

## Can We Use Automated Data to Assess Quality of Hypertension Care?

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**Objective:** To determine whether extractable blood pressure (BP) information available in a computerized patient record system (CPRS) could be used to assess quality of hypertension care independently of clinicians' notes.

**Study Design:** Retrospective cohort study of a random sample of hypertensive patients from 10 Department of Veterans Affairs (VA) sites across the country.

**Methods:** We abstracted BPs from electronic clinicians' notes for all medical visits of 981 hypertensive patients in 1999. We compared these with BP measurements available in a separate vitals signs file in the CPRS. We also evaluated whether assessments of performance varied by source by using patients' last documented BP reading.

**Results:** When the vital signs file and notes were combined, a BP measurement was taken for 71% of 6097 medical visits; 60% had a BP measurement only in the vital signs file. Combining sources, 43% of patients had a BP reading of less than 140/90 mm Hg; by site this varied (34%-51%). Vital signs file data alone yielded similar findings; site rankings by rates of BP control changed minimally.

**Conclusions:** Current performance review programs collect clinical data from both clinicians' notes and automated sources as available. However, we found that notes contribute little information with respect to BP values beyond automated data alone. The VA's vital signs file is a prototypical automated data system that could make assessment of hypertension care more efficient in many settings.

(*Am J Manag Care.* 2004;10:473-479)

Obtaining valid data describing processes and outcomes of care is central to quality assessment and improvement. Traditionally, such data could be obtained from a variety of sources including administrative databases, medical records, and patient surveys. Administrative databases contain information typically collected for billing purposes or to track utilization, including demographics, diagnoses, and procedure codes. Such databases allow cost-efficient study of large numbers of cases but lack the clinically detailed information available from medical records.<sup>1-3</sup> Increasingly though, clinically detailed information such as laboratory and vital signs data are becoming incorporated into comprehensive informa-

tion systems.<sup>3,4</sup> The completeness and accuracy of these data systems are often in question.<sup>5,6</sup> Consequently, assessment of their validity remains necessary.

Hypertension is an important condition whose treatment is in need of quality improvement.<sup>7</sup> It affects more than 50 million Americans and more than 1 million veterans.<sup>8,9</sup> Despite readily available, effective therapy for lowering blood pressure (BP) and preventing cardiovascular morbidity and mortality,<sup>8,10-12</sup> most patients with hypertension have inadequate BP control.<sup>13-18</sup> In the 1999-2000 National Health and Nutrition Examination Survey, 69% of patients with a diagnosis of hypertension had a BP reading greater than or equal to 140/90 mm Hg.<sup>8</sup> Further, several studies have shown that despite reported familiarity and agreement with national hypertension guidelines, clinicians tolerate higher BPs than are recommended.<sup>13,19-21</sup>

Improving hypertension care requires ongoing assessment. Unadjusted BP control is the only widely used measure to assess hypertension care, used by both the Health Plan Employer Data and Information Set (HEDIS) and the Department of Veterans Affairs (VA) performance review program.<sup>22,23</sup> Unlike many other performance indicators that involve first examining automated data and then reviewing the medical chart if data are not available, hypertension assessment has traditionally relied solely on chart review.<sup>24</sup> This is at least in part because BP data may be recorded by several individuals. In most ambulatory clinics, a nurse takes an initial BP and documents this reading in an intake note. Clinicians may then do additional BP measurements, which are documented in their medical notes.

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This project was funded in part by the Department of Veterans Affairs Health Services Research and Development Service (grant SDR 99-300-1).

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For those settings with computerized patient record systems (CPRS), the initial vital signs information recorded by the nurse also may be entered into a separate data field of the record, which may then be readily extracted. In previous work, we found that only 1 BP reading was taken at most visits, which usually was present in the nurse's intake note.<sup>14</sup> In a setting where this information is entered directly into the computerized record, it is unknown how much information would be lost by examining only these automated vital signs data, and whether using only these data would impact quality measurement.

The current study compares the availability and agreement of BP measurements from an extractable data field of the CPRS with BP measurements obtained from clinicians' notes. We address the following 3 questions:

1. How complete is the automated BP information?
2. What factors are associated with discrepancies between the automated data and the clinicians' notes?
3. How do judgments about the quality of hypertension care vary based on the data sources used?

