Hypothesis: Medicare health maintenance organizations (HMOs) do not reduce the cost of colon resections in elderly patients.

Design: Review of prospectively collected and mandatory reported Florida hospital discharge data from January 1, 1995, through December 31, 1999. We used the χ² test for trend analysis to assess significant change in age, mortality, and complications, and the Kruskal-Wallis test to compare inflation-adjusted hospital charges, comorbidity, length of stay, and secondary procedures.

Setting: Administrative database including all community- and university-based surgeons.

Patients: All patients 70 years or older who underwent colon resection from 1995 through 1999.

Main Outcome Measures: Age, mortality, complications, length of stay, number of comorbidities and secondary procedures, hospital charges, and type of colon resection.

Results: The frequency of different colon resections increased by 10% to 30% from 1995 through 1999. Total hospital charges increased during the study period (P<.001), whereas mortality and complications remained unchanged. Length of stay, number of secondary procedures, and comorbidities were the most significant contributors to hospital charges. Despite a significantly shorter hospital stay, Medicare HMO patients had similar hospital charges to those of original Medicare patients.

Conclusions: Colon resections can be undertaken in elderly patients with acceptable morbidity. Per diem charges were higher for patients covered by Medicare HMO, despite their having shorter lengths of stay, fewer comorbidities, and fewer secondary procedures.
We sought to evaluate the hypothesis that Medicare HMO reduces health care costs by characterizing the outcomes of a commonly undertaken surgical procedure in elderly Floridians covered by original Medicare or Medicare HMO. This study focused on Florida because of its high percentage of elderly individuals and its diverse senior community consisting of retirees from around the country. Second to California, Florida has been the testing ground for HMO models and a marketplace with significant HMO penetration. The significance of Florida as a sentinel state for insurance and health care economics and its impact on the nation is further cemented by recent changes in coverage of bariatric surgery. These characteristics make Florida a unique health care community for forecasting the effects that Medicare HMO may have on elderly care nationwide.

We analyzed all operations undertaken in Florida from January 1, 1995, through December 31, 1999, and identified colon resection as the most common abdominal operation in patients older than 70 years. We therefore used right hemicolectomy (RH), left hemicolectomy (LH), and sigmoid colon resection (SR) as index operations to characterize contemporary surgical outcomes in Floridians older than 70 years. The aim of this study was to evaluate the hospital cost of colon resection in an HMO vs a non-HMO model of Medicare beneficiaries as reported to the Florida Agency for Health Care Administration (AHCA) database.

**METHODS**

We queried the Florida database for the AHCA, which mandates all nonfederal Florida hospitals to report outcomes and patient discharge information (data obtained and collated by Information Management Systems, Inc, Tallahassee, Fla). All patients older than 70 years who underwent an inpatient surgical procedure from 1995 through 1999 were included. Colon resection was identified as the most common abdominal surgery for this age group. Age, complications, vital status at discharge (alive vs dead), length of stay (LOS), hospital charges, third-party payers, number of comorbidities, and number of secondary procedures were abstracted and analyzed for RH, LH, and SR as identified by primary procedure codes (International Classification of Diseases, Ninth Revision, Clinical Modification procedure codes for RH [45.73], LH [45.75], and SR [45.76]). The number of secondary procedures, comorbidities, and complications were included as reported by the AHCA database. Hospital charges were adjusted for inflation by converting 1995-1998 charges to 1999 dollars using the Consumer Price Index as published by the US Department of Labor.

We used the χ² test for trend analysis and the Mantel-Haenszel statistic to examine changes in patient characteristics (categorical variables) during the study period. Comparisons of hospital charges, comorbidities, LOS, and secondary procedures from 1995 through 1999 were made using the nonparametric Kruskal-Wallis test for comparison of multiple independent groups by rank. To examine factors affecting hospital charges, separate analysis of covariance (ANCOVA) models for each procedure type were used. Hospital charges were natural-logarithm transformed (ln x + 1) for analysis purposes to help normalize the response variable. Variables that did not contribute significantly to variation in hospital charges were subsequently removed, and the model was iteratively solved until all remaining variables were significant (α = .05). Patients who died after surgery were censored from the data set before modeling.

