Background. The aim of this project was to develop a set of quality indicators to assess surgical decision making in the care of patients with non-small cell lung cancer (NSCLC).

Methods. A multidisciplinary Expert Panel of 16 physicians used a modified Delphi process to identify quality indicators that evaluated the processes of care in patients with NSCLC. A systematic review identified potential indicators, which were rated on actionability, validity, usefulness, discriminability, and feasibility in two rounds of questionnaires. The first questionnaire was completed by the Expert Panel and by the larger thoracic surgical community of practice; the second questionnaire was sent to only the Expert Panel. Expert Panel members attended an in-person meeting to review the results of the two questionnaires and to compile the final list of indicators by consensus.

Results. From the literature review, 41 potential indicators were identified. An additional 16 indicators were suggested by the Expert Panel: 13 indicators in the two rounds of questionnaires and three after the discussion at the in-person meeting. One further indicator was identified after the in-person meeting. In the end, 17 indicators were chosen from seven domains: preoperative assessment, staging, surgical procedures, pathology, adjuvant therapy, surgical outcomes, and miscellaneous.

Conclusions. By use of a modified Delphi process, 17 indicators to assess the quality of processes of surgical care for patients with NSCLC were developed.

Ensuring access to high-quality cancer surgical procedures is one of the mandates of Cancer Care Ontario (CCO), which is the principal adviser to the Ontario government on the delivery of cancer services. An Expert Panel was convened to develop thoracic surgical oncology standards because data from the province of Ontario and from other jurisdictions reported improved outcomes for pneumonectomy and esophagectomy for high-volume centers (unpublished data). The standards document stipulated volume levels, surgeon criteria, and hospital resources for level I and level II centers.

Before 2004, approximately 46 hospitals in Ontario were performing thoracic surgical procedures. After the implementation of the standards, as of December 31, 2010, there were 13 level I and two level II designated thoracic surgery centers, and approximately 90% of all procedures were performed in these centers. In an effort to assess the quality of surgical care, an Expert Panel was convened to develop a set of quality indicators that would assess the surgeon decision making component of care of patients with non-small cell lung cancer (NSCLC). This article outlines the process and outcome of those deliberations.

Material and Methods
A modified Delphi method was used to develop the Lung Cancer Surgery Quality Indicators (LCSQI) (Fig 1). This method combines the nominal group process, which uses structured meetings to gather information from experts, and the Delphi process, which uses questionnaires to elicit responses in a systematic manner over several rounds [1]. In the modified Delphi process, participants attend at least one in-person meeting. During development of the LCSQI, a systematic review of the literature was performed to extract potential indicators, which were reviewed and rated by clinical experts in two rounds of questionnaires and at an in-person meeting.
Panel Selection

Three thoracic surgeons representing both academic and community centers led the panel (GD, JD, RM). Other members were nominated by these physician leaders, ensuring that the majority of regions of the Province of Ontario were represented. In addition to thoracic surgeons, representatives from radiation oncology, medical oncology, respirology, diagnostic radiology, nuclear medicine, and CCO administrators were included on the panel. In total, the Expert Panel was composed of 16 members, including the three physician leaders.

Literature Search

A literature search was performed by two of the authors (CN and LM) to identify potential evidence-based quality indicators that were relevant to surgical decision making (Fig 2). The target population was adult patients with stage I, II, or III NSCLC who underwent surgical resection with curative intent. The goal was to identify synthesized research evidence including clinical practice guidelines, systematic reviews, metaanalyses, population-based studies, and consensus statements that supported interventions and practices leading to improved patient outcomes.

The MEDLINE database was searched by use of the following text/MeSH subject headings: “Surgical procedures,” “Operative/Surgery/Surgery Department,” “Hospital/Thoracic Surgery,” “Thoracic Surgical Procedures,” and “Thoracic Neoplasms.” The search was limited to human studies in the English language published between 1995 and the second week of January 2009. Two reviewers (CN and LM) independently reviewed the abstracts, and disagreements were resolved by consensus. Articles were selected for inclusion if they were fully published English-language reports.

The grey literature was searched with the Google search engine. Also searched for were nonpublished organizational reports, guidelines, and statements. Reviewers hand-searched the reference lists of the included articles and all review articles to identify any additional articles missed in the literature search.

Each retrieved article was examined by two independent reviewers (CN and LM) to extract possible indicators for consideration. For each potential quality indicator, the phase of care, type of article, and citation were collected, and a list of unique indicators with the level of supporting evidence was created. The indicators were organized into seven categories that covered the continuum of care (preoperative assessment, staging, surgical procedures, pathology, adjuvant therapy, surgical outcomes, and miscellaneous).

