Correlation of Inpatient and Outpatient Measures of Stroke Care Quality Within Veterans Health Administration Hospitals

Joseph S. Ross, MD, MHS; Greg Arling, PhD; Susan Ofner, MS; Christianne L. Roumie, MD, MPH; Salomeh Keyhani, MD; Linda S. Williams, MD; Diana L. Ordin, MD, MPH; Dawn M. Bravata, MD

Background and Purpose—Quality of care delivered in the inpatient and ambulatory settings may be correlated within an integrated health system such as the Veterans Health Administration. We examined the correlation between stroke care quality at hospital discharge and within 6 months postdischarge.

Methods—We conducted a cross-sectional hospital-level correlation analyses of chart-abstracted data for 3467 veterans discharged alive after an acute ischemic stroke from 108 Veterans Health Administration medical centers and 2380 veterans with postdischarge follow-up within 6 months in fiscal year 2007. Four risk-standardized processes of care represented discharge care quality: prescription of antithrombotic and antilipidmic therapy, anticoagulation for atrial fibrillation, and tobacco cessation counseling along with a composite measure of defect-free care. Five risk-standardized intermediate outcomes represented postdischarge care quality: achievement of blood pressure, low-density lipoprotein, international normalized ratio, and glycosylated hemoglobin target levels, and delivery of appropriate treatment for poststroke depression along with a composite measure of achieved outcomes.

Results—Median risk-standardized composite rate of defect-free care at discharge was 79%. Median risk-standardized postdischarge rates of achieving goal were 56% for blood pressure, 36% for low-density lipoprotein, 41% for international normalized ratio, 40% for glycosylated hemoglobin, and 39% for depression management and the median risk-standardized composite 6-month outcome rate was 44%. The hospital composite rate of defect-free care at discharge was correlated with meeting the low-density lipoprotein goal (r=0.31; P=0.007) and depression management (r=0.27; P=0.03) goal but was not correlated with blood pressure, international normalized ratio, glycosylated hemoglobin goals, nor with the composite measure of achieved postdischarge outcomes (probability values >0.13).

Conclusions—Hospital discharge care quality was not consistently correlated with ambulatory care quality. (Stroke. 2011; 42:2269-2275.)

Key Words: acute stroke ■ healthcare ■ outcomes ■ quality of care ■ stroke care

The Institute of Medicine’s landmark reports To Err Is Human1 and Crossing the Quality Chasm2 brought national attention to healthcare quality. Several studies have examined the correlation between performance on delivering inpatient processes of care measured by the Centers for Medicare & Medicaid Services Hospital Compare program and 30-day clinical outcomes, finding mixed results.3–6 None examined whether quality of care delivered at discharge from the hospital was correlated with quality delivered in the ambulatory care setting. In a fragmented private and public healthcare system, inpatient quality may not be associated with ambulatory care quality, because communication and coordination between settings are frequently disrupted and not sufficiently incentivized through payment policies.7,8 However, integrated health systems such as the Veterans Health Administration (VHA) may be more likely to promote...
better transitions of care between the inpatient and ambulatory care settings, improving quality.9–11 For instance, widespread implementation of information technology and service integration within VHA medical centers (VAMCs) facilitates physician communication and coordination of care. The VHA Office of Quality and Performance, in partnership with the VHA Stroke Quality Enhancement Research Initiative Program, recently conducted a nationwide assessment of quality of ischemic stroke care delivered by VAMCs. Data from this project provide a unique opportunity to examine the correlation between hospital-specific stroke care quality at the time of hospital discharge from the inpatient setting with quality of care delivered within 6 months postdischarge in the ambulatory setting within an integrated health system.