Lessons learned from our experience may be useful to other researchers and individuals interested in measuring healthcare quality.

## METHODS

This is a retrospective cohort study that analyzed VA databases. The VA, as the largest integrated healthcare system in the United States, provides care to more than 4 million veterans and is considered to be a leader in establishing "a multifunctional integrated electronic medical record system."<sup>25-27</sup>

### Study Subjects and Sites

We identified individuals with hypertension who were receiving regular outpatient medical care at 10 VA sites across the country during 1999. (A site comprises a hospital-based outpatient clinic and associated community-based outpatient clinics.) Selected sites had been entering BP measurements into a separate vital signs file of the CPRS and using electronic clinicians' notes for medical clinics, both as of at least January 1, 1999.

We used a national administrative VA database, the OutPatient Clinic file, to identify eligible subjects. To be eligible, patients needed to have at least 1 OutPatient Clinic-listed hypertension diagnosis (*International Classification of Diseases, Ninth Revision, Clinical Modification [ICD-9-CM]* code 401,

402 or 405) in 1998 and to be regular VA users (ie,  $\geq 2$  OutPatient Clinic-listed medical clinic visits at least 6 months apart in 1999). The study sample was randomly selected from among all eligible patients stratified by site. We sought 100 patients per site and achieved a final sample size of 981.

### Data Collection and Sources

We used the VA's CPRS, known as the Veterans Health Information Systems and Technology Architecture, and the OutPatient Clinic file. The Veterans Health Information Systems and Technology Architecture, which is maintained at the hospital within a site, contains multiple files, including those with clinical data such as vital signs, laboratory and radiologic test results, pharmacy data, problem lists, and provider notes. It also contains an administrative-encounter file with diagnoses and procedures from all clinic visits that is transferred to a central VA data repository in Austin, Texas, and incorporated into the OutPatient Clinic file.<sup>28</sup> At the clinic level, BP measurements usually are taken by a nurse and either directly entered into a separate vital signs file with structured data entry fields in the CPRS, or reported on encounter forms and then entered by a clerk into this file. Additional BP data may be available through provider notes, which are either dictated and transcribed or typed directly into the provider notes file of the CPRS. (These clinical files are not yet routinely transferred centrally.)

Study data were collected during the 12 months in 1999. For automated data, patient demographics, *ICD-9-CM*-coded diagnoses, and medical clinic visit dates were obtained from the OutPatient Clinic file; BP measurements were extracted from the CPRS vital signs file. Vital signs file data were merged with OutPatient Clinic visit information such that a visit was assigned to each BP recording. For dates with multiple clinic visits, such as visits to primary care and a general surgical clinic, we assigned all BP recordings to the medical clinic.

Clinicians' notes from all medical visits of selected patients were obtained by accessing each site's local intranet and printing a hard copy. (As mentioned, the file containing these notes also is part of the CPRS, but the information would not be considered automated because it is free text.) An experienced nurse-abstractor then extracted note information including visit type, date, and BP. Blood pressure information from nurses' intake notes or clinicians' note entries that used an object template taken from the vital signs file were ignored because we were interested in whether the clinician took additional BP readings.

A 5% random sample of charts (a chart comprises all clinical notes on a given patient) was reviewed by one of

the authors (A.M.B.) for interrater reliability. Observed agreement on the presence and value of all readings was 96%. The only discrepancies found related to the presence of a BP reading rather than to its value. Such discrepancies were more likely to occur for patients who had more than 6 visits and more than 5 BP readings available, with one or the other reviewer missing an available BP.

### Statistical Analyses

**Completeness of Automated Blood Pressure Information.** First, we determined whether BP measurements were available in the CPRS vital signs file. Our denominator consisted of all OutPatient Clinic-identified medical clinic visits in 1999. We examined the percentage of visits with at least 1 BP measurement, as well as the percentage with 2 or more measurements. If multiple identical BP values were found in the vital signs file for the same day, we deleted duplicates.

