

Cost-Effectiveness Analysis of Watchful Waiting, Sentinel Lymph Node Biopsy, and Elective Neck Dissection in the Diagnosis and Management of Early Stage Oral Cavity Cancer

Ankita Naraparaju, Vikas Mehta

Abstract

Background: The optimal management strategy of early stage oral cavity cancer without evidence of clinical nodal involvement has yet to be fully elucidated. Electively addressing the nodal basin has demonstrated superior survival outcomes. Both elective neck dissections (ENDs) and sentinel lymph node biopsies (SLNB) have been shown to be effective strategies in elective nodal management for early stage oral cavity disease

Objective: To assess the cost-effectiveness of three strategies for the diagnosis and management of early stage oral cavity cancer

Methods: A cost-effectiveness analysis was performed by creating a Markov model to simulate outcomes of three strategies for the diagnosis and management of early stage oral cavity cancer: 1) Watchful Waiting (WW); 2) Sentinel Lymph Node Biopsy (SLNB); and 3) Elective Neck Dissection (END). The model was simulated for 20 years after resection of the primary cancer. Aggregate costs and quality-life years were measured fee schedules from the Centers of Medicare and Medicaid, as well as values cited in literature. Strategies were considered cost-effective if incremental cost-effectiveness ratios (ICER) were less than a willingness-to-pay (WTP) of \$100,000 / QALY. One-way sensitivity analysis was performed for all utility, cost, and transition probability variables.

Results: Over 20 years, the estimated total cost for managing a single patient with early stage oral cavity cancer was \$30,560 in the WW strategy; \$38,718 in the SLNB strategy; and \$45,878 in the END strategy. Management of early stage oral cavity cancer with the three strategies provided 1.17, 3.75, and 3.36 QALYs in the WW, SLNB, and END strategies respectively. At a willingness-to-pay set at \$100,000 / QALY, both the SLNB with an ICER of \$3,163 / QALY and the END, with an ICER of \$6,995 / QALY, were shown to be cost effective. The sensitivity analyses showed that SLNB and END management always resulted in higher costs and greater quality-adjusted life years than WW management over the sensitivity ranges for individual variables.

Conclusion: The degree of cost savings and improved patient utility of END and SLNB management compared to WW management was quantified with SLNB shown to be the most cost-effective. We demonstrated that these findings persisted in sensitivity analysis to account for variability in recurrence rate, surveillance approaches, and other model inputs. These findings allow for greater understanding of the economic and quality-of-life impact of management of patients with early stage oral cavity cancer with no evidence of clinically nodal metastases at presentation.

Introduction

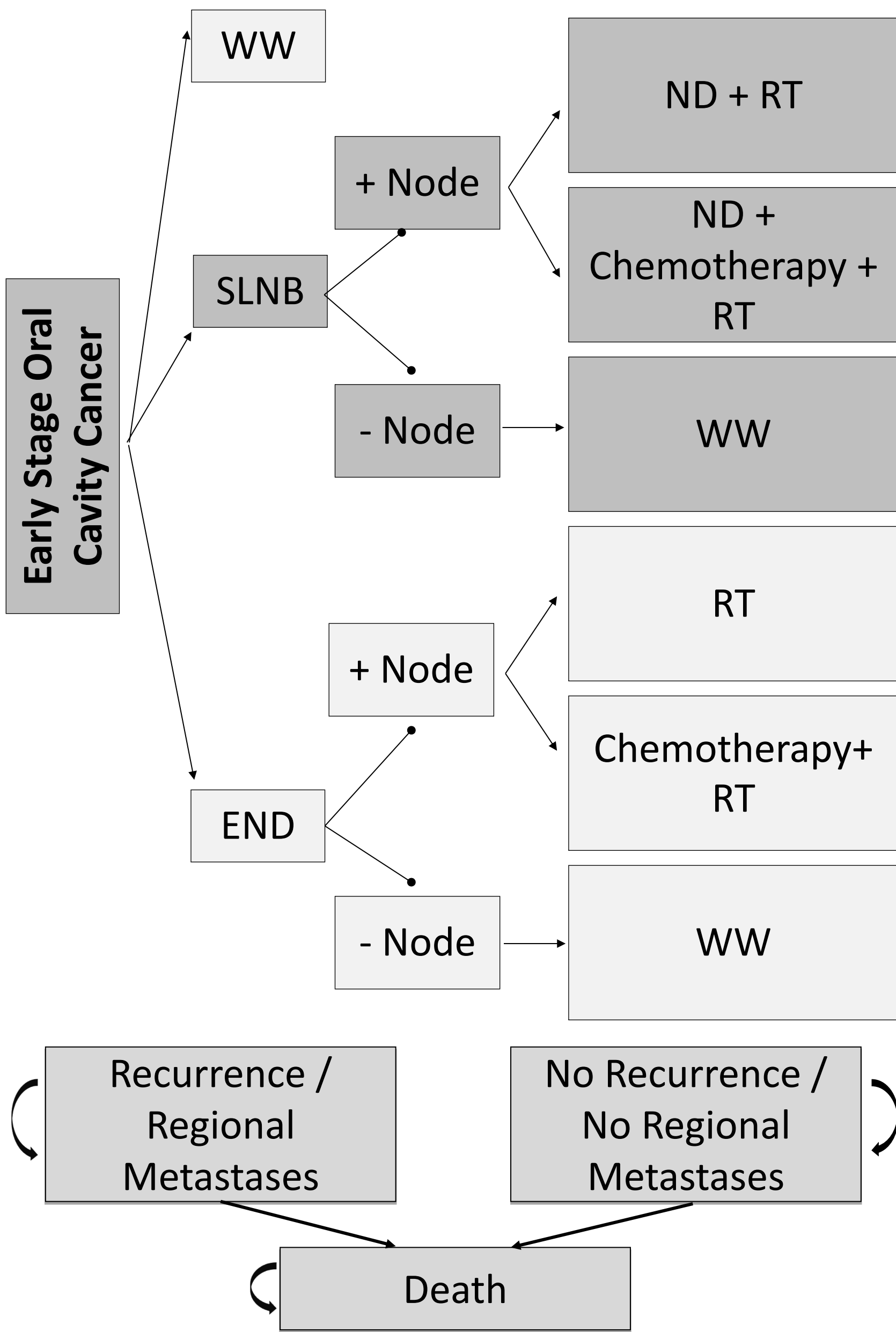
Cancers of the oral cavity and pharynx comprise approximately 3% of all cancers diagnosed and approximately 2% of all cancer-related deaths in the United States. An estimated 53,260 new cases of oral cavity and pharynx cancer will be diagnosed in 2020. Furthermore, 90% of these cancers are squamous cell carcinomas.¹⁻³

