The Learning Curve for Sentinel Node Biopsy in Breast Cancer

Practical Considerations

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Hypothesis: Performance of sentinel node biopsy (SNB) instead of full axillary lymph node dissection (ALND) by inexperienced surgeons will lead to understaging of some women with breast cancer and increased costs.

Design: A decision analysis model was used to investigate the implications of SNB vs full ALND during the learning phase (60-80 procedures). This model simulates a randomized trial of 10,000 women in each arm. Data regarding the learning curve were obtained from published series.

Main Outcome Measures: Percentage of women with inaccurate staging of their breast cancer, overall survival, quality-adjusted survival, and potential costs of SNB vs ALND.

Results: Performance of SNB instead of ALND results in inability to locate a sentinel node in 38% of attempts during the learning phase (compared with 10% in later cases) and understaging in 12% of patients during the learning phase (compared with 0% in later cases). This understaging is associated with a small decrement in survival (1%-2%) and an increased risk of axillary recurrence. Sentinel node biopsy is cost-effective only when the ability to detect sentinel nodes exceeds 80%; and the cost of SNB is less than 50% of the cost of ALND.

Conclusions: To ensure accurate staging of patients with breast cancer, all surgeons should perform full ALND while learning SNB techniques. Only after documentation of accuracy of SNB (sensitivity >90%) should full ALND be omitted for women with negative sentinel nodes.

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XILLY NODE dissection (ALND).has been a routine part of breast cancer surgery, although its necessity for women with clinically negative axillae is being questioned. In 1992, Morton et al introduced sentinel lymph node biopsy (SNB) as a less invasive alternative for assessing lymph node metastases in patients with melanoma. Subsequent investigations by Krag et al., using radiocolloid, and Giuliano et al., using isosulfan vital blue dye, proved the effectiveness of SNB for staging patients with breast cancer as well.

Turner and coworkers have shown that the sentinel node is the most likely axillary node to harbor metastases, and proposed that patients with histologically negative sentinel nodes may be spared full ALND. Several other research groups have also demonstrated promising results of SNB (Table). Despite this enthusiasm, Morton and Cox et al. have commented on the “learning curve” inherent in mastering new procedures. Proper identification of the sentinel node requires multidisciplinary expertise, including a surgeon trained in the technique and nuclear medicine and pathologic experts. Morton recommends that surgeons learning SNB should perform a full axillary clearance on all patients during this learning phase (60-80 cases) to monitor the accuracy of the procedure. He asserts that a surgeon’s inexperience (or lack of appropriate multidisciplinary support) will lead to understaging of patients and to increased breast cancer recurrence.

Apparently some surgeons are performing SNB instead of axillary clearance, forgoing the formal learning phase recommended by Reintgen. This trend will likely become more prevalent as SNB becomes popularized in the lay press, especially since few surgeons have access to the number of patients with breast cancer required to surmount the learning curve in a reasonable period. To assess the potential significance of performing SNB instead of ALND, we used a clinical decision analysis model to evaluate the effectiveness of SNB done by experienced vs inexperienced surgeons.

RESULTS

Use of SNB during the learning curve phase results in a significant number of incorrectly staged patients. For our baseline sce-
predicted survival related to the avoidance of full ALND be-

As the sensitivity of SNB approaches 100%, the loss in ex-

postoperative year.

approximately half of these recurrences occurring within the first

3% of patients with “negative” SNB results, with approxi-

mately-adjusted life expectancy. Axillary recurrence occurs in

patients receiving SNB averaged a 1.3% decrement in qual-

ity-adjusted life-years, 10.2; and for SNB: life expectancy,

sis were for ALND: life expectancy, 18.7 years; nondis-


tancy of 4 months (1.6%) for the SNB cohort, compared

with patients receiving full ALND. Results of decision analy-

sis were derived from Velanovich,32 and local expert opinion.

Models were created and analyses performed using the soft-

ware DATA 3.0 (TreeAge Software Inc, Williamstown, Mass).

All costs and utilities were discounted over time, using a dis-

count rate of 3%. For our initial analysis, we assumed that

the patients have palpable 3-cm tumors, and that the like-

lihood of positive nodes is 46%.

nario (3-cm palpable tumor), 12% of patients declared

“node negative” by SNB will actually harbor metastatic dis-

case. This incorrect staging leads to a loss in life expec-

tancy of 4 months (1.6%) for the SNB cohort, compared

with patients receiving full ALND. Results of decision analy-

sis were for ALND: life expectancy, 18.7 years; nondis-

counted quality-adjusted life-years, 13.0; discounted qual-

ity-adjusted life-years, 10.2; and for SNB: life expectancy,

18.4 years; nondiscounted quality-adjusted life-years, 12.8;

discounted quality-adjusted life-years, 10.0. Quality-

adjusted survival figures are similar. Compared with ALND,
patients receiving SNB averaged a 1.3% decrement in qual-

ity-adjusted life expectancy. Axillary recurrence occurs in

3% of patients with “negative” SNB results, with approxi-
mately half of these recurrences occurring within the first

postoperative year.

