

## Original Article



# Sentinel lymph node mapping in endometrial and cervical cancer: a survey of practices and attitudes in gynecologic oncologists

Laura Moulton Chambers , Roberto Vargas , Chad M. Michener

Division of Gynecologic Oncology, Ob/Gyn & Women's Health Institute, Cleveland Clinic Foundation, Cleveland, OH, USA

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### Correspondence to

Laura Moulton Chambers

Division of Gynecologic Oncology,  
Ob/Gyn & Women's Health Institute, Cleveland  
Clinic Foundation, 9500 Euclid Ave, Cleveland,  
OH 44195, USA.

E-mail: Laurajmoulton@gmail.com

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cited.

### ORCID iDs

Laura Moulton Chambers   
<https://orcid.org/0000-0002-3773-7060>  
Roberto Vargas   
<https://orcid.org/0000-0003-4262-7824>  
Chad M. Michener   
<https://orcid.org/0000-0001-5170-6626>

### Conflict of Interest

No potential conflict of interest relevant to this  
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## ABSTRACT

**Objective:** To determine patterns among gynecologic oncologists in sentinel lymph node mapping (SLNM) for endometrial cancer (EC) and cervical cancer (CC).

**Methods:** A online survey assessing the practice of SLNM, including incidence, patterns of usage, and reasons for non-use was distributed to Society of Gynecologic Oncology candidate and full members in August 2017. Descriptive statistics and univariate analysis was performed.

**Results:** The 1,117 members were surveyed and 198 responses (17.7%) were received. Of the 70% (n=139) performing SLNM, the majority reported use for both CC and EC (64.0%) or EC alone (33.1%). In those using SLNM in EC, the majority (86.6%) performed SLNM in >50% of cases for all patients (56.3%), International Federation of Gynecology and Obstetrics grade 1 (43.0%) and 2 (42.2%). Reported benefits of SLNM in EC were reduced surgical morbidity (89.6%), lymphedema (85.2%), and operative time (63.7%). Among those using SLNM for CC, the majority (73.1%) did so in >50% of cases. In EC, 77.2% and 21.3% reported that micro-metastatic disease (0.2–2.0 cm) and isolated tumor cells (ITCs) should be treated as node positive, respectively. In those not using SLNM for EC (n=64) and CC (n=105), concerns were regarding efficacy of SLNM and lack of training. When queried regarding training, 73.7% felt that SLNM would impact skill in full lymphadenectomy (LND).

**Conclusion:** The SLNM is utilized frequently among gynecologic oncologists for EC and CC staging. Common reasons for non-uptake include uncertainty of current data, lack of training and technology. Concerns exist regarding impact of SLNM in fellowship training of LND.

**Keywords:** Sentinel Lymph Node; Endometrial Cancer; Cervical Cancer; Lymphadenectomy

## INTRODUCTION

Endometrial cancer (EC) is the most common gynecologic malignancy diagnosed in the United States [1]. The standard of care for EC is hysterectomy and bilateral salpingo-oophorectomy via a minimally invasive surgical (MIS) approach [2]. Pelvic lymphadenectomy (LND) and/or para-aortic LND may be performed depending upon uterine factors, cancer stage and grade [3]. While 2 randomized control trials have studied the role of LND in EC and demonstrated no benefit in disease-specific or overall survival (OS), nodal information plays a crucial role in disease staging and treatment planning [4,5].

### Author Contributions

Conceptualization: C.L.M., V.R., M.C.M.; Data curation: C.L.M.; Formal analysis: C.L.M.; Investigation: C.L.M., V.R.; Methodology: C.L.M., V.R., M.C.M.; Project administration: V.R., M.C.M.; Resources: C.L.M., M.C.M.; Software: C.L.M.; Supervision: V.R., M.C.M.; Validation: C.L.M.; Visualization: C.L.M., V.R., M.C.M.; Writing - original draft: C.L.M., V.R., M.C.M.; Writing - review & editing: C.L.M., V.R., M.C.M.

There is growing evidence supporting the role of sentinel lymph node mapping (SLNM) in EC [6-12]. In the prospective multicenter study by Rossi et al. [11], specificity of greater than 97% was reported in patients with early stage EC undergoing SLNM. Similarly, data has increasingly demonstrated a role for SLNM in cervical cancer (CC) [13-16]. SLNM has become standard protocol at some institutions but despite growing evidence supporting use of SLNM and support of organizations including National Comprehensive Cancer Network (NCCN) and the Society of Gynecologic Oncology (SGO) consensus group, this technology has not become widespread in the United States [12,17-19]. Identification of the provider trends and attitudes and reasons for non-incorporation of SLNM may be helpful in guiding future studies and technologic advancements for MIS surgical staging in EC and CC.

