Prediction of the Adequacy of Lymph Node Retrieval in Colon Cancer by Hospital Type

Maheswari Senthil, MD; Vijay Trisal, MD; I. Benjamin Paz, MD; Lily L. Lai, MD

Background: Examination of 12 or more regional lymph nodes (LNs) is the accepted minimum for nodal staging in colon cancer and serves as a surrogate for adequate resection.

Objective: To determine the contributing role of the hospital in the number of LNs retrieved.

Design/Setting: We retrospectively reviewed colon resections in 83 patients by 2 surgical oncologists at a National Comprehensive Cancer Network (NCCN) hospital or at community-based hospitals from January 1, 2002, through December 31, 2007.

Patients: We included all patients undergoing colectomy for primary colon cancer and excluded patients with recurrence, rectal cancer, or preoperative chemotherapy.

Main Outcome Measures: Total number of LNs retrieved. We also analyzed clinical factors accounting for differences.

Results: The median number of LNs examined at the NCCN hospital (42 patients) vs the community hospitals (41 patients) were 17.8 vs 7.0 (P < .001), and the frequency of an inadequate number of LNs examined (<12) was 11 of 42 cases (26%) vs 35 of 41 cases (85%) (P < .001). Potential predictive factors for LNs retrieved were grouped into modifiable (hospital type, surgeon, and surgical approach [laparoscopic vs open]) and nonmodifiable (age, sex, and tumor location). On multivariate analysis of the factors, hospital type was the only modifiable factor predictive of LNs reported (P < .001).

Conclusions: Our study is the first, to our knowledge, to demonstrate that the number of LNs removed in colectomies performed by the same 2 surgeons depends on the hospital type (NCCN vs community) in which the resection occurred. We postulate that the number of LNs retrieved may be related to the institution’s pathological review in addition to the extent of surgical resection.

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More than 80% of patients with colon cancer present with locoregional disease, and in this subgroup of patients regional lymph node (LN) status is the most important predictor of long-term survival. Numerous studies have shown an improvement in survival with an increasing number of LNs examined in stages II and III colon cancer. Adequate LN evaluation is critical for staging and treating patients with colon cancer because the decision for adjuvant treatment largely depends on the LN status. Although there has been significant debate and controversy regarding the minimum number of LNs that should be examined for adequate nodal evaluation, numerous studies and consensus guidelines have suggested that examination of 12 regional LNs is the acceptable minimum for adequate LN evaluation in colon cancer. In addition to being recommended as the treatment standard in colon resections for adequate staging by organizations such as the American College of Surgeons, American Society of Clinical Oncology, and National Comprehensive Cancer Network (NCCN), the National Quality Forum has endorsed the 12-LN minimum as a measure of quality in cancer care.

Despite these recommendations, a national cancer database study evaluating colectomies performed in nearly 1300 hospitals reported that more than 60% of the hospitals failed to achieve the 12-LN measure. Putative factors contributing to adequacy of LN retrieval include tumor characteristics, patient differences, pathological processing and review, and surgical technique and resection. Of these, the modifiable factors are the adequacy of surgical resection and thoroughness of pathological evaluation. However, the individual contribution of the surgeon and the pathological review in the number of LNs reported remain unknown. Consequently, we analyzed the colectomies performed by 2 fellowship-trained surgical oncologists (V.T. and I.B.P.) at an NCCN hospital or at community hospitals. The objective was to examine the factors associated with retrieval of pericolic LNs in patients with colon cancer. In particular, we wanted to determine the role of hospital type in LN retrieval while controlling for the individual surgeon.
MEDICAL RECORD REVIEW

We conducted a retrospective medical record review of colectomies performed by 2 surgical oncologists from January 1, 2002, through December 31, 2007, at an NCCN hospital and 2 community hospitals. The study was conducted under institutional approval.

Patients were identified from electronic databases using International Classification of Diseases, Ninth Revision codes for colectomies. We excluded patients with recurrent disease, rectal cancer, or preoperative chemotherapy. Demographics, diagnosis, tumor location, operative procedure, and staging information were obtained from the medical record review. The primary end point was number of LNs examined, which was ascertained from the surgical pathology report. Clinical and patient factors such as age, sex, and tumor location were grouped as nonmodifiable factors. Hospital type, surgeon, and surgical approach (laparoscopic vs open) were grouped as modifiable factors.

STATISTICAL ANALYSIS

To test for associations between categorical- and ordinal-valued data, we used the \( \chi^2 \) test. The paired, 2-tailed \( t \) test was used for univariate comparisons of means assuming homogeneous variances. A linear regression model was used for multivariate analysis of factors that could independently influence the number of LNs retrieved and examined. \( P < .05 \) was considered statistically significant.

