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# Quality Indicators for the Evaluation of Patients With Lung Cancer

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**BACKGROUND:** Ideally, quality indicators are developed with the input of professional groups involved in the care of patients. This project, led by the Thoracic Oncology Network and Quality Improvement Committee of the American College of Chest Physicians (CHEST), had the goal of developing quality indicators related to the evaluation and staging of patients with lung cancer.

**METHODS:** Evidence-based guidelines were used to generate a list of process-of-care quality indicators, and project members revised the content and wording of this list. A survey of the Steering Committee of the Thoracic Oncology Network was performed to rate the validity, feasibility, and relevance of the indicators. Predefined thresholds were used to select indicators from the list. This process was repeated for the selected indicators through a survey available to all members of the Thoracic Oncology Network. Three academic medical centers determined if the surviving indicators were feasible and relevant within their practices.

**RESULTS:** Eighteen quality indicators were drafted. Eleven survived the first round of voting, and seven survived the second round of voting. One was related to tissue acquisition for molecular testing, four were related to staging and stage documentation, one was related to smoking cessation counseling, and one was related to documentation of a performance status measure. The indicators were feasible and relevant within the practices assessed.

**CONCLUSIONS:** We have defined seven process-of-care quality indicators related to the evaluation and staging of patients with lung cancer, which are felt to be valid, feasible, and relevant by lung cancer specialists.

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**ABBREVIATIONS:** CHEST = American College of Chest Physicians

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Quality care has been defined as "the degree to which health services for individuals and populations increase the likelihood of desired health outcomes and are consistent with current professional knowledge."[1] It is important to ensure that patients with lung cancer receive the highest quality of care. Means of providing quality care for patients with lung cancer have been summarized in a variety of clinical guidelines, but the availability of these evidence-based guidelines does not necessarily translate into implementation of the recommendations in practice. Understanding the nature of current care and the barriers to implementing optimal care can help promote changes, with the goal of improving care. To this end, valid, reliable, and useful indicators of the quality of care can help us measure the state of care and variations in practice and track the success of quality-improvement activities.[2]

Quality indicators have been defined as measurable elements of practice performance for which there is evidence or consensus that they can be used to assess the quality of care.[2] The most useful quality indicators are practical, measurable, and improvable; have the potential to vary among practices; and affect a large portion of the patients of interest.[1]

Quality indicators usually fall into three categories based on the aspect of care that they assess. Structural indicators relate to the providers and the health system (material and human resources, and organizational structure); these are not always actionable, providing limited opportunities for improvement. There should be evidence that a change in a structural indicator is linked to a change in a process that has been connected to improved outcomes. Process indicators relate to the procedures or methods of care delivery (that which is actually done). They are more actionable but may not consider the individual patient's unique situation. Process indicators are most useful when quality improvement is the goal, an explanation is sought for particular outcomes, short time frames are necessary, performance of low-volume providers is of interest, and tools to risk stratify are lacking. Process indicators are easier to interpret and are more sensitive to small differences than comparisons of outcomes. There should be an evidence-based link between process indicators and health outcomes, which are states of health or events that follow care and may be affected by health care. Outcome indicators are most useful if they are affected by health care, long time frames are possible, performance of whole systems is being evaluated, or a high volume of cases is available. Their advantages include a better reflection of all aspects of the entire process of care, whereas their limitations include confounding by patient factors, particularly in small-volume settings (ie, they may reflect variations in patient population or case mix rather than in quality of care), and the length of time required for many outcome measures. Outcome indicators, typically, require risk adjustment for patient and confounding variables when comparing among settings. They can be expressed as the five "Ds": death, disease, discomfort, disability, and dissatisfaction.[1,3-6]

Quality indicators are being used increasingly by governing bodies, payers, and patients for credentialing, reimbursement, and provider selection. Many quality indicators are developed without the input of professional groups who are involved in the care of patients and are knowledgeable about the evidence available to justify the measures. To date, there is a small literature base about the development and assessment of lung cancer-related quality indicators. The current article is the result of a project of the Thoracic Oncology Network and Quality Improvement Committee of the American College of Chest Physicians (CHEST) that had the goal of identifying quality indicators related to the evaluation and staging of patients with lung cancer.