The objective of this study is to identify trends in the utilization of SLNM for EC and CC among gynecologic oncologists and identify reasons for non-adoption of SLNM techniques among gynecologic oncologists.

## MATERIALS AND METHODS

### 1. Study design

We designed an anonymous online questionnaire to assess member demographics, practice patterns, and attitudes regarding the use of SLNM in EC and CC. The study was approved by the Institutional Review Board at Cleveland Clinic Foundation, the Case Western Reserve University Comprehensive Cancer Center Protocol Review and Monitoring Committee (# 17-1050) and by the SGO for the purpose of surveying candidate members and full members.

### 2. Survey creation and study variables

The survey consisted of 24 questions querying demographics, SLNM usage in practice, perceived benefits of SLNM, reasons for non-uptake of SLNM, attitudes regarding usage patterns, and interest in additional training. The first part of the survey queried demographic variables including years of practice, gender, practice setting, and location. The second part of the survey assessed whether members were using SLNM for EC alone, CC alone, both EC and CC, or were not using SLNM in practice. If members reported use of SLNM in practice for EC, CC, or both, questions were asked regarding patterns of percentage of use, stage, and histologies in which SLNM was being used, surgical platform of use (MIS, multi-port laparoscopy, single port laparoscopy, robotic assisted laparoscopy; and laparotomy) and medium used for mapping (isosulfan blue, indocyanine green [ICG], technetium-99, and other). Questions were asked regarding use of full LND with alongside SLNM and personal mapping rate awareness and percentage, if known. For members who reported use of SLNM, questions were perceived benefits of SLNM in EC, CC, or both. In members not using SLNM for EC, CC, or both, they were asked for reasons for non-use (including concerns for efficacy of mapping, missing nodal positive disease and impact of ultra-staging, aid in training full LND, pathology department unsure how to process specimens, and lack of training during fellowship). Next, training practices for SLNM were assessed including where training was received, number of sentinel and full lymphadenectomies performed during fellowship and preparedness for SLNM after fellowship. Members were then queried whether they agreed, disagreed or were neutral regarding practice patterns in SLNM. Topics that were queried included perception of current data supporting SLNM in CC and EC, utility of current technology in SLNM, impact on fellowship training, whether they felt that micro-metastatic disease (0.2–2.0 mm) or

isolated tumor cells (ITCs) should be staged and treated as node positive. The complete survey is presented in Appendix.

### 3. Study participants

An E-mail invitation to participate in the anonymous study was distributed to all full and candidate gynecologic oncologist members of the SGO in August and September 2017. Fellows were excluded. Within the body of the E-mail, members were invited to participate in the confidential survey via the Research Electronic Data Capture (REDCap) website on a voluntary basis with an “opt-out” option [20]. No identifying data was collected, including the respondent's fellowship or current institution. Secure data storage was maintained with REDCap software (Vanderbilt, Nashville, TN, USA) [20]. The study was open for 4 weeks and members received an initial E-mail invitation, followed by up to 2 additional E-mails for members who did not complete the study which was automated in the REDCap program [20]. All members who were emailed the survey were included in the denominator of total surveys to calculate the response rate.

### 4. Statistical analysis

All returned surveys, including those with incomplete responses, were used for the final analysis. Descriptive statistics were performed to assess member demographics and for all survey responses. Percentage of response per question was divided by the denominator of answering responses per question. Respondent survey responses were analyzed with for multiple co-variates using Fisher's exact test and  $\chi^2$  tests. Selected co-variates used to compare survey responses included years of practice, geographical location, gender, and training for SLNM. Two-tailed p-values <0.05 were considered significant. Statistical analysis was performed with JMP software (13.0; SAS Institute Inc., Cary, NC, USA).

## RESULTS

### 1. Demographics

Of the 1,117 members who were surveyed, 198 responses (17.7%) were received. **Table 1** displays the respondent demographics. Among those participating in the survey, there was a varied distribution of experiences within gynecologic oncology with over half (n=108; 54.5%) of respondents reporting more than 10 years of clinical practice. There was a broad geographic representation from across the United States among the responding gynecologic oncologists. The majority were in academic practice (n=103; 52.0%) or a combination of academic, and private practice (n=53; 26.8%). Among the 198 respondents, 70.2% (n=139) reported use of SLNM mapping for either EC, CC, or both in their practice.

