Prevalence of Achievement of A1c, Blood Pressure, and Cholesterol (ABC) Goal in Veterans with Diabetes

Scott Martin Vouri, PharmD; Robert F. Shaw, PharmD, MPH; Nancee V. Waterbury, PharmD; Jason A. Egge, PharmD, MS, BCPS; and Bruce Alexander, PharmD, BCPP

ABSTRACT

BACKGROUND: The “ABCs of Diabetes” are defined as hemoglobin A1c <7.0%, blood pressure <130/80 millimeters mercury (mm Hg), and low-density lipoprotein cholesterol (LDL-C) < 100 milligrams per deciliter (mg per dl). Assessments of 3-part goal attainment of A1c, blood pressure, and cholesterol have been reported using data from the National Health and Nutrition Examination Survey (NHANES) for several time periods (e.g., 1988-1994, 1999-2000, 1999-2002, and 2003-2004), Look Action for Health in Diabetes (Look AHEAD, 2001-2004), and community-based endocrinology practice (CBEP, 2000-2004). In 2002, an unpublished analysis of data from 2001-2002 at the Iowa City Veterans Affairs (ICVA) Medical Center found less than 50% of patients met each of the 3 individual goals. In the 5 years following the 2001-2002 assessment, the care for veterans with diabetes at the ICVA was enhanced to include (a) an increased number of diabetes classes and clinics, (b) implementation of the diabetes Care Coordination/Home Telehealth (CCHT) program, and (c) clinical reminding for diabetes performance measures that were added to the electronic medical record (EMR).

OBJECTIVES: To (a) describe the prevalence of veterans meeting the ABC goals of diabetes in 1 VA medical center; (b) differentiate the proportion of diabetes patients who met the individual targets for A1c, blood pressure, and LDL-C and compare the results for 2008 through September 2009 with the earlier data from this facility (2001-2002); and (c) examine results reported previously in the literature for NHANES, Look AHEAD, and CBEP data sources.

METHODS: Single-center, retrospective analysis of veterans at the ICVA for dates of service from January 1, 2008, through September 30, 2009, who (a) filled at least 1 prescription for an antidiabetic medication and (b) had each of the 3 biomarker values recorded in the EMR for A1c, blood pressure, and LDL-C after the antidiabetic prescription fill date.

RESULTS: Of the 5,426 (97.6% male) patients meeting inclusion criteria in 2008-2009, 17.3% (n = 936) achieved the 3-part ABC goal. In this managed care setting, achievement of the 3-part ABC goal surpassed the proportions reported in previous studies in NHANES data (5.2% in 1988-1994, 7.3% in 1999-2000, 7.0% in 1999-2002, 13.2% in 2003-2004), and 10.1% in Look AHEAD 2001-2004, but fell short of the 22.0% reported in CBEP (2000-2004) performance (22.8%).

What this study adds

• Compared with an assessment in 2001-2002 in the same medical facility, a larger proportion of VA patients with diabetes who received at least 1 antidiabetic medication attained each of the 3 goals for A1c, blood pressure, and LDL-C in 2008-2009, and 17.3% of patients attained the 3-part ABC goal in 2008-2009, higher than the rates reported in national studies from 1988-2004 but lower than the 22.0% reported in the 2000-2004 CBEP study.

• Improvement in the proportion of diabetes patients attaining A1c, blood pressure, and cholesterol goals followed the addition of diabetes-care interventions such as clinical reminders in electronic medical records (EMRs), more opportunities for patient education and endocrinology clinics, and a telephone-based diabetes disease management program. However, patient participation was low for the endocrinology clinics, diabetes education classes, and telephone-based disease management.

What is already known about this subject

• The ABCs of diabetes include reduction of hemoglobin A1c, blood pressure, and low-density lipoprotein cholesterol (LDL-C), which individually have proven to be associated with lower morbidity and mortality due to microvascular and macrovascular complications.


Conclusion

Implementation of yearly clinical reminders for diabetes care, enhanced patient education, and other program changes that included home-based telephone monitoring with diabetes case management for some patients. Achievement of the 3-part ABC goal in 2008-2009 (17.3%) surpassed 5 assessments reported in the literature but was lower than the CBEP (2000-2004) performance (22.8%).

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The National Diabetes Education Program (NDEP)\(^1\)\(^2\) and the Diabetes Quality Improvement Project (DQIP)\(^3\) were established in 1997 to improve diabetes care. From these programs and published literature, the American Diabetes Association (ADA) established biomarker goals for successful management of diabetes: hemoglobin A1c < 7.0%, blood pressure < 130/80 millimeters mercury (mm Hg), and low-density lipoprotein cholesterol (LDL-C) < 100 milligrams per deciliter (mg per dL).\(^4\) These goals are collectively known as the “ABCs of Diabetes.” Despite the inception of programs such as NDEP and DQIP, providers and patients are often unaware of these treatment goals. The NDEP report in 2007 showed that in 2005 only about 20% of physicians and slightly less than 40% of nurse practitioners were aware of the term “ABCs of Diabetes.”\(^5\) However, physicians in 2005 self-reported showing that in 2005 only about 20% of physicians and slightly unaware of these treatment goals. The NDEP report in 2007 showed that in 2005 only about 20% of physicians and slightly less than 40% of nurse practitioners were aware of the term “ABCs of Diabetes.”\(^5\) However, physicians in 2005 self-reported monitoring diabetes patients “frequently” (every 0-3 months) for A1c (almost 80%), blood pressure (more than 80%), and cholesterol (about 25%).