**RESULTS**

**OUTCOMES OF COLON RESECTIONS**

A total of 31,162 colon resections were undertaken in Florida from 1995 through 1999 (RH in 15,540 patients, LH in 5,223 patients, and SR in 10,399 patients). The frequency of each of the 3 types of colon resection increased from 1995 to 1999 (Table 1). During the study period, in-hospital mortality remained relatively stable (6% for RH, 8%-10% for LH, and 6%-8% for SR); however, complications were significantly increased for SR but not LH or RH (Table 2). Although median LOS trended down for all 3 procedures from 9 to 8 days for RH, from 10 to 9 days for LH, and from 10 to 9 days for SR, inflation-adjusted hospital charges significantly increased throughout 1995 to 1999 (P < .001) (Table 3).

**DETERMINANTS OF HOSPITAL CHARGES**

To assess determinants of hospital charges, all abstracted variables were included in an ANCOVA mathematical model. All deaths (n = 2072) were censored from this analysis.
Table 3. Median Hospital Charges for Colon Resection in Floridians Older Than 70 Years*  

<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>LH</td>
<td>31,087</td>
<td>31,679</td>
<td>32,840</td>
<td>33,811</td>
<td>34,978</td>
</tr>
<tr>
<td>RH</td>
<td>26,211</td>
<td>26,223</td>
<td>27,076</td>
<td>27,317</td>
<td>27,829</td>
</tr>
<tr>
<td>SR</td>
<td>28,864</td>
<td>28,622</td>
<td>30,019</td>
<td>30,533</td>
<td>31,451</td>
</tr>
</tbody>
</table>

Abbreviations: LH, left hemicolectomy; RH, right hemicolectomy; SR, sigmoid colon resection.
*P<.001 for each year for all procedures.

Table 4. LOS, Comorbid Conditions, and Secondary Procedures After Colon Resection in Floridians Older Than 70 Years*  

<table>
<thead>
<tr>
<th>Subject Groups</th>
<th>RH</th>
<th>LH</th>
<th>SR</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>LOS, d</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Medicare HMO</td>
<td>9.2 ± 0.1†</td>
<td>10.3 ± 0.2†</td>
<td>9.8 ± 0.1†</td>
</tr>
<tr>
<td>Original Medicare</td>
<td>10.8 ± 0.1</td>
<td>12 ± 0.2</td>
<td>11.4 ± 0.1</td>
</tr>
<tr>
<td><strong>No. of comorbid conditions</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Medicare HMO</td>
<td>6.7 ± 0.1†</td>
<td>6.8 ± 0.1†</td>
<td>6.7 ± 0.1†</td>
</tr>
<tr>
<td>Original Medicare</td>
<td>7.4 ± 0.1</td>
<td>7.6 ± 0.1</td>
<td>7.4 ± 0.1</td>
</tr>
<tr>
<td><strong>No. of secondary procedures</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Medicare HMO</td>
<td>3.09 ± 0.1†</td>
<td>3.48 ± 0.1†</td>
<td>3.31 ± 0.1†</td>
</tr>
<tr>
<td>Original Medicare</td>
<td>3.44 ± 0.1</td>
<td>3.9 ± 0.1</td>
<td>3.73 ± 0.1</td>
</tr>
</tbody>
</table>

Abbreviations: LH, left hemicolectomy; LOS, length of stay; RH, right hemicolectomy; SR, sigmoid colon resection.
*Data are expressed as mean ± SD.
†P<.001, Medicare HMO vs original Medicare patients.

Table 5. Per Diem Hospital Charges for Colon Resection in Floridians Older Than 70 Years*  

<table>
<thead>
<tr>
<th>Subject Groups</th>
<th>RH</th>
<th>LH</th>
<th>SR</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Hospital Charges, US $†</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Original Medicare</td>
<td>3451 ± 1838*</td>
<td>3814 ± 2046*</td>
<td>3667 ± 2176*</td>
</tr>
<tr>
<td>Medicare HMO</td>
<td>(3418-3485)</td>
<td>(3750-3879)</td>
<td>(3619-3715)</td>
</tr>
<tr>
<td>Mean ± SD</td>
<td>4144 ± 2042*</td>
<td>4344 ± 2147*</td>
<td>4257 ± 2414*</td>
</tr>
<tr>
<td>95% CI</td>
<td>(4059-4229)</td>
<td>(4195-4403)</td>
<td>(4133-4381)</td>
</tr>
</tbody>
</table>

Abbreviations: CI, confidence interval; LH, left hemicolectomy; RH, right hemicolectomy; SR, sigmoid colon resection.
*P<.001, Medicare HMO vs original Medicare patients.
†In thousands of dollars.