Round 1

The list of unique quality indicators was formatted by category in a questionnaire and distributed by e-mail to all members of the Expert Panel and to all other thoracic surgeons practicing at designated centers in Ontario, with the exception of the three physician leaders. Respondents were asked to rate the indicators by three criteria: (1) actionability, which refers to whether the care that the indicator assesses is under the control of the stakeholder (ie, the surgeon); (2) validity, which assesses the indicator as a measure of quality; and (3) usefulness, which determines whether the stakeholders would find data on the indicator informative. Each criterion was ranked on a seven-point Likert scale (1 = disagree, 7 = agree).

Respondents were also given the opportunity to provide written comments and were asked to suggest additional indicators. E-mail reminders were sent 2 weeks after the initial distribution, with follow-up phone calls to Expert Panel members a week later.

Questionnaire responses were analyzed and results organized according to whether there was consensus for inclusion (>51% of respondents ranked all three criteria 5, 6, or 7 on the Likert scale), consensus for exclusion (>51% of respondents ranked all three criteria 1, 2, 3, or 4 on the Likert scale), or unclear consensus (indicators that did not meet the criteria for inclusion or exclusion).
Round 2

In round 2, the indicators were organized according to those for which there was consensus for inclusion, consensus for exclusion, or unclear consensus based on the results of round 1. Additional indicators suggested in the first round were included for rating. Information on the frequency of responses and comments from round 1 were also included. Panel members were asked to rate the original indicators on two additional criteria: (1) discriminability, which refers to whether the indicator shows variability in practice and (2) feasibility, which refers to whether the indicator is feasible to measure. Respondents could answer either “yes,” “no,” or “unsure” to these criteria. The additional indicators suggested in round 1 were rated by all five criteria (actionability, validity, usefulness, discriminability, feasibility).

The questionnaire was distributed by e-mail exclusively to the 13 Expert Panel members (excluding the three physician leaders), followed by a reminder e-mail 2 weeks later.

In a manner similar to round 1, responses were analyzed, and frequencies were calculated and categorized as clear consensus for inclusion, clear consensus for exclusion, or unclear consensus. On the basis of these results, the indicators were separated into the three groups for discussion at the Expert Panel meeting.

Round 3

Panel members were invited to an in-person Expert Panel meeting, facilitated by two of the physician leaders (GD, JD). It was anticipated that after two rounds, there would be fewer potential indicators to discuss. However, there was actually an increase from 41 original indicators to 54 for review because of additional indicator suggestions and only one indicator having clear consensus for exclusion after rounds 1 and 2.

The indicators were divided into seven categories of care for discussion at the in-person meeting. The goal was to have approximately 10 to 15 indicators, with one to three indicators from each of the seven categories. The Expert Panel members discussed each potential indicator and by consensus eliminated some indicators, leaving between one and five potential indicators in each category. Modifications, such as wording changes and combining of indicators, were also made. Discussion resulted in the addition of three more indicators to the list.

At the end of the discussion period, the selected indicators were included in the final (third) questionnaire, which was completed by all Expert Panel members who attended the in-person meeting. They were asked to rank the top three indicators in each category that were thought to be the best measures of quality of lung cancer surgical procedures. The top indicator in each category was assigned three points, the second was assigned two points, and the third was assigned one point. If there were fewer than three indicators in a category, all indicators were ranked.

The indicator in each category with the most points was automatically selected for inclusion. The rest of the indicators were selected by consensus of the physician leaders. After the in-person meeting, the physician leaders made several modifications to the chosen indicators, which included the addition of one indicator, the omission of one indicator, and wording modifications to several indicators to more accurately reflect the evidence. The evidence for each indicator was also reviewed again. The final list was e-mailed to all Expert Panel members for their review and approval.

Results

The development process began in October 2008 and concluded in December 2011. The Expert Panel included nine surgeons, two radiation oncologists, a medical oncologist, a respirologist, a radiologist, a nuclear
medicine physician, and a regional vice president of CCO, representing 11 of 13 regions in Ontario with a designated thoracic surgery center. As shown in Figure 2, 592 articles were identified in the literature search, of which 263 full-text articles were reviewed and 25 articles were used to identify 41 unique potential LCSQI.

Round 1
The response rate for the first-round questionnaire was 100% for the Expert Panel and 33% (11/33) for thoracic organizations interested in assessing and reporting on the performance measurement is important for health care system (eg, patient status, preferences). As shown in Table 1, 12 of the indicators were identified in the systematic review; four were suggested by the Expert Panel, and the final list was approved.

