# Managed Care Penetration and Other Factors Affecting Computerized Physician Order Entry in the Ambulatory Setting

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**Objectives:** To estimate the current uses level of ambulatory computerized physician order entry (A-CPOE) among physicians and to examine the relationship of managed care penetration as well as other market and practice characteristics to use of A-CPOE by physicians.

**Data Sources:** This study uses both primary and secondary data sources. The primary data source was a large-scale survey of physicians' use of information technologies in Florida. Secondary data on managed care penetration were obtained from the Florida Agency for Health Care Administration, and other market-level data were extracted from the area resource file.

**Methods:** A hierarchical logistic regression model was used to examine the correlation of county-level and practice-level characteristics with physicians' self-reported use of A-CPOE systems.

**Results:** Overall, 1360 physicians (32.4%) indicated use of an A-CPOE system. Findings suggest that 1% more managed care penetration was associated with 2.1% lower use of A-CPOE ($P = .003$). Additionally, practice size, multispecialty affiliation, and primary care practice were significantly and positively correlated with the use of A-CPOE. Physician age was negatively associated with A-CPOE use.

**Conclusion:** Managed care organizations may experience significant financial savings from A-CPOE use by physicians; however, managed care penetration in a community negatively affects A-CPOE use among physicians in their practices. Further study regarding the causal nature of this association is warranted.

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Prescribing of medications for patients occurs frequently in ambulatory facilities. An estimated 66.8% of clinical encounters in this setting result in a physician prescribing or continuing a medication for a patient.[1] Furthermore, 82.2% of prescription writing in the ambulatory setting takes place in a physician's private office.[2] Given the frequency with which medications are prescribed, it is important to note that preventable adverse drug events are common in the ambulatory clinical setting.[3]

Ambulatory computerized physician order entry (A-CPOE), a health information technology (HIT) noted for its potential ability to reduce medication errors and improve quality,[4-6] is a software application that supports the ordering of medications, diagnostic tests, interventions, and referrals by outpatient providers.[7] Similar to inpatient systems, A-CPOE systems include lab test ordering functions. However, electronic drug prescribing is by far the most common use of A-CPOE systems.[4]

Analysis has shown that use of A-CPOE can bring substantial financial savings to consumers, physicians, and payers. Potential savings have been estimated to be as much as $44.2 billion annually in the United States if such systems were universally adopted.[7] Additionally, stories in the lay press have highlighted the benefits of A-CPOE systems to patients and health payers.[8] As a result, the national strategic plan for the adoption of HIT has included A-CPOE, and the Medicare Modernization Act of 2003 has sought to promote the use of A-CPOE systems.[9]

Compared with the growing literature on hospital-based CPOE systems,[10-18] empirical research on the use of A-CPOE systems is relatively rare and often consists of case studies. Among the available studies, Schectman et al found that the use of an A-CPOE system in one academic ambulatory clinic was strongly associated with physicians' attitudes toward the potential benefits of the system.[19] Overhage et al found that after a brief learning period, little or no ongoing training was required for physicians using a well-designed A-CPOE system.[20] Pizzi et al found that early adopters of A-CPOE systems were more likely to be generalists, have fewer years in practice, and work in technology-equipped offices.[21] However, this later study's generalizability was limited for a variety of reasons, including a narrow sample of online users, a very low response rate (3.7%), and the use of descriptive statistical methods that did not control for other important factors (eg, practice characteristics,



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market variables). To our knowledge, no study has documented the organizational factors (eg, practice size, type, specialty) that relate to the use of A-CPOE in private physicians' offices. Nor has any study examined the relationship of market-level factors (eg, managed care penetration, competition) with A-CPOE adoption decisions in the office setting.

The purpose of this paper is to fill those gaps in the literature. First, we sought to estimate the current A-CPOE utilization level among physicians in private practices. In particular, we were interested in the function of electronic prescription order entry. Second, we examined the correlation of managed care penetration, as well as other market, organizational, and individual factors, with the use of A-CPOE among physicians. As such, this study makes 2 new contributions to the study of health information technology (IT). First, it establishes a benchmark for A-CPOE adoption that can be used to measure progress in the diffusion of this technology. Second, it comprehensibly evaluates physicians' A-CPOE utilization levels in the practice context and competitive market environments. Such information will allow policymakers and physicians to more effectively target their A-CPOE promotion efforts.

