The Influence of Reconstructive Modality on Cost of Care in Head and Neck Oncologic Surgery

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Objective: To determine the differential costs of 3 reconstructive modalities in patients undergoing head and neck oncologic surgery.

Design: Cost-identification analysis.

Setting: Academic tertiary care medical center.

Methods: Retrospective review of 104 major head and neck resections involving primary tumors of the upper aerodigestive tract requiring a tracheotomy (primary hospital discharge, diagnosis related group 482 from the International Classification of Diseases, Ninth Revision, Clinical Modification) from July 2, 1999, through June 30, 2000. Patients were stratified by reconstruction modality: (1) microvascular free tissue transfer (MFFT), (2) pedicle myocutaneous flaps (PMF), and (3) primary reconstruction and/or skin graft (PR). Dependent variables included length of hospitalization, direct and indirect hospital costs, total hospital costs, the percentage of total costs attributable to direct costs, and the percentage of total costs attributable to indirect costs.

Results: No significant age differences existed among the 3 patient groups. Significant differences (Kruskal-Wallis) were observed for all variables. The PR group was compared with the PMF and MFFT groups. Total patient charges were greatest in the MFFT group (mean, $22821.04) and least for the PR group (mean, $13125.70). Length of stay was greatest in the MFFT group (mean, 7.53 days) and shortest in the PR group (mean, 5.53 days).

Conclusions: Intricate reconstructions are frequently more times consuming than primary closure, and the additional surgical procedures are more likely to use more hospital resources. Efforts at providing superior functional outcomes must be balanced against increasing restrictions on the use of health care dollars. Careful evaluation of functional outcomes and quality of life will be required to justify the increased expenditure incurred when providing complex reconstructions.


OVER THE last 30 years, health care spending in the United States has risen from 6.0% of gross domestic product to its current level of almost 14%. This translates to an average health care expenditure of approximately $8000 per capita, with an estimated 40 million Americans (15% of the population) uninsured. The failure of national health care reform efforts from 1992 to 1994 resulted in the evolution of 2 mechanisms to reduce overall health care expenditures. The first is a market-driven attempt by private-sector insurers to reduce costs by increasing the copayment and deductible portions of insurance policies and reducing payments to providers through increased enrollments in more restrictive health maintenance organizations and preferred provider organizations. The second mechanism involves reduced payments to providers from public-sector insurers, primarily Medicare and Medicaid. Legislation such as the Balanced Budget Act of 1997 places limitations on Medicare and Medicaid expenditures, which translate into reduced reimbursement to providers and acute care hospitals.2 Worst case projections include speculation that by 2010 national health expenditures will approach 20% of gross domestic product, resulting in 65 million uninsured Americans, collapse of the “safety net” for uninsured and underinsured individuals, and radical restriction of access to health care.3

Patients with head and neck malignancies represent a high-risk population for increased utilization of health care resources associated with cancer treatments. These patients usually present in the later decades of life and commonly have cardiac, pulmonary, and vascular comorbidities associated with their long-term consumption of tobacco and alcohol.4 Critical pathways, creation of specialized head and neck surgery nursing units, case management programs, and quality assurance reviews are specific initiatives implemented in many centers to control costs and improve quality of care for patients with head and neck cancer.5-9
Complex 3-dimensional defects following resection of head and neck tumors frequently require reconstruction with tissue distant from the primary surgical site. Much consideration has been directed at the technical refinement of these reconstructions, and while they continue to be evaluated in the context of the recovery of deglutition, speech, and acceptable cosmesis, little attention has been given to their cost to the health care delivery system. With federal and private-sector health care payers increasing restrictions on reimbursements to hospitals and providers, these expensive procedures must be justified in terms of benefits to patients. We undertook this study to stratify the costs of care based on reconstructive modality.

**METHODS**

We retrospectively reviewed the medical records of all patients discharged from the Loyola University Medical Center, Foster G. McGaw Hospital, Maywood, Ill, from July 2, 1999, through June 30, 2000, and found 117 patients who underwent primary surgical tracheotomy by one of us (G.J.P.) to treat head, neck, and mouth disorder (diagnosis related group 482 from the International Classification of Diseases, Ninth Revision, Clinical Modification [ICD-9-CM]). Only those with the primary medical diagnosis of an upper aerodigestive tract malignancy (International Classification of Diseases, Ninth Edition) and who underwent definitive surgical resection were included in this review. Patients requiring multiple procedures or those with failed reconstructions were excluded from analysis. A total of 104 patients who underwent major head and neck resections that involved primary tumors of the upper aerodigestive tract and required a tracheotomy were analyzed.