RESULTS

Eighty-three patients who underwent colon resection for colon cancer or polyp were identified (42 patients at the NCCN hospital and 41 patients at the community hospitals). Patient characteristics are provided in Table 1. The median age of patients at the NCCN and community hospitals was 64 (range, 36-91) and 71 (range, 42-90) years, respectively. Most of the patients were male (>60%), and the distribution was similar in both types of hospitals. The tumor location was not significantly different between the hospitals except for a slightly increased trend of right-sided colon lesions at the community hospitals and multiple lesions at the NCCN hospital. The surgical approach was also not significantly different between these institutions. Most of the colectomies were performed laparoscopically at both types of hospitals (NCCN hospital, 35 patients [83%]; community hospitals, 37 patients [90%]).

Surgeon 1 performed 50 of the 83 cases (60%), whereas surgeon 2 performed the remainder (33 cases [40%]). As shown in Table 1, most of the cases at the NCCN hospital (29 cases [69%]) were completed by surgeon 1, whereas the cases were evenly distributed between the 2 surgeons at the community hospitals. However, the proportion of cases performed by each surgeon at the 2 types of hospitals did not reach statistical difference. The median number of LNs examined in colectomies performed by surgeons 1 and 2 were 18.8 and 15.6, respectively, at the NCCN hospital vs 7.3 and 6.6, respectively, at the community hospitals (Figure 1). The mean number of LNs retrieved was not different between the surgeons at either type of hospital (Figure 1).

The number of LNs retrieved was significantly different by the hospital type in which the procedure was performed. The median number of LNs examined at the NCCN vs community hospitals was 17.8 vs 7.0 (\( P < .001 \)) (Figure 2). The frequency of an inadequate number of LNs examined, that is, evaluation of fewer than 12 LNs, was 11 of 42 cases (26%) at the NCCN hospital vs 35 of 41 cases (85%) at the community hospitals (\( P < .001 \)). The distribution of T stages was not significantly different be-

### Table 1. Characteristics of the Study Population in the NCCN and Community Hospitals

<table>
<thead>
<tr>
<th>Factor</th>
<th>NCCN</th>
<th>Community</th>
<th>( P ) Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of patients</td>
<td>42</td>
<td>41</td>
<td>.91</td>
</tr>
<tr>
<td>Sex</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>26 (62)</td>
<td>26 (63)</td>
<td>.88</td>
</tr>
<tr>
<td>Female</td>
<td>16 (38)</td>
<td>15 (37)</td>
<td></td>
</tr>
<tr>
<td>Age, median (range), y</td>
<td>64 (36-91)</td>
<td>71 (42-90)</td>
<td>.07</td>
</tr>
<tr>
<td>Surgeon</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>29 (69)</td>
<td>21 (51)</td>
<td>.09</td>
</tr>
<tr>
<td>2</td>
<td>13 (31)</td>
<td>20 (49)</td>
<td></td>
</tr>
<tr>
<td>Surgical approach</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Laparoscopic</td>
<td>35 (83)</td>
<td>37 (90)</td>
<td>.35</td>
</tr>
<tr>
<td>Open</td>
<td>7 (17)</td>
<td>4 (10)</td>
<td></td>
</tr>
<tr>
<td>Tumor location</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Right colon</td>
<td>22 (52)</td>
<td>28 (68)</td>
<td></td>
</tr>
<tr>
<td>Transverse colon</td>
<td>1 (2)</td>
<td>1 (2)</td>
<td></td>
</tr>
<tr>
<td>Left colon</td>
<td>5 (12)</td>
<td>5 (12)</td>
<td>.14</td>
</tr>
<tr>
<td>Sigmoid colon</td>
<td>6 (14)</td>
<td>6 (15)</td>
<td></td>
</tr>
<tr>
<td>Multiple lesions</td>
<td>8 (19)</td>
<td>1 (2)</td>
<td></td>
</tr>
<tr>
<td>T stage</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>0</td>
<td>18 (43)</td>
<td>14 (34)</td>
<td>.50</td>
</tr>
<tr>
<td>1</td>
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<td>8 (20)</td>
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</tr>
<tr>
<td>2</td>
<td>7 (17)</td>
<td>8 (20)</td>
<td>.70</td>
</tr>
<tr>
<td>3</td>
<td>15 (36)</td>
<td>10 (24)</td>
<td>.30</td>
</tr>
<tr>
<td>4</td>
<td>2 (5)</td>
<td>1 (2)</td>
<td>&gt;.99</td>
</tr>
</tbody>
</table>

Abbreviation: NCCN, National Comprehensive Cancer Network.

\( ^a \)Unless otherwise specified, data are expressed as number (percentage) of patients. Percentages have been rounded and might not total 100.