## Materials and Methods

### *Approvals*

The project received approval from the leadership of CHEST. Each site that participated in the pilot assessment phase of the project obtained institutional review board approval from their respective institutions. These included the institutional review boards of the Cleveland Clinic (13-001), the University of Michigan (HUM00072395), and the University of Pennsylvania (81769).

### *Team Structure*

A core group of specialists with an interest in the evaluation and staging of lung cancer was recruited from the Thoracic Oncology Network and Quality Improvement Committee of CHEST. The six members included three pulmonologists and three thoracic surgeons. The group decided to focus on process-of-care indicators felt to reflect quality from the specialists' viewpoint. Other stakeholders, such as patients, patient advocate groups, and insurers, were not recruited.

### *Evidence Base*

Several evidence-based guidelines with sections pertinent to the evaluation and staging of lung cancer were reviewed to guide the initial development of the quality indicators. These included lung cancer guidelines from CHEST,[7-11] the European Respiratory Society/European Society of Thoracic Surgeons,[12] the British Thoracic Society,[13] the National Comprehensive Cancer Network,[14] the European Society for Medical Oncology,[15,16] the Sociodad Espanola de Neumologfa y Cirugfa Toraclca,[17] and the National Institute for Health and Clinical Excellence.[18] These

guidelines varied in their scope, and, at times, in their recommendations. A summary of the recommendations from each guideline relevant to this project is available in e-Tables 1-3.

### *Indicator Development*

The project leader reviewed the available evidence base and drafted possible quality indicators. This draft was circulated to the core project members for review, editing for clarity of wording, and additional suggestions.

The resulting quality indicators were then evaluated by members of the Steering Committee of the Thoracic Oncology Network (13 members). The evaluation included voting to judge the potential validity, feasibility, and relevance of these indicators through evaluation within the following domains:

- Evidence or consensus of link to outcome: The evidence base supporting a link between this indicator and patient outcome is robust, or a consensus of experts is likely to feel that a link is present.
- Practical: This indicator is capable of being translated into practice.
- Measurable: This indicator is capable of being measured from documentation that would reasonably be expected to be available within the medical record.
- Room for improvement: There is room to improve the performance of this indicator in current clinical practice across the spectrum of current practice settings.
- Variability among practices: Performance of this indicator is likely to vary across the spectrum of current practice settings.
- Important to a large portion of patients of interest: This indicator is likely to be relevant to a large portion of patients to whom it applies.

In addition, the Steering Committee members were asked to propose a threshold of performance that would suggest a high level of performance within each quality indicator.

To survive this round of voting, the quality indicator had to obtain a mean score of $\geq 7$ out of 9 on a Likert scale, and had to have at least 70% of voters rate the indicator at $\geq 7$, in each of the domains of validity, feasibility, and relevance. A second round of voting, using only the indicators that survived this round of voting, then occurred. The voting survey for the second round was sent to all members of the Thoracic Oncology Network of CHEST. The same thresholds were used for indicator assessment.

### *Pilot Assessment*

The indicators that survived the voting rounds were assessed for feasibility and relevance by reviewing their performance and the ease of assessing performance, for cases of lung cancer diagnosed and treated at each of three large hospitals with members in the project's core group (200 cases in two hospitals, 100 in one). The ease of assessing performance was based on a scale of 1 to 9 for each indicator, for each patient, with 1 = very easy ($<$ 1 min), 5 = neither easy nor hard (approximately 15-min search), and 9 = very difficult ($>$ 30-min search).

## Results

The evidence review led to 17 drafted quality indicators. These were reviewed by the project's core group, wording changes were made, and an additional indicator was added. The resulting 18 indicators were evaluated by all 13 members of the Thoracic Oncology Network Steering Committee. Eleven of the 18 indicators survived this round of voting (Table 1). All but one indicator related to preoperative cardiopulmonary physiology evaluation was eliminated, as were indicators related to chest CT imaging performed within 3 months of initiating treatment and discussion of cases at multidisciplinary tumor boards. All indicators were felt to be relevant to practice. Four indicators failed based on measures of validity, two based on feasibility, and one based on both validity and feasibility.