Next, we examined how much additional BP information would be obtained by combining vital signs file data and information available in clinicians' notes. We used the same denominator and eliminated duplicate values in the notes. We examined the amount of information lost by calculating the differences between sources overall and by site.

**Discrepancies Between Sources.** For visits with BP measurements available in both sources, we compared the number and value of BP recordings in the clinicians' notes with those in the vital signs file. We cross-tabulated visits by number of automated BP measurements against the number of BP measurements from the corresponding visit notes. Additionally, we checked whether each BP recording in the vital signs file had an exact match in the clinicians' notes, and noted the frequency of visits at which this match occurred. We checked for a match using both individual BPs from a given source and the average of available BPs.

We also examined whether BP documentation differences between sources (both in terms of BP presence and average BP value at a given visit) were because the BP was high and therefore the clinician was more likely to repeat the measurement and report it in his or her note. We used the average BP in the vital signs file at a given visit and determined whether it was high ( $\geq 140/90$  mm Hg). We tested whether visits with vital signs file BPs versus those with BPs in both sources were more or less likely to have a high BP reading by using the chi-square test. We similarly compared the BPs of matching and nonmatching visits.

**Variation in Judgment of Blood Pressure Control.** We first examined differences in BP control (BP  $< 140/90$  mm Hg) at the individual visit level. We then

determined patient-level control by calculating the average BP for each patient at his or her last visit of the year for which a BP value was available. We calculated the percentage of patients with a BP less than 140/90 mm Hg, examining results by source for the whole sample and testing for site differences by using the chi-square test. We again computed differences between combined sources and the vital signs file alone.

## RESULTS

Baseline sample characteristics are presented in **Table 1**. The number of patients per site varied from 71 to 103 because of differential adoption of electronic notes by site. There were 6097 visits to primary care, medical subspecialty clinics, and urgent and emergent care. Of these, 3987 were primary care visits; 629 were subspecialty primary care visits (general internal medicine, geriatrics, women's clinic, hypertension, cardiology, spinal cord clinic); and 1481 were subspecialty, urgent care, or nursing visits.

### How Complete Are the Data?

Sixty percent of all medical visits had at least 1 BP measurement in the vital signs file (**Table 2**). Combining automated (vital signs file) and clinician note information, 71% of visits had at least 1 recorded BP measurement (**Table 2**). Therefore, 11% of visits had a BP measurement in the clinicians' notes that was not

**Table 1.** Baseline Characteristics of 981 Patients With Hypertension

Characteristic	No. (%)
Age, y*	65.3 $\pm$ 11.1
Male sex	951 (97)
Nonwhite race	112 (11)
Number of antihypertensive medications	
0	87 (9)
1	249 (25)
2	309 (31)
3	194 (20)
$\geq 4$	142 (15)
Selected coexisting conditions	
Diabetes mellitus	322 (33)
Hyperlipidemia	442 (45)
Coronary artery disease	339 (35)
Cerebrovascular disease	79 (8)
Tobacco use	192 (20)

\*Mean  $\pm$  SD.

**Table 2.** Prevalence of Visits With at Least 1 or 2 Blood Pressure Measurements, by Source

Visits (n = 6097)	Mean ± SE, % (No.)	
	Vital Signs File	Vital Signs File + Notes*
With >1 blood pressure measurement	60.3 ± 0.6 (3677)	71.4 ± 0.6 (4350)
With ≥2 blood pressure measurements	1.9 ± 0.2 (115)	14.6 ± 0.5 (890)

\*Notes are electronic clinicians' notes.

in the vital signs file. By site, the amount of available information lost using only the vital signs file varied from 1% to 35% ( $P < .0001$ ; data not shown). Only 2% of visits had 2 or more BP measurements in the vital signs file, whereas 15% of visits had at least 2 BP measurements recorded by combined sources. Thus, 13% of visits had a second BP measurement in the clinicians' notes that was not in the vital signs file.

**What Factors Are Associated With Discrepancies Between Sources?**

A BP measurement was available in both the vital signs file and the clinicians' notes for 1361 visits. Seventy-nine percent (1070/1361) of these visits had only 1 BP measurement in each source. The BP measurement matched exactly for 50% (678/1361) of these visits. Of these matching visits, 99% (674/678) had only 1 BP measurement in each source.

