Objective: To determine if age alone is a prognostic indicator of surgical outcomes for major head and neck procedures.

Design: Retrospective cohort study over a 4-year period.

Setting: Academic referral center, institutional practice, hospitalized care.

Patients: Included in this study were patients who had undergone ablative, reconstructive, and other major surgical procedures of the head and neck, including neck dissection, laryngectomy, maxillectomy, thyroidectomy with lymphadenectomy, and composite resection of the oral cavity with reconstruction, for both malignant and benign disease.

Main Outcome Measures: Patient data and intraoperative and postoperative course factors were recorded. Comorbidity was graded using an Adult Comorbidity Evaluation 27 test, Charlson Comorbidity Index, and American Society of Anesthesiology score. Postoperative complications were dichotomized, and multiple logistic regression was used for data analysis.

Results: Medical chart review identified 157 cases. Analysis of data revealed that time under general anesthesia was the only factor consistently related to complications (P<.006), and it was the only factor consistently related to length of stay (P<.001). Analysis of major complications (6% incidence) as an outcome using univariate analysis resulted in a strong positive correlation with both comorbidity indexes: Adult Comorbidity Evaluation 27 (P=.002) and Charlson Comorbidity Index (P=.005). Multiple logistic regression showed no significant relationship between age 70 years or older (20% of patients) and either complications or hospital length of stay.

Conclusions: Patient’s age alone is not a prognostic indicator of surgical outcome for major head and neck procedures. However, comorbidity is an important predictive factor for postoperative complications in any age group. Time under general anesthesia showed a statistically significant relationship with complication rate and hospital length of stay in multivariate analyses. Consequently, prevention of complications should focus on optimizing preoperative comorbid conditions.


The number of elderly people in the United States has risen almost exponentially from 3.1 million in 1900 to 34.7 million in 2000 and continues to do so to a projected 69.4 million persons older than 65 years in 2030. This trend results in greater numbers of elderly patients requiring major head and neck surgical procedures. Age has received increasing multidisciplinary attention as a prognostic factor for postoperative complications. However, suitability of surgical candidates based on age has been traditionally the source of controversy. Certain authors state that risk increases among all ages, whereas others indicate that major procedures for patients older than 70 years are fraught with cardiac risk. Both beliefs have been subject to strict scientific scrutiny in a wide range of disciplines in recent years. There is a growing concern that such bias will lead to withholding curative treatment with radical surgical procedures while opting for more “conservative” or palliative therapies in elderly patients, compelling us to embark on research specific to that population.

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To adequately assess risk in medicine, prognostic grading systems have been developed and standardized for both general and specific medical conditions. These include the Kaplan-Feinstein Index (KFI), developed originally for diabetes mellitus, Charlson Comorbidity Index (CCI), National Cancer Institute/National Institutes of Aging Index, and Index of Co-
METHODS

A retrospective cohort study reviewing medical records from Long Island College Hospital and State University Hospital, Downstate Medical Center, Brooklyn, NY, between January 1999 and January 2004, was performed. Included in this study were patients who had undergone ablative, reconstructive, and other major surgical procedures of the head and neck, including neck dissection, laryngectomy, maxillectomy, thyroidectomy with lymphadenectomy, and composite resection of the oral cavity with reconstruction, for both malignant and benign disease. Patients with multiple procedures were logged as unique cases if surgery was performed on separate admissions. Patients undergoing nonmajor procedures, including tracheotomy, diagnostic procedures such as endoscopy with biopsy, neck mass biopsy, parathyroidectomy, and partial or total thyroidectomy without neck dissection, were excluded.

