

# Pulmonary Metastasectomy

## A Survey of Current Practice Amongst Members of the European Society of Thoracic Surgeons

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**Objective:** Currently, no randomized trials exist to guide thoracic surgeons in the field of pulmonary metastasectomy. This study investigates the current clinical practice among European Society of Thoracic Surgeon (ESTS) members.

**Methods:** A Web-based questionnaire was created exploring the clinical approach to lung metastasectomy. All ESTS members were surveyed.

**Results:** One hundred forty-six complete responses were received from the 494 consultant ESTS members surveyed (29.6%). For most respondents (68%), lung metastasectomy represents a minor proportion (0–10%) of their clinical volume. Approximately 90% of respondents always/usually review their lung metastasectomy cases within a multidisciplinary meeting. Helical computed tomography is most commonly used (74%) for the detection of metastases, while positron emission tomography is used additionally in less than 50%. Most of respondents (92% and 74%, respectively) consider unresectable primary tumor and predicted incomplete metastasectomy as absolute contraindications to lung metastasectomy. The most frequently performed resection is wedge excision (92%). Palpation of the lung is considered necessary by 65%, while 40% use a thoracoscopic approach with therapeutic intent. Though 65% consider pathologically positive nodes a contraindication to metastasectomy, a similar number rarely/never perform mediastinoscopy before metastasectomy. At the time of metastasectomy 55% perform mediastinal lymph node sampling whereas 33% perform no nodal dissection whatsoever.

**Conclusions:** The survey provides a large, time-sensitive database summarizing the clinical practice of pulmonary metastasectomy by

members of the ESTS. Responses demonstrate a remarkable consistency of practice patterns, though certain areas of potential controversy showed greater variance. Conceivably, these divergent approaches will encourage future collaborative studies aimed at identifying evidence-based practices for patients with pulmonary metastases.

**Key Words:** Lung metastases, Metastasectomy, Survey.

(*J Thorac Oncol.* 2008;3: 1257–1266)

Surgical resection is widely employed as a conventional treatment option for patients with lung metastases originating from a wide range of primary tumors. There is to date, however, no higher level of evidence than case series and metastasectomy registries to support the many aspects of this form of treatment.<sup>1</sup> From the fundamentals of basic patient selection, to the chosen surgical approach, there is no prevailing evidence that guides practice. The heterogeneity in the biologic behavior of the many primary tumors adds to the difficulty in drawing conclusions from mixed series. The very essence of the practice, that is a belief that pulmonary metastasectomy can prolong survival, has been questioned.<sup>1–3</sup> With such a paucity of evidence in support of clear practice guidelines, and the potential for significant practice variation, the European Society of Thoracic Surgeons (ESTS) Pulmonary Metastasectomy Working Group (PMWG) decided to survey ESTS members in an effort to define the current practice of pulmonary metastasectomy.

### MATERIALS AND METHODS

A Web-based questionnaire was designed by a subgroup of the PMWG and all ESTS members were invited to respond from November 2006 through January 2007 using a commercially available, online survey designer ([www.surveymonkey.com](http://www.surveymonkey.com)). During this 3-month period three reminders were sent to the ESTS members to boost responses. The questionnaire consisted of 39 questions, subdivided in 7 sections, exploring the various aspects of lung metastasectomy: indications and contraindications, role of chemotherapy, preoperative diagnosis, role of mediastinal node assessment, extent of resection, surgical

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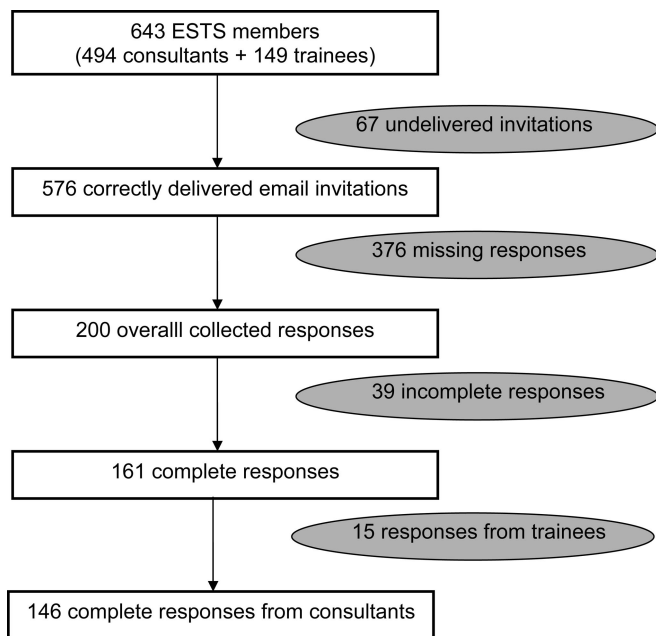
Disclosure: The authors declare no conflicts of interest.