### 2. Trends in SLNM for EC

Of the 139 of gynecologic oncologists using SLNM in their practice, 97.2% (n=135) endorsed use for EC. **Table 2** displays the trends in usage in SLNM in EC. Robotic assisted laparoscopy was used as the most common surgical platform for SLNM in EC (n=109; 80.7%) and ICG was the most frequently used mapping dye (n=131; 97.0%).

The majority of respondents (n=94; 70.7%) utilized SLNM in over three-quarters of their surgical cases with 24.8% (n=33) using SLNM in all EC surgeries. When queried regarding usage of SLNM for EC, over half (56.3%; n=76) reported use for all patients regardless of histology without evidence of extra-uterine disease. Additionally, 43.0% (n=58) utilized SLNM for International Federation of Gynecology and Obstetrics (FIGO) 1 and 42.2%

**Table 1.** Demographic information for survey respondents

Variable	No. (%)
Duration of practice (yr)	
<3	31 (15.7)
3–5	25 (12.6)
>5–10	33 (16.7)
>10–15	24 (12.1)
>15–20	21 (10.6)
>20–25	29 (14.6)
>25	34 (17.2)
Sex	
Female	91 (46.0)
Male	104 (52.5)
Prefer to not answer	1 (0.5)
Practice setting	
Academic	103 (52.0)
Private	36 (18.2)
Academic/Private	53 (26.8)
Military	4 (2.0)
Retired	0
Location of practice	
Northeast US	50 (25.3)
Midwest US	44 (22.2)
South US	54 (27.3)
West US	38 (19.2)
Canada	3 (1.5)
Outside of US/Canada	7 (3.5)

US, United States.

(n=57) for FIGO2. Use of SLNM was less frequently reported for patients with FIGO3 (n=30; 22.2%), complex atypical hyperplasia (n=26; 19.3%), high-risk histologies including serous carcinoma, clear cell carcinoma, and carcinosarcoma (n=24; 17.8%).

Over half of respondents (n=85; 63%) reported concurrent use of SLNM and full systematic LND in EC staging when they first adopted the technique. The median number of reported concurrent cases was 25 (range, 2–250). Less than half of respondents (n=59; 43.7%) were aware of their individual mapping rate for SLNM. Median unilateral SLNM rate was 90% (range, 0%–100%) and median bilateral SLNM rate was 85% (range, 50%–100%).

Among those performing SLNM for EC perceived benefits included reduced surgical morbidity (n=121; 89.6%), decreased lymphedema (n=115; 85.2%), lower blood loss (n=55; 40.7%), and increased speed vs. full LND (n=86; 63.7%). Additional reported benefits included faster recovery (n=28; 20.7%), improved detection of small volume metastatic disease (n=8; 5.9%), and reduced lymphocyst or lymphocele formation (n=3; 2.2%).

### 3. Trends in SLNM for cervical cancer

Of the 139 of gynecologic oncologists using SLNM in their practice, 67.0% (n=93) reported use for CC. **Table 3** displays the trends in usage in SLNM in CC. Similar to EC, robotic assisted laparoscopy was used as the most common surgical platform for SLNM in CC (n=74; 80.0%) and ICG was the most frequently used mapping dye (n=86; 92.5%). The majority of respondents (n=57; 64.0%) utilized SLNM in over three-quarters of their surgical cases for CC. When queried regarding usage of SLNM for CC, the majority used the technology for stage IA2 (n=87; 93.5%) and stage IB1 (n=88; 95.0%) disease. Additionally, 50.5% (n=47) utilized SLNM for stage IA1 and 40.9% (n=38) for stage IB2 patients.

