Appendix 2: Questionnaire to Gyncecologic oncologists

1. Does this report provide sufficient information for pre-operative staging purposes?

   | Yes | No |

2. Does this report provide sufficient information to make next clinical management decision?

   | Yes | No |

3. Based on this report, if you decide to operate, would you modify your surgical approach?

| Yes | No |

4. How **helpful** is this report for surgical planning (1- not helpful, 5 - extremely helpful)?

| 1 | 2 | 3 | 4 | 5 |

5. How **easy to understand** is this report (1 - very difficult, 5 - very clear)?

| 1 | 2 | 3 | 4 | 5 |

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