Materials and Methods

Study Population

As part of the original quality assessment project that was conducted by the VHA Office of Quality and Performance and Quality Enhancement Research Initiative,12 a retrospective cohort was assembled that included 5721 veterans hospitalized at VAMCs in the United States and Puerto Rico during fiscal year 2007, October 1, 2006 through September 30, 2007, with a primary discharge diagnosis of ischemic stroke, identified using a modified high specificity algorithm of the International Classification of Diseases, Ninth Revision, Clinical Modification codes. A sample of 5030 medical records was obtained by including all patients with stroke at VAMCs with $\geq$55 and an 80% random sample of patients at VAMCs with $>55$ ischemic stroke hospitalizations. Medical record abstraction was performed by the West Virginia Medical Institute, VHA’s External Peer Review Program contractor, using remote electronic data. Among the 307 data elements, 90% had an interobserver reliability $\geq70\%$. Veterans were excluded from the ischemic stroke cohort if the admitting diagnosis of acute ischemic stroke was not confirmed, they were hospitalized for transient ischemic attack or poststroke rehabilitation, experienced an ischemic stroke after index hospitalization for another condition, or were admitted for carotid endarterectomy, leaving a sample of 3987 veteran patients.

Study Cohort

We assembled 2 cohorts of patients, the first composed of patients who received acute stroke care in the inpatient setting and were eligible for at least 1 discharge quality indicator and the second a subset of these discharges that received postacute stroke care in the outpatient setting within 6 months. For the first sample, we excluded veterans who died during the index hospitalization; were discharged to hospice; had a code status of comfort care during the inpatient period; left the index hospitalization against medical advice; had an unknown discharge disposition; or were ineligible for all of the discharge quality indicators. In addition, to ensure sufficient sample size for the calculation of hospital performance, we excluded patients who were hospitalized or received postdischarge care at a VAMC with $<10$ ischemic stroke hospitalizations in fiscal year 2007 (Figure 1). For the second sample, we created a subset of the first sample limited only to patients who had care in the VHA during the 6 months postdischarge. Thus, we further limited our sample by excluding veterans who died within 30 days of discharge, were readmitted to a VAMC within 30 days of discharge, or did not receive care at a VAMC within 6 months postdischarge.

Quality-of-Care Measures

Four processes of care were available to study discharge care quality: prescription of antithrombotic and antilipidmic therapy for all patients; prescription of anticoagulation therapy for veterans with atrial fibrillation; and tobacco cessation counseling for current tobacco users. Because VAMCs provided generally high rates of these 4 processes of care to eligible patients, we constructed a composite indicator measuring defect free care at discharge: the proportion of patients who received all processes of care for which
they were eligible. Each patient was eligible for 1 to 4 of the discharge processes of care.

Five intermediate outcomes of care were available to study postdischarge care quality within 6 months: blood pressure measurement of <140/90 mm Hg for all patients (for patients with a medical history of diabetes or kidney disease, a cutoff of 130/80 mm Hg was used); serum low-density lipoprotein (LDL) measurement of <100 mg/dL for poststroke patients with LDL measurement of ≥100 mg/dL or not measured during index hospitalization; serum international normalized ratio measurement of between 2 and 3 inclusive for poststroke patients discharged on warfarin; serum glycosylated hemoglobin measurement of <8% for poststroke patients with diabetes who had a serum glycosylated hemoglobin measurement of ≥7% or not measured during the index hospitalization; and depression screening and appropriate management through counseling or treatment for all poststroke patients. For patients with multiple measurements of these outcomes during the 6-month postdischarge period, the last measurement was selected for analysis. These 5 outcomes were then used to create a composite indicator of postdischarge care: the proportion of outcomes of care achieved among eligible patients (ie, outcome achievement rate). Each patient was eligible for 1 to 5 of the postdischarge outcomes.

**Statistical Analysis**

We estimated hospital performance on each quality measure (ie, processes of care and intermediate outcome achievement rates) with hierarchical generalized linear models that account for the clustering of patients within facilities and the problems of estimation error arising from small numbers of patients per facility.\(^{13–17}\) A patient-level model was fit for each quality indicator following procedures used in prior research.\(^{18}\) Each model included 6 patient-level covariates for risk standardization: age, medical history of any cerebrovascular comorbidity (yes/no) or of any noncerebral cardiovascular comorbidity (yes/no) before hospitalization, admission stroke severity measured by the retrospective National Institute of Health Stroke Scale, index hospitalization length of stay, and discharge to home or subacute facility (eg, nursing home). The VAMC facility was treated as a random effect to take into account clustering of patients within facilities. The hierarchical generalized linear models produced empirical Bayes estimates of hospital-specific rates for the processes of care and outcomes adjusted for patient characteristics.\(^{19}\) This technique results in conservative estimates for small facilities and for those facilities at the extremes; scores tend toward the pooled mean for all of the hospitals in the sample.