<sup>a</sup>For listing of membership see acknowledgments section.

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ISSN: 1556-0864/08/0311-1257



**FIGURE 1.** Calculation of the response rate of the survey.

approach (open versus thoracoscopic, sequential bilateral procedures versus median sternotomy, etc.) and technique (anatomic versus nonanatomic resection, stapled wedge resection versus laser enucleation, etc.), the role of palpation of the lungs, and follow-up strategies (Appendix).

Demographic data from the responders were collected (type of practice, age, years in practice, unit size, country of practice).

The questionnaire was pretested on the members of the PMWG ( $n = 24$ ) to identify errors in question formulation and clarity. No major change was required prior to release of the questionnaire to the membership at-large.

Only completely answered questionnaires by full-members of the ESTS (consultants) were considered for analysis (i.e., trainee responses were not included in this analysis).

Data are presented in both numbers and percentages. Percentages are rounded to one decimal place.

## RESULTS

### Response

At the time the survey was administered, the ESTS had 494 full-members and 149 trainees. E-mail delivery of the survey was successful in 576 cases. By the closure of the survey, 200 responses had been collected. Of these, 39 were incomplete and were excluded from further analysis. Among the remaining 161, 15 were from trainees, thus also eliminated. One hundred forty-six completed questionnaires by consultant ESTS members are the object of the analysis of this study (Figure 1). These completed surveys reflect the practice of 29.6% of the ESTS full-members from 29 countries (Table 1). The responses of the members of the Working Group are included in the 146 completed surveys analyzed for this study.

**TABLE 1.** Geographic Distribution of the Responses

Country	No. of Responses	(%)
Italy	23	(15.8)
Germany	14	(10.0)
Spain	11	(7.5)
The Netherlands	10	(6.8)
Greece	9	(6.2)
United Kingdom	9	(6.2)
Switzerland	7	(4.8)
Turkey	7	(4.8)
Austria	6	(4.1)
Belgium	5	(3.4)
France	5	(3.4)
Poland	5	(3.4)
USA	5	(3.4)
Denmark	4	(2.7)
Romania	4	(2.7)
Serbia	3	(2.1)
Croatia	2	(1.4)
Hungary	2	(1.4)
Portugal	2	(1.4)
Canada	1	0.7
Cyprus	1	0.7
Czech Republic	1	0.7
Estonia	1	0.7
India	1	0.7
Israel	1	0.7
Luxembourg	1	0.7
Saudi Arabia	1	0.7
Slovenia	1	0.7
Sweden	1	0.7
Total responders	143	97.9
Unknown country (skipped question)	3	2.1

### Responders

The mean age of the responders was 46.6 years (range, 33–67). Eighty-eight (60.3%) of the responders work in a unit of more than 20 beds. Eighty-two (56.2%) work in academic hospitals, 60 (41.1%) in public hospitals, and 4 (2.7%) in private hospitals.

All the responders perform lung metastasectomy in their clinical practice. The number of lung metastasectomy cases per year varies widely (median 17, range 2–150), but for most of the surveyed surgeons, metastasectomy represents a minor proportion of their clinical volume: 0 to 10% for 68.8% (99/144) and 10 to 25% for 28.5% (41/144). This datum does not seem to differ according to age of the surgeon, thoracic unit size or academic/public practice.

### Preoperative Work Up

Among reported ESTS thoracic surgeons 52.1% declared that they review all candidates for pulmonary metastasectomy cases in a multidisciplinary meeting. Another 39% did so usually while 2.7% never discuss such cases within a multidisciplinary team. Reported rates were similar for academic and public hospital practices.