Although many studies have examined individual components of the ABCs of diabetes, only a few have reported the proportion of patients achieving all 3 goals, and a direct comparison between the studies is difficult due to differences in patient samples and study methodology (Tables 1 and 2). The National Health and Nutrition Examination Survey (NHANES) data were analyzed for several different time periods for achievement of the 3-part ABC goal and have been reported for several time periods, for example, 5.2% for 1988-1994,\(^6\) 7.3% for 1999-2000,\(^7\) 7.0% for 1999-2002,\(^7\) and 13.2% for 2003-2004.\(^8\) From 2001 to 2004, the Look Action for Health in Diabetes (Look AHEAD) study reported 10.1% of people with diabetes who were overweight or obese met the ABC goal.\(^9\) From 2000 to 2004, the community-based endocrinology practice (CBEP) study evaluated consecutive patients with diabetes followed aggressively by endocrinology providers and found 22.0% achieved the ABC goal.\(^10\)

In 2002, the cardiovascular management of a random sample of 380 patients with type 2 diabetes from the Iowa City Veterans Affairs (ICVA) Medical Center was reported in a poster abstract.\(^11\) This cross-sectional analysis from 2001-2002 found 43.2% of patients (n = 164) had an A1c < 7.0%, and 29.2% (n = 111) had a blood pressure < 130/80 mm Hg. Of the 287 patients with type 2 diabetes who had lipid laboratory values, 49.5% (n = 142) had calculated LDL-C < 100 mg per dL. This poster abstract did not report the percentage of patients achieving the 3-part ABC goal.

Clinical reminders were added to the electronic medical record (EMR) at the ICVA after the 2001-2002 study, and these were standardized for all facilities in the Veterans Integrated Service Network (VISN) 23 (Midwest) in 2004. These reminders help clinicians comply with specific performance measures and guidelines in an effort to help improve patient care; they can be displayed in 4 areas of the EMR, including the main cover sheet and notes section. Clicking on the reminder provides more details about the individual alert. From 2004-2007, the Veterans Affairs/Department of Defense (VA/DOD) diabetes performance measures were supported by clinical reminders that included targeting A1c < 9%, outpatient blood pressure < 140/90 mm Hg, and LDL-C < 120 mg per dL (note: these reminder thresholds are higher than the ABC goals of A1c < 7%, blood pressure < 130/80 mm Hg, and LDL-C < 100 mg per dL used in both the 2001-2002 and 2008-2009 ICVA studies). Evidence-based VA/DOD guidelines promote risk stratification, guiding providers to assess the risk and benefits of therapeutic targets for individual patients; these guidelines do not represent the ideal target values for all patients.\(^12\)

To accommodate an increase in the number of veterans requesting diabetes-related care (based on referrals from health care providers), the number of diabetes clinics and classes expanded. At the end of 2003, the number of monthly diabetes endocrine clinics (clinics established to focus on the management of diabetes and staffed by endocrinologists, an advanced-practice nurse who is a certified diabetes educator, and a clinical pharmacy specialist who reviews medication use with patients prior to the appointment with the endocrinologist) increased from 3 to 4 and further expanded to 5 in 2007. In 2007, the frequency of diabetes education classes increased to at least 1 per calendar quarter, and class schedules were expanded to all ICVA-affiliated community-based outpatient clinics. The diabetes education class is a 4-hour class emphasizing the importance of carbohydrate counting, exercise, oral and injectable medications, and microvascular and macrovascular complications of diabetes. The clinical pharmacy specialist uses 1 hour of the 4-hour class to review the mechanisms of actions of diabetes medications along with proper dosing and use, explain the definition and proper treatment for hypoglycemia, and describe the importance of exercise and proper foot care.

Other quality of care initiatives included implementation of a network-wide, systematic effort in the VISN 23 (Midwest) region in 2006 to target high-risk patients with chronic illnesses including diabetes. In 2007, the diabetes Care Coordination/ Home Telehealth (CCHT) program was implemented at the ICVA Medical Center. Patients self-enroll in CCHT based on referral from a provider, and the target population is composed of patients with A1c > 9%.

We believed these clinical care changes would contribute to quality improvement in the number and proportion of veterans achieving the individual and 3-part ABC goal at our medical center.