Conversely, 50% (683/1361) of the BP measurements taken during visits did not match exactly. Fifty-eight percent (396/683) of these visits had only 1 BP measurement in each source. Of the 287 visits with more than 1 BP measurement available in either source, 188 visits had 1 BP value that matched and 237 visits had multiple BP measurements only in the clinicians' notes; 30 visits had multiple BPs only in the vital signs file.

Next we examined whether BP documentation differences between sources were related to BP level. Of the 4350 visits with a BP measurement in either source, 2316 had a BP measurement only in the vital signs file. Of these 2316 visits, 57% had a high BP reading ( $\geq 140/90$  mm Hg), compared with 63% of visits with a BP measurement in both sources ( $P = .02$ ). Thus, a clinician-noted BP value was more likely if the intake or vital signs file BP was high. Of the 1361 visits with a BP measurement in both sources, 78% of visits where the average BP values did not match had a measurement indicating uncon-

trolled BP in the vital signs file only, compared with 48% of visits where the BP measurements did match ( $P < .0001$ ). This suggests the clinician was more likely to repeat the BP measurement when the intake value was high, resulting in non-matching values, rather than just transcribe the intake BP (matching values).

**How Do Judgments of Blood Pressure Control Vary Based on the Data Source?**

At the visit level, only 61 visits would have been misclassified depending on the source. At 48 visits, the BP would have been classified as uncontrolled according to the vital signs file, but would have been considered controlled when the combined source was used. At 13 visits, the BP would have been classified as controlled according to the vital signs file, but would have been considered uncontrolled when the combined source was used.

At the patient level, using only automated data, the BP of 41% of the patients was controlled (see Table 3). Using both sources yielded similar results in terms of overall control and site rankings by percent control. Overall, 43% of patients had controlled BP, and the most a site changed ranking was by 2 places (Table 3). Thus, the extra information provided in the notes changed the assessment of BP control for a given patient in fewer than 2% of cases. In those few cases, the BP changed from uncontrolled to controlled.

If one assumed patients with missing BP measurements had uncontrolled BP ( $\geq 140/90$  mm Hg) at their last visit, this assumption made minimal difference to overall results or site rankings, even for the site missing the most data (10/101 patients), when just automated information was used. Health Employer Data and Information Set and the VA's performance review program use the lowest available BP and assume the BP is uncontrolled if missing.<sup>22,23</sup> Analyzing by both these criteria made little difference to results (data not shown).

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**DISCUSSION**

Current assessments of BP control rely largely on chart review and are therefore time-consuming and limited in scope. If valid BP data were available in automated form, this would make evaluations of BP control and quality of hypertension care more useful by encompassing more cases and allowing more timely feedback of information to providers, so that corrective actions would be more likely.<sup>29</sup>

In the present study, we found that most BP data were available in an automated form in the vital signs file of the VA's CPRS and that most medical visits had only 1 BP measurement available regardless of source. Of the 22% of visits with BP values available in both the automated data and the clinician's notes, half the time the BP in the clinician's note was a duplicate of the vital signs file BP, suggesting that the clinician was simply taking this information from the vital signs file or the nurse's note and incorporating it into his or her note. As expected, clinicians were more likely to repeat the BP measurement when the initial readings by nurses were high, but this situation did not occur very often. Most repeat measurements were not appreciably different, and their inclusion did not significantly affect judgments of control. Despite additional BP values available in the notes at 11% of visits, the percentage of patients with controlled BP did not change appreciably when comparing automated data with automated data plus notes.