## METHODS

The analyses presented herein used both primary and secondary data sources. The primary data source was a comprehensive large-scale survey (n = 14 921) of physicians' use of HITs in Florida. Secondary data on managed care penetration were obtained from the Florida Agency for Health Care Administration, and other market data were extracted from the area resource file (ARF). The following sections describe each of these data sources, as well as the variables and analytical approach used in the study. A list of variables and their sources is in **Table 1**.

### Primary Data

In the spring of 2005, a large-scale survey of physicians practicing in Florida was conducted. The survey, which was approved by the Florida State University institutional review board, targeted all primary care physicians (family doctors, general internists, general pediatricians, and obstetrician-gynecologists) in the state. In addition, 25% of the other physicians practicing in the ambulatory setting (eg, medical and surgical specialists, general surgeons, dermatologists, psychiatrists) were randomly selected from the Florida Department of Health's list of physicians with clear and active licenses. The survey included questions regarding types of IT (eg, e-mail, personal digital assistants [PDAs], electronic health records) used by physicians in the office setting. A complete description of the survey methodology,[22,23] including an analysis of potential response bias (none detected),[24] was previously published. Briefly, the survey was developed based on a comprehensive literature review and refined with the aid of experts' advice to establish content and face validity. Before deployment, the survey instrument was cognitively tested with a panel of physicians for clarity and readability. This process resulted in several iterations before the final version of the questionnaire.

Numerous vendors and system variants exist for A-CPOE. For example, electronic order entry can occur via a stand-alone software application on a personal computer (PC), a handheld device (eg, a PDA), or an existing electronic health record (EHR) system.[4,21,25,26] As mentioned above, the survey asked respondents to indicate whether or not they used a PC, PDA, and/or EHR system in the scope of their practice. When responding in the affirmative to any of these questions, each respondent was further asked to select from a list the functions that they used on each of these platforms. For example, those using a PDA were asked to indicate by a check mark whether they used their PDA for things such as drug references, medication interactions, electronic order entry (eg, labs, x-rays), electronic prescriptions, and various other clinical and administrative functions. In the current study, we were interested in the A-CPOE functionality regardless of system variant (eg, PC, PDA, EHR). In addition, given the nature of the data, it was feasible for a given physician to have A-CPOE capabilities via more than 1 such platform. Therefore, the selected outcome variable for the current study was physicians' self-reported use of at least 1 of these forms of A-CPOE in their office practice.

Physician-level independent variables from the survey were measured as follows. Practice size was categorized into 4 levels representing the number of physicians at a given practice location (solo, 2-9, 10-49, or 50+). The medical-training variable was dichotomized to facilitate comparison between primary care physicians versus other specialists. Last, physicians practicing in rural communities were identified by 1 of the following criteria: 1) their office was located in one of Florida's 33 statutorily designated rural counties, 2) their office was located in a rural part of a nonrural county as designated by the Rural Urban Commuting Area codes,[27] or 3) their address was in the current Health Resources and Services Administration list of defined Florida rural zip codes. Collectively, along with physician demographic information, these practice characteristics

**Table 1.** Descriptive Characteristics of Variables Used and Their Sources*

| Variable | Value | Data Source |
|---|---|---|
| **County-level market characteristics, mean (range)** | | |
| Physicians per (1000) capita | 2.53 (.07-7.72) | ARF 2004 |
| Poverty rate, % | 12.9 (7.4-21.8) | ARF 2004 |
| Managed care penetration, % | 21.7 (0-46.1) | Florida AHCA |
| White race, % | 77.6 (38.7-95.0) | ARF 2004 |
| Age ≥65 y, % | 16.4 (8-33.0) | ARF 2004 |
| Newborn, % | 1.2 (.06-1.8) | ARF 2004 |
| Unemployment rate, % | 5.3 (2.6-10.8) | ARF 2004 |
| Geographic location of physician practice | | Practice address† |
| Urban | 3950 (94.2) | |
| Rural | 245 (5.8) | |
| **Practice-level characteristics, no. (%)** | | |
| Practice size | | Physician IT survey |
| Solo practice | 1228 (30.9) | |
| 2-9 physicians | 2150 (54.2) | |
| 10-49 physicians | 385 (9.7) | |
| 50 or more physicians | 206 (5.2) | |
| Practice type | | Physician IT survey |
| Single specialty | 2713 (85.6) | |
| Multispecialty | 457 (14.4) | |
| Primary care | | Physician IT survey |
| No | 1995 (48.2) | |
| Yes | 2141 (51.8) | |
| Physician age | | Physician IT survey |
| <40 y | 485 (16.0) | |
| 41-50 y | 1130 (37.3) | |
| 51-60 y | 930 (30.7) | |
| ≥61 y | 486 (16.0) | |
| Physician sex | | Physician IT survey |
| Male | 2479 (75.9) | |
| Female | 786 (24.1) | |

*Sample size varies slightly by question. Numbers may not add up to 100% due to rounding.
†Practice addresses were obtained from the Florida Department of Health list of licensed physicians.
ARF indicates area resource file; Florida AHCA, Agency for Health Care Administration in Florida; IT, information technology.

allowed for the examination of the factors that may be related to the use of A-CPOE.