Data forms were used for each case to collect information such as age, sex, tobacco or substance use, admitting diagnosis and medical history including comorbidity factors. Comorbid conditions were classified using American Society of Anesthesiologists’ scores, ACE-27 test, and CCI. The ASA score was assigned on a scale of 1 to 4, as recorded on the patient’s preoperative record by the attending anesthesiologist. Comorbid conditions were classified according to the ACE-27 data form, which includes comorbid conditions of various organ systems such as cardiovascular, respiratory, gastrointestinal, renal, endocrine, neurological, psychiatric, rheumatologic, and immunological systems, as well as malignancy, substance abuse, and body weight. Each category contains 3 grades (1, mild; 2, moderate; and 3, severe), with the overall comorbidity score defined according to the highest ranked single ailment. Two or more grade 2 ailments occurring in different organ systems results in a grade 3 assignment. Patients were also evaluated using the CCI, which was developed by Charlson et al in 1987 and was based on a cohort of medical patients as a method of classifying comorbidity and estimating risk of death from comorbid disease for use in longitudinal studies. The index is calculated by summation of assigned weights (1, 2, 3, and 6 points) for each comorbid condition present, ranging from prior myocardial infarction or congestive heart failure (each having a weight of 1) to AIDS or metastatic solid tumor (each having a weight of 6).

Time under general anesthesia (TUGA), recorded in minutes, was used as a single independent variable and was defined as the time from induction with general anesthetic (GA) agents to cessation of GA agents and extubation as recorded by the anesthesiologist. Inherent in this period are (1) time from induction to intubation; (2) precission preparation such as placement of arterial line, Swan Ganz and Foley catheters, and hemodynamic stabilization; (3) procedure time that reflects both the surgical complexity and surgeon’s experience; and (4) the time from completion of the surgical procedure to extubation.

Postoperative course data included hospital length of stay (LOS), number of days in the intensive care unit (ICU), and postoperative complications. Discharge type was also noted, ranging from home, home with home-health assistance, or long-term skilled nursing facility. Stay in the ICU included time spent in both the recovery room with close observation by the anesthesiologist and primary team during the immediate postoperative care period, as well as formal stay in the ICU with management by the critical care team.

Postoperative complications were extracted from daily progress notes. They were classified into surgical, major, and minor complications as described in Table 1. Surgical complications can be exclusive to the procedure performed. Because this study did not control for procedure type, surgical complications were excluded from data analysis.

Major and “any” (major and minor) complications as dependent variables were studied initially with univariate analysis using the Mann-Whitney test for continuous independent variables such as age, ASA score, ACE-27 grade, CCI score, and TUGA in minutes. The Fisher exact test was used in preliminary univariate analysis for age (<70 years vs older) as well as sex. Multiple logistic regression was used in data analysis for each comorbidity scale separately. Hospital LOS as a continuous dependent variable was evaluated using the Spearman rank correlation and Mann-Whitney test in univariate analysis and multiple linear regression for each index separately. Hospital LOS as a continuous dependent variable was analyzed using multiple linear regression for each index separately. Statistical analyses, data summaries, and graphic presentations were created with SPSS software (release 11.5; SPSS Inc, Chicago, Ill). P < .05 was considered statistically significantly.

RESULTS

The initial medical chart review identified 230 cases meeting inclusion criteria based on diagnosis. The final review yielded 157 cases of patients who had undergone a major head and neck surgical procedure, of whom 31 (20%) were 70 years or older. The patients’ ages ranged from 9 to 95 years (mean ± SD, 56.1 ± 17.7 years), and 92 (59%) were men and 65 (41%) were women. Comorbidity scoring according to the ACE-27 test revealed the following distribution: grade 0, 38 cases (24%); grade 1, 35 cases (22%); grade 2, 51 cases (33%); and grade 3, 33 cases (21%). Scores based on the CCI score ranged from 0 to 7 with the following distribution: 0, 63 cases (40%); 1, 31 cases (20%); 2, 26 cases (17%); and 3 or higher, 37
cases (23%). The ASA class scores obtained from the preoperative records were distributed as follows: 1, 9 cases (7%); 2, 88 cases (63%); 3, 39 cases (28%); and 4, 2 cases (1%). One case (1%) was missing an ASA score in the assessment.