**TABLE 2.** Indications According to the Histology of the Primary Tumor

	Yes	No	Response Count
“For which kind of primary tumors do you perform lung metastasectomy?”			
Colon cancer	99.3% (141)	0.7% (1)	142
Kidney cancer	98.6% (137)	1.4% (2)	139
Soft tissue sarcomas	95.6% (131)	4.4% (6)	137
Osteosarcomas	92% (127)	8% (11)	138
Germ cell tumors	89.4% (110)	10.6% (13)	123
Breast cancer	84.3% (107)	15.7% (20)	127
Melanoma	84% (105)	16% (20)	125
Head and neck tumors	83.1% (98)	16.9% (20)	118
Endometrial cancer	70.6% (77)	29.4% (32)	109
Lung cancer	69.4% (86)	30.6% (38)	124
Cervix cancer	66.1% (72)	33.9% (37)	109
Ovarian cancer	57.9% (62)	42.1% (45)	107

All the responding surgeons use computed tomography (CT) scan (49% conventional CT, 51% helical CT scan) as the main imaging modality to diagnose and plan for pulmonary metastasectomy. The choice between standard or helical CT scan is likely to be dictated by local availability rather than by personal preference. The use of positron emission tomography (PET) in the preoperative assessment of lung metastasectomy is less common: 44.5% always/usually use it, 29.5% sometimes, 26% rarely/never.

Serum tumor markers, depending on the histology of the primary tumor, are measured systematically by 33.6% of the responders, another 30.8% usually check them.

### Primary Tumor Histology

In most cases, the primary tumor cell type was not stated to be a limitation/contraindication to lung metastasectomy by those responding (Table 2). This remained true for cancers known to have a poor prognosis such as melanoma. The lowest rates were for gynaecological cancers but still about two thirds of surgeons reported resecting these. Pulmonary metastasectomy for a lung cancer primary was reported to be performed by 69% of the responders.

### Indications/Contraindications

Multiple pulmonary metastases, bilateral or recurrent pulmonary metastases are not considered per se contraindications to resection by 84.9%, 82.2%, and 74.7% of the responders respectively. Synchronous lung metastases, meaning those found at the time of diagnosis of the primary tumor (disease free interval = 0) are not a contraindication for 50% of responders, and a relative contraindication for 47% (Table 3).

The number of metastases as a selection criterion was investigated. For 85.6% of the surveyed surgeons there is no maximum number of metastases that can be considered for removal, with any number being acceptable provided that complete resection is considered achievable. On the contrary, the surveyed cohort is divided as to the maximum number of repeat metastasectomies: 52.7% declare having no limit as

**TABLE 3.** Perceived Contraindications to Lung Metastasectomy

	Absolute Contraindication	Relative Contraindication	Not a Contraindication
“Do you consider any of the following as contraindications to pulmonary metastasectomy?”			
Multiple ( $\geq 1$ ) metastases	0 (0%)	22 (15%)	124 (85%)
Bilateral pulmonary metastases	2 (1%)	24 (16%)	120 (82%)
Previous pulmonary metastases	1 (1%)	36 (25%)	109 (75%)
Synchronous pulmonary metastases (found at the time of diagnosis of primary malignancy)	4 (3%)	69 (47%)	73 (50%)
Disease free interval shorter than 12 mo	2 (1%)	51 (35%)	93 (64%)
Concurrent metastases in a nonpulmonary site	49 (34%)	84 (58%)	13 (9%)
Poor performance status (Karnofsky score $< 50\%$ )	56 (38%)	87 (60%)	3 (2%)
Poor lung function (FEV1 or DLCO $< 40\%$ of predicted)	37 (25%)	100 (68%)	9 (6%)
Clinically positive mediastinal lymphadenopathy	25 (17%)	93 (64%)	28 (19%)
Pathologically positive (mediastinoscopy) mediastinal lymphadenopathy	94 (64%)	46 (32%)	6 (4%)
Unresectable primary malignancy	134 (92%)	10 (7%)	2 (1%)
Metastasis/metastases requiring pneumonectomy for complete resection	34 (23%)	93 (64%)	19 (13%)
Age $> 70$	1 (1%)	56 (38%)	89 (61%)
Age $> 80$	27 (18%)	77 (53%)	42 (29%)
BMI $> 35$ kg/m <sup>2</sup>	2 (1%)	90 (62%)	31 (21%)
BMI $< 15$ kg/m <sup>2</sup>	25 (17%)	90 (62%)	31 (21%)
Complete resection of pulmonary metastasis/metastases is not possible as evidenced on preoperative investigations	108 (74%)	35 (24%)	3 (2%)