The final ANCOVA model for each procedure included the same covariants (age, payer status, number of comorbidities, number of secondary procedures, and LOS) and explained 69%, 72%, and 70% of the variability in charges for RH, LH, and SR, respectively. For all 3 types of colon resection, LOS, number of secondary procedures, and number of comorbidities were the most significant factors affecting hospital charges (P<.001).

Length of stay alone was the most important predictor of hospital charges, accounting for more than 17% of the variation in this model. Age was a significant source of variation in hospital charges for RH and SR but not LH. Despite controlling for these factors, median hospital charges increased by 8.5%, 8.6%, and 9.1% from 1995 through 1999 for RH, LH, and SR, respectively.

**MEDICARE VS MEDICARE HMO**

As expected, most patients (90%) were beneficiaries of original Medicare or Medicare HMO. The percentage of patients who were covered by Medicare HMO increased from 8% in 1995 to 19% in 1999.

Hospital charges for the 3 types of colon resection were similar for original Medicare and Medicare HMO patients. However, we found that the determinants of hospital charges (LOS, number of secondary procedures, and number of comorbid conditions) as depicted by our statistical model were significantly lower (P<.001) in Medicare HMO compared with Medicare patients (Table 4), thereby indicating that per diem charges for Medicare HMO patients were significantly higher than for original Medicare patients for all 3 procedures (Table 5).

**COMMENT**

Elderly Americans represent the fastest growing demographic group in our nation and are expected to continue consuming considerable portions of health care resources. In the face of reduced health care budgets, it is imperative for our society to formulate policies to provide and maintain quality health care for our elderly population.

As the state with the highest percentage of elderly residents in the United States, Florida is a sentinel state for the study of health care for the elderly. In addition, Florida has one of the most robust health care administrative databases and a health care delivery market that is well represented by industry leaders. All of these considerations make Florida nearly ideal for outcomes analysis and the study of health care economics, particularly in the elderly population.

We identified colon resection as the most common abdominal operation in Floridians older than 70 years. Furthermore, colon resection is commonly performed in both academic and community-based hospitals by general surgeons as well as colorectal surgeons. Therefore, we chose colon resection as the index operation to evaluate the medical and economic trends in geriatric surgery during the 5 years from 1995 through 1999.
We found that surgeons were able to undertake colon resections with reproducible quality as reflected through low and stable rates of mortality and morbidity. This ability to maintain low mortality and morbidity rates was consistent, despite a significant increase in comorbidities as reflected by the number of secondary procedures and diagnoses in this cohort during the 1995-1999 study period. As expected, LOS trended down throughout the study period; more importantly, hospital charges demonstrated an escalating trend from 10% to 30% for all 3 procedures.

We assessed the relative contribution of each abstracted variable and potential predictive factor to hospital charges in a statistical model of ANCOVA. Length of stay, number of secondary procedures, and number of comorbidities were the most important predictive factors of hospital charges in our model.

It is intuitive that increases in LOS, number of secondary procedures, and comorbidities reflect the severity of illness and thereby increase use of health care services. Although increasing age was associated with higher mortality in patients who underwent colon resection for cancer, age was not an independent predictor of hospital charges in our cohort. Nevertheless, median hospital charges for all 3 types of colon resection significantly increased throughout the study period, despite relatively stable mortality and morbidity rates, and outpaced inflation as measured by the medical care–adjusted Consumer Price Index. We uncovered yet another troubling trend. Despite statistically significant shorter LOS, lower mortality, and fewer secondary procedures and diagnoses in Medicare HMO patients, overall hospital charges were similar for both groups of patients. Consequently, hospital per diem charges were significantly higher for Medicare HMO patients compared with original Medicare patients.

Although current practice dynamics as influenced by financial pressures from insurance companies may have resulted in shorter LOS in Medicare HMO beneficiaries, most of the hospital charges in surgical patients are incurred at the front end of hospitalization. Therefore, the difference in LOS cannot be solely explained by the differences in hospital charges between traditional Medicare and Medicare HMO beneficiaries. Moreover, the availability of postdischarge care and patients’ eligibility for such services as dictated by third-party payers may explain in part a relatively long LOS in an acute care setting compared with findings in younger patients. In our cohort, only 65% were discharged home; the remainder required home health care or were discharged to a nursing home or other facility.