TUGA ranged from 75 to 1160 minutes, with a median of 240 minutes. Hospital LOS ranged from 0 (<24-hour admission for observation) to 56 days (median, 3.0 days). Thirty-four patients (22%), ranging in age from 11 to 86 years, had a documented ICU stay ranging from 1 to 17 days (median, 1.0 day; mean, 2.9 days). Only 7 (21%) of 34 patients were 70 years or older. Of those 7 patients, only one 81-year-old man had a prolonged (>1 day) stay in the ICU for medical management by the critical care team. This patient's overall hospital course (hospital LOS, 10 days; ICU stay, 5 days) was not complicated by major events. However, it is important to note that most of our patients are followed postoperatively in the head and neck surgery/neurosurgery stepdown unit.

Major complications as described in Table 1 were documented in 10 patients (6%), and 57 patients (36%) had “any” (major or minor) complications.

MAJOR COMPLICATIONS

Analysis of major complications as an outcome using univariate analysis resulted in a strong positive correlation with TUGA in minutes (P = .003) as well as both comorbidity indexes: ACE-27 test (P = .002) and CCI (P = .005). The ASA score resulted in only a weak correlation (P = .03) in univariate analysis, which became statistically insignificant in multivariate logistic regression (Table 2). No statistically significant correlation existed between the outcome and age as a continuous variable using the Mann-Whitney test (P = .06) and the Fisher exact test (age <70 years vs older; P > .99), nor between outcome and sex (male vs female; P = .53).

In this cohort, there were 2 documented deaths. Both were male patients younger than 70 years (age, 60 and 67 years), with severe cardiomyopathy (ejection fraction, 20% and 30%, respectively), with significant comorbid conditions as graded by the ACE-27 test (3 and 2, respectively), CCI (2 and 2, respectively), and ASA score (4 and 2, respectively), and with a TUGA of 495 and 1160 minutes, respectively.

ANY COMPLICATION

Analysis of any complications as an outcome using univariate analysis resulted in a strong positive correlation with TUGA in minutes (P = .002) and CCI score (P = .02) but not with the ACE-27 grade (P = .06) or ASA score (P = .28). Age (Mann-Whitney test [P = .07] or Fisher exact test, age <70 years vs older [P = .30]), and sex (P = .24) did not yield statistical significance. When multiple logistic regression analysis was applied to the data, all comorbidity indexes lost their predictive value for any complication as an outcome (Table 3). From these results, the odds ratio for TUGA is 1.006 (Table 2) (ie, the odds of having a complication increase by 0.6% with every minute of anesthesia). Therefore, every 60 minutes would increase the odds of having a complication by 36%. When the same calculations were extended to both major and any complications, every 60 minutes of additional anesthesia time increased the odds of having a complication by 18% to 36%, depending on the analysis.

HOSPITAL LOS

Univariate analysis with the Spearman rank correlation test for hospital LOS outcome resulted in a positive as-

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Table 2. Logistic Regression Using the ACE-27 Test and CCI for Which Major Complications Are an Outcome

<table>
<thead>
<tr>
<th>Variable</th>
<th>β Coefficient (SE)</th>
<th>Wald χ²</th>
<th>P Value</th>
<th>Odds Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACE-27 test*</td>
<td>Sex</td>
<td>-0.219 (0.366)</td>
<td>0.357</td>
<td>.55</td>
</tr>
<tr>
<td>ACE-27 grade</td>
<td></td>
<td>0.298 (0.201)</td>
<td>2.198</td>
<td>.14</td>
</tr>
<tr>
<td>TUGA in min</td>
<td></td>
<td>0.003 (0.001)</td>
<td>7.605</td>
<td>.006</td>
</tr>
<tr>
<td>ASA class</td>
<td></td>
<td>-0.117 (0.374)</td>
<td>0.098</td>
<td>.76</td>
</tr>
<tr>
<td>Age &lt;70 y vs older</td>
<td></td>
<td>0.585 (0.340)</td>
<td>1.773</td>
<td>.18</td>
</tr>
<tr>
<td>Constant</td>
<td></td>
<td>-1.622 (0.378)</td>
<td>14.190</td>
<td>.001</td>
</tr>
<tr>
<td>CCI†</td>
<td>Female sex</td>
<td>0.506 (0.442)</td>
<td>1.313</td>
<td>.25</td>
</tr>
<tr>
<td></td>
<td>CCI score</td>
<td>0.163 (0.112)</td>
<td>2.127</td>
<td>.15</td>
</tr>
<tr>
<td></td>
<td>TUGA in min</td>
<td>0.003 (0.001)</td>
<td>8.063</td>
<td>.005</td>
</tr>
<tr>
<td></td>
<td>ASA class</td>
<td>-0.077 (0.359)</td>
<td>0.046</td>
<td>.83</td>
</tr>
<tr>
<td></td>
<td>Age &lt;70 y vs older</td>
<td>0.506 (0.442)</td>
<td>1.313</td>
<td>.25</td>
</tr>
<tr>
<td></td>
<td>Constant</td>
<td>-1.537 (0.806)</td>
<td>3.638</td>
<td>.02</td>
</tr>
</tbody>
</table>