We used weighted Pearson correlation coefficients to measure the strength of associations between hospital-specific rates of processes of care at discharge and outcomes postdischarge. We calculated 6 sets of pairwise correlations using the risk-standardized empirical Bayes estimates of hospital rates for the composite measure of defect-free care for processes at discharge and the postdischarge outcomes, including discharge care and each of the 5 postdischarge outcomes as well as the postdischarge composite. In addition, because different numbers of patients were eligible for the process and outcome measures at different hospitals, correlation coefficients were weighted by the total number of patients from that hospital who were included in the measure estimate. For each correlation, \(r\), we tested the hypothesis that \(r = 0\), adjusting the probability values for multiple comparisons using the Sidak method.

We report both the relevant correlation coefficients and the percentage of the hospital-specific variation in postdischarge outcomes explained by the hospital-specific rates of delivering the processes of care at discharge (ie, the square of the correlation coefficient as an indicator of the strength of the associations). Furthermore, as a secondary analysis, we calculated additional pairwise correlations for each risk-standardized measure of hospital-specific rates of delivering discharge processes of care and postdischarge outcomes for exploratory purposes but did not examine the correlation coefficients with statistical testing. Analyses were conducted using SAS Version 9.1 (SAS Institute, Cary, NC) and HLM6.

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**Table 1. Veterans Health Administration Medical Center Characteristics (n=108)**

<table>
<thead>
<tr>
<th>Demographic characteristics of patients hospitalized for stroke</th>
<th>Mean age, y (SD)</th>
<th>67.4 (3.2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male, % (SD)</td>
<td>96.6 (10.3)</td>
<td></td>
</tr>
<tr>
<td>White non-Hispanic, % (SD)</td>
<td>70.2 (23.1)</td>
<td></td>
</tr>
<tr>
<td>Index admission use among patients hospitalized for stroke</td>
<td>Mean length of stay (SD), d</td>
<td>7.8 (3.8)</td>
</tr>
<tr>
<td>Discharged to home, % (SD)</td>
<td>69.0 (15.1)</td>
<td></td>
</tr>
<tr>
<td>Discharged to nursing home or transferred, % (SD)</td>
<td>31.0 (15.1)</td>
<td></td>
</tr>
<tr>
<td>Mean no. of ambulatory visits during 6-mo postdischarge* (SD)</td>
<td>4.8 (1.3)</td>
<td></td>
</tr>
<tr>
<td>Clinical characteristics of patients hospitalized for stroke, % (SD)</td>
<td>National Institutes of Health Stroke Scale on index hospitalization</td>
<td>3.9 (1.4)</td>
</tr>
<tr>
<td>MH of ischemic stroke</td>
<td>22.7 (10.4)</td>
<td></td>
</tr>
<tr>
<td>MH of TIA</td>
<td>6.7 (5.4)</td>
<td></td>
</tr>
<tr>
<td>MH of cerebrovascular ischemic disease (ischemic stroke, TIA, or prior CEA)</td>
<td>28.2 (11.1)</td>
<td></td>
</tr>
<tr>
<td>MH of noncerebrovascular ischemic disease (previous myocardial infarction, MH of CAD or PVD or prior CABG surgery or PTCA)</td>
<td>36.8 (12.3)</td>
<td></td>
</tr>
<tr>
<td>MH of atrial fibrillation</td>
<td>15.5 (7.5)</td>
<td></td>
</tr>
<tr>
<td>MH of hypertension</td>
<td>78.4 (11.0)</td>
<td></td>
</tr>
<tr>
<td>MH of hyperlipidemia</td>
<td>47.6 (17.0)</td>
<td></td>
</tr>
<tr>
<td>MH of coronary artery disease</td>
<td>27.6 (13.4)</td>
<td></td>
</tr>
<tr>
<td>Previous myocardial infarction</td>
<td>11.2 (7.7)</td>
<td></td>
</tr>
<tr>
<td>MH of heart failure</td>
<td>11.2 (6.3)</td>
<td></td>
</tr>
<tr>
<td>MH of diabetes</td>
<td>39.5 (11.0)</td>
<td></td>
</tr>
<tr>
<td>MH of chronic kidney disease</td>
<td>0.9 (1.9)</td>
<td></td>
</tr>
<tr>
<td>MH of depression</td>
<td>17.0 (10.2)</td>
<td></td>
</tr>
</tbody>
</table>