**Table 2.** Trends in usage in SLNM in endometrial cancer

Variable	No. (%)
<b>Reported usage of SLNM</b>	
Endometrial CA	46 (23.2)
Cervical CA	4 (2.0)
Endometrial and cervical CA	89 (44.9)
No	59 (29.8)
<b>Percentage of surgeon time using SLNM in endometrial CA (n=133)</b>	
1%–25%	9 (6.8)
26%–50%	7 (5.3)
51%–75%	23 (17.3)
76%–99%	61 (45.9)
100%	33 (24.8)
<b>Career total of number of SLNM cases for endometrial CA performed</b>	
Less than 10	13 (1.0)
10–50	41 (30.4)
51–100	32 (23.7)
101–200	27 (20.0)
201–500	15 (11.1)
Greater than 500	4 (3.0)
<b>Surgical platform using SLNM in endometrial CA</b>	
Robotic assisted laparoscopy	109 (80.7)
Multi-port laparoscopy	39 (28.9)
Single-site laparoscopy	3 (2.2)
Laparotomy	7 (5.2)
<b>Mapping medium used for SLNM in endometrial CA</b>	
Isosulfan blue	17 (12.6)
Indocyanine Green	131 (97.0)
Technectium-99	4 (3.0)
Other	1 (0.7)
<b>Proportion of usage of SLNM in endometrial CA histologies</b>	
All histologies without extra-uterine disease	76 (56.3)
CAH	26 (19.3)
FIGO1	58 (43.0)
FIGO2	57 (42.2)
FIGO3	30 (22.2)
High-risk histologies (USC, UCC, CS)	24 (17.8)
<b>Surgeon performing concurrent SLNM with full LND for endometrial CA</b>	
Yes	85 (63.0)
No	47 (34.8)
<b>Number of concurrent SLNM cases with full LND for endometrial CA</b>	25 (2–250)
<b>Surgeon awareness of SLNM rate for endometrial CA</b>	
Yes	59 (43.7)
No	73 (54.1)
<b>Unilateral SLNM rate for endometrial CA</b>	90 (0–100)
<b>Bilateral SLNM rate for endometrial CA</b>	85 (50–100)
<b>Perceived benefits of SLNM for endometrial CA</b>	
Reduced surgical morbidity	121 (89.6)
Faster than full lymphadenectomy	86 (63.7)
Reduced lymphedema	115 (85.2)
Faster recovery time	28 (20.7)
Reduced blood loss	55 (40.7)
Detection of small volume disease	8 (5.9)
Reduced lymphocele/lymphocyst	3 (2.2)
Other	5 (3.7)

The SLNM mapping rates and number of concurrent SLNM cases are reported as median +/- reported range. CA, cancer; CAH, complex atypical hyperplasia; CS, carcinosarcoma; FIGO, International Federation of Gynecology and Obstetrics; LND, lymphadenectomy; SLNM, sentinel lymph node mapping; UCC, clear cell carcinoma; USC, uterine serous carcinoma.

**Table 3.** Trends in usage in sentinel lymph node mapping in cervical cancer

Variable	No. (%)
Percentage of surgeon time using SLNM for cervical CA (n=89)	
1%–25%	13 (14.6)
26%–50%	8 (9.0)
51%–75%	11 (12.4)
76%–99%	20 (22.5)
100%	37 (41.6)
Career total of number of SLNM cases for cervical CA performed (n=91)	
Less than 10	32 (35.1)
10–50	47 (51.6)
51–100	6 (6.7)
101–200	4 (4.5)
201–500	2 (2.2)
Greater than 500	0 (0.0)
Surgical platform using SLNM in cervical CA	
Robotic assisted laparoscopy	74 (80.0)
Multi-port laparoscopy	25 (26.9)
Single-site laparoscopy	1 (1.1)
Laparotomy	4 (4.3)
Mapping medium used for SLNM in cervical CA	
Isosulfan blue	17 (18.3)
Indocyanine green	86 (92.5)
Technectium-99	7 (7.5)
Other	0 (0.0)
Proportion of usage of SLNM in cervical CA histologies	
Stage IA1	47 (50.5)
Stage IA2	87 (93.5)
Stage IB1	88 (95.0)
Stage IB2	38 (40.9)
Stage II	7 (7.5)
Stage III	2 (2.1)
Stage IV	1 (0.0)
Surgeon performing concurrent SLNM with full LND for cervical CA	
Yes	72 (77.4)
No	18 (19.4)
Number of concurrent SLNM cases with full LND for cervical CA	20 (5–400)
Surgeon awareness of SLNM rate for cervical CA	
Yes	25 (26.9)
No	65 (70.0)
SLNM rate for cervical CA	91.5 (70–100)
Perceived benefits of SLNM for cervical CA	
Reduced surgical morbidity	82 (88.2)
Faster than full lymphadenectomy	59 (63.4)
Reduced lymphedema	81 (87.1)
Faster recovery time	18 (19.4)
Reduced blood loss	38 (40.9)
Improved accuracy in finding node positive disease	9 (9.7)
Other	1 (1.1)

The SLNM mapping rates and number of concurrent SLNM cases are reported as median +/- reported range. CA, cancer; LND, lymphadenectomy; SLNM, sentinel lymph node mapping.