## Methods

### Patients and Study Measures

Our objective was to determine the proportion of veterans with diabetes who received at least 1 prescription for an antidiabetic
# Prevalence of Achievement of A1c, Blood Pressure, and Cholesterol (ABC) Goal in Veterans with Diabetes


<table>
<thead>
<tr>
<th>Study</th>
<th>A1c</th>
<th>Blood Pressure</th>
<th>Cholesterol</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>NHANES&lt;sup&gt;6&lt;/sup&gt; Included 2 samples: 1988-1994&lt;sup&gt;4&lt;/sup&gt; 1999-2000&lt;sup&gt;5&lt;/sup&gt;</td>
<td>Measured once</td>
<td>Mean of 2nd &amp; 3rd reading (1988-1994) Mean of 3rd or 4th readings excluding the 1st reading (1999-2000)</td>
<td>Measured once (TC &lt; 200 mg per dL considered to be at goal); measured only in morning session after self-reported 8:5- to 24-hour fast; TC was used because of too few participants with valid LDL-C measurements</td>
<td>Patients (male and nonpregnant females) aged 0 years or older (except for women who were diabetic during a pregnancy) Non-Hispanic Whites in study sample: (1988-1994): 74.6% (1999-2000): 79.8% Mean years since diabetes diagnosis: (1988-1994): 10.2 (1999-2000): 12.5</td>
</tr>
<tr>
<td>NHANES (1999-2006)&lt;sup&gt;7&lt;/sup&gt; Included 2 samples: 1999-2002&lt;sup&gt;6&lt;/sup&gt; 2003-2006</td>
<td>Measured once</td>
<td>Mean of 3rd or 4th readings excluding the 1st reading</td>
<td>Measured once; LDL-C calculated using Friedewald equation; measured only in morning session after self-reported 8:5- to 24-hour fast</td>
<td>Patients (male and nonpregnant females) aged 20 years or older (except for women who were diabetic during a pregnancy) Non-Hispanic Whites in study sample: (1999-2000): 64.2% (2003-2006): 64.2% Mean years since diabetes diagnosis: (1999-2000): 11.7 (2003-2006): 11.2</td>
</tr>
<tr>
<td>NHANES (1999-2004)&lt;sup&gt;8&lt;/sup&gt; Included 3 samples: 1999-2000 2001-2002 2003-2006</td>
<td>Measured once</td>
<td>Mean of 3rd or 4th readings excluding the 1st reading</td>
<td>Measured once (TC &lt; 200 mg per dL considered to be at goal); measured only in morning session after self-reported 8:5- to 24-hour fast; TC &lt; 200 mg per dL used based on NCEP ATP III guideline</td>
<td>Patients (male and nonpregnant females) aged 20 years or older (except for women who were diabetic during a pregnancy) Non-Hispanic Whites in study sample: (1999-2000): 69.9% (2001-2002): 64.6% (2003-2004): 63.5% Mean years since diabetes diagnosis: (1999-2000): 12.5 (2001-2002): 11.0 (2003-2004): 12.6</td>
</tr>
<tr>
<td>Look AHEAD&lt;sup&gt;9,13&lt;/sup&gt; 2001-2004&lt;sup&gt;4&lt;/sup&gt;</td>
<td>Measurement closest to randomization (fasting); patients with A1c &gt; 11% were excluded</td>
<td>Mean of 2 seated readings 30 seconds apart after 5-minute rest period; excluded if blood pressure ≥ 160/100 mm Hg</td>
<td>Measurement closest to randomization (fasting); LDL-C calculated using Friedewald equation; excluded if fasting triglycerides ≥ 600 mg per dL</td>
<td>Patients aged 45-74 years All 5,145 participants were either overweight or obese (defined as a BMI ≥ 25 kg/m² or ≥ 27 kg/m² if on insulin) Whites: 63.2% of study sample Mean years since diabetes diagnosis: 6.8 Many exclusion criteria including: weight loss exceeding 10 pounds within 3 months, history of weight loss surgery, chronic treatment with systemic corticosteroids, current use of medications for weight, pregnant or nursing, any CVD comorbidity, serum creatinine &gt; 1.4 mg per dL (females) or 1.5 mg per dL (males), or receiving dialysis</td>
</tr>
<tr>
<td>CBEP&lt;sup&gt;10&lt;/sup&gt; 2001-2004&lt;sup&gt;4&lt;/sup&gt;</td>
<td>Mean of at least 2 measurements throughout study</td>
<td>Mean of at least 2 blood pressure measurements throughout study</td>
<td>Mean of at least 2 TC measurements; TC &lt; 200 mg per dL considered to be at goal in ABC assessment Mean LDL-C was calculated by Friedewald equation and reported as a secondary analysis</td>
<td>Patients aged 18 years or older Analyzed consecutive patients seen in consultation for diabetes management Non-Hispanic Whites: 92.7% of study sample Mean years since diabetes diagnosis: 11.2 Providers were endocrinologists Blood glucose checked 2-4 times per day in insulin-requiring patients and at least twice per day in patients on oral therapy; all patients were encouraged to contact CBEP at least once per week for adjustments to their treatment regimen; office follow-up every 1-2 months in patients not meeting ABC goal and 3-4 months in patients meeting ABC goal</td>
</tr>
<tr>
<td>ICVA&lt;sup&gt;11&lt;/sup&gt; 2001-2002&lt;sup&gt;4&lt;/sup&gt;</td>
<td>No details available</td>
<td>Only 75.5% of the sample had a fasting lipid panel drawn during study period. Calculated LDL-C was used</td>
<td>No details available</td>
<td>Inclusion criteria: diagnosis of type 2 diabetes for at least 1 year Race of sample not collected Mean years since diagnosis not collected</td>
</tr>
<tr>
<td>ICVA 2008-2009&lt;sup&gt;4&lt;/sup&gt;</td>
<td>Last measured A1c prior to end of study period (mean if 2 or more were collected on the same day)</td>
<td>Last measured blood pressure prior to end of study period (mean if 2 or more were measured on the same day)</td>
<td>Last measured direct LDL-C prior to end of study period (mean if 2 or more were collected on the same day) Fasting status was unknown</td>
<td>Veterans aged 18 years or older filling at least 1 antidiabetic agent during study period Race of sample not collected Mean years since diabetes diagnosis not collected</td>
</tr>
</tbody>
</table>