The final list of 17 LCSQI assesses aspects of care that are at the discretion of surgeons. Fourteen are process measures, and three are outcome measures. Process measures tend to be more useful because outcome indicators may not be immediately available (eg, 5-year survival) and may be affected by factors other than the health care system (eg, patient status, preferences). As shown in Table 1, 12 of the indicators were identified in the systematic review; four were suggested by the Expert Panel, and the final list was approved.
<table>
<thead>
<tr>
<th>Indicator No.</th>
<th>Indicator Definition</th>
<th>Evidence</th>
<th>Additional Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Proportion of NSCLC patients who underwent operations who received a CT scan of the chest and a pulmonary function assessment preoperatively</td>
<td>Six [2, 3, 4, 5, 6^a, 7]</td>
<td>One [8] One [9]</td>
</tr>
<tr>
<td>2</td>
<td>Time from date of consultation with the surgeon to date of decision to treat</td>
<td>Not identified in evidence; consensus by Expert Panel</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Proportion of resectable clinical stage I-IIIA NSCLC patients who receive preoperative PET-CT scanning</td>
<td>Five [4, 16, 5, 7, 6^a]</td>
<td>One [11]</td>
</tr>
<tr>
<td>4</td>
<td>Proportion of NSCLC patients with no extrathoracic metastases who receive invasive mediastinal staging (excluding those who have a normal CT results and negative PET-CT results in the mediastinum and a peripheral clinical stage 1A tumor)</td>
<td>Five [7, 5, 12, 6^a, 2] One [13]</td>
<td>Two [9, 11]</td>
</tr>
<tr>
<td>5</td>
<td>Proportion of NSCLC patients who receive biopsy of at least one ipsilateral, one contralateral, and one subcarinal node to include suggestive nodes on preoperative imaging during invasive mediastinal staging</td>
<td>One [6^a]</td>
<td>Expert Panel added “suspicious nodes” to indicator</td>
</tr>
<tr>
<td>7</td>
<td>Proportion of all patients with stage I and stage II NSCLC who receive a resection</td>
<td>Five [14, 2, 10, 7, 5] One [15] One [16]</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Proportion of all patients with stage I and stage II NSCLC older than 75 years who receive a resection</td>
<td>Two [2, 3] One [8]</td>
<td>Expert Panel changed age from 71 years to 75 years</td>
</tr>
<tr>
<td>9</td>
<td>Proportion of patients found to be unresectable at the time of operation</td>
<td>One [2]</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Proportion of patients with resected NSCLC who receive adequate lymph node dissection or sampling (&gt;10 lymph nodes removed and at least 3 mediastinal lymph node stations sampled) at the time of resection</td>
<td>Five [14, 19, 10, 5, 7, 4] Two [17, 18] One [11]</td>
<td></td>
</tr>
</tbody>
</table>
### Table 1. Continued

<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>11</td>
<td>Proportion of patients with resected NSCLC with an R0 resection</td>
<td>One [10]</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Proportion of patients undergoing resection who stay in an acute care hospital &gt;14 days after anatomic resection</td>
<td></td>
<td>Not identified in evidence; consensus by Expert Panel</td>
</tr>
<tr>
<td>14</td>
<td>5-year overall survival rate for resected patients, by stage</td>
<td></td>
<td>Not identified in evidence; consensus by Expert Panel</td>
</tr>
<tr>
<td>15</td>
<td>30-day reoperation rate after surgical resection</td>
<td></td>
<td>Not identified in evidence; consensus by Expert Panel</td>
</tr>
<tr>
<td>16</td>
<td>Proportion of patients with clinical or pathologic stage IIIA and stage IIIB NSCLC who receive multidisciplinary evaluation either by direct consultation or discussion at a multidisciplinary cancer conference</td>
<td>Three [10, 19, 3]</td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>Proportion of patients scheduled to have an elective lung cancer resection that is canceled</td>
<td></td>
<td>Not identified in evidence; added by leaders of Expert Panel</td>
</tr>
</tbody>
</table>

* Guideline based on expert consensus.