Abbreviations: ACE-27, Adult Comorbidity Evaluation 27; ASA, American Society of Anesthesiology; CCI, Charlson Comorbidity Index; TUGA, time under general anesthesia.

*Overall model, χ² = 25.1, P < .001; R² = 14.9 (eg, explains 14.9% of overall variance).
†Overall model, χ² = 19.2, P = .002; R² = 11.6 (eg, explains 11.6% of overall variance).

Table 3. Logistic Regression Using the ACE-27 Test and CCI for Which Any Complication Are an Outcome

<table>
<thead>
<tr>
<th>Variable</th>
<th>β Coefficient (SE)</th>
<th>Wald χ²</th>
<th>P Value</th>
<th>Odds Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACE-27 test*</td>
<td>Sex</td>
<td>-0.191 (0.366)</td>
<td>0.272</td>
<td>.60</td>
</tr>
<tr>
<td>ACE-27 grade</td>
<td></td>
<td>0.163 (0.112)</td>
<td>2.127</td>
<td>.15</td>
</tr>
<tr>
<td>TUGA in min</td>
<td></td>
<td>0.003 (0.001)</td>
<td>8.063</td>
<td>.005</td>
</tr>
<tr>
<td>ASA class</td>
<td></td>
<td>-0.077 (0.359)</td>
<td>0.046</td>
<td>.83</td>
</tr>
<tr>
<td>Age &lt;70 y vs older</td>
<td></td>
<td>0.163 (0.112)</td>
<td>2.127</td>
<td>.15</td>
</tr>
<tr>
<td>Constant</td>
<td></td>
<td>-1.537 (0.806)</td>
<td>3.638</td>
<td>.02</td>
</tr>
</tbody>
</table>

Abbreviations: ACE-27, Adult Comorbidity Evaluation 27; ASA, American Society of Anesthesiology; CCI, Charlson Comorbidity Index; TUGA, time under general anesthesia.

*Overall model, χ² = 15.1, P = .010; R² = 9.4 (eg, explains 9.4% of overall variance).
†Overall model, χ² = 15.0, P = .010; R² = 9.2 (eg, explains 9.2% of overall variance).
sociation with TUGA in minutes ($r=0.672; P<.001$), CCI score ($r=0.213; P=.007$), ACE-27 grade ($r=0.199; P=.01$), ASA score ($r=0.202; P=.01$), and age ($r=0.181; P=.02$). The median LOS for male patients was 3.0 days vs 2.0 days for female patients. Using the Mann-Whitney test, there was a small positive association ($P=.04$) between male sex and increased LOS, but this disappeared in the multivariate analysis. All but TUGA and CCI lost their significance when multiple linear regression analysis was applied (Table 4).

TUGA was the only factor consistently related to complications in multiple logistic regression and to hospital LOS in multiple linear regression analysis (Table 4). Comorbidity was related to outcome in some analyses (Tables 2 and 4—major complications and LOS, respectively), but the effect size was smaller than for GA and the relationship was inconsistent. However, age of 70 years or older was not related to complications or hospital LOS in any of the multivariate analyses.