*These samples are reported in Figure 2 and in grey shade in Table 2.

A1c = hemoglobin A1c; ABC = hemoglobin A1c < 7%; blood pressure < 130/80 mm Hg, and LDL < 100 mg per dL; BMI = body mass index; CBEP = community-based endocrinology practice; CVD = cardiovascular disease; ICVA = Iowa City Veterans Affairs; kg per m² = kilogram per square meter; LDL-C = low density lipoprotein cholesterol; Look AHEAD = Look Action for Health in Diabetes; mg per dL = milligrams per deciliter; mm Hg = millimeters mercury; NCEP ATP III = National Cholesterol Education Program Third Adult Treatment Panel; NHANES = National Health and Nutrition Examination Survey; TC = total cholesterol.
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### TABLE 2: Patient Characteristics for NHANES, Look AHEAD, CBEP, and ICVA

<table>
<thead>
<tr>
<th>Study</th>
<th>Number of Subjects</th>
<th>Mean Age in Years</th>
<th>% Male</th>
<th>% Type 2 Diabetes</th>
<th>% BMI ≥ 30</th>
<th>% on Antidiabetic Medication</th>
</tr>
</thead>
<tbody>
<tr>
<td>NHANES (1988-1994)</td>
<td>1,160</td>
<td>60.2</td>
<td>43.2</td>
<td>100.0</td>
<td>41.6</td>
<td>75.2</td>
</tr>
<tr>
<td>NHANES (1999-2000)</td>
<td>441</td>
<td>59.3</td>
<td>50.0</td>
<td>100.0</td>
<td>54.6</td>
<td>81.3</td>
</tr>
<tr>
<td>NHANES (1999-2006)</td>
<td>1,780</td>
<td>NR</td>
<td>NR</td>
<td>100.0</td>
<td>NR</td>
<td>NR</td>
</tr>
<tr>
<td>NHANES (1999-2002)</td>
<td>827</td>
<td>58.8</td>
<td>49.9</td>
<td>100.0</td>
<td>52.3</td>
<td>81.6</td>
</tr>
<tr>
<td>NHANES (2003-2006)</td>
<td>953</td>
<td>59.2</td>
<td>45.4</td>
<td>100.0</td>
<td>56.7</td>
<td>82.2</td>
</tr>
<tr>
<td>NHANES (1999-2004)</td>
<td>1,318</td>
<td>NR</td>
<td>NR</td>
<td>100.0</td>
<td>NR</td>
<td>NR</td>
</tr>
<tr>
<td>NHANES (1999-2000)</td>
<td>415</td>
<td>59.1</td>
<td>49.8</td>
<td>100.0</td>
<td>NR</td>
<td>80.4</td>
</tr>
<tr>
<td>NHANES (2001-2002)</td>
<td>412</td>
<td>57.3</td>
<td>50.3</td>
<td>100.0</td>
<td>NR</td>
<td>81.8</td>
</tr>
<tr>
<td>NHANES (2003-2004)</td>
<td>491</td>
<td>59.7</td>
<td>46.7</td>
<td>100.0</td>
<td>NR</td>
<td>81.5</td>
</tr>
<tr>
<td>Look AHEAD (2001-2004)</td>
<td>5,145</td>
<td>58.7</td>
<td>40.5</td>
<td>100.0</td>
<td>85.1</td>
<td>86.5</td>
</tr>
<tr>
<td>CBEP (2000-2004)</td>
<td>395</td>
<td>60.4</td>
<td>59.2</td>
<td>84.1</td>
<td>NR</td>
<td>99.8</td>
</tr>
<tr>
<td>ICVA (2001-2002)</td>
<td>380</td>
<td>68.4</td>
<td>NR</td>
<td>100.0</td>
<td>NR</td>
<td>91.0</td>
</tr>
<tr>
<td>ICVA (2008-2009)</td>
<td>5,426</td>
<td>67.3</td>
<td>97.6</td>
<td>98.9%</td>
<td>54.5%</td>
<td>100.0</td>
</tr>
</tbody>
</table>

*The 8 grey-shaded rows indicate the data points reported in Figure 2.