BMI, body mass index; DLCO, diffusing capacity of the lung for carbon monoxide.

**TABLE 4.** Surgical Approach

	<i>n</i>	(%)
“Which is your preferred approach for clinical unilateral disease?”		
Anterolateral thoracotomy	53	(36.3)
Thoracoscopy (VATS)	42	(28.8)
Posterior muscle sparing thoracotomy	38	(26)
Posterolateral thoracotomy	33	(22.6)
Horizontal axillary thoracotomy	15	(10.3)
Vertical axillary thoracotomy	10	(6.9)
Sternotomy	2	(1.4)
Other	7	(4.8)
“Which is your preferred approach for clinical bilateral disease?”		
Bilateral staged thoracotomy	96	(66.2)
Sternotomy (one stage)	39	(26.9)
Bilateral sequential thoracotomy (one stage)	28	(19.3)
Bilateral staged thoracoscopy	18	(12.4)
Bilateral thoracoscopic (one stage)	11	(7.6)
Clamshell (one stage)	11	(7.6)
Other	3	(2.1)

VATS, video-assisted thoracoscopic surgery.

long as complete resection is possible, whereas the remaining 47.3% mostly set a limit to redo resections between 2 and 5.

Completeness of resection represents an absolute contraindication to metastasectomy for 74% of the responders and a relative contraindication for 24%.

### Surgical Approach

Palpation of the lung is deemed mandatory by 65.1% of the responding surgeons, whereas 34.9% consider it not always necessary. The surveyed cohort is similarly segregated with regard to the use of the video-assisted thoracoscopic surgery/thoracoscopic (without complete palpation) approach: 60.3% consider it a valuable option only with diagnostic intent, while 39.7% recommend it also with the aim at obtaining complete resection in selected cases. Among the supporters of the open approach, different types of thoracotomy are used for resection clinically unilateral disease; sternotomy is not popular (Table 4). In the case of bilateral disease, bilateral staged thoracotomy is the favored approach (66.2%), followed by sternotomy (26.9%) and bilateral sequential (one stage) thoracotomy (19.3%); bilateral thoracoscopy (either staged or sequential) is performed by 20%. Notably, for the 83.6% of the surveyed thoracic surgeons, the surgical approach is not always the same, but tailored for each case according to: performance status and lung function (84%), age of the patient (56%), type of primary tumor (41%), location (98%), and number (88%) of metastases.

In the case of staged operations for bilateral disease, 3 to 4 weeks is the time interval advocated by ¾ of the surveyed surgeons (with a range of 2 days to 6 weeks).

### Extent of Resection and Surgical Technique

Wedge resection is definitely the most common way to resect metastases (89% of respondents). Precision excision is advocated by 17.8%, while anatomic segmentectomy (4.8%) and lobectomy (2.1%) are preferred by a relative few. The

**TABLE 5.** Preoperative and Intraoperative Mediastinal Nodes Assessment

	<i>n</i>	(%)
“Do you perform cervical mediastinoscopy with lymph node biopsy prior to metastasectomy?”		
Always	2	(1.4)
Usually	3	(2.1)
Sometimes	42	(28.8)
Rarely	64	(43.8)
Never	35	(24)
“At the time of pulmonary metastasectomy, which of the following do you routinely perform?”		
Mediastinal lymph nodal sampling	81	(55.5)
No lymph nodal sampling/dissection	47	(32.2)
Complete mediastinal lymphadenectomy	19	(13)
Prethoracotomy cervical mediastinoscopy	6	(4.1)
Prethoracotomy TEMLA	2	(1.4)

TEMLA: Transcervical Extended Mediastinal Lymphadenectomy.

need for pneumonectomy to achieve complete resection is considered a relative contraindication for 2 of 3 of the respondents, and an absolute contraindication for a further 23%. The resection is carried out by means of a surgical stapler (82.2%), electrocautery (32.2%), direct suture (24.7%), laser (12.3%). Other instruments (harmonic scalpel, Ligasure, etc) are rarely used.