The remaining 11 quality indicators underwent a second round of voting, this time through a survey of the members of the Thoracic Oncology Network of CHEST. The number of respondents varied from a low of 75 for the latter indicators to a high of 99 for the early indicators. Seven of the 11 indicators survived this round of voting (Table 2). The remaining indicator related to preoperative cardiopulmonary physiology evaluation was eliminated, as were indicators related to reviewing former chest imaging studies in patients with lung nodules, collecting adequate tissue for histologic subtyping, and performing PET imaging. All four remaining indicators were felt to be feasible to collect and relevant to practice, but all failed based on the respondents' view of their validity.

The seven remaining indicators were assessed for feasibility and relevance through a retrospective review of patients with lung cancer diagnosed and treated at each of three large medical centers. Feasibility was assessed through an estimate of the time taken to determine if the indicator was performed, and relevance by the percentage of time the indicator was completed (Table 3). The review suggested that there is room for improvement in the performance of the indicators, even at large medical centers. The mean room for improvement across the three sites ranged from 6.4% for indicator 2 to 34.6% for indicator 5. The institutions had different strengths. The largest range of room for improvement for a single indicator was 3% to 50% for indicator 3. The information to determine if the indicators were performed could be identified in the medical record with modest effort and some variability among sites. The mean time to search for performance of the indicator ranged from 1.22 out of 9 (close to 1 min) for site 1 to 3.45 out of 9 (between 1 and 15 min) for site 3.

**TABLE 1** ] Eighteen Quality Indicators With Measures of Validity, Feasibility, and Relevance Voted on by Thoracic Oncology Network Steering Committee Members

| Quality Indicator | Validity | | Feasibility | | Relevance | | Performance,[a] % |
|---|---|---|---|---|---|---|---|
| | Mean | % ≥ 7 | Mean | % ≥ 7 | Mean | % ≥ 7 | |
| 1. Percentage of patients presenting for the evaluation of a lung nodule in which the presence or absence of prior chest imaging studies is documented | 7.86 | 78.6 | 7.57 | 78.6 | 7.55 | 78.6 | 84.3 |
| 2. Percentage of nonsurgical biopsies in patients with clinical stage III or IV lung cancer that obtained an adequate amount of tissue for histologic subtyping | 7.64 | 85.6 | 7.86 | 85.6 | 8.0 | 83.3 | 80.36 |
| 3. Percentage of nonsurgical biopsies in patients with clinical stage IV nonsquamous lung cancer that obtained an adequate amount of tissue for molecular testing | 7.86 | 71.4 | 7.71 | 82.1 | 8.02 | 90.5 | 76.43 |
| 4. Percentage of patients with lung cancer who have had a chest CT scan performed within 3 mo of initiating treatment[b] | 6.86 | 57.1 | 8.36 | 100 | 7.26 | 71.4 | 85.71 |
| 5. Percentage of patients with clinical stage IB or higher lung cancer who have had PET imaging performed to stage their cancer within 3 mo of initiating treatment | 7.71 | 78.6 | 8.11 | 96.4 | 7.48 | 78.6 | 84.64 |
| 6. Percentage of patients with clinical stage III or IV lung cancer, or neurologic symptoms, who have had brain imaging performed within 3 mo of the initiation of treatment | 7.57 | 78.6 | 8.11 | 96.4 | 7.43 | 81 | 84.29 |
| 7. Percentage of patients with evidence of one to three distant metastases that have had an attempt at biopsy confirmation of a site of metastasis, or documentation of a reason that this was not possible or necessary | 8.14 | 100 | 7.71 | 85.7 | 8.05 | 92.9 | 84.64 |
| 8. Percentage of patients with clinical stage IB or higher but no evidence of metastatic disease, that have had a mediastinal lymph node sampling procedure performed prior to the initiation of curative-intent therapy | 7.14 | 78.6 | 8.0 | 89.3 | 8.02 | 85.7 | 78.57 |
| 9. Percentage of patients with lung cancer that have an AJCC seventh edition clinical lung cancer stage documented prior to curative-intent therapy | 7.5 | 75.6 | 8.21 | 89.3 | 8.12 | 88.1 | 88.57 |
| 10. Percentage of patients being considered for curative-intent resection who have had spirometry performed within 6 mo of surgery[b] | 7.0 | 57.1 | 7.89 | 85.7 | 7.29 | 69 | 81.79 |