Overall number of subjects used to determine 3-part ABC goal was not reported.

In NHANES, diabetes was not categorized as type 1 versus type 2; subjects with diabetes diagnosed at 30 years of age or younger and treated with insulin alone were excluded because they were considered likely to have type 1 diabetes.

In NHANES 1999-2004 and 1999-2006, overall patient characteristics were not reported; characteristics of subjects within each phase are reported above.

Mean BMIs for 1999-2000, 2001-2002, and 2003-2004 were 32.3, 31.37, and 32.34 kg per m², respectively. Percentage BMI ≥ 30 kg per m² was reported only in individual assessments of A1c, blood pressure, and total cholesterol in the overall sample from 1999-2006 and (within samples).

In CBEP, the mean BMI was 33.1 kg per m² (range 18.61 kg per m²). Percentages were not reported for normal weight, overweight, and obese categories.

Type 1 diabetes (based on ICD-9-CM codes: 250.x1 or 250.x3) represented 1.1% (n = 62) of the sample during the study period.

BMI values were available for 4,855 patients (89.5%) and represent the most recent BMI in the study period.

A1c = hemoglobin a1c; BMI = body mass index; CBEP = community-based endocrinology practice; ICD-9-CM = International Classification of Diseases, Ninth Revision, Clinical Modification; ICVA = Iowa City Veterans Affairs; kg per m² = kilogram per square meter; Look AHEAD = Look Action for Health in Diabetes; NHANES = National Health and Nutrition Examination Survey; NR = not reported.

Drug who met the (a) ADA-defined 3-part ABC goal and (b) individual targets for A1c, blood pressure, and LDL-C, comparing our results with earlier data from our medical center and to examine results reported previously in the literature for NHANES, Look AHEAD, and CBEP data sources. Our study was a single-center, retrospective analysis in a sample of veterans who were enrolled in the services of the ICVA Medical Center from January 1, 2008, through September 30, 2009. Of the 52,452 unique patients seen at the medical center during this 21-month period, 19.7% (n = 10,345) had a diagnosis of diabetes (International Classification of Diseases, Ninth Revision, Clinical Modification [ICD-9-CM] codes 250.00 through 250.93; Figure 1). Patients with type 1 diabetes were defined by ICD-9-CM codes 250.x1 or 250.x3.

Patients who received at least 1 antidiabetic agent between January 1, 2008, and September 30, 2009, and had each of the 3 biomarker values for A1c, blood pressure, and LDL-C (laboratory value) recorded during the study period were included in the analysis; the direct measure of LDL-C was used. The most recent biomarker value after the first prescription fill date but within the date range for the study was included in the analysis. If more than 1 value was listed for the day (e.g., blood pressure), a mean average of the results was used. All data were extracted from EMRs using Fileman, an electronic database management program used to access VA data. This study was approved by the University of Iowa Institutional Review Board and the Iowa City VA Research and Development Committee in September 2009 and October 2009, respectively.

**Statistical Analysis**

Descriptive statistics were used for the primary measure (proportion of veterans who met the 3-part ADA-defined ABC goal) and the secondary measure (proportion who met individual targets for A1c, blood pressure, and LDL-C) as well as summarizing baseline sample characteristics. Pearson chi-square was used to compare the individual goals from 2001-2002 with the 2008-2009 findings. Analysis was 2-tailed and performed using SPSS version 15.0 (SPSS Inc., Chicago, IL).

**Results**

Of 52,452 total ICVA medical center patients, 7,337 (14.0%) received at least 1 antidiabetic prescription fill for service dates from January 1, 2008, through September 30, 2009 (Figure 1). A diagnosis of diabetes was confirmed, and laboratory documentation after the prescription fill date was available for the 3 biomarker values for 5,426 patients (74.0%, Figure 1). The mean and [median] number of days after the prescription fill date for each biomarker was as follows: A1c (373.6 [387]), blood
pressure (398.0 [411]), and LDL-C (352.5 [369]). The majority of patients (98.9%) had type 2 diabetes, and this percentage is higher than national statistics, which may be explained in part by restrictions on military enlistment for individuals with diabetes (Table 2). The mean age was 67.3 years, with many patients being obese (54.5%) and predominantly male (97.6%). During the 21-month study period in 2008-2009, 62.5% (n = 3,389) of the patients received at least 1 prescription fill for metformin; sulfonylureas were received by 56.6% (n = 3,073); insulins by 38.9% (n = 2,112); thiazolidinediones by 8.8% (n = 478); alpha-glucosidase inhibitors by 1.0% (n = 55); and incretins/exenatide by 0.5% (n = 28). During the study period, a small percentage of our patients were managed by the endocrinology clinic (4.7%), participated in diabetes class (7.1%), or were enrolled in the CCHT program (6.2%).