Over three-quarters of respondents (n=72; 77.4%) reported concurrent use of SLNM and full systematic LND in CC staging when they first adopted the technique with a median number of 20 cases (range, 5–400). Less than one-third of respondents (n=25; 26.9%) were aware of their individual mapping rate for SLNM in CC, specifically. The median reported SLNM rate was 91.5% (range, 70%–100%).

Among gynecologic oncologists utilizing SLNM for CC perceived benefits included reduced surgical morbidity (n=82; 88.2%), decreased lymphedema (n=81; 87.1%), lower blood loss (n=38; 40.9%), and increased speed vs. full LND (n=59; 63.4%). Additional reported benefits included faster recovery (n=18; 19.4%) and improved detection of small volume metastatic disease (n=9; 9.7%).

#### 4. Reasons for non-uptake of SLNM

Of the 198 gynecologic oncologists who responded to the survey, 30% (n=59) did not use SLNM in their practice in the management of both EC and CC. When non-use was stratified by type of malignancy, 31.8% (n=63) reported non-use of SLNM for EC and 53.0% (n=105) reported non-use of SLNM for CC. **Table 4** displays reported reasons for non-use of SLNM in EC and CC.

Reported reasons for non-use of SLNM for EC staging included uncertainty of data (n=26; 46.0%), lack of training (n=23; 36.5%), technology (n=22; 34.9%), issues with specimen processing for ultra-staging (n=11; 17.5%), and to aid with training of fellows in full LND (n=8; 12.7%). Concerns reported by non-users regarding SLNM included efficacy of mapping (n=20; 31.7%), implications of missing nodal positive disease (n=18; 28.6%), and uncertainty for how SLNM data will impact patient outcomes (n=20; 31.7%). Similarly for SLNM in CC, respondents reported uncertainty of data (n=62; 59.0%), lack of training (n=22; 21.0%), technology (n=19; 18.1%), and issues with specimen processing for ultra-staging (n=10; 9.5%) as reasons for non-uptake. Concerns reported by non-users regarding SLNM included efficacy of mapping (n=25; 23.8%), implications of missing nodal positive disease (n=34; 32.4%) and uncertainty for how SLNM data will impact patient outcomes (n=20; 19.0%).

**Table 4.** Reasons for non-usage of SLNM in endometrial and cervical CA

Reasons for non-usage	No. (%)
Endometrial CA (n=63)	
Uncertain of data supporting SLNM	29 (46.0)
Lack of training in fellowship	23 (36.5)
Concerns regarding efficacy of mapping	20 (31.7)
Concerns for how information will impact outcomes	20 (31.7)
Concerns for missing nodal positive disease	18 (28.6)
Lack of technology	22 (34.9)
Uncertainty for processing specimens for ultra-staging	11 (17.5)
Aid in training of fellows in full lymphadenectomy	8 (12.7)
Not fond of current technology	3 (4.8)
Other	10 (15.9)
Cervical CA (n=105)	
Uncertain of data supporting SLNM	62 (59.0)
Lack of training in fellowship	22 (21.0)
Concerns regarding efficacy of mapping	25 (23.8)
Concerns for how information will impact outcomes	20 (19.0)
Concerns for missing nodal positive disease	34 (32.4)
Lack of technology	19 (18.1)
Uncertainty for processing specimens for ultra-staging	10 (9.5)
Aid in training of fellows in full lymphadenectomy	8 (7.6)
Not fond of current technology	3 (2.9)
Too infrequently seen	8 (7.6)
Other	8 (7.6)

CA, cancer; SLNM, sentinel lymph node mapping.

## 5. Provider attitudes toward SLNM

Provider Attitudes and Practices toward SLNM are displayed in **Table 5**. For EC, 45.5% (n=90) of respondents reported that data supported the use of SLNM in all EC cases regardless of histology, while 75.8% (n=150) felt that SLNM was supported in low-risk histologies (FIGO1/2) only. While the majority of respondents (n=154; 77.2%) agreed that micro-metastatic disease (0.2–2.0 cm) should be treated as node positive, only 21.3% (n=42) agreed for ITCs. When queried regarding practice patterns after positive lymph nodes were identified after SLNM, the majority reported proceeding direct to adjuvant treatment (n=108; 54.5%) or performing additional imaging to evaluate for additional metastatic disease (n=70; 35.4%).