Changes in coding practices may explain in part the increased number of comorbid conditions and procedures; however, this cannot be verified by the database used in this study. Most likely, the increase in the number of secondary procedures and diagnoses reflect improved documentation of associated comorbidities during the index hospitalization. However, as reflected by the lesser number of comorbidities and secondary diagnoses, Medicare HMO beneficiaries were relatively healthier than the traditional Medicare group in our cohort. Despite being a healthier population, Medicare HMO beneficiaries incur the same hospital charges as their original Medicare counterparts, and it follows that Medicare HMO has not resulted in any appreciable cost savings.

The Medicare HMO is the most significant and fundamental change in the delivery of health care to the elderly since the establishment of Medicare in 1965. The public health theory of managed care and economic theory of privatization were used to tout Medicare HMO as the most promising cost-effective health care delivery scheme.

Since its introduction in 1997, enrollment in Medicare HMO has increased steadily to nearly 5 million patients nationwide. Our finding that Medicare HMO failed as a cost-control mechanism is confirmed by the current departure of the major HMOs from the Medicare market, citing significant losses. In Florida, major HMO plans including Aetna, Blue Cross/Blue Shield, and Humana have all commended their exodus from the market. Furthermore, in a recent Harvard University study, Schneider and others also concluded that the rates of high-cost operative procedures were not lower among Medicare HMO enrollees and questioned whether the Medicare HMO model can effectively control cost.

The administrative database of AHCA and our abstracted data cannot provide validated explanations of the increased per diem for Medicare HMO. However, if we accept that there is a linear relationship between hospital charges and actual cost, then it becomes clear why Medicare HMO failed as a financial model. While Medicare HMO was reducing LOS, it was incurring a higher per diem rate for inpatient care. Whether these 2 events are related remains unproved by this study and warrants further investigation. Other factors that may explain the discrepancy between original Medicare and Medicare HMO, such as contractual obligations, costs of living and labor, and other important determinants of health care expenditure, warrant further investigation and are well beyond the scope of this study.

Although past reports from our group have used the AHCA database to study outcomes of pancreatoduodenectomies and use of bariatric surgery, this administrative database has certain shortcomings. First, it cannot be stratified by sex, race, or severity of illness and risk. Furthermore, complications are reported under diagnosis related groups without stratification into minor or major complications that may affect LOS differently. Although ANCOVA is well suited for large-sample analysis, the difference in sample size (original Medicare vs Medicare HMO) is a potential weakness of our statistical model.

These mortality data are reported by hospitals independent of physician input and represent overall hospital mortality. One limitation of the administrative database is that outcomes such as death are not stratified and therefore cannot be deciphered into whether they are operation or disease specific. Although we cannot explain why the mortality rates and LOS are higher than expected, we have no reason to believe that these data are not accurate. Because every hospital has different fiscal operations, charges for the same procedure may vary within the same city or county in Florida. For the purposes of this study, we assumed that there is a linear relationship between charges of a particular hospital and the actual cost;
however, the actual cost-charge ratio is tightly guarded by hospital executives and, therefore, cannot be independently evaluated. Even if the AHCA database provided cost data (which it does not) linking these data to actual hospital cost, data are impossible to generate because the AHCA data are patient anonymous.

Those limitations notwithstanding, the AHCA database, which excludes the Veterans Affairs health care system, mandates reporting of hospital outcomes and therefore is free of physician and administrator bias. These data represent a powerful tool to analyze trends in both outcomes and population-based economies.16

Our findings that Medicare HMO has not resulted in notable cost savings are supported and emphasized by studies conducted by the Inspector General of the Department of Health and Human Services and the General Accounting Office documenting higher administrative costs and higher payment rates in Medicare HMO.5,12

The failure of cost containment in Medicare HMO and the significant reduction in the federal Medicare budget are placing tremendous economic pressure on the ever-growing number of elderly surgical patients and their surgeons. Surgeons and their respective professional organizations should use these data to influence policymakers at local, regional, and federal levels.

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Correspondence: Michel M. Murr, MD, Department of Surgery, University of South Florida, c/o Tampa General Hospital, PO Box 1289, Tampa, FL 33601 (mmurr@hsc.usf.edu).

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REFERENCES