*(Continued)*

**TABLE 1** ] *(continued)*

| Quality Indicator | Validity | | Feasibility | | Relevance | | Performance,[a] % |
|---|---|---|---|---|---|---|---|
| | Mean | % ≥ 7 | Mean | % ≥ 7 | Mean | % ≥ 7 | |
| 11. Percentage of patients being considered for curative-intent resection who have had a diffusing capacity measured within 6 mo of surgery | 7.93 | 85.7 | 7.93 | 82.1 | 7.57 | 81 | 76.07 |
| 12. Percentage of patients being considered for curative-intent resection with an $FEV_1$ and DLCO < 80% predicted who have had their predicted postoperative lung function documented[b] | 6.93 | 71.4 | 6.5 | 60.7 | 7.64 | 85.7 | 67.5 |
| 13. Percentage of patients with stage I or II non-small cell lung cancer and a ppo$FEV_1$ < 30% predicted in which there is documentation of counseling about sublobar resection and nonoperative treatment options for their lung cancer[b] | 7.43 | 85.7 | 6.71 | 67.9 | 7.86 | 88.1 | 73.93 |
| 14. Percentage of patients being considered for curative-intent lung resection who have a ppo$FEV_1$ or ppoDLCO < 40% who have had a formal measure of exercise capacity performed[b] | 6.43 | 57.1 | 6.36 | 64.3 | 7.83 | 78.6 | 62.1 |
| 15. Percentage of patients with stage I or II non-small cell lung cancer and a peak $\dot{V}O_2$ < 10 mL/kg/min in which there is documentation of counseling about sublobar resection and nonoperative treatment options for their lung cancer[b] | 7.07 | 78.6 | 6.71 | 71.4 | 7.55 | 81 | 60.71 |
| 16. Percentage of active smokers with lung cancer who have had smoking cessation counseling documented | 7.93 | 92.9 | 8.07 | 89.3 | 8.33 | 95.2 | 78.93 |
| 17. Percentage of patients with lung cancer whose evaluation and/or treatment has been discussed at a multidisciplinary tumor board[b] | 7.0 | 64.3 | 7.32 | 78.6 | 8.14 | 92.9 | 69.64 |
| 18. Percentage of patients with lung cancer in whom a performance status measure is documented in the pretreatment phase | 7.36 | 71.4 | 8.18 | 92.9 | 7.67 | 88.1 | 77.86 |

Likert scale from 1 to 9 used for voting. AJCC = American Joint Committee on Cancer; DLCO = diffusing capacity of the lung for carbon monoxide; ppo = predicted postoperative; $\dot{V}O_2$ = oxygen consumption.

[a]Performance is the minimal level voted to be acceptable for that indicator.

[b]Indicator was eliminated based on voting (mean score was < 7, or fewer than 70% of all votes were ≥ 7 in one of the measures).

## Discussion

The aim of this project was to have a group of physicians with expertise in the evaluation of patients with lung cancer develop process-of-care quality indicators for the diagnosis and staging of lung cancer. The indicators selected passed rounds of voting in which their validity, feasibility, and relevance were judged. In this project, validity referred to an evidence- or consensus-based link to improved outcomes, feasibility referred to a consensus that the indicator could be obtained from