### ABC Goal Attainment

In our study, 17.3% of patients (n = 936) achieved the 3-part ABC goal for diabetes management (Table 3). The remaining participants achieved 2 goals (39.1%, n = 2,122), 1 goal (32.4%, n = 1,759), and 11.2% (n = 609) did not meet any of the 3 goals. The individual goals were achieved by 2,932 patients (54.0%) for A1c < 7.0%, 2,266 (41.8%) for blood pressure < 130/80 mm Hg, and 3,613 (66.6%) for LDL-C < 100 mg per dL. The proportion of patients achieving the A1c goal improved by an absolute 10.8%; blood pressure goal improved by 12.6%; and LDL-C goal increased by 17.1% compared with the 2002 results (P < 0.001 for all 3 comparisons, Table 3).

### Table 3

<table>
<thead>
<tr>
<th>Goal</th>
<th>2001-2002 n = 380 n (%)</th>
<th>2008-2009 n = 5,426 n (%)</th>
<th>P Valuea</th>
</tr>
</thead>
<tbody>
<tr>
<td>3-part ABC goal</td>
<td>NR (0.0)</td>
<td>936 (17.3)</td>
<td>NA</td>
</tr>
<tr>
<td>A1c</td>
<td>164 (43.2)</td>
<td>2,932 (54.0)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Blood pressure</td>
<td>111 (29.2)</td>
<td>2,266 (41.8)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>LDL-C</td>
<td>142 (49.5)b</td>
<td>3,613 (66.6)c</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

aP values calculated using Pearson chi-square.
bOnly 287 of 380 patients (75.5%) had LDL-C values recorded, calculated via the Freidewald equation.
cDirect LDL-C laboratory value was recorded in the electronic medical record.

A1c = hemoglobin A1c; ABC = hemoglobin A1c < 7%, blood pressure < 130/80 mm Hg, and LDL-C < 100 mg per dL; ADA = American Diabetes Association; ICVA = Iowa City Veterans Affairs; LDL-C = low density lipoprotein cholesterol; NA = not applicable; NR = not reported.

### Discussion

There are significant differences in the patient samples and methodology for the studies of ABC goal attainment that have been described in the literature (Tables 1 and 2), preventing definitive comparisons with the data from the ICVA. However, recognition of the differences in the patient samples and study methods permits informed comparison of the results of the present study with the results that have been reported previously (Figure 2).

The NHANES studies, comprising 4 of the 6 evaluations of ABC goal attainment reported in the literature, are very similar with regards to patient characteristics. Derived from the same survey, the inclusion criteria in these studies included male and nonpregnant females aged 20 years or older with diabetes.
Whereas patients in the NHANES studies were included based on self-reported diabetes, the participants in Look AHEAD and CBEP had diabetes diagnosed by health care providers, similar to the inclusion criteria in the present (2008-2009) ICVA study. Because the present ICVA study involved patients with diabetes who received at least 1 fill of an antidiabetic medication, this patient sample most closely resembles the sample in the CBEP study in which 99.8% received antidiabetic medication and contrasts with the NHANES and Look AHEAD data where 13.8% to 24.8% of the subjects were diet controlled. The exclusion of diet-controlled diabetes in our study may contribute to a lower proportion of all diabetes patients with ABC goal attainment because an analysis in the Look AHEAD trial showed that patients not on antidiabetic medications were more likely to meet the ABC goals and A1c goal compared with patients who used oral antidiabetic medications or insulin.

Body mass index (BMI) is an important assessment for patients with diabetes. In a multivariate analysis of the Look...
AHEAD trial, patients with a BMI < 30 kilogram per square meter (kg per m²) were more likely to meet all 3 goals compared with patients with a BMI > 40 kg per m². The Look AHEAD study had the highest percentage of obese patients (84.1%), defined as BMI > 30 kg per m². The NHANES, CBEP, and ICVA (2008-2009) studies had much lower proportions of patients with BMI > 30 kg per m²—between 41.6% and 56.7% (Table 2).6-8

NHANES (1999-2004)8 and NHANES (1999-2006)7 also differed from the previous NHANES,6 Look AHEAD,9 CBEP,10 ICVA (2001-2002),11 and ICVA (2008-2009) in the study objectives. All studies reported attainment of the 3-part ABC goal (except ICVA 2001-2002), along with the 3 individual goals. However, the aim of NHANES (1999-2004) and NHANES (1999-2006) was to examine trends in both diagnosis of diabetes and treatment of diabetes via sample populations. Although these studies showed similar achievement of ABC goals—11.4%6 and 10.0%,7 respectively—the longitudinal trend in improvement in ABC goal attainment was not significant.