The treatment paradigm for the management of node-negative patients has yet to be fully elucidated. Patients who are node-negative upon primary tumor resection have a significant rate of nodal involvement down the line.⁴ Once there is nodal involvement, the prognosis for patients drops substantially.⁵ Multiple studies have shown that elective neck dissection (END) and sentinel lymph node biopsy (SLNB) are both cost-effective alternatives to watchful waiting (WW).^{4,5,6} Neck dissections, while associated with superior survival outcomes⁶, are invasive and costly procedures that subject patients to increased morbidity risk and decreased quality of life. SLNB may prove to be an intermediate option; while still somewhat invasive, SLNBs are associated with a lower morbidity risk.⁵

The purpose of this study was to perform a cost-effectiveness analysis for three management strategies for the management of node-negative T1,2,N0 oral cavity cancer after primary tumor resection – 1) WW, 2) SLNB, and 3) END. Our analysis incorporates costs, quality of life utility values, and transition state probabilities of the aforementioned strategies.

Methods

We created a decision tree and Markov model in TreeAge Pro Healthcare to compare three main strategies for the management of early stage oral cavity cancer after the initial resection of the primary cancer. The three strategies are: 1) Watchful Waiting, 2) Sentinel Lymph Node Biopsy, and 3) Elective Neck Dissection. Each outcome described in the model was represented by a probability. These probabilities were identified from the literature or from expert consensus and aggregated using a pooled analysis. Costs were aggregated using fee schedules from the Centers of Medicare and Medicaid, as well as from the literature. Costs were measured in USD, and any historical costs used from literature were inflation-adjusted to reflect costs in 2020 by applying an annual growth rate of 3%. Utility values represent changes in quality of life based on treatment paradigm and range from 0 to 1, with 0 representing death and 1 representing perfect health. Utility values for each transition state were aggregated based on values cited in literature for similar health states. Incremental cost-effectiveness ratios were evaluated for each of the strategies. One-way sensitivity analysis was performed for cost, probability, and utility variables to determine the effects of variability on each of these parameters on overall cost-effectiveness of these strategies.



Results & Discussion

The estimated cost for managing a single patient with early stage oral cavity cancer for 20 years was \$30,560 in the WW strategy; \$38,718 in the SLNB strategy; and \$45,878 in the END strategy. Management of early stage oral cavity cancer with the three strategies provided 1.17, 3.75, and 3.36 QALYs in the WW, SLNB, and END strategies respectively. Thus, the SLNB and END strategies offered an incremental effectiveness of 2.58 and 2.19 QALYs relative to the WW management strategy, respectively. Both of the SLNB and END strategies were more expensive than the WW strategy. At a willingness-to-pay set at \$100,000 / QALY, the SLNB has an ICER of \$3,163 / QALY, whereas the END strategy has an ICER of \$6,995 / QALY.

One-way sensitivity analyses for incremental cost and incremental effectiveness were performed over the following variables: utilities of each final health state in each management strategy, transition probabilities between all health states except those between SLNB and END to either radiation therapy alone or chemoradiation, and the costs of all procedures involved in each health state. The range of incremental costs associated with SLNB management across all one-way sensitivity analysis ranged from savings of \$1,768 to cost incurred of \$20,245. Cost savings occurred when the transition probability of WW to NED was the lowest. The greatest incremental costs of the SLNB were incurred at the lowest probability of transition from WW to disease recurrence. The range of incremental effectiveness of SLNB compared to WW across all one-way sensitivity analysis ranged from 1.74 to 3.24. The lowest incremental effectiveness occurred at the lowest utility value for the SLNB management strategy in which a patient has a negative node and NED; the highest incremental effectiveness occurred at the lowest transition probability of WW to NED.

The range of incremental costs associated with END management across all one-way sensitivity analysis ranged from \$5,392 to \$27,405. As seen in the SLNB strategy, the lowest incremental costs of END relative to WW occurred when the transition probability of WW to NED was the lowest. The greatest incremental costs of the SLNB were incurred at the lowest probability of transition from WW to disease recurrence. The range of incremental effectiveness of END compared to WW across all one-way sensitivity analysis ranged from 1.18 to 4.42. The transition probability for a patient in END management strategy who had negative nodes and ultimately NED accounted for the entire range incremental effectiveness.

Variable	WW	SLNB	END
Cost (\$)	30,650	38,718	45,878
Effectiveness (QALY)	1.17	3.75	3.36
ICER (\$ / QALY) (WW Strategy as Baseline)		3,163	6,995

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