No other studies have attempted to validate automated BP readings or other vital signs data in this way. One other study by Goldstein et al examined recorded BP values and assessments of control, although its methods were somewhat different.<sup>30</sup> These researchers studied chart BPs, comparing the BP in the initial note by the nurse (which is comparable to the CPRS vital signs file) with BP measurements done by clinicians for 350 patients participating in a hypertension intervention study, at 2 separate primary care visits at the Palo Alto, California, VA, a site also used in our study. The BP was rechecked at 48% of visits where patients had uncontrolled BP and 38% of all visits. For approximately 25% of visits, patients who had an initial uncontrolled BP reading had a controlled BP at clinician recheck. Given their findings, Goldstein et al argue for including repeat BP measurements in quality assessments. However, our data show that, despite this site having the highest percentage (26%) of visits with 2 or more available BP measurements in the combined source, BP values at only 18 of 656 (2.7%) visits changed from uncontrolled to controlled when clinician information

**Table 3.** Blood Pressure Control by Source\*

Site <sup>†</sup>	No. of Patients <sup>‡</sup>	% Patients With Blood Pressure <140/90 mm Hg		Rank Change	% Difference Between Sources <sup>§</sup>
		Vital Signs File	Vital Signs File + Notes		
1	103	50.5	50.5	0	0.0
2	101	46.5	48.5	-1	2.0
3	103	46.5	48.5	+1	2.0
4	100	40.4	43.0	-1	2.6
5	101	41.1	43.0	0	1.9
6	71	41.2	45.1	+2	3.9
7	101	38.5	39.6	-1	1.1
8	99	38.8	40.4	+1	1.6
9	101	36.6	38.6	0	2.0
10	101	31.7	33.7	0	2.0
<b>Whole sample</b>	<b>981</b>	<b>41.2</b>	<b>43.1</b>	<b>—</b>	<b>1.9</b>

\*Blood pressure control was determined by using the average of blood pressure measurements at the last visit for which blood pressure was available.

<sup>†</sup>Sites are ranked 1 to 10, from highest to lowest percentage based on the vital signs file.

<sup>‡</sup>The total number of patients per site varied from 71 to 103. At site 6, electronic clinic notes were available for only 71 hypertensive patients.

<sup>§</sup>There were no significant differences between sites.

was considered (data not shown). The study by Goldstein et al was presented as a meeting abstract, so full details were not available. However, it is likely that dissimilar methods account for the discrepant results. Further, our methods better reflect those of current performance review programs.

Most of the available studies of automated data elements have used claims data to examine the validity of diagnoses or process measures.<sup>24</sup> Few have examined the use of automated clinical data for process or outcome measures, and only 1 other study has looked at BP. Kerr et al compared automated data from a central VA diabetes registry with medical record data (both electronic and paper) with respect to diabetes quality measures including the measurement and level of control of BP, low-density lipoprotein (LDL) cholesterol, and glycosylated hemoglobin (HbA<sub>1c</sub>).<sup>27</sup> They also investigated whether combining information from both sources (compared with using either source alone) affected quality assessments for approximately 800 veterans receiving diabetes care in 1999. They found lower rates for all process measures using automated data, compared with either the medical record or with both sources combined. Unlike our study, they found fewer

BP measurements available in the automated data than the chart. For the process measure of the proportion of patients with a BP measurement in 1999, the respective proportions by source were 84%, 99%, and 99% for automated data, medical record, and combined sources. If we were to construct a similar measure, 98% of our sample's patients would have a BP measurement according to the automated data, whereas only 33% would have a BP measurement based on clinician note data alone; when the sources are combined, 100% would have a BP measurement. These differing results may have occurred because Kerr et al collected the BP data at different time periods within sources and perhaps because they used a different, less complete, automated source. However, like our study, the Kerr et al study found that overall rates for outcome measures, including the percentage of patients with BP less than 140/90 mm Hg, LDL cholesterol less than 130 mg/dL, or HbA<sub>1c</sub> less than 9.5%, were comparable regardless of source, although they could not construct a combined BP control measure because BP data were measured at different time periods.

Thus, we are the first to examine an automated database with BP measurements and compare it with medical notes from the same time period. We found it yielded as much or more information than medical note review and gave assessments of performance comparable to those of a combined measure using automated data and notes.

Our data are already a few years old. However, increased automation and familiarity with the VA's CPRS have occurred over this time period. Blood pressure information is now more likely to be entered into the database and is more likely to be entered directly by the nurse who took the measure, as opposed to a third party. Thus, newer vital signs file data should be even more accurate and complete. (In this study, 673 visits had a BP value only in the notes, which is unlikely to occur in the present VA ambulatory clinic setting.)