### Secondary Data

Using the latest available version (2004) of the ARF, various market-level indicators were matched, by county, to the primary data collected via the physician IT survey described above. The ARF dataset is compiled by the Health Resources and Services Administration and contains county-level information aggregated from numerous national sources.[28] In particular, we were interested in managed care penetration rates. However, the current version of the ARF data contained outdated (1999) information for this variable. As such, managed care penetration rates for the first quarter of 2005, for each Florida county, were obtained from the Florida Agency for Health Care Administration. This agency licenses all health insurers and managed care organizations in the state and collects this information for statutorily required reporting purposes. The county-level managed care penetration rate was calculated by taking the number of residents enrolled in an HMO and dividing it by the total number of residents in that county.

Higher managed care penetration rates have been shown to slow the diffusion of some medical technologies.[29,30] However, less is known about the relationship between managed care penetration and use of HIT among physicians. Theoretically, use of HIT is consistent with the goals of managed care; that is, to improve information gathering, increase administrative and clinical efficiencies, and promote clinical effectiveness. Therefore, a continuously measured market-level (county) managed care penetration rate was included in the analysis. Additionally, a number of the documented benefits[4,6,7] associated with A-CPOE may make it an attractive investment for physicians, particularly when practicing in more competitive environments. To control for competition, we computed the county number of physicians per (1000) capita using the ARF data. Last, we included several other county-level measures to control for environmental factors that may be related to A-CPOE use. These measures included poverty and unemployment rates, percentage of the population that is white/non-Hispanic, percentage of the population age 65 years or older, and newborns as a percentage of the population.

### Statistical Analyses

To analyze the data, standard descriptive statistics were calculated to examine the data for anomalies and to ensure that the assumptions of all analyses were met. To examine the independent relationship of the market-level and practice-level characteristics to the outcome variable, a hierarchical logistic regression model was used. The model utilized the "enter" method for variable inclusion and a 2-block nested approach. The first

block represented county-level characteristics such as percent managed care penetration, poverty rate, physicians per capita, geographic location (rural vs urban), and other county-level demographic information (see Table 1). The second block represented practice-level characteristics including physician age and sex as well as practice scope (primary care or specialty practice), size, and type (single specialty vs multispecialty). This method was selected because physician-level and practice-level characteristics are likely influenced by local market forces. As such, controlling for these factors in a nested model was warranted. It should be noted that the current statistical approach had a cross-sectional design that cannot assess causality. Therefore, the results should be interpreted as associations. All analyses were conducted with SPSS version 13.0 (SPSS Inc, Chicago, Ill), and significance was assessed at the $P < .05$ level.

## RESULTS

Overall, 4203 physicians completed the survey and could be matched to the ARF data, representing a 28.2% response rate. Demographic and practice characteristics, along with descriptive information on the ARF variables used, appear in Table 1. Respondents' demographics were consistent with known physician demographic patterns in Florida.[31] Briefly, the average age of physicians was 50.6 years with a range of 30 to 86 years. The majority of respondents were Caucasian (68.4%) and male (75.9%), and worked in a single-specialty practice (85.6%).

In descriptive analysis, the presence of an academic medical center did not correlate with being in a high or low HMO penetration area ($\chi^2 = .622$, $P = .430$). However, those in rural areas ($\chi^2 = 158.4$, $P < .001$) and those in central Florida ($\chi^2 = 903.7$, $P < .001$) were more likely to be in low HMO penetration areas. Alternatively, those in the southern part of the state were more likely to be in high HMO penetration areas ($\chi^2 = 903.7$, $P < .001$).

A total of 1360 physicians (32.4%) indicated they used an A-CPOE function in their office practice. When all variables in the hierarchical model were controlled for, 4 factors had a significant independent relationship with the use of an A-CPOE system among physicians (see **Table 2**). Among the county-level variables examined, only the managed care penetration variable was significantly and negatively correlated with A-CPOE availability. Specifically, 1% more managed care penetration was associated with 2.1% less use of A-CPOE ($P = .003$).