### Lymph Node Assessment and Dissection

The presence of clinically positive lymphadenopathy is believed to be a relative contraindication to pulmonary metastasectomy by 64% (Table 3), while biopsy proven or pathologically positive mediastinal nodes constitute an absolute (64%) or relative (32%) contraindication for most of the observed population. Nevertheless, a systematic assessment of mediastinal nodes prior to lung metastasectomy is apparently an uncommon practice (Table 5): most of the responders rarely (43.8%) or never (24%) perform mediastinoscopy, while another 28.8% state this is done only “sometimes,” and usually because of increased suspicion raised by preoperative imaging tests. Only 3.4% of responders consistently verify mediastinal lymph nodes by mediastinoscopy (2% usually, 1.4% always) before selecting a patient for surgical resection. At the time of pulmonary metastasectomy, roughly half (55.5%) of the responding surgeons perform mediastinal lymph nodal sampling, while 13% perform a complete mediastinal lymphadenectomy. One surgeon out of 3 (32.2%) performs no lymph node biopsy whatsoever.

### Follow-Up

Just over half of the responding surgeons always (22.6%) or usually (29.5%) personally carry out the follow-up of their metastasectomy patients, with the rest of cohort referring the patients to an oncologist for continued follow-up. Those surgeons who do follow-up their patients generally use either helical or conventional CT scan (100% of the 110 who answered this question), PET scan (40/110, 36.4%) and tumor markers (75/110, 68.2%). The most pop-

ular time interval between follow-up CT imaging is between 6 and 12 months.

## DISCUSSION

Lung metastasectomy is widely performed in the treatment of a variety of primary solid tumors. All surgeons responding to this survey perform pulmonary metastasectomies, though, in most cases, it accounts for a minor part of their surgical volume. A certain bias is inherent in this aspect of the study as those who do not perform pulmonary metastasectomy may be much less likely to participate in such a survey.

It is likely that this survey is biased towards those with a greater commitment to performing metastasectomy.

The largest series to date regarding the role of pulmonary metastasectomy is provided by the report from the International Registry of Lung Metastases (IRLM).<sup>4</sup> It should be noted that drawing inferences about the cause and effect of treatment from case series has a number of statistical pitfalls.<sup>5</sup> Nevertheless in so far as the series allows us to identify which patients among those operated have longer and shorter survival time, the evidence from the register is reliable and consistent with smaller series. The IRLM defined four major prognostic indicators for long-term survival of patients following lung metastasectomy: completeness of resection, disease free interval, number of metastases, and primary tumor histology. It is accepted that implementation of selection on the basis of these criteria would lead to biases in the long term results of surgical resection because of selecting biologically favorable tumors.<sup>3</sup> Papers reporting the predictive power of these factors often stress that the metastasectomy seems to be effective in selected cases and advocate that these factors should be the basis of selection. Contrary to this advice we note that half of the responders will operate when there is no “disease free interval,” 85% operated on multiple metastases and most do not exclude patients on the basis of the histologic type.

Other numerous and varied issues that could not be adequately addressed by the IRLM in 1997 and would require prospective trials (such as reliability of imaging tools, open versus thoracoscopic approach, need for bilateral exploration in cases of clinically unilateral disease) remain areas of clinical controversy as evidenced by the lack of consensus in practice among the surveyed surgeons<sup>6,7</sup> 10 years following this report.