**TABLE 2** ] Eleven Quality Indicators With Measures of Validity, Feasibility, and Relevance Voted on by Members of Thoracic Oncology Network

| Quality Indicator | Responses, No. | Validity | | Feasibility | | Relevance | | Performance,[a] % |
|---|---|---|---|---|---|---|---|---|
| | | Mean | % ≥7 | Mean | % ≥7 | Mean | % ≥7 | |
| 1. Percentage of patients presenting for the evaluation of a lung nodule in which the presence or absence of prior chest imaging studies is documented[b] | 99 | 6.98 | 68.7 | 7.26 | 74.2 | 7.23 | 72.7 | 77.63 |
| 2. Percentage of nonsurgical biopsies in patients with clinical stage III or IV lung cancer that obtained an adequate amount of tissue for histologic subtyping[b] | 87 | 6.91 | 64.4 | 7.34 | 74.1 | 7.57 | 81.61 | 77.06 |
| 3. Percentage of nonsurgical biopsies in patients with clinical stage IV nonsquamous lung cancer that obtained an adequate amount of tissue for molecular testing | 86 | 7.12 | 72.1 | 7.34 | 77.33 | 7.47 | 76.74 | 73.36 |
| 4. Percentage of patients with clinical stage IB or higher lung cancer who have had PET imaging performed to stage their cancer within 3 mo of initiating treatment[b] | 80 | 6.76 | 66.25 | 7.58 | 78.75 | 7.26 | 75.0 | 75.65 |
| 5. Percentage of patients with clinical stage III or IV lung cancer, or neurologic symptoms, who have had brain imaging performed within 3 mo of the initiation of treatment | 80 | 7.76 | 86.25 | 7.96 | 88.75 | 7.22 | 73.33 | 78.43 |
| 6. Percentage of patients with evidence of one to three distant metastases who have had an attempt at biopsy confirmation of a site of metastasis, or documentation of a reason that this was not possible or necessary | 76 | 7.21 | 73.68 | 7.24 | 71.05 | 7.15 | 72.37 | 78.87 |

*(Continued)*

**TABLE 2** ] *(continued)*

| Quality Indicator | Responses, No. | Validity | | Feasibility | | Relevance | | Performance,[a] % |
|---|---|---|---|---|---|---|---|---|
| | | Mean | % ≥7 | Mean | % ≥7 | Mean | % ≥7 | |
| 7. Percentage of patients with clinical stage IB or higher, but no evidence of metastatic disease, who have had a mediastinal lymph node sampling procedure performed prior to the initiation of curative-intent therapy | 76 | 7.28 | 73.68 | 7.68 | 81.58 | 7.64 | 78.51 | 77.68 |
| 8. Percentage of patients with lung cancer who have an AJCC seventh edition clinical lung cancer stage documented prior to curative-intent therapy | 75 | 7.73 | 82.67 | 7.99 | 88.0 | 7.75 | 84.0 | 83.57 |
| 9. Percentage of patients being considered for curative-intent resection who have had a diffusing capacity measured within 6 mo of surgery[b] | 75 | 6.79 | 60.0 | 7.41 | 76.67 | 7.28 | 74.67 | 71.33 |
| 10. Percentage of active smokers with lung cancer who have had smoking cessation counseling documented | 75 | 7.59 | 77.33 | 7.62 | 78.0 | 7.73 | 81.33 | 80.16 |
| 11. Percentage of patients with lung cancer in whom a performance status measure is documented in the pretreatment phase | 75 | 7.69 | 78.67 | 7.63 | 82.67 | 7.67 | 85.33 | 79.8 |

Likert scale from 1 to 9 used for voting. See Table 1 legend for expansion of abbreviation.
[a]Performance is the minimal level voted to be acceptable for that indicator.
[b]Indicator was eliminated based on voting (mean score was <7, or fewer than 70% of all votes were ≥7 in one of the measures).

standard documentation, and relevance referred to a consensus that performance of the indicator varies in practice, has room for improvement, and would impact a meaningful number of patients. Through this process, seven quality indicators were developed. One indicator is related to obtaining tissue for molecular testing, four are related to staging and stage documentation, one is related to smoking cessation counseling, and the final is documentation of a performance status measure prior to initiating treatment. We went on to review the feasibility and relevance of these indicators at three large academic medical centers, and we found that measurement of each indicator was quite feasible and that there was room for performance improvement even at large medical centers.