There is no way to know the true reliability and accuracy of data entered into the vital signs file or clinicians' notes because we have no control over the measurement, documentation, and data entry process. This is true for all information systems and medical records.

Site 6 had the fewest patients because of difficulty finding patients with available electronic notes. Also at this site, assessment of performance regarding BP control varied the most by source. It had the lowest percentage of BP values entered into the vital signs file and the second highest percentage with BP values only in the notes. This site was clearly behind the others in the adoption of the electronic record and also in the entry of BP measurements into the vital signs file. This likely

has changed with time so that there will be less of a discrepancy between the 2 sources.

Because we could not analyze by individual clinician, we do not know whether such assessments would vary by source. However, most visits were associated with only 1 BP value in either source, with more visits having information available in the vital signs file than in the notes. With increased adoption of the vital signs file, we would expect that those visits where only 1 BP value was available only in the notes would now have that information entered into the vital signs file. Therefore, clinician assessments should be consistent between sources.

All healthcare systems face the challenge of developing effective methods for assessing the quality of care. In the case of hypertension, such assessments require accurate BP information. Although this study only examined VA data systems and settings, it is likely that non-VA clinicians behave similarly with regard to BP measurement. We believe that by implementing or enhancing existing medical record systems with similar extractable data fields, other healthcare organizations also may find that they are able to make more efficient decisions about hypertension care. Moreover, such systems could incorporate other clinical data fields that could be likewise extractable, making clinically detailed information more readily obtainable and facilitating monitoring of various quality indicators across many medical conditions. These could include information such as whether a pneumococcal vaccination was given or a foot exam performed on a patient with diabetes.<sup>27</sup>

Current performance review programs collect clinical data from both clinicians' notes and automated sources as available.<sup>22</sup> Given the demonstrated completeness of automated BP data in the electronic record, we believe assessments of hypertension care can be made based on these data alone, making such evaluations more efficient. Where effective databases do not currently exist, the VA's vital signs file is a prototypical clinical computerized data system that could be easily adopted by other settings.

#### Acknowledgments

We thank Elaine Czarnowski, RN, for data abstraction and Marshall Goff for editorial assistance.

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#### REFERENCES

1. Fisher ES, Whaley FS, Krushat WM, et al. The accuracy of Medicare's hospital claims data: progress has been made, but problems remain. *Am J Public Health.* 1992;82:243-248.
2. Kashner TM. Agreement between administrative data files and written medical records. *Med Care.* 1998;36:1324-1336.
3. Iezzoni LI. Assessing quality using administrative data. *Ann Intern Med.* 1997; 127:666-674.