When queried regarding SLNM in CC, approximately one-third of respondents both independently agreed (n=68; 34.4%) and disagreed (n=55; 27.8%) that data supported use.

Similar to EC, the majority of respondents (n=141; 71.2%) agreed that micro-metastatic disease (0.2–2.0 cm) should be treated as node positive, only 34.3% (n=68) agreed for ITCs. While the majority of gynecologic oncologists disagreed that improved technologies would increase

**Table 5.** Provider attitudes and practice patterns for use of SLNM in gynecologic oncology

Provider attitudes	No. (%)
Data supports use of sentinel lymph node evaluation in all endometrial cancer staging routinely regardless of histology	
Strongly agree	21 (10.7)
Agree	69 (34.8)
Neutral/uncertain	44 (22.2)
Disagree	51 (25.8)
Strongly disagree	12 (6.1)
Data supports use of sentinel lymph node evaluation in all cervical cancer staging	
Strongly agree	19 (9.6)
Agree	49 (24.7)
Neutral/uncertain	74 (37.4)
Disagree	43 (21.7)
Strongly disagree	12 (6.1)
Data supports use of sentinel lymph node evaluation in endometrial cancer staging in low risk histology endometrial cancer (FIGO1/2)	
Strongly agree	76 (38.4)
Agree	74 (37.4)
Neutral/uncertain	32 (16.2)
Disagree	9 (4.5)
Strongly disagree	5 (2.5)
Improved technologies are needed before I would consider incorporating sentinel lymph node evaluation into my practice	
Strongly agree	7 (3.5)
Agree	20 (10.1)
Neutral/uncertain	33 (16.7)
Disagree	70 (35.4)
Strongly disagree	67 (33.8)
Sentinel lymph node evaluation will impact fellows training and skill in performing full systemic lymphadenectomy	
Strongly agree	41 (20.7)
Agree	105 (53.0)
Neutral/uncertain	20 (10.1)
Disagree	29 (14.6)
Strongly disagree	2 (1.0)
Patients with micro-metastatic disease (0.2–2.0mm) appreciated on sentinel lymph node evaluation for endometrial cancer should be assigned a stage as if they had node positive disease	
Strongly Agree	27 (13.6)
Agree	120 (60.6)
Neutral/Uncertain	45 (22.7)
Disagree	5 (2.5)
Strongly Disagree	0

(continued to the next page)

**Table 5.** (Continued) Provider attitudes and practice patterns for use of SLNM in gynecologic oncology

Provider attitudes	No. (%)
Patients with micro-metastatic disease (0.2–2.0mm) appreciated on sentinel lymph node evaluation for endometrial cancer should be treated as if they had node positive disease	
Strongly agree	27 (13.6)
Agree	126 (63.6)
Neutral/uncertain	38 (19.2)
Disagree	5 (2.5)
Strongly disagree	0
Patients with ITCs appreciated on sentinel lymph node evaluation for endometrial cancer should be assigned a stage as if they had node positive disease	
Strongly agree	8 (4.0)
Agree	41 (20.7)
Neutral/uncertain	82 (41.4)
Disagree	59 (29.8)
Strongly disagree	6 (3.0)
Patients with ITCs appreciated on sentinel lymph node evaluation for endometrial cancer should be treated as if they had node positive disease	
Strongly agree	6 (3.0)
Agree	36 (18.2)
Neutral/uncertain	91 (46.0)
Disagree	56 (28.3)
Strongly disagree	7 (3.5)
Patients with micro-metastatic disease (0.2–2.0mm) appreciated on sentinel lymph node evaluation for cervical cancer should be treated as if they had node positive disease	
Strongly agree	33 (16.7)
Agree	108 (54.5)
Neutral/uncertain	47 (23.7)
Disagree	9 (4.5)
Strongly disagree	0
Patients with ITCs appreciated on sentinel lymph node evaluation for cervical cancer should be treated as if they had node positive disease	
Strongly agree	12 (6.1)
Agree	56 (28.3)
Neutral/uncertain	95 (48.0)
Disagree	32 (16.2)
Strongly disagree	1 (0.5)
In patients with a positive sentinel lymph node (macro-metastatic disease) in endometrial cancer does your practice involve?	
Proceeding to adjuvant treatment based on sentinel lymph node data	108 (54.5)
Returning to OR for completion lymphadenectomy in all cases	4 (2.0)
Returning to OR for completion lymphadenectomy in high risk disease (FIGO3, UCC, USC, CS)	5 (2.5)
Further imaging (PET, CT) to evaluate for additional metastatic disease	70 (35.4)
In patients with a positive sentinel lymph node (macro-metastatic disease) in cervical cancer does your practice involve?	
Proceeding to adjuvant treatment based on sentinel lymph node data	75 (37.9)
Returning to OR for completion lymphadenectomy in all cases	3 (1.5)
Returning to OR for completion lymphadenectomy in high risk disease (FIGO3, UCC, USC, CS)	2 (1.0)
Further imaging (PET, CT) to evaluate for additional metastatic disease	37 (18.7)
Has the decision to proceed with SLNM changed any component of your pre-operative work-up (imaging, labs, etc)?	
Yes	14 (10.7)
No	122 (87.8)