Patient charges as a surrogate for actual health care costs were determined from the Loyola University general ledger and activity bases cost accounting system (TDS 7000; Ellipsys Corporation, Delray Beach, Fla). Data were reported as direct, indirect, and total costs. Direct costs were further subdivided into variable and fixed costs. Variable direct costs included those items associated with a particular patient for a particular episode of care, including disposable supplies, radiology charges, and laboratory tests. Fixed direct costs were those that did not vary with the level of care provided and included those assigned to a particular hospital department independent of particular patients (eg, the cost of a computed tomographic scanner). Finally, indirect costs were those outside particular departments (eg, social services). Hospital overhead is usually taken as the aggregate of the fixed direct and indirect costs.10

Operative reports were reviewed, and patients were stratified by their reconstruction modality: (1) microvascular free tissue transfer (MFFT), (2) pedicle myocutaneous flaps (PMF), and (3) primary reconstruction and/or skin graft (PR). To compare cost with outcome data, we also reviewed charts for gastrostomy-tube dependence and complications. Dependent variables included length of hospitalization, direct and indirect hospital costs, total hospital costs, the percentage of total costs attributable to direct costs, and the percentage of total costs attributable to indirect costs. Specific cost centers, including the operating room, respiratory therapy, and pharmacy, were also identified as to their relative percentage contribution to the total cost of care. Descriptive statistics are reported as mean (SD) for all variables. Statistical significance was determined with either the Wilcoxon W or the Mann-Whitney U test, as appropriate.

A total of 104 patients met our inclusion criteria during the study period. All patients underwent tracheotomy: 24 (23%) received MFFT; 15 (14%) received PMF; and 64 (63%) were treated with PR. Table 1 lists the summary of the variables studied in the 3 groups. Length of stay was greatest in the PMF group (mean, 7.53 days) and shortest in the PR group (mean, 5.53 days); total patient charges were greatest in the MFFT group (mean, $22,821.04) and least for the PR group (mean, $13,125.70); and direct and indirect costs were also greatest in the MFFT group (means, $12,792.91 and $10,028.13, respectively). Significant differences were observed for all variables when all 3 groups were compared at once (Kruskal-Wallis test). Significant differences were also observed when PR was compared with PMF and MFFT groups separately (Mann-Whitney U test). While the MFFT and PMF groups showed no differences in their lengths of stay, there was a significant cost differential between these groups (Table 2).

To determine relative percentages of hospital overhead charged to individual groups, we also compared the percentages of the direct and indirect costs with total cost (Table 1 and Table 3). Patients in the PR group had a significantly higher percentage of indirect cost attributable to total costs (45.64%), indicating that even though their overall expenses were lower, they contributed a greater portion to hospital overhead expenses.

The percentage of total attributable to charges for the 3 cost centers common to all 3 groups was also examined, and for simplicity the PMF and MFFT groups were combined. As summarized in Table 4, the greatest difference between the flap and no-flap groups was in operating room charges (42.64% vs 35.13%). In the PMF group, 67% of patients were ultimately able to tolerate a general diet; 89% of the MFFT group were completely gastrostomy-tube independent; and 96% of the PMR group tolerated a general diet without gastro-