A few large-scale efforts have been undertaken to develop programs aimed at improving the quality of lung cancer care. The Danish National Indicator project, established in 2000, has produced evidence-based, disease-specific quality indicators, developed by multiprofessional physicians, for eight diseases (including lung cancer). The project focused on documentation, monitoring, and improvement of the quality of health care. Results from data collection were analyzed continuously, interpreted, evaluated, and communicated at local and national levels, to the professional environment and to the public. The nine indicators for lung cancer were all outcome indicators (as opposed to the process

**TABLE 3** ] Assessment of Feasibility and Relevance of Quality Indicators

| Quality Indicator | Site 1 | | | Site 2 | | | Site 3 | | |
|---|---|---|---|---|---|---|---|---|---|
| | NR, % | Yes, % | Time[a] | NR, % | Yes, % | Time[a] | NR, % | Yes, % | Time[a] |
| 1. Percentage of nonsurgical biopsies in patients with clinical stage IV nonsquamous lung cancer who obtained an adequate amount of tissue for molecular testing | 81 | 89.5 | 1.18 | 82 | 72.2 | 2.48 | 84 | 62.5 | 3.13 |
| 2. Percentage of patients with clinical stage III or IV lung cancer, or neurologic symptoms, who have had brain imaging performed within 3 mo of the initiation of treatment | 48 | 96.2 | 1.14 | 46 | 96.3 | 2.21 | 49 | 88.2 | 3.5 |
| 3. Percentage of patients with evidence of one to three distant metastases who have had an attempt at biopsy confirmation of a site of metastasis, or documentation of a reason that this was not possible or necessary | 82.5 | 62.9 | 1.16 | 80 | 50 | 2.11 | 67 | 97.0 | 3.16 |
| 4. Percentage of patients with clinical stage IB or higher, but no evidence of metastatic disease, who have had a mediastinal lymph node sampling procedure performed prior to the initiation of curative-intent therapy | 47.5 | 95.2 | 1.24 | 43.5 | 96.5 | 2.11 | 64 | 80.6 | 3.21 |
| 5. Percentage of patients with lung cancer who have an AJCC seventh edition clinical lung cancer stage documented prior to curative-intent therapy | 24.5 | 58.3 | 1.61 | 24.5 | 61.6 | 1.98 | 16 | 76.2 | 3.77 |
| 6. Percentage of active smokers with lung cancer who have had smoking cessation counseling documented | 74.5 | 70.6 | 1.20 | 81.5 | 59.5 | 1.74 | 76 | 75 | 3.15 |
| 7. Percentage of patients with lung cancer in whom a performance status measure is documented in the pretreatment phase | 0 | 100 | 1.01 | 0 | 71 | 1.54 | 1 | 88.9 | 4.21 |

Two hundred patients were reviewed at site 1 and site 2, 100 at site 3. NR = not relevant. See Table 1 legend for expansion of other abbreviation.
[a]Time scale is 1 = very easy (< 1-min search), 5 = neither easy nor hard (approximately 15-min search), 9 = very difficult (> 30-min search).

indicators in our project). They included five related to survival, one related to time until diagnosis, and three related to treatment waiting times. All indicators have been reported to improve over time.[19,20]

In 2004, the Dutch Association of Comprehensive Cancer Centres and the Dutch Association for Pulmonology developed an evidence-based guideline for the diagnosis and treatment of patients with non-small cell lung cancer. The guideline was published and distributed and

discussed at regional tumor boards. A systematic procedure was followed to develop a set of indicators and to test the clinimetric characteristics of the indicators. The chosen quality indicators were then assessed retrospectively for measurability, improvement potential, discriminating capacity, and feasibility, in a cohort of subjects with lung cancer. In total, seven quality indicators related to the evaluation of patients with non-small cell lung cancer were developed. Their assessment suggested relevance and feasibility within their population. Patient-related characteristics (age, stage of disease, and comorbidity) influenced compliance with the indicators more than did professional (experience, knowledge of guideline) and hospital (teaching status, multidisciplinary team, and specialized nurses) characteristics.[2,21] Those common to our project included mediastinal sampling and brain imaging as part of staging. Topics present in the Dutch study that did not pass voting in our project included an indicator related to PET imaging and another related to multidisciplinary case discussion. Both failed in our validity domain of voting, suggesting that those who voted did not feel there was evidence of, or consensus on, a link to outcome.