### Table 4. Multiple Linear Regression Using the ACE-27 Test and CCI for Which Length of Stay Are an Outcome

<table>
<thead>
<tr>
<th>Variable</th>
<th>$b$ Coefficient (SE)</th>
<th>$t$ Statistic</th>
<th>$P$ Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACE-27 test</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sex</td>
<td>0.646 (1.148)</td>
<td>0.563</td>
<td>.58</td>
</tr>
<tr>
<td>ACE-27 grade</td>
<td>0.958 (0.624)</td>
<td>1.535</td>
<td>.13</td>
</tr>
<tr>
<td>TUGA in min</td>
<td>0.017 (0.003)</td>
<td>5.446</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>ASA class</td>
<td>1.737 (1.172)</td>
<td>1.482</td>
<td>.14</td>
</tr>
<tr>
<td>Age &lt;70 y vs older</td>
<td>−0.581 (1.416)</td>
<td>−0.030</td>
<td>.68</td>
</tr>
<tr>
<td>CCI†</td>
<td>−5.251 (2.456)</td>
<td>−2.138</td>
<td>.03</td>
</tr>
<tr>
<td>Constant</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sex</td>
<td>0.729 (1.132)</td>
<td>0.644</td>
<td>.52</td>
</tr>
<tr>
<td>CCI score</td>
<td>0.883 (0.356)</td>
<td>2.482</td>
<td>.01</td>
</tr>
<tr>
<td>TUGA in min</td>
<td>0.017 (0.003)</td>
<td>5.689</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>ASA class</td>
<td>1.308 (1.119)</td>
<td>0.644</td>
<td>.52</td>
</tr>
<tr>
<td>Age &lt;70 y vs older</td>
<td>−0.960 (1.405)</td>
<td>−0.683</td>
<td>.50</td>
</tr>
<tr>
<td>Constant</td>
<td>−4.322 (2.467)</td>
<td>−1.752</td>
<td>.08</td>
</tr>
</tbody>
</table>

Abbreviations: ACE-27 Test, Adult Comorbidity Evaluation 27; ASA, American Society of Anesthesiology; CCI, Charlson Comorbidity Index; TUGA, time under general anesthesia.

*Overall model, $F = 9.057$, $df = 5$, $P<.001$; $R^2 = 23.2$ (eg, explains 23.2% of overall variance).
†Overall model, $F = 10.033$, $df = 5$, $P<.001$; $R^2 = 25.1$ (eg, explains 25.1% of overall variance).

The geriatric population in our society is growing rapidly and, with it, the number of elderly patients presenting for surgery. This raises the question, is age a risk factor for surgery? Many studies have attempted to answer this question, most extensively in the field of cardiac risk in noncardiac surgery. A review article by Goldman and others stated that... 

...studies have consistently shown that older patients have higher risk of cardiac complications, and in most studies age has been an independent predictive factor, even after controlling for the severity of cardiac disease and comorbid conditions.

Concern has been growing, however, that such prevailing attitudes may lead to undertreatment or even inappropriate treatment of the elderly. A recent study of elderly patients with breast cancer found a negative association between age and discussion of treatment options, including surgery, by their physicians. Trepidation over decreased physiologic reserve in elderly patients, and, hence, perceived increased risk associated with operative treatment, is a major factor driving this bias. This has prompted authors such as Ellis et al to conduct reviews of their experience and to advocate an aggressive surgical approach in elderly patients (age ≥70 years) for cancer of the esophagus and cardia. Caution should be taken comparing surgical procedures from other fields, especially general and thoracic surgery, in which varying postoperative pain, hemodynamic shifts, and longer time to mobilization present with complications not directly comparable with head and neck surgery. A literature search on head and neck surgery revealed studies of outcome vs age in acoustic neuroma, thyroid, and laryngeal surgery that warn against minimal palliative approaches and cite comparable results to morbidity and mortality in younger patients.