CS, carcinosarcoma; CT, computed tomography; FIGO, International Federation of Gynecology and Obstetrics; ITC, isolated tumor cell; PET, positron emission tomography; SLNM, sentinel lymph node mapping; UCC, clear cell carcinoma; USC, uterine serous carcinoma.

their likelihood of uptake of the practice (n=137; 69.1%), the majority agreed that SLNM would impact fellows training and skill level in performing full LND for EC (n=146; 73.7%).

## 6. Provider factors associated with usage of SLNM

**Table 6** displays results of univariate analysis for provider factors associated with usage of SLNM in EC and CC. There were no significant differences in the utilization of SLNM based upon gender (p=0.29), duration of practice as a gynecologic oncologist (p=0.13), practice

**Table 6.** Provider factors associated with usage and non-uptake of SLNM for endometrial and cervical cancer

Variable	Providers reporting usage of SLNM	Providers reporting non-usage of SLNM	p-value
Gender			0.29
Women	62 (45.6)	29 (49.2)	
Men	74 (54.4)	30 (50.8)	
Prefer to not answer	0 (0.0)	0 (0.0)	
Practice setting			0.99
Academic	72 (52.6)	31 (52.5)	
Private	25 (18.2)	11 (18.6)	
Academic/private	37 (27.0)	16 (27.1)	
Military	3 (2.2)	1 (1.7)	
Retired	0 (0.0)	0 (0.0)	
Location of practice			0.59
Northeast US	34 (25.0)	16 (27.1)	
Midwest US	33 (24.3)	11 (18.6)	
South US	35 (25.7)	19 (32.2)	
West US	25 (18.4)	13 (22.0)	
Canada	3 (2.2)	0 (0.0)	
Outside of US/Canada	6 (4.4)	0 (0.0)	
Training			<0.001
Endometrial CA	20 (14.8)	4 (6.8)	
Cervical CA	1 (0.7)	1 (1.7)	
Endometrial and cervical CA	94 (69.6)	7 (11.9)	
No	20 (14.8)	47 (79.7)	
Duration of practice (yr)			0.13
<3	22 (16.1)	9 (15.0)	
3–5	22 (16.1)	3 (5.0)	
5–10	18 (13.1)	15 (25.0)	
10–15	17 (12.4)	7 (11.7)	
15–20	17 (12.4)	4 (6.7)	
20–25	18 (13.1)	11 (18.3)	
>25	23 (16.8)	11 (18.3)	

Values are presented as median (interquartile range).

CA, cancer; SLNM, sentinel lymph node mapping; US, United States.

setting ( $p=0.99$ ), or location of practice ( $p=0.59$ ). Among providers not using SLNM, the vast majority had not been trained to do so ( $n=47$ ; 79.7%) compared to those performing SLNM routinely ( $n=20$ ; 14.8%) ( $p<0.001$ ).

## 7. Current training practices in SLNM

Of the 127 respondents (64.1%) who had been trained in SLNM, the majority ( $n=85$ ; 66.9%) were trained to perform the procedure as attending physicians. Among those not using SLNM in their practice, 76.7% reported that they would be interested in further training through surgical videos, case proctoring and observation. Among those trained in fellowship, 83.3% ( $n=35$ ) felt prepared to independently perform SLNM at the end of fellowship.