There is a clear perception among the surveyed surgeons that there is merit in discussing the metastasectomy cases within multidisciplinary meetings. One of the arguments to pursue the surgical treatment of lung metastases is the lack of better systemic alternative. As advances in systemic treatment progress, the selection criteria for surgical resection of metastases change as well, as has happened in the last decades for lung metastases from breast cancer or germ cell tumors. Moreover, chemotherapy can be considered as a “time window” to test the biologic aggressiveness of the tumor in doubtful cases. When widespread progression of metastases occurs during chemotherapy, it is generally accepted that the disease will progress regardless of surgery. This is clearly perceived by the surgeons surveyed in this study but the

observation cannot distinguish between benefit totally attributable to chemotherapy and an added effect of surgery.

As far as the preoperative assessment is concerned, imaging plays a major role. Our study population relies predominantly on CT scanning (either conventional or helical, depending on local availability), which remains the standard procedure investigation for evaluating pulmonary metastases. The use of PET is not as common (less than 50% of the responders use it). It may simply be less available to some surgeons. It may improve preoperative staging by detecting extrapulmonary disease, but because of its insensitivity for nodules below about a centimeter in size, it currently does not add to CT scan in regard to the definition of number and location of lung nodules.

Bearing in mind the widely accepted importance of the completeness of resection, an argument for palpation of the lung in all cases of metastasectomy has been put forward. The lack of consensus on this point among our surveyed cohort of surgeons is in line with the failure of a recent systematic review<sup>6</sup> to define the role of palpation. A similar dilemma remains regarding the need for bilateral exploration and palpation of both lungs in case of clinical unilateral disease.<sup>7</sup> These issues, although explored in retrospective series, have not been proven in a prospective study and still present controversy for thoracic surgeons. There was an attempt to run a trial of the effectiveness of CT scan and video-assisted thoracoscopic surgery but in 10 of 18 cases additional malignant lesions were found at thoracotomy and the study was abandoned.<sup>8</sup> Two-thirds of our surveyed population believe palpation of the lung is necessary when performing lung metastasectomy with curative intent, but 1 of 3 of those surveyed are willing to forego this for the most part by using thoracoscopy in some circumstances. Nevertheless, the percentage of surgeons who perform a bilateral exploration (either by sternotomy or bilateral thoracotomy) is quite low (Table 4). The precise incidence and clinical relevance of lymph node involvement in patients with lung metastases has not yet been completely elucidated. The incidence of lymph node involvement reported in the literature varies from about 14.5%<sup>9,10</sup> to 28.6%.<sup>11,12</sup> As would be expected these observed ranges vary by the cell-type of the primary tumor, the variation in preoperative work-up and lymph node assessment (sampling versus complete dissection).

This study has some limitations that must be discussed. Though, of course, it should be noted that the opinion of the ESTS members responding to the questionnaire may not necessarily reflect all the ESTS members, the response rate of 29.5% is significant enough to avoid a “nonresponse error.” It should be considered also that only those who do perform metastasectomy answered the questionnaire. We therefore do not have data on how many ESTS Members, if any, do not perform pulmonary metastasectomy or the reasons for such a choice.

Another limitation innate in a survey is that it is not possible to check in detail all the different aspects of lung metastasectomy by means of a questionnaire made of closed-ended questions and meant to be easy, direct and not time-

consuming for the responder. Nevertheless, it was possible to sketch some general patterns of the actual clinical practice.

Survey studies rely on “self-report” data, they depend on how true and accurate the respondents are, so biases due to the respondents trying to conform consciously or unconsciously to the expectations of those who are studying them must be kept in mind.

The ESTS Lung Metastasectomy Working Group realizes that this survey merely provides a time-sensitive perspective of the patterns of practice in pulmonary metastasectomy. It is, however, the largest such comprehensive examination of clinical practice in this field of surgery to date. Clearly, the emergence of new technologies, be they in imaging or surgical instrumentation, will cause practices to evolve.

It should be underlined that the findings of this survey do not serve as a series of recommendations in the field of pulmonary metastasectomy but rather a snapshot of current practice of surgical treatment of lung metastases. The results of the survey do emphasize certain areas of current clinical practice where there is consistency: pulmonary metastasectomy is not warranted in cases where the primary tumor is uncontrolled or where complete resection of lung metastases is not likely. The survey also uncovers or confirms areas where considerable debate remains as evidenced by the wide variability of practice in such areas as surgical approach and the role of repeat metastasectomy. Going forward with the results of this survey, it may be possible to foster support for cooperative research projects within the ESTS or other similar bodies to embark on systematic research projects in these areas of controversy.