The National Institute for Health and Clinical Excellence has developed a quality standard for lung cancer. This includes 15 quality statements, each with defined quality measures related to structural, process, and outcome considerations with relevance to service providers, health-care professionals, commissioners, and patients.[22] Cancer Care Ontario has established a lung cancer quality-improvement initiative, including the development of a lung cancer disease-management pathway.[23] The American College of Surgeons Commission on Cancer used Geisenger's ProvenCare Program for a multi-institutional collaborative for the care of patients with potentially resectable lung cancer.[24] In addition, a few single-center reports have looked at adherence to quality indicators felt to be important in the setting of pulmonary resection.[25-27]

The National Quality Forum lists four quality indicators related to the evaluation and/or staging of lung cancer: the percentage of all surgical patients undergoing treatment procedures for lung cancer that have clinical TNM staging provided, the percentage of patients undergoing resection of a lung cancer who had their performance status recorded within 2 weeks of the surgery date, the percentage of patients undergoing lobectomy for lung cancer who had a prolonged length of stay ($>$ 14 days), and the percentage of patients undergoing resection who developed postoperative cardiopulmonary complications.[28] The first two are process-of-care indicators similar to those developed in the current project, and the latter two are outcome indicators.

The strengths of our project include a comprehensive review of available evidence-based guidelines; a rigorous voting procedure that included specialists from relevant areas, with voting that included validity, feasibility, and relevance domains; and confirmation of the feasibility and relevance of the selected indicators. Performing the selected indicators is felt to have a strong connection to improved outcomes. For example, obtaining enough tissue for molecular analysis in patients with stage IV nonsquamous cell carcinoma ensures that these patients receive the most effective systemic therapy, and confirming imaging findings that suggest the presence of distant metastases with a biopsy ensures that patients with early-stage disease are not mislabeled as being incurable. Our project differs from other large-scale efforts in its scope, the type of indicators proposed, and the nature of the group supporting the project. We focused only on the development of process-of-care indicators for the pretreatment phase of lung cancer care. The specialists involved and CHEST are not in a position to mandate performance of the indicators developed. The goal of the project was to provide guidance to policy makers from a group of clinical experts. With further research, indicators that did not quite meet our predefined standards may also prove to be important drivers of outcome.

A potential weakness of our project is the lack of inclusion of other relevant stakeholders. We chose to include only subspecialists in lung cancer care in the project because we were developing process-of-care indicators that required a detailed understanding of the evidence base and clinical practice. In future work, it will be important to include patient and payer perspectives because the outcomes of importance to these groups may vary from those of a lung cancer physician. Another potential weakness is the lack of evidence supporting improved outcomes through tracking the selected quality indicators. Five of these seven indicators were developed directly from specific recommendations within evidence-based guidelines. The grade of evidence related to these five in the updated CHEST lung cancer guidelines ranges from IB for the indicators related to adequate tissue acquisition for molecular testing and biopsy confirmation of imaging findings suggesting distant metastases,[29,30] to 2C for brain imaging of all patients with stage III or IV lung cancer.[30] The remaining two indicators were developed at the suggestion of

members of the core project team based on an amalgam of multiple guideline recommendations (documentation of stage and performance status prior to treatment). Of the 18 quality indicators that were developed, nine were eliminated because voting suggested they were not valid, and two were not feasible. All were felt to be relevant. Over time, evidence may be produced that confirms the validity of the rejected indicators, and technology advances may occur that allow the indicator to be assessed more readily, increasing the usefulness of some of the rejected indicators. We believe that future projects should aim to prove that the performance of the selected indicators will lead to improved patient outcomes. In summary, our project defined seven process-of-care quality indicators related to the evaluation and staging of patients with lung cancer, which are felt to be valid, feasible, and relevant by lung cancer specialists.

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**Additional information:** The e-Tables can be found in the Supplemental Materials section of the online article.

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