## DISCUSSION

The SLNM is a targeted approach to MIS staging for EC and CC. This study was designed to identify usage patterns in SLNM and determine reasons for non-adoption. While SLNM for EC and CC is being utilized at many institutions and has received endorsement by NCCN and SGO, SLNM accounted for only 10% of lymphadenectomies for EC in 2015 [12,17-19]. Our results demonstrate that SLNM is more prevalent than previously reported with over two-thirds of responding gynecologic oncologists performing SLNM. Among the one-third

reporting non-use of SLNM, the most common reasons were uncertainty of the data, concern for missing positive nodes, and efficacy of mapping. These reservations are interesting given that several studies have identified high accuracy and net present value (NPV) of SLNM and increased detection of nodal metastasis with ultra-staging [8-11,14-17,21].

A dichotomy identified in this study is provider attitudes towards utilization of SLNM in low vs. high-risk EC. Patients with high-risk EC may have the most to gain from SLNM due to their increased risk for lymph node metastasis leading to adjuvant treatment which can increase morbidity. Emerging data supports SLNM in high-risk EC [10,22-24]. In a prospective study of patients with high grade EC, SLNM alone detected 95% of positive lymph nodes with a NPV of 1.4% [10]. At present, SGO supports the NCCN SLN algorithm for low grade (FIGO1/2) EC and comments that SLNM is feasible in high-risk patients with consideration for concurrent full LND until more data is available [18]. Further studies are needed focusing on disease free and OS for patients with high-risk EC undergoing SLNM.

Inherent to SLNM is the pathological ultra-staging of sentinel nodes leading to the detection of micrometastasis (MM) and ITCs, but the significance of low-volume metastases in CC and EC is unclear. In this study, the majority of respondents agreed that MM should be treated as node positive, but less than one-third felt that ITCs should be treated as node positive. Similarly, in a study by St Clair et al. [25], the recurrence-free survival at 36 months was comparable for ITCs and MM (86%) but significantly decreased in patients with macrometastasis (71%). Additional research is needed to understand the prognostic impact of ITCs and MM after SLNM and whether low-volume metastasis should guide adjuvant treatment.

Training in LND is required for gynecologic oncology fellows [26]. Our study validated concerns that SLNM may impact training, with over 70% reporting this concern. Fellows should be trained to perform the necessary surgical techniques, which may include both full LND and SLNM via MIS. Interestingly, among gynecologic oncologists not using SLNM, the majority expressed interest in additional training. Providing both trainees and attending gynecologic oncologists with opportunities for training in SLNM and full LND should be prioritized.

An individual surgeon's learning curve and awareness of mapping rates is critical to high accuracy and low false negative rates in SLNM. Studies in SLNM for vulvar cancer have demonstrated the importance of experience, high-volume and surgeon self-awareness to ensure acceptable NPVs [27,28]. In our study, less than 50% of those performing SLNM for EC and CC reported an awareness of their mapping rates and the majority of providers performing SLNM were not or had not performed concurrent validation with full LND. While the literature reports a low false negative rate for SLNM, it is important to note that these studies are often conducted by high-volume surgeons and may not be generalizable to all. The SGO recommends that completion LND be performed, in addition to SLNM, until the individual surgeon's experience is comparable with currently published literature [18]. Surgeon awareness of mapping rates and performing concurrent SLNM with full LND is important to ensure acceptable false negative rates.

The survey response rate of 17.7% is a major limitation of the study and in the interpretation of findings. The decision to survey the entire SGO cohort, including both full and candidate members, was deliberate to reflect contemporary practice patterns and attitudes for SLNM while acknowledging that engagement of a large multi-disciplinary group may be lower.

However, the respondents are well-balanced for time in practice, geographic region and practice setting which makes our findings applicable to the majority of practitioners. Despite there being no significant association between number of cases performed and trends, it is possible that survey findings may be more representative of early-adopters of SLNM compared to the entire cohort of SGO members. While this may lead to response bias in the interpretation of the results, perspectives of early-adopters may herald trends and practice patterns that are important with utilization of this technology going forward. Additionally, because of the survey design of the study, recall bias may exist in question responses. Despite these important limitations, this study identifies important trends in SLNM and highlights pertinent areas where future study is necessary.

In conclusion, SLNM is utilized frequently among gynecologic oncologists for EC and CC staging. Common reasons for non-uptake include uncertainty of current data, lack of training and technology. The majority of those not using SLNM would like additional training. Future studies should focus on disease-free and survival outcomes in high-risk EC patients undergoing SLNM vs. full LND and understanding how low-volume metastasis impact treatment, recurrence and survival.

## SUPPLEMENTARY MATERIAL

### Supplementary Data 1

Sentinel LND in endometrial and cervical cancer: a survey of practices and attitudes among gynecologic oncologists, survey copy.

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