#### ACKNOWLEDGMENTS

*The authors thank ESTS Pulmonary Metastasectomy Working Group: Richard Berrisford, Stephen Cassivi, Frank Detterbeck, Godehard Friedel, Markus Furrer, Mariano Garcia Yuste, Cengiz Gebitekin, Tomasz Grodzki, Ab Hensens, Eveline Internullo, Radislav Jakovic, Walter Klepetko, Marcello Migliore, Thomas Molnar, Christian Paleru, John Robert,*

*Gaetano Rocco, Axel Rolle, Tom Treasure, Akif Turna, Dirk van Raemdonck, Paul Van Schil, Roger Vaughan, Federico Venuta and all ESTS members for their cooperation in completing the survey.*

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**APPENDIX**

**APPENDIX. ESTS Lung Metastasectomy Working Group. Questionnaire**

1. Do you perform lung metastasectomy in your clinical practice?  
Yes  
No
2. How many pulmonary metastasectomy cases per year do you personally perform?
3. As a proportion of your clinical volume, pulmonary metastasectomy accounts for approximately what percent of you practice?  
0–10%  
10–25%  
25–50%  
>50%
4. For which kind of primary tumors do you perform metastasectomy?

	Yes	No
Colon cancer		
Osteosarcomas		
Soft tissue sarcomas		
Kidney cancer		
Melanoma		
Germ cell tumors		
Hand and neck tumors		
Endometrial cancer		
Cervix cancer		
Ovarian cancer		
Lung cancer		
Breast cancer		

5. Others (please specify)

6. Do you administer preoperative chemotherapy before metastasectomy?

- Always
- Usually
- Sometimes
- Never

Decision rests with medical oncologists

7. For which primary histologies listed below do you recommend preoperative chemotherapy before pulmonary metastasectomy?

	Always	Usually	Sometimes	Rarely	Never
Colon cancer					
Osteosarcomas					
Soft tissue sarcomas					
Kidney cancer					
Melanoma					
Germ cell tumors					
Lung cancer					
Breast cancer					
Endometrial cancer					
Cervix cancer					
Ovarian cancer					

8. Others (please specify)

9. Do you review pulmonary metastasectomy cases in a multidisciplinary (thoracic surgery, pulmonology, medical oncology, radiation oncology) meeting?

- Always, every case
- Usually
- Rarely
- Never

10. Which imaging studies do you use for diagnosis and planning pulmonary metastasectomy?

	Always	Usually	Sometimes	Rarely	Never
Conventional CT scan					
Helical CT scan					
PET scan					

(Continued)

**APPENDIX.** (Continued)

11. Other diagnostic tools (please describe):
12. Do you perform cervical mediastinoscopy with lymph node biopsy prior to metastasectomy?  
 Always, every case  
 Usually  
 Sometimes  
 Rarely  
 Never
13. Do you measure serum tumor markers (according to the primary tumor histology) before metastasectomy?  
 Always, every case  
 Usually  
 Sometimes  
 Rarely  
 Never
14. Do you consider any of the following as contraindications to pulmonary metastasectomy?

	Absolute Contraindication	Relative Contraindication	Not a Contraindication
Multiple (more than one) metastases			
Bilateral pulmonary metastases			
Previous pulmonary metastases			
Synchronous pulmonary metastases (found at the time of diagnosis of primary malignancy)			
DFI <12 mo			
Concurrent metastases in a nonpulmonary site			
Poor performance status (Karnofsky score <50%)			
Poor lung function (FEV <sub>1</sub> or DLCO <40% of predicted)			
Clinically positive (mediastinoscopy) mediastinal lymphadenopathy			
Pathologically positive (mediastinoscopy) mediastinal lymphadenopathy			
Unresectable primary malignancy			
Metastasis/metastases requiring pneumonectomy for complete resection			
Age >70			
Age >80			
BMI >35 kg/m <sub>2</sub>			
BMI <15 kg/m <sub>2</sub>			
Complete resection of pulmonary metastasis/metastases is not possible as evidenced on preoperative investigations			
15. Do you have an absolute maximum number of metastases that you will remove at the time of surgery? If yes, what is your maximum limit? No Yes Please specify your maximum limit			
16. Do you perform repeat pulmonary metastasectomy? If yes, do you have an absolute maximum number of repeat resections that you would consider for recurrent pulmonary metastatic disease? No Yes Please specify your maximum limit			
17. Do you believe palpation of the lung is necessary in metastasectomy with therapeutic intent? Always Sometimes Never			
18. Do you use the VATS/thoroscopic (without palpation) approach for lung metastases surgery? For diagnosis only (ex.: indeterminate nodule/nodules) Also with therapeutic intent (metastasectomy)			
19. Which is your preferred approach for clinical unilateral disease? Posterolateral thoracotomy Anterolateral thoracotomy Vertical axillary thoracotomy			