Our study demonstrated results in accordance with this recent literature. Age 70 years or older was not related to postoperative complications or hospital LOS in any of the multivariate analyses. Univariate analysis of age vs complication rate showed a weak correlation but did not achieve statistical significance. Multivariate analysis showed no statistically significant difference in outcome based on advanced age across a wide variety of major head and neck surgical procedures. The results fall in line with a recent article by Harwood in the anesthetics literature:

The evidence overwhelmingly indicates that comorbid conditions and physiological age, and not calendar or chronological age itself, are the primary influences on postoperative outcome in the elderly.

In our study, only some analyses revealed that comorbidity graded with the ACE-27 test and CCI, but not with ASA score, was related to outcome. However, the effect was smaller than for TUGA as a predictor of complication rates, and the relationship was inconsistent. Furthermore, our study revealed a statistically significant correlation between complication rate and TUGA in minutes. In fact, there was a quantifiable increase in rate: every 60 minutes of anesthesia time increased the odds of having a complication by 18% to 36%, depending on the analysis. Of interest, TUGA was also the only factor consistently related to hospital LOS in multiple linear regression.

An extensive review of multidisciplinary literature using the MD Consult database, MEDLINE, and Google search engines did not yield results of prior research analyzing the effect of TUGA and its correlation to surgical outcome and complication rate. Few studies that were relevant have used "type of surgery" as a variable. The review by Goldman stated that... 

...there appears to be little if any correlation between the length of an operation and the probability of postoperative complications after controlling for the type of surgery.

However, a review of the original literature supporting this statement revealed that neither of the studies...
took into account TUGA as a quantifiable variable but looked at factors known about the surgical case preoperatively (eg, type of operation, type of anesthesia, and elective vs emergency case).

Other risks have been documented with TUGA. According to an international multisite study, 10% of patients older than 60 years demonstrated some memory loss and poor concentration for 3 months after major surgery with GA lasting 2 hours or longer. While not directly applicable, Rolfson et al reported that the outcome of coronary artery bypass grafting was directly affected by time spent on cardiopulmonary bypass. TUGA is a variable that may be reduced, for example, by performing some of the preincision procedures required for monitoring prior to induction with GA, by staging surgical procedures, or by applying a multiple operating team approach for extensive procedures in patients with high perioperative risk for complication.

Our study was not initially designed to analyze risk of TUGA and therefore does not control for case type. Rather, we assume that major head and neck surgical procedures inherently place similar stresses on the body in contrast to other types of surgery that have greater hemodynamic shifts both intraoperatively and postoperatively.

Finally, our study has the same limitations of any retrospective study in being neither controlled nor randomized, including the possibility of bias in preselection of patients. In addition, the possibility of type II error exists in failing to identify a correlation between age and surgical complication rate. There were 157 cases with 10 “major complications” and 57 “any complications” as previously described. Therefore, there may not have been enough cases to prove that the null hypothesis (ie, there is no independent correlation between age and complication rate) is false. We also acknowledge that because our literature search and review included only “English-language” articles, language bias may exist in our discussion.

CONCLUSIONS

Our findings support the growing acceptance that age, in and of itself, is not a risk factor for major head and neck surgery. Furthermore, there are growing numbers of reports and concerns that the elderly are not receiving optimal care or choices because of incorrect medical prejudices of advanced age. Instead of relying on a single clinical factor, multifactorial indexes that combine many important patient characteristics should be used to assess perioperative risk and provide counseling to the patient accordingly. This study supports the conclusion of Borggreven et al that prevention of complications should focus on comorbid conditions. Care should be taken to carefully control preoperative comorbid conditions and offer the appropriate medical care.

TUGA showed a statistically significant relationship with complication rate and hospital LOS in multivariate analyses. This relationship held true for all age groups.

Future research efforts should focus on prospective case-controlled studies looking at age vs postoperative outcome. Furthermore, the study design should include TUGA controlling for specific case type to better understand how TUGA may affect postoperative complication rates and adverse outcomes.

Submitted for Publication: August 2, 2004; accepted December 16, 2004.

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Previous Presentation: This study was presented at the Sixth International Conference on Head and Neck Cancer; August 9, 2004; Washington, DC.

REFERENCES