Achievement of the 3-part ABC goal in the NHANES samples for 1999-2000, 2001-2002, and 2003-2004 were 7.5%, 13.1%, and 13.2%, respectively (P > 0.05).8 For NHANES, during the 8-year period from 1999 through 2006, achievement of the 3-part ABC goal in the samples for 1999-2002 and 2003-2006 were 7.0% and 12.2%, respectively (P = 0.06).8

The results from the CBEP study demonstrate the effect of aggressive diabetes management, with 4.7% more patients achieving the 3-part ABC goal compared with our 2008-2009 data (22.0% vs. 17.3%). The CBEP intervention included endocrinology follow-up every 1 to 2 months if the A1c was not at goal or every 3 to 4 months if at goal. Patients were also encouraged to contact the clinic on a weekly basis to reassess labs and to make medication adjustments. Along with pharmacologic diabetes treatment, CBEP also focused on nonpharmacologic options to improve diabetes. Patients were directed to pamphlets and handouts detailing the risks associated with microvascular and macrovascular complications, offered grocery shopping guides to aid in selecting healthy food choices (low fat, low glycemic, and high fiber), and encouraged to engage in physical activity when feasible. Aggressive pharmacological management and promotion of nonpharmacologic options for treatment of diabetes contributed to the CBEP study having the highest percentage of patients meeting the ABC goals.10

Control of hypertension and cholesterol are also important to reduce the risk of microvascular and macrovascular disease. Blood pressure was at goal in less than one-half of our patients (41.8%). Our results for blood pressure goal attainment were higher than NHANES 1988-1994, 1999-2000, and 1999-2002 but lower than NHANES 2003-2004, CBEP, and Look AHEAD studies. In our study, we included the patient’s last blood pressure during the study period, and we could not control for the method of blood pressure measurement. The likelihood of different staff taking blood pressures with different methods (automatic/manual) is considerable. In the other studies, an average of at least 2 readings was used to determine the blood pressure for each patient.

In our 2008-2009 study, 66.6% of patients achieved their cholesterol (LDL-C) goal, similar to 68.8% reported in the CBEP study (Figure 2). However, CBEP used total cholesterol (TC) < 200 mg per dL to determine goal attainment; LDL-C was collected as part of a secondary analysis.10 The individual goal of TC < 200 mg per dL was also used as the cholesterol benchmark to determine the 3-part ABC goal in NHANES 1988-1994, 1999-2000, and 2003-2004. LDL-C assessment was used in NHANES 1999-2002, Look AHEAD, ICVA 2001-2002, and 2008-2009, and the Friedewald equation was used to calculate LDL-C except in the 2008-2009 ICVA data in which direct laboratory values were available in the EMR. Accordingly, use of direct LDL-C meant that values were not excluded for elevated A1c or significantly elevated triglycerides. In 2004, Lindsey et al. revealed a slight difference between calculated LDL-C and direct LDL-C where calculated LDL-C underestimated actual LDL-C by up to 20 mg per dL.14 The differences in methodology for the measurement of cholesterol among the studies should be acknowledged when comparing these data.

Overall, the proportion of patients with diabetes achieving the 3-part ABC goal and individual goals remains less than optimal. However, NHANES data from 1999-2004 and 1999-2006 showed improvement over time, suggesting advancement in diabetes care.7,8 We have identified several factors that may have contributed to improvement in achieving the 3 individual ABC goals at the ICVA in 2008-2009 compared with 2001-2002. Programs such as NDEP2 and DQIP3 encourage providers to emphasize to their patients the importance of reducing A1c, blood pressure, and LDL-C for the prevention of microvascular and macrovascular complications, as the CBEP intervention did as part of the nonpharmacological interventions.19 In addition, the VA has worked to improve adherence to diabetes goals including improvements in the EMR with the implementation of computerized clinical reminders for performance measures and expansion of diabetes clinics, classes, and programs. However, patient participation in voluntary education and other care interventions is low.

The Veteran’s Health Administration’s (VHA) performance measures have similarities with the Health Plan Employer Data and Information Set (HEDIS) measures. For the majority of health plans in the United States, HEDIS assesses annually the quality of care performance via 75 measures across 8 domains, including “comprehensive diabetes care.”25 For January 1, 2009, through December 31, 2009, mean attainment of 3 diabetes goals among commercial U.S. health plans on the HEDIS measures was 61.6% for A1c (<8%), 65.1% for blood pressure < 140/90 mm Hg (33.9% for blood pressure < 130/80 mm Hg),
and 47.0% for LDL-C.\textsuperscript{16} According to the HEDIS FY 2011 Q1 Technical Manual, the patient selection criteria for the HEDIS “comprehensive diabetes care” measures include members with diabetes aged 18 to 75 years and at least 2 encounters with ICD-9-CM codes 250.xx, 357.2, 362.0x, 366.41, or 648.0x. Exclusions include patients with gestational diabetes, hyperglycemia not otherwise specified, or steroid-induced hyperglycemia/diabetes. The HEDIS A1c and blood pressure goals differ somewhat from the current ADA goals (i.e., A1c < 7.0% and blood pressure < 130/80 mm Hg) and from the 2010 VA/DOD performance measures (i.e., A1c target is individualized based on the provider’s evaluation of the risk-benefit ratio and discussion with the patient [goal A1c < 9% for any patient with diabetes and blood pressure ≤ 140/90 mm Hg]).\textsuperscript{17} HEDIS data are reported to employers, and the VHA measures are reported to facility administrators.\textsuperscript{18} These measures and reports provide the basis for assessment of quality improvement initiatives.