SENSITIVITY ANALYSIS

As the sensitivity of SNB approaches 100%, the loss in ex-
pected survival related to the avoidance of full ALND be-
comes nil. For example, the expected survival decrement
drops to 1 month if 90% of axillae with metastases are cor-
rectly diagnosed by SNB. As expected, the likelihood of posi-
tive lymph nodes is also a major determinant of the out-
come following SNB. Fewer than 20% of patients with non-

palpable T1 tumors will have axillary nodal metastases.

Consequently, patients in this subgroup experience less

benefit from full ALND—1 month of better life expec-
tancy than SNB. The incorporation of an independent sur-
vival benefit for ALND in our model and varying the per-
centage of cases in which a sentinel node could not be iden-
tified had little effect on the relative life expectancies for the
2 strategies. Other important variables having minimal ef-

fects on the model’s predictions include baseline survival prob-
abilities, patient age, and quality-of-life adjustments.

Our baseline analysis assumes that patients with his-
tologically negative nodes did not receive chemotherapy.

In reality, many patients with known risk factors (eg, pre-

menopausal, T2 tumors, aggressive histological features,

and estrogen receptor negative) are treated with chemo-
therapy irrespective of nodal status. If we assume that 50%

of node-negative patients will receive chemotherapy, then

the advantage of ALND declines significantly, with ALND

patients gaining only 1 month of life expectancy over SNB

patients. As the number of node-negative patients receiv-
creasing chemotherapy increases, the benefit of full ALND decreases proportionately.

**COST ANALYSIS**

Because of the significant number of sentinel nodes not identified during the learning curve phase (38%), SNB is relatively expensive. Patients with unidentified sentinel nodes receive the expenses of ALND in addition to those of SNB, which include costs for additional operating room time, additional frozen sections, and radiocolloid localization (if used). The SNB arm is more expensive than the ALND arm during the learning curve phase unless the cost of SNB can be reduced to less than 40% of the cost of ALND. This implies a "break even" SNB cost of $4000 when compared with a typical overnight hospitalization, but only $1200 when compared with outpatient surgery. As surgical experience increases, with a consequent increase in the likelihood of identifying the sentinel node, the cost of SNB decreases proportionately. For example, if 90% of sentinel nodes are identified, the "break even" costs increase to $6000 (compared with inpatient ALND) and $1800 (compared with outpatient ALND).

Table: Published Series of Sentinel Node Biopsies for Breast Cancer

<table>
<thead>
<tr>
<th>Source, y</th>
<th>Total N</th>
<th>Node Positive, %</th>
<th>Sentinel Nodes Identified, %</th>
<th>Sensitivity, %</th>
<th>Method</th>
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<td>Giuliano et al, 1994</td>
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<tr>
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*The results include the authors’ “learning experience” as well as later procedures.

Our analysis has some important limitations. We cannot totally reconcile the suggestion that surgeons in the learning curve phase will identify some node-positive patients who would not have been identified without any axillary surgery. We believe that the literature does not support this approach, as series of axillary node sampling have shown higher rates of axillary recurrence as well as suggesting diminished survival. We did not consider the possibility that SNB may identify more patients with positive nodes by using sophisticated histologic techniques for sentinel node examination, but doubt that omission of the possibility of increased detection of occult metastases will change the results of our analysis.

Many authors have described the learning curves peculiar to laparoscopic surgery, and guidelines have been proposed to ensure the safety of these procedures. In a review, Gates has outlined several key points that allow surgeons to learn new procedures while benefiting patients, including avoidance of harm, peer review, and informed consent. Obviously, prevention of harm to patients must be foremost. As Copeland observes, the learning phase for SNB is different from that of laparoscopic procedures. A technical failure of SNB will not be apparent in the short term, but may lead to grave long-term effects, as opposed to the technical failures of laparoscopy, which are apparent immediately, or in the discernible future. It is impossible to ensure the accuracy of SNB during the learning phase without comparison with the criterion standard—full ALND. Hospital peer reviewers must have this information to comfortably certify surgeons in their institutions to assure that patients are not harmed by inadequate operations. Patients must be informed of an individual surgeon’s “track record” regarding SNB, as well as the potential of her being understaged by the procedure. This study strongly supports the requirement for surgeons to perform full ALND during the learning phase, until the surgeon can document acceptable identification of sentinel nodes and sensitivity for detecting metastatic disease.
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