CT = computed tomography; NSCLC = non-small cell cancer; PET = positron emission tomography.
Panel, either in one of the questionnaires or at the in-person meeting; and one indicator was suggested by the leaders of the Expert Panel after the in-person meeting. All 12 indicators identified in the systematic review were supported by clinical practice guideline recommendations, metaanalysis, or systematic review, with three of those indicators also supported by population-based studies. The remaining five indicators identified were based on Expert Panel consensus, and supporting evidence was not assessed. The indicators chosen also have face validity because nine members of the panel were thoracic surgeons. Although morbidity and mortality are two commonly measured outcome indicators, CCO already collects mortality data, so those two terms were not included in our list. Morbidity was not included in our indicator list primarily because many factors other than the surgeon’s judgment or skill influence morbidity. These indicators were developed to assess the quality of lung cancer surgical procedures in the province of Ontario, specifically to determine the effect of implementation of the Thoracic Surgical Oncology Standards, which regionalized thoracic surgical procedures to 15 centers in the province. Currently, data for eight indicators can be obtained from the Canadian Institute for Health Information database (includes all hospital discharges in Canada with the exception of Quebec), the CCO ePath database (which collects pathology and stage data by means of electronic synoptic reporting), and through Ontario Health Insurance Plan billing claims. These initial data will be analyzed and presented to the thoracic surgeons in Ontario in aggregate and anonymized form. Individual surgeon data is not collected. Our immediate goal is to determine current practice and acceptable variations and then to determine potential quality gaps. Previous indicators have been developed to assess the spectrum of care from diagnosis to treatment rather than just treatment related to the operations. Hermens and colleagues [27] developed a set of 15 indicators to assess compliance with a guideline previously developed by their group. Four indicators are similar to those developed by our group. Reifel [28] reported on a set of indicators developed by Research and Devlopment (RAND) Corporation in 2000. Indicators were again developed to assess the quality of care across the spectrum and for both NSCLC and small cell lung cancer. Some indicators are similar to ours, including the proportion of patients who have pulmonary function assessment and an electrocardiogram, and the proportion of stage I and II NSCLC patients who undergo surgical procedures.

Quality indicators are important for evaluating the quality of health care delivery. In thoracic operations, historically the prime indicators used are in-hospital mortality, length of stay, and 5-year survival. Although these are important, those responsible for health care delivery require more detailed and timely measures to understand the quality of care provided. By use of a modified Delphi process, 17 quality indicators related to processes of care and outcome measures were identified for evaluating the quality of thoracic surgical care in Ontario. This process ensured that the LCSQI have face validity, and it also promotes the quality agenda in a collegial collaboration among surgeons, other health care providers, and administrators.

The authors thank the members of the Lung Cancer Surgery Expert Panel, Drs Paul Chiasson, Bill Evans, Marisa Finlay, Ken Gehman, Karen Galenchyn, Matthew Kilmurry, Donna Maziat, Ken Reid, Shafeequr Salahudeen, Michael Sanatani, Julius Toth, Yee Ung, and John Vlasschaert, for their help in developing and determining the final list of Lung Cancer Surgery Quality Indicators.

References

INVITED COMMENTARY

Evaluation of quality of care in thoracic surgery is of paramount importance for patients, providers, and administrators. Quality is an abstract and complex construct, which cannot be captured or explained by a single indicator. Several components may influence what is commonly defined as quality of care.

Selection of quality indicators therefore becomes critical to the definition and grading of quality of care. Traditional outcome endpoints (mortality and morbidity) are insufficient to fully capture the complexity of lung cancer patient management and are influenced by many factors often not under the direct control of the surgeon or their team. Process indicators appear more appropriate for quality improvement initiatives as they are actionable by the providers.

Darling and colleagues [1] reported the work of a multidisciplinary expert panel mandated by the Cancer Care Ontario to identify a set of quality indicators aimed at assessing the surgeon decision-making components of care for non-small cell lung cancer patients. Seventeen indicators (14 processes and 3 outcomes) were finally agreed upon using the Delphi method.

There are some caveats that in my opinion would need to be addressed in future investigations.

(1) Process indicators need corresponding legitimate exclusion criteria. Allowing for selected patients to legitimately fall out of the predetermined process scheme would prevent to penalize those units dealing with very high-risk patients.

(2) The outcome indicators need to be risk adjusted to be fairly applied. This would prevent risk-aversion attitudes. Future analyses should focus at developing risk-adjusting models for the selected outcomes.

(3) The inclusion of both outcomes and processes warrants exploratory analyses to identify methods for their concomitant application. Composite performance scores have been previously proposed to this purpose [2, 3].

Composite scores are appealing because they express with a single number the performance of a provider. Nevertheless, a composite score must be actionable and interpretable by the provider and should retain the possibility to be decomposed into its individual components. This would allow providers to analyze their performance in specific areas and to formulate improvement strategies.

The authors should be commended for this important effort, which represents in my opinion a milestone contribution on this subject and will constitute a solid reference for future lung cancer management quality initiatives.

Alessandro Brunelli, MD
Department of Thoracic Surgery
St. James’ University Hospital, Bexley Wing
Beckett St
Leeds, LS9 7TF
United Kingdom

e-mail: brunellialex@gmail.com

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