**Facility characteristics**

<table>
<thead>
<tr>
<th>Census region, %</th>
<th>Caribbean</th>
<th>0.9</th>
</tr>
</thead>
<tbody>
<tr>
<td>Northeast</td>
<td>14.8</td>
<td></td>
</tr>
<tr>
<td>Midwest</td>
<td>25.0</td>
<td></td>
</tr>
<tr>
<td>South</td>
<td>40.7</td>
<td></td>
</tr>
<tr>
<td>West</td>
<td>18.5</td>
<td></td>
</tr>
<tr>
<td>Complexity, %</td>
<td>High</td>
<td>63.9</td>
</tr>
<tr>
<td>Medium</td>
<td>26.8</td>
<td></td>
</tr>
<tr>
<td>Low</td>
<td>9.3</td>
<td></td>
</tr>
<tr>
<td>Median annual stroke volume (25th–75th percentile)</td>
<td>43 (27–65.5)</td>
<td></td>
</tr>
<tr>
<td>Median proportion of facility enrollees within 30 min commute (25th–75th percentile), %</td>
<td>65 (56–81)</td>
<td></td>
</tr>
</tbody>
</table>

MH indicates medical history; TIA, transient ischemic attack; CEA, carotid endarterectomy; CAD, coronary artery disease; PVD, peripheral vascular disease; CABG, coronary artery bypass graft; PTCA, percutaneous transluminal coronary angioplasty; SD, standard deviation.

*Ambulatory visits defined as appointments at a Veterans Health Administration clinic for general internal medicine, cardiology, diabetes, geriatrics, hypertension, infectious disease, nephrology, neurology, pulmonary care, or women’s health; Coumadin care; a telephone appointment with general internal medicine, geriatrics, or neurology; and home-based primary care appointments with a physician, registered nurse, or physician assistant.
(Scientific Software International, Lincolnwood, IL). All reported probability values are 2-sided and considered significant at <0.05.

**Results**

**Study Cohort**

As described in Figure 1, the first study cohort consisted of 3467 veterans discharged from 108 VAMCs after hospitalization for ischemic stroke and the second study cohort consisted of 2380 veterans who received VAMC outpatient follow-up care within 6 months of discharge, among whom 2302 (96.7%) received the majority of their outpatient follow-up care at the same VAMC where they were initially hospitalized. The majority of veterans hospitalized for stroke were white and male, had an average National Institute of Health Stroke Scale score of 3.8, and more than two thirds were discharged to home (Table 1). Nearly two thirds of VAMCs were high-complexity facilities and median annual stroke volume was 43.0.

**Quality of Care**

**Discharge Processes of Care**

Most hospitals delivered the recommended processes of care at discharge at high rates (Table 2). Median risk-standardized rates were 97% for prescription of antithrombotic therapy, 84% for antilipidemic therapy, 69% for anticoagulation therapy for patients with atrial fibrillation, and 97% for provision of tobacco cessation counseling. The median risk-standardized rate of defect free care at discharge was 79% (25th, 75th percentiles: 74%, 83%).

**Postdischarge Intermediate Outcomes**

Hospitals achieved modestly high rates of intermediate outcomes within 6 months after discharge. Median risk-standardized rates of target achievement were 56% for blood pressure, 36% for LDL, 41% for international normalized ratio, 40% for serum glycosylated hemoglobin, and 39% for depression screening and management. The median risk-standardized rate of intermediate outcomes achieved postdischarge was 44% (25th, 75th percentiles: 41%, 47%).

**Correlation Between Discharge Process of Care and Postdischarge Outcomes**

There was a significant correlation between hospital rates of delivering processes of care at discharge, as measured by the composite of defect-free delivery of processes at discharge, and hospital performance on 2 postdischarge intermediate outcomes: serum LDL meeting goal ($r=0.31$; $P=0.007$) and poststroke depression screening and delivery of appropriate treatment when indicated ($r=0.27$; $P=0.03$; Figure 2B and 3A; Table 3). However, these analyses demonstrated that quality at discharge accounted for only 9.4% and 7.4% of the hospital-level variation in the postdischarge achievement of LDL targets and depression management, respectively. There was no significant correlation between quality of care at discharge and hospital postdischarge outcomes for any of the other 3 intermediate outcomes or the composite achievement of outcomes within 6 months (Figures 2D and 3B; probability values >0.13).