4. Jollis JG, Ancukiewicz M, DeLong ER, et al. Discordance of databases designed for claims payment versus clinical information systems. *Ann Intern Med.* 1993; 119:844-850.
5. Halpern J. The measurement of quality of care in the Veterans Health Administration. *Med Care.* 1996;34 (3 suppl):MS55-MS68.
6. Arts DGT, De Keizer NF, Scheffer GJ. Defining and improving data quality in medical registries: a literature review, case study and generic framework. *J Am Med Inform Assoc.* 2002;9:600-611.
7. Chobanian AV. Control of hypertension—an important national priority. *N Engl J Med.* 2001;345(7):534-535.
8. Hajjar I, Kotchen TA. Trends in prevalence, awareness, treatment, and control of hypertension in the United States, 1988-2000. *JAMA.* 2003;290:199-206.
9. Yu W, Ravelo AL, Wagner TH, et al. The cost of common chronic diseases in the VA health care system. Presented as an abstract at: 20th Annual Meeting of the Department of Veterans Affairs Health Services Research and Development Service; February 13-15, 2002; Washington, DC.
10. SHEP Cooperative Research Group. Prevention of stroke by antihypertensive drug treatment in older persons with isolated systolic hypertension: final results of the Systolic Hypertension in the Elderly Program (SHEP). *JAMA.* 1991;265:3255-3264.
11. Amery A, Birkenhager W, Brixko P, et al. Mortality and morbidity results from the European Working Party on High Blood Pressure in the Elderly trial. *Lancet.* 1985;1:1349-1354.
12. Collins R, Peto R, MacMahon S, et al. Blood pressure, stroke, and coronary heart disease, part 2: short-term reductions in blood pressure: overview of randomized drug trials in their epidemiological context. *Lancet.* 1990;335:827-838.
13. Berlowitz DR, Ash AS, Hickey EC, et al. Inadequate management of blood pressure in a hypertensive population. *N Engl J Med.* 1998;339:1957-1962.
14. Borzecki AM, Wong AT, Hickey EC, et al. Hypertension control: how well are we doing? *Arch Intern Med.* 2003;163:2705-2711.
15. Frijling BD, Spies TH, Lobo CM, et al. Blood pressure control in treated hypertensive patients: clinical performance of general practitioners. *Br J Gen Pract.* 2001;51:9-14.
16. Joffres MR, Hamet P, Rabkin SW, et al. Prevalence, control and awareness of high blood pressure among Canadian adults. *CMAJ.* 1992;146:1997-2005.
17. Colhoun HM, Dong W, Poulter NR. Blood pressure screening, management and control in England: results from the health survey for England 1994. *J Hypertens.* 1998;16:747-752.
18. Meissner I, Whisnant JP, Sheps SG, et al. Detection and control of high blood pressure in the community. Do we need a wake-up call? *Hypertension.* 1999;34: 466-471.
19. Oliveria SA, Lapuerta P, McCarthy BD, et al. Physician-related barriers to the effective management of uncontrolled hypertension. *Arch Intern Med.* 2002; 162:413-420.
20. Hyman DJ, Pavlik VN. Self-reported hypertension treatment practices among primary care physicians. *Arch Intern Med.* 2000;160:2281-2286.
21. Hajjar I, Miller K, Hirth V. Age-related bias in the management of hypertension: a national survey of physicians' opinions on hypertension in elderly adults. *J Gerontol Med Sci.* 2002;57A:M487-M491.
22. Sennett C. Implementing the new HEDIS hypertension performance measure. *Manag Care.* 2000;9(4 suppl):2-17.
23. Veterans Health Administration/Department of Defense. *FY 2002 VHA Performance Measurement System Technical Manual.* Washington, DC: The Office of Performance and Quality, Veterans Health Administration; March 2002. Available at: [http://www.oqp.med.va.gov/cpg/HTN/P/HTN\\_3\\_8\\_02\\_techman.doc](http://www.oqp.med.va.gov/cpg/HTN/P/HTN_3_8_02_techman.doc). Accessed December 20, 2003.
24. Dresser MVB, Feingold L, Rosenbranz SL, Coltin KL. Clinical quality measurement: comparing chart review and automated methodologies. *Med Care.* 1997;35:539-552.
25. Ashton CM, Septimus J, Petersen NJ, et al. Healthcare use by veterans treated for diabetes mellitus in the Veterans Affairs medical care system. *Am J Manag Care.* 2003;9:145-150.
26. Kizer KW. The "new VA": a national laboratory for health care quality management. *Am J Med Qual.* 1999;14:3-20.
27. Kerr EA, Smith DM, Hogan MM, et al. Comparing clinical automated, medical record, and hybrid data sources for diabetes quality measures. *Jt Comm J Qual Improv.* 2002;28:555-565.
28. VA Information Resource Center. Toolkit for new users of national VA data at the Austin Automation Center. Available at: <http://www.virec.research.med.va.gov/Support/Training-NewUsersToolkit/Toolkit.htm> Accessed December 20, 2003.
29. Mugford M, Banfield P, O'Hanlon M. Effects of feedback of information on clinical practice: a review. *BMJ.* 1991; 303:398-402.
30. Goldstein MK, Hoffman BB, Coleman RW, et al. Differences between initial and repeat blood pressure measurements during the same clinic visit in primary care practice. Presented as an abstract at: 19th Annual Meeting of the Department of Veterans Affairs Health Services Research and Development Service; February 14-16, 2001; Washington, DC.