### Table 1. Summary of Relevant Patient Characteristics and Costs*

<table>
<thead>
<tr>
<th></th>
<th>Free Flap</th>
<th>Pedicle Flap</th>
<th>No Flap</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Age, y</strong></td>
<td>58.2 (9.8)</td>
<td>64 (12.8)</td>
<td>61.1 (11.0)</td>
</tr>
<tr>
<td><strong>Length of stay, d</strong></td>
<td>6.9 (1.9)</td>
<td>7.5 (4.3)</td>
<td>5.3 (2.1)</td>
</tr>
<tr>
<td><strong>Direct costs</strong></td>
<td>$12,792.91 (2794.44)</td>
<td>$9869.88 (4541.36)</td>
<td>$7144.83 (2890.90)</td>
</tr>
<tr>
<td><strong>Indirect costs</strong></td>
<td>$10,028.13 (2282.33)</td>
<td>$7778.41 (3317.15)</td>
<td>$5980.87 (2309.68)</td>
</tr>
<tr>
<td><strong>Total costs</strong></td>
<td>$22,821.04 (5062.81)</td>
<td>$17,648.20 (7817.86)</td>
<td>$13,125.70 (5153.58)</td>
</tr>
<tr>
<td><strong>Direct costs, %</strong></td>
<td>56.09 (.89)</td>
<td>55.69 (2.13)</td>
<td>54.38 (4.42)</td>
</tr>
<tr>
<td><strong>Indirect costs, %</strong></td>
<td>43.91 (.89)</td>
<td>44.31 (2.13)</td>
<td>45.62 (2.42)</td>
</tr>
</tbody>
</table>

*All data are mean (SD); costs are measured in fiscal year 2000 dollars (July 1, 2000, to June 30, 2001).
The ideal reconstructive modality should reliably restore natural anatomic barriers; allow for rapid, single-staged recovery of deglutition, respiration, and speech; and provide for acceptable cosmesis. Mindful of the limitations of health care resources, we should direct efforts at accomplishing these goals with some consideration to the costs associated with the various reconstructive modalities.

The analysis of cost of medical care has been divided into 3 main types of studies: cost-identification (as in the present study), cost-effectiveness, and cost-benefit. Common to the 3 types of studies is the concept of potential compromise between cost of therapy (resources) and potential benefit to the patient. Cost-identification analysis assumes all outcomes are equivalent in terms of quality of life, survival, and functional indices; therefore, cost becomes the only metric examined. Cost-identification analysis forms the basis for the remaining 2 study types, cost-effectiveness and cost-benefit analyses. Cost-effectiveness (or cost-utility) studies attempt to measure the cost of an intervention against a particular unit of outcome (ie, quality-adjusted life-years), while cost-benefit analysis produces a unitless ratio of the cost to an estimation of the monetized benefit of a particular intervention. Cost-identification studies are the most common type of health-related economic analyses in the head and neck surgery literature.11,12

Cost-identification analyses have been applied in several settings in head and neck surgery. The most common application has been to measure the cost and resource utilization prior to and following the implementation of a critical pathway in patients undergoing head and neck surgery. In 1997, Cohen et al8 reported a 1.5- to 1.6-day reduction in length of stay in patients undergoing head and neck tumor resection with or without flap closure. Savings in total costs for these patients ranged from $9845 to $7407 in the groups with and without flap reconstruction, respectively. Similarly, Husbands et al10 reported that the implementation of a clinical care pathway in patients undergoing head and neck surgery resulted in a 5-day reduction in length of stay (from 15 to 10 days) and mean savings of $26,000 per patient. This was accomplished by overall reductions in all cost centers examined and without significant cost shifting to skilled nursing or rehabilitation facilities. Data from our own institution demonstrate lower overall lengths of stay and mean cost per case compared with these 2 studies.

In addition to their utility in the general head and neck cancer surgical population, the use of clinical pathways has also been applied to more selected populations of patients with head and neck cancer. Data from the University of Texas M.D. Anderson Cancer Center, Houston, have shown that the use of a clinical pathway for patients undergoing a unilateral neck dissection has led to a 2-day reduction in length of stay and an associated reduction in the total cost of care for pathway patients compared with historical controls and contemporaneous nonpathway patients.13 Hanna and coworkers14 described a series of 15 patients undergoing total laryngectomy managed on a clinical pathway demonstrating a 29% reduction in length of stay and a 14% reduction in variable hospital costs compared with 30 controls (nonpathway) patients. The logic and ultimate success of the implementation of critical pathways led us to develop and put into practice our own head and neck cancer clinical pathway. All patients reviewed in the present study were managed on this protocol.