In the present study, we did not specifically assess the effects of diabetes care interventions in our medical facility, including the use of clinical reminders. In directly relevant research, Hunt et al. (2009) found that implementation of a physician-directed, multifaceted health information system, including clinical reminders in primary care, was associated with a 24 percentage-point improvement in the proportion of patients attaining the LDL-C goal of < 100 mg per dL (from 32% to 56%), a 22% absolute improvement in goal blood pressure < 130/80 mm Hg (from 30% to 52%), and a 3% absolute improvement in the proportion of patients achieving A1c goal < 7.0% (from 47% to 50%).\textsuperscript{19} Agrawal and Mayo-Smith (2004) found that provider adherence to 15 clinical reminders was highly variable across 49 clinics in 8 VA medical centers (ranging from 67% to 97%), and adherence among physicians ranged from 29% to 100%\textsuperscript{20}.

We also did not assess the effects of the other interventions that were initiated at the ICVA between 2001-2002 and 2008-2009, including expansion in the number of diabetes clinics and education classes. During the ICVA 2008-2009 study period, 4.7% of patients were managed by the endocrinology clinic, a consulting clinic that does not manage patients long term—patients are returned to their primary care provider when stabilized on their antidiabetic regimens. Also during the 2008-2009 study period, 7.1% of the patients participated in a diabetes education class, a 1-time offering for each patient (i.e., patients who attended classes in years prior to 2008-2009 were not counted). During 2008-2009, clinicians could also refer patients with an A1c > 9.0% to the diabetes CCHT program in which patients are asked to upload their readings (e.g., A1c) on a weekly or bi-weekly basis, and these readings are included in the EMR. The primary care provider or the advanced practice nurse certified in diabetes education reviews the uploaded information and makes recommendations to the patient for any changes in diabetes care. The CCHT program was still in its infancy during the 2008-2009 study period, and only 6.2% of the patients were enrolled in CCHT.

Limitations

Foremost among the limitations of the present study is the absence of assessment of the 3-part ABC goal attainment for the ICVA sample in 2001-2002 and different sample selection criteria for the 2001-2002 study versus the follow-up analysis in 2008-2009. Third, only 287 of 380 patients (75.5%) had LDL-C values recorded in the 2001-2002 assessment, and the LDL-C values were calculated via the Freidewald equation versus the direct laboratory values recorded in the EMRs for the 2008-2009 assessment. Fourth, we did not assess the effects of several changes in diabetes care management that occurred over the period between 2001-2002 and the current evaluation period 2008-2009. Fifth, comparisons with the national studies are merely suggestive and not definitive because of the significant differences in the methods of data collection, inclusion/exclusion criteria, biomarker measures, and the characteristics of the patients in the samples. Sixth, our study sample was limited to patients filling at least 1 antidiabetic agent during the study period, thereby excluding patients with diet-controlled diabetes and making our study sample different than the national studies with the exception of CBEP in which 99.8% of the participants received antidiabetic medication. Seventh, biomarkers were collected for prevalence analysis and do not represent clinical endpoints. Finally, the generalizability of the present study is limited by the gender, race, and geographical characteristics of the sample.

Conclusions

The proportion of patients attaining the 3 individual goals of A1c, blood pressure, and LDL-C in 2008-2009 improved in each category compared with the 2001-2002 assessment. The improvement in these biomarker performance measures followed several changes in diabetes care processes, including an increased number of diabetes classes and clinics, implementation of a telephone-based home care coordination program, and adoption of clinical reminders in EMRs for suboptimal A1c, blood pressure, and LDL-C goal attainment in this VA medical center. Clinical reminders in EMRs potentially affected all patients in the present study whereas patient participation rates in the other diabetes interventions were low.
Prevalence of Achievement of A1c, Blood Pressure, and Cholesterol (ABC) Goal in Veterans with Diabetes

Authors

SCOTT MARTIN VOURI, PharmD, is a Post-Graduate Year 2 (PGY-2) Geriatrics Pharmacotherapy Resident, Texas Tech University Health Sciences Center School of Pharmacy, Dallas, Texas. ROBERT F. SHAW, PharmD, MPH, is a Clinical Pharmacy Specialist in Critical Care, Iowa City Veterans Affairs Medical Center, and Assistant Professor in the Clinical and Administrative Pharmacy Division, College of Pharmacy, University of Iowa, Iowa City, Iowa. NANCÉE V. WATERBURY, PharmD, is a Clinical Pharmacy Specialist in Ambulatory Care; JASON A. EGGE, PharmD, MS, BCPS, is a Clinical Pharmacy Specialist in Ambulatory Care; and BRUCE ALEXANDER, PharmD, BCPP, is a Clinical Pharmacy Specialist VISN 23 in Mental Health, Iowa City Veterans Affairs Medical Center, Iowa City, Iowa.

AUTHOR CORRESPONDENCE: Scott Martin Vouri, PharmD, Texas Tech University Health Sciences Center School of Pharmacy, 4500 S. Lancaster Rd., Bldg. 7, R#119A, Dallas, TX 75216. Tel.: 214.742.8387. ext. 70592; Fax:214.372.5020; E-mail: scott.vouri.pharmd@gmail.com.

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