Four practice-level characteristics were related to A-CPOE adoption as well. For example, compared with physicians in solo practice, those in groups of 10 to 49 physicians (odds ratio [OR] = 2.78, $P < .001$) or 50+ physicians (OR = 7.36, $P < .001$) were significantly more likely to indicate using A-CPOE. Moreover, those physicians practicing in primary care (OR = 1.43, $P = .001$) or in a multispecialty practice (OR = 1.43, $P = .013$) were more likely to use an A-CPOE system. Physician sex did not seem to have an effect; however, age was negatively related to A-CPOE use. Specifically, a 1-year increase in age was associated with a 2.5% decrease in the frequency of physicians reporting A-CPOE use ($P < .001$).

## DISCUSSION

The literature about CPOE usage in hospitals is extensive[10-18] and growing rapidly. However, less is known about the use of CPOE in ambulatory settings. Taking into consideration the unique nature of ambulatory medical practice and the importance of A-CPOE in ensuring medication safety, the present study examined the overall utilization rate of A-CPOE and the factors that are related to the adoption of this technology in the outpatient setting.

Overall, in mid-2005, about one third of physicians responding to the Florida survey indicated using an A-CPOE function in their office practice. This level is markedly higher than the estimated 2% of all prescriptions written in 1999 that were done electronically[32] and the reported 19% of physicians that used an A-CPOE system in 2003.[21] The rate for A-CPOE usage among respondents is also higher than recent data on CPOE usage (approximately 10%) in the inpatient setting.[33] Given the more visible pressures from hospital stakeholders (eg, the Leapfrog group) to adopt CPOE, the motivation for A-CPOE may not be as strong. However, the difference in adoption rates between the inpatient and outpatient settings may reflect the less complex, and less costly, installations associated with the ambulatory setting.[34,35] Also, at this point, it is unclear what role the e-prescribing adoption incentives from the Medicare Modernization Act of 2003 have on A-CPOE systems.

With respect to adoption factors, our findings suggest that managed care penetration in a community appears to be negatively related to the use of A-CPOE among physicians. This trend is consistent with previous research that identified a negative relationship between managed care penetration rates and the use of magnetic resonance imaging and other "high tech" services.[29,30] With respect to A-CPOE, there may be several explanations for this finding. First, managed care penetration may be associated with decreased financial flexibility

**Table 2.** Adoption of Computerized Physician Order Entry by Florida Physicians in the Ambulatory Setting (n = 4203)*

| Variable | Use of A-CPOE | |
|---|---|---|
| | Percentage | Odds Ratio |
| **County-level market characteristics** | | |
| Physicians per (1000) capita† | | .996 |
| Poverty rate† | | .986 |
| Managed care penetration rate† | | .979‡ |
| % White race | | .972 |
| % Age ≥65 y | | 1.06 |
| % Newborn | | .419 |
| Unemployment rate | | .944 |
| Geographic location of physician practice | | |
| Urban | 32.6 | 1.00 |
| Rural | 29.0 | .876 |
| **Practice-level characteristics** | | |
| Practice size | | |
| Solo practice | 21.6 | 1.00 |
| 2-9 physicians | 30.3 | 1.14 |
| 10-49 physicians | 54.8 | 2.78‡ |
| 50 or more physicians | 74.3 | 7.36‡ |
| Practice type | | |
| Single specialty | 25.4 | 1.00 |
| Multispecialty | 47.7 | 1.43‡ |
| Primary care§ | | |
| No | 29.1 | 1.00 |
| Yes | 35.4 | 1.40‡ |
| Physician age† | | .975‡ |
| Physician sex | | |
| Male | 31.9 | 1.00 |
| Female | 33.8 | .900 |

*Sample size varies slightly by question. Hierarchical logistic regression was used to compute the adjusted odds ratios, controlling for all market-level and practice-level characteristics listed in the table.
†Measured on a continuous scale.
‡$P < .01$.
§Primary care includes family physicians, general internists, general pediatricians, and general practitioners.
A-CPOE indicates ambulatory computerized physician order entry.

among physicians.[36-39] The lower level of resource availability may arise from systematically lower reimbursements, more time pressures, and/or potentially higher overhead that is needed to contract with managed care organizations. As a result, less capital may be available to physicians and their practices to invest in A-CPOE systems and other HITs.