(Continued)



**APPENDIX.** (Continued)

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- Horizontal axillary thoracotomy  
 Hemi-clamshell (submammary)  
 Posterior muscle sparing thoracotomy  
 Thoracoscopy (VATS)  
 Sternotomy  
 Others
20. Which is your preferred approach for clinical bilateral disease?  
 Bilateral thoracoscopy (one stage)  
 Bilateral staged thoracoscopy  
 Sternotomy (one stage)  
 Clamshell (one stage)  
 Bilateral sequential thoracotomy (one stage)  
 Bilateral staged thoracotomy  
 Others
21. In the case of bilateral staged thoracotomy/thoracoscopy, what time interval do you advocate/prefer between the 2 operations?
22. Do you use different surgical approaches for metastasectomy based on individual factors?  
 Yes  
 No
23. If yes, what might influence your decision?
- |   | Yes | No |
|---|-----|----|
| <hr/>   |     |    |
| Preoperative performance status and lung function   |     |    |
| Age   |     |    |
| Type of primary tumor   |     |    |
| Location of the metastasis/metastases   |     |    |
| Number of the metastases  |     |    |
| 24. In the case of a solitary peripheral pulmonary metastasis (high probability or proven), which type of resection do you most commonly use? |     |    |
| Local excision  |     |    |
| Wedge resection   |     |    |
| Segmentectomy   |     |    |
| Lobectomy   |     |    |
| 25. In the case of a solitary peripheral pulmonary metastasis (high probability or proven), which type of resection do you most commonly use? |     |    |
| Local excision  |     |    |
| Wedge resection   |     |    |
| Segmentectomy   |     |    |
| vLobectomy  |     |    |
| 26. For pulmonary metastasectomy, which of these instruments do you most commonly use?  |     |    |
| Electrocautery  |     |    |
| Stapler   |     |    |
| Laser   |     |    |
| Harmonic scalpel  |     |    |
| Direct suture   |     |    |
| Other   |     |    |
| 27. At the time of pulmonary metastasectomy, which of the following do you routinely perform?   |     |    |
| No lymph nodal sampling/dissection  |     |    |
| Mediastinal lymph nodal sampling  |     |    |
| Complete mediastinal lymphadenectomy  |     |    |
| Prethoracotomy cervical mediastinoscopy   |     |    |
| Prethoracotomy TEMPLA   |     |    |
| 28. Feel free to add any comment to the previous question.  |     |    |
| 29. Do you personally carry out long term follow-up of your pulmonary metastasectomy patients?  |     |    |
| Always  |     |    |
| Usually   |     |    |
| Sometimes   |     |    |
| Rarely  |     |    |
| Never   |     |    |

(Continued)

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**APPENDIX.** (Continued)

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30. If yes, what are your standard investigations?  
Conventional CT scan  
Helical CT scan  
PET scan (positive tumors)  
Tumor markers (positive tumors)
31. Feel free to add any comment to the previous question
32. Type of practice  
Academic  
Public  
Private
33. Level of practice  
Trainee  
Consultant
34. Age (yr)
35. Years in practice
36. Hospital size (number of beds)
37. Unit size (number of beds)
38. Country of practice
39. Feel free to add any comment/consideration on this questionnaire
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VATS, video-assisted thoracoscopic surgery; PET, positron emission tomography; CT, computed tomography; BMI, body mass index.

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