**Discussion**

We found that VHA hospital care quality on delivering recommended processes of care at discharge for patients with ischemic stroke, as measured using a composite of defect-free delivery of care, explained only 9% and 7% of the hospital-level variation in the achievement of 2 intermediate outcomes of care during the 6-month postdischarge period for patients with ischemic stroke: meeting LDL goals and appropriate screening and management of depression. However, VA hospital performance on care at discharge was not associated with 3 other intermediate outcomes of care for patients with ischemic stroke.

### Table 2. Risk-Adjusted Veterans Health Administration Hospital Quality of Care for Patients With Ischemic Stroke, Fiscal Year 2007*

<table>
<thead>
<tr>
<th>Stroke Quality of Care Components</th>
<th>No. of Hospitals</th>
<th>Median No. of Eligible Patients per VAMC (Range)</th>
<th>Median Hospital Rates, % (25th, 75th Percentile)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Processes of care at discharge</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Antithrombotic therapy (n=3417)</td>
<td>108</td>
<td>30 (9–97)</td>
<td>97 (96, 98)</td>
</tr>
<tr>
<td>Antilipidemic therapy (n=2949)</td>
<td>108</td>
<td>26 (5–82)</td>
<td>84 (79, 88)</td>
</tr>
<tr>
<td>Anticoagulation for atrial fibrillation (n=430)</td>
<td>101</td>
<td>4 (1–10)</td>
<td>69 (66, 72)</td>
</tr>
<tr>
<td>Tobacco cessation counseling for smokers (n=1241)</td>
<td>108</td>
<td>9 (1–35)</td>
<td>97 (93, 99)</td>
</tr>
<tr>
<td>Composite delivery of defect-free processes of care (n=3467)</td>
<td>108</td>
<td>30 (9–100)</td>
<td>79 (74, 83)</td>
</tr>
<tr>
<td><strong>6-month postdischarge ambulatory care outcomes</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Blood pressure measured and meets goal (n=2380)</td>
<td>108</td>
<td>21 (3–78)</td>
<td>56 (55, 57)</td>
</tr>
<tr>
<td>Serum LDL measured and meets goal (n=1651)</td>
<td>108</td>
<td>14 (2–45)</td>
<td>36 (35, 37)</td>
</tr>
<tr>
<td>Serum INR measured and meets goal (n=338)</td>
<td>94</td>
<td>3 (1–15)</td>
<td>41 (41, 41)</td>
</tr>
<tr>
<td>Serum HbA1c measured and meets goal (n=239)</td>
<td>79</td>
<td>2 (1–16)</td>
<td>40 (38, 43)</td>
</tr>
<tr>
<td>Depression screening and appropriate treatment (n=2380)</td>
<td>108</td>
<td>21 (3–78)</td>
<td>39 (32, 46)</td>
</tr>
<tr>
<td>Composite achievement of outcomes of care (n=2380)</td>
<td>108</td>
<td>21 (3–78)</td>
<td>44 (41, 47)</td>
</tr>
</tbody>
</table>

VAMC indicates Veterans Administration Medical Center; LDL, low-density lipoprotein; INR, international normalized ratio; HbA1c, glycosylated hemoglobin.

*Hospital rates risk-adjusted for patient characteristics.
ischemic stroke: meeting blood pressure, international normalized ratio, and serum glycosylated hemoglobin goals. Also, VHA hospital performance at discharge was not associated with a composite measure of these 5 postdischarge intermediate outcomes of care. These findings suggest that a VHA hospital’s 6-month achievement of important ambulatory care outcomes cannot be reliably inferred from performance on process measures at discharge.