Several administrative practices commonly promoted by HMOs are more easily executed with the use of IT. For example, IT enables data gathering and management for activities such as physician profiling, identifying patients with chronic diseases, engaging in quality improvement, establishing benchmarks of excellence, and estimating both case mix and expected resource utilization. Ironically, if the negative relationship we identify is causal, managed care organizations may be inadvertently slowing the adoption of A-CPOE, whose benefits (eg, preventing duplicate orders and medication errors) primarily accrue to the payer.[4-7] Traditionally, HMOs are cost conscious and do not spend resources on initiatives that do not have a demonstrated return on investment that is superior to other alternatives. Perhaps more evidence of a direct return on investment will be necessary before managed care organizations actively incentivize the adoption of A-CPOE among independent physicians working in their networks.

Previous research suggests that medical practices owned by HMOs were 3 times more likely to use EHR systems than self-owned or group-owned practices.[40] Moreover, HMO clinics in areas with higher HMO penetration were more likely to use various ITs.[41] These trends suggest that HMOs recognize several benefits from the use of IT in their own in-house, clinical operations. If all physicians adopted A-CPOE, 1 apparent benefit to managed care organizations would include an improved ability to manage and enforce compliance with their formularies. Future research should examine how the adoption of A-CPOE and other IT by physicians can specifically benefit managed care organizations.

It should be noted, however, that managed care organizations may have a financial interest to negatively influence the adoption of HIT among physicians with whom they contract. As physicians increasingly use HIT to manage their administrative and clinical duties, electronic access to practice-level data may make them better equipped to negotiate contractual arrangements with HMOs and other third-party payers. Medical practice managers also may be more effective at managing their claims, thus reducing their accounts receivable and denied charges. Presumably, these features would cost the insurer more money. Last, managed care arrangements of differing types (eg, capitation, discount fee for service) may have dif-

fering financial incentives regarding physician use of HIT.

Other factors in the current study that were found to be linked to A-CPOE availability among physicians were practice size, practice type, primary care practice, and physician age. Specifically, larger practices or those with multiple specialties were significantly more likely to indicate the use of A-CPOE. These findings echo the conclusions of similar work that examined EHR systems,[22,42,43] and are likely related to the additional financial and human resources available in larger group practices. The greater use of A-CPOE among primary care physicians also seems to confirm previous work.[21] Primary care physicians prescribe more drugs per patient and see more patients per day than specialists. As a result, they may have a greater need for, and can benefit more from, A-CPOE systems to increase practice throughput and charge capture.

Notwithstanding the contribution of the current study, several limitations are worth mentioning. For example, our dependent variable did not inherently measure the frequency of use or the cost of A-CPOE systems among respondents. Instead, it captured information about whether or not a physician had reportedly adopted an A-CPOE system. Moreover, we measured managed care market penetration at the county level, not as a percentage of a given physician's patient base that is covered by an HMO. Although both approaches provided important information, the latter approach is more suited for clinician-level conclusions. Furthermore, given the limitation of county-level information, it is possible that dense urban counties have poorer granularity than less dense rural areas. Granularity, in this case, refers to the level of detail necessary to distinguish differences if they exist. If so, this may influence the results we present. Additionally, given the nature of the survey method used, response bias is always possible, although none was detected in a formal assessment[24] using established methodologies.[44-46] Last, our cross-sectional correlation study utilized data from 1 state, at a single point in time, and may have been limited by missing variables not included in our models. As such, generalizability to other locations and causality should be inferred with caution.

In conclusion, market-level managed care penetration and other physician factors seem to be correlated with the diffusion of an important HIT that can improve the safety and quality of care. Knowing the factors that influence A-CPOE utilization by physicians and their practices will allow policymakers, researchers, payers, and other stakeholders to understand the barriers and facilitators that influence the adoption of A-CPOE technology.

## REFERENCES


**1. Burt C, Schappert S.** Ambulatory care visits to physician offices, hospital outpatient departments, and emergency departments: United States, 1999–2000. National Center for Health Statistics. *Vital Health Stat13.* 2004;157:1-70.

**2. National Center for Health Statistics.** Fast Stats A to Z: therapeutic drug use. Available at: http://www.cdc.gov/nchs/fastats/drugs.htm. Accessed February 17, 2006.

**3. Zhan C, Arispe I, Kelley E, et al.** Ambulatory care visits for treating adverse drug effects in the United States, 1995-2001. *Jt Comm J Qual Patient Saf.* 2005;31: 372-378.