Recently, Cohen et al15 attempted to further stratify resource utilization requirements of patients undergoing head and neck surgery by comparing 4 groups of patients: those with tracheotomy and microvascular reconstruction, those with only microvascular reconstruction, those with only tracheotomy, and those with neither a tracheotomy nor microvascular reconstruction. Significant differences in lengths of stay, total cost of admission, and in the specific cost centers of the intensive care unit, surgical ward, and operating room were demonstrated.

Cost-identification studies have also been employed to support the use of microvascular reconstructions over pedicle and other flaps. Kroll and coworkers16 retrospectively reviewed the 6-year experience at the M.D. Anderson Cancer Center of 33 patients with myocutaneous flaps compared with 145 patients undergoing microvascular re-
constructions for complex head and neck defects. Relative failure rates and operative times were comparable in both groups, but significant differences were identified in lengths of stay and overall cost of admission. Patients undergoing myocutaneous flap reconstruction had an average increased length of stay of 6 days and consumed approximately $12000 more in hospital resources than patients receiving microvascular reconstructions.\(^\text{16}\) These authors cited favorable patient selection for microvascular reconstruction as the reason for the more favorable outcomes in patients receiving microvascular reconstruction.

These data differ from our own in that there was no difference in the present study in length of stay between the myocutaneous and microvascular flap groups. Additionally, unlike the findings in the M.D. Anderson study,\(^\text{16}\) the myocutaneous and microvascular flap groups. Additionally, the findings in the M.D. Anderson study,\(^\text{16}\) resource utilization in the present study was approximately $5000 higher for patients undergoing free tissue transfer than for those receiving pedicle flap reconstructions. Interestingly, we found a lower rate of complications in our MFTT group than in our PMF group. Many of the patients in our PMF group had multiple medical comorbidities, making them unsuitable for MFTT. Therefore, it is not surprising that there were more complications in the PMF group. Despite this, the overall costs were still higher in the MFTT group. The low rate of complications in our PMR group probably occurred as a result of selection bias as well. Many of these cases involved smaller tumors requiring less complicated reconstructions, which accounts for the overall lower costs in this group.

Smeele et al\(^\text{17}\) retrospectively reviewed the records of 127 patients who underwent free-flap reconstruction for oromandibular defects over 6 years with and without bone replacement. No differences in cost, operative time, complications, or return to oral diet were demonstrated between patients receiving soft tissue only and the bone–soft tissue reconstructions.\(^\text{17}\) These authors argue for an individualized approach in determining the reconstructive modality for composite (bone and soft tissue) defects, citing the lack of negative consequences to harvesting bone with the soft tissue reconstruction flaps. However, they fail to objectively demonstrate the superiority of one technique over the other.

Similarly, Tsue and coworkers\(^\text{18}\) have presented a cost-effectiveness analysis between microvascular and pedicle-flap reconstruction of posterior oral cavity and oropharyngeal defects. Twenty-nine patients undergoing reconstruction with fasciocutaneous free flaps were compared with 24 patients who received pedicle pectoralis major flaps over a 4-year period. Populations were comparable with regard to physical status and tumor burden. Their data demonstrated no significant difference in median overall length of stay between free-flap and pedicle-flap groups (11 and 10 days, respectively), and the free-flap group incurred on average an additional $4000 in hospital charges.\(^\text{18}\) Additionally, Tsue et al\(^\text{18}\) demonstrated a significant improvement in oral intake and reduced reliance on enteral tube feedings in patients undergoing free tissue transfers. Our data are consistent with all of these findings. Tsue et al concluded that the intangible benefit of the earlier re-sumption of oral intake and reduced requirement for enteral tube feedings was satisfactory justification for the additional costs of free-flap reconstruction. Studies such as these appear to support the hypothesis that free flaps are superior to other forms of reconstruction for oropharyngeal or oral cavity defects.\(^\text{19}\)

In conclusion, we have shown through cost-identification analysis that intricate reconstructions are likely to utilize greater hospital resources. While our results support other studies that have demonstrated superior functional results and fewer complications associated with these types of reconstructions, efforts at providing superior outcomes must be balanced against the increasing restriction on the use of health care dollars. Future comparisons of head and neck cancer treatment strategies should include some economic impact or assessment component. Careful evaluation of function outcomes and quality of life will be required to justify the increased expenditure incurred when providing complex reconstructions.

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REFERENCES