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In the absence of distant metastasis, regional LN status is the most important predictor of long-term survival in colon cancer. In addition, LN status is the key factor that influences the decision to administer adjuvant chemotherapy. Multiple studies have found that, when additional LNs are examined, patients with stages II and III disease have a significant survival advantage.\(^5\)\(^6\) In a study of 4300 patients, Vather et al\(^8\) showed that the number of LNs examined was a predictor of 5-year mortality after controlling for factors such as age, sex, ethnicity, and site. The survival advantage was minimal after 16 nodes were removed and examined. Similarly, Joseph and colleagues\(^7\) found that the 5-year survival rate was 100% when more than 30 LNs were examined and fell to 80% when fewer than 30 LNs were found. The observed improvement in overall survival may be due in part to stage migration and more accurate staging leading to increased use of adjuvant treatment.

The number of LNs examined depends on multiple factors, including surgical technique, diligence of the pathological examination, and patient-related factors such as obesity, age, sex, and tumor location.\(^9\)\(^10\)\(^20\) In our data, the only patient factor that predicted the number of LNs retrieved was location of cancer, as previously shown in other studies.\(^14\)\(^20\) Bilimoria et al\(^20\) showed that patients with left-sided colon cancer are 59% less likely to undergo adequate nodal evaluation. Similar results were echoed by Baxter et al\(^14\) in a study of more than 100 000 patients in which left-sided lesions were 59% less likely to receive adequate nodal evaluation. Although we did not find any correlation between age and sex and the number of LNs retrieved in contrast to previous studies that showed decreased LN evaluation in men and older patients (Baxter et al,\(^14\) age $\geq$51 years and Bilimoria et al,\(^20\) age $\geq$67 years), our sample size might be inadequate to identify these differences.

Based on several observational studies, the current recommendation is to examine a minimum of 12 LNs for adequate nodal staging. However, despite these recommendations, inadequate nodal evaluation in colon cancer resections remains the norm. A recent study using the National Cancer Database reported that the percentage of hospitals that adhere to the 12-LN measure increased from 15% during 1995 to 1996 to 38% during 2004 to 2005.\(^21\) Those findings confirmed the results of a previous population-based study by Baxter et al,\(^14\) which reported that only 37% of patients with colon cancer receive adequate nodal evaluation in the United States.
Our study demonstrates that the number of LNs examined varies by hospital type. The frequency of inadequate LN examination at the NCCN and community hospitals was 26% and 85%, respectively. These results are consistent with data from other studies. A report by Bilimoria et al. that evaluated colectomies performed in nearly 1300 hospitals reported that NCCN-designated cancer hospitals more frequently adhered to the 12-LN measure compared with other academic, Veterans Affairs, and community hospitals (78.1% vs 52.4%, 53.1%, and 33.7%, respectively). Although these studies clearly demonstrate that the number of LNs is different between types of institutions, they do not account for the role of specific surgeons involved in these resections.

Our data, when controlled for the surgeon, still show that the number of LNs retrieved in colon specimens depends on hospital type. Although there was no difference in the number of LNs retrieved at specific hospital types between the 2 surgeons, the number of LNs retrieved was very different between types of institution (Figure 1) and was different for all resections regardless of surgeon (Figure 2). These findings were confirmed on multivariate analysis, in which the hospital type was the only modifiable factor for the number of LNs retrieved (P < .001).

Our study has several limitations. First, we did not evaluate or compare the pathological processing of the surgical specimen at each type of hospital. This information was not easily obtained from the retrospective medical record review. Second, we limited our study to 2 surgeons who each operated in both types of hospitals. We assumed that the surgeons did not vary the resection technique between locations, and our assumption was supported by the finding that the number of LNs retrieved was similar between surgeons at both types of hospitals, arguing for standardized resections performed by both surgeons. Finally, the size of our cohort (N = 83) may have precluded adequate statistical power to identify less robust clinical and patient factors, such as age and sex, that may account for differences in LN retrieval.

Strengths of our study include the use of only 2 surgeons who operated at both the NCCN and community institutions. By comparing the LN recovery from each of the hospital types for each of the 2 surgeons, we were able to control for the surgeon as a factor in differences in LN retrieval. In addition, the ability to study an NCCN institution as well as community hospitals enabled us to focus on distinct types of hospitals as a factor in the number of LNs retrieved at colon resections.

Given the national emphasis to apply standards of quality to health care, the number of LNs retrieved in a colon resection for colon cancer has become critical in the care of colon cancer patients. The importance of adequate oncologic resection cannot be overemphasized; however, the number of LNs examined depends on more than the surgical resection and requires careful, standardized pathologic evaluation at each institution.

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REFERENCES