This is the first study, to our knowledge, to have examined whether the quality of care delivered on discharge from the inpatient setting predicts patient outcomes in the ambulatory care setting. There are several possible reasons for why we did not observe a consistent correlation between delivery of processes of care at discharge and intermediate outcomes postdischarge after hospitalization for ischemic stroke. First, organizationally, we hypothesized that within a facility oper-

Figure 2. Correlation between hospital rates of delivering care to patients with ischemic stroke at discharge and 6-month postdischarge outcomes, specifically achieving target (A) blood pressure, (B) serum low-density lipoprotein, (C) serum international normalized ratio, and (D) serum glycosylated hemoglobin.

Figure 3. Correlation between hospital rates of delivering care to patients with ischemic stroke at discharge and 6-month postdischarge outcomes, specifically (A) poststroke depression screening and management and (B) composite achievement of outcomes.

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therapy or providing tobacco cessation counseling at dis-

sponsible for prescribing antithrombotic or antilipidemic
gaged partnership. For instance, providers are directly re-

ment of blood pressure is far more complicated and is not
follow-up such as adherence to medical therapy or manage-

whereas achieving better outcomes during postdischarge

are principally under the locus of control of providers,

controlled by either providers or patients but requires en-

comprehensive discharge planning that includes patient edu-

cation and appointment scheduling would have been corre-

ated within an integrated healthcare system, quality would
diffuse across areas of the medical center. Unfortunately, our
results suggest that excellence in 1 area of care (ie, care at
discharge) does not predict quality in another area of care (ie,
ambulatory follow-up care), even if restricted to care for a
single condition. Despite physician continuity between the
inpatient and outpatient setting for stroke care, there are still
transitions between different types of providers, perhaps
limiting correlation of performance. Second, clinically, the
components of care that were evaluated in this study included
discrete aspects of care delivery rather than being a compro-
hensive assessment of quality. Although these processes of
care are included in clinical practice guidelines and have been
linked to patient outcomes, and despite explicit links between
certain processes and intermediate outcomes such as prescrib-
ing antilipidemic therapy and meeting LDL goals, outcomes
of care postdischarge are likely influenced by many factors
that are independent of these processes of care at discharge.
Furthermore, the composite measure of discharge care quality
included only a subset of measurable activities for ischemic
stroke care at VHA hospitals. Perhaps a measure that in-
cluded additional processes of care such as the provision of
comprehensive discharge planning that includes patient edu-
cation and appointment scheduling would have been corre-
lated with ambulatory care quality.

Another reason for why we may not have observed a
consistent correlation is that the processes of care at discharge
are principally under the locus of control of providers,
whereas achieving better outcomes during postdischarge
follow-up such as adherence to medical therapy or manage-
ment of blood pressure is far more complicated and is not
controlled by either providers or patients but requires en-
gaged partnership. For instance, providers are directly re-
ponsible for prescribing antithrombotic or antilipidemic
therapy or providing tobacco cessation counseling at dis-

charge. However, ensuring that blood pressure or serum
markers such as LDL or serum glycosylated hemoglobin are
measured and meet goal requires patients to keep appoint-
ments, providers to order the necessary follow-up tests,
providers to prescribe proper medical therapy, and patients to
adhere to therapy.

There are other considerations. First, our analysis focused
on 5 intermediate outcomes of care and did not include
patient-centered outcomes such as satisfaction or function.
For the intermediate outcomes, there is disagreement over
target thresholds for complex patients such as those recently
hospitalized with ischemic stroke. However, we deliberately
chose conservative thresholds for measurement. Second, our
study focused on only 1 condition, ischemic stroke, and may
not be generalizable to other conditions for which quality
measurement is more common such as myocardial infarction.
Third, our study was cross-sectional and unable to assess
causation. Finally, nearly 6% of patients were excluded from
analyses because they had no postdischarge care at a VAMC
within 6 months, although it is unclear whether these patients
received appropriate care outside of the VHA or were lost to
follow-up.

**Conclusions**

In conclusion, hospital discharge care quality was not con-
sistently correlated with ambulatory care quality within the
VHA’s integrated healthcare system. Quality improvement
efforts should remain focused on clinically important pro-
cesses of care; however, quality managers should be aware
that there may be only minimal “creep” of high-quality
performance from 1 setting to another. The impact of bundled
payments around episodes of care on quality across settings
as well as the medical home model that is now being
implemented within VHA and in the private sector deserve
further scrutiny.
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Disclosures
None.

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