**4. Papshev D, Peterson AM.** Electronic prescribing in ambulatory practice: promises, pitfalls, and potential solutions. *Am J Manag Care.* 2001;7:725-736.

**5. Kaushal R, Bates DW.** Information technology and medication safety: what is the benefit? *Qual Saf Health Care.* 2002;11:261-265.

**6. Bell DS, Cretin S, Marken RS, Landman AB.** A conceptual framework for evaluating outpatient electronic prescribing systems based on their functional capabilities. *J Am Med Inform Assoc.* 2004;11:60-70.

**7. Johnston D, Pan E, Walker J.** The value of CPOE in ambulatory settings. *J Healthc Inf Manag.* 2004;18:5-8.

**8. Merx K.** E-Prescribe lowers drug costs, errors. *Detroit Free Press.* February 23, 2006.

**9. Bell DS, Friedman MA.** E-prescribing and the Medicare Modernization Act of 2003. Paving the on-ramp to fully integrated health information technology? *Health Aff (Millwood).* 2005;24:1159-1169.

**10. Bates DW, Leape LL, Cullen DJ, et al.** Effect of computerized physician order entry and a team intervention on prevention of serious medication errors. *JAMA.* 1998;280:1311-1316.

**11. Cutler DM, Feldman NE, Horwitz JR.** U.S. adoption of computerized physician order entry systems. *Health Aff (Millwood).* 2005;24:1654-1663.

**12. King WJ, Paice N, Rangrej J, Forestell GJ, Swartz R.** The effect of computerized physician order entry on medication errors and adverse drug events in pediatric inpatients. *Pediatrics.* 2003;112(3 pt 1):506-509.

**13. Mekhjian HS, Kumar RR, Kuehn L, et al.** Immediate benefits realized following implementation of physician order entry at an academic medical center. *J Am Med Inform Assoc.* 2002;9:529-539.

**14. Ohsfeldt RL, Ward MM, Schneider JE, et al.** Implementation of hospital computerized physician order entry systems in a rural state: feasibility and financial impact. *J Am Med Inform Assoc.* 2005;12:20-27.

**15. Poon EG, Blumenthal D, Jaggi T, Honour MM, Bates DW, Kaushal R.** Overcoming barriers to adopting and implementing computerized physician order entry systems in U.S. hospitals. *Health Aff (Millwood).* 2004;23:184-190.

**16. Teich JM, Merchia PR, Schmiz JL, Kuperman GJ, Spurr CD, Bates DW.** Effects of computerized physician order entry on prescribing practices. *Arch Intern Med.* 2000;160:2741-2747.

**17. Ash JS, Bates DW.** Factors and forces affecting EHR system adoption: report of a 2004 ACMI discussion. *J Am Med Inform Assoc.* 2005;12:8-12.

**18. Ash JS, Sittig DF, Seshadri V, Dykstra RH, Carpenter JD, Stavri PZ.** Adding insight: a qualitative cross-site study of physician order entry. *Int J Med Inform.* 2005;74:623-628.

**19. Schectman JM, Schorling JB, Nadkarni MM, Voss JD.** Determinants of physician use of an ambulatory prescription expert system. *Int J Med Inform.* 2005;74: 711-717.

**20. Overhage JM, Perkins S, Tierney WM, McDonald CJ.** Controlled trial of direct physician order entry: effects on physicians' time utilization in ambulatory primary care internal medicine practices. *J Am Med Inform Assoc.* 2001;8:361-371.

**21. Pizzi LT, Suh DC, Barone J, Nash DB.** Factors related to physicians' adoption of electronic prescribing: results from a national survey. *Am J Med Qual.* 2005;20:22-32.

**22. Menachemi N, Brooks RG.** EHR and other IT adoption among physicians: results of a large-scale statewide analysis. *J Healthc Inf Manag.* 2006;20:79-87.

**23. Menachemi N, Perkins R, Van Durme D, Brooks RG.** Examining the adoption of EHR and PDA use by family physicians in Florida. *Inform Prim Care.* 2006;14: 1-9.

**24. Menachemi N, Hikmet N, Stutzman M, Brooks RG.** Investigating response bias in a health information technology survey of physicians. *J Med Syst.* 2006;30: 277-282.

**25. Lipton HL, Miller RH, Wimbush JJ.** Electronic prescribing: ready for prime time? *J Healthc Inf Manag.* 2003;17:72-79.

**26. Fox GN, Weidmann E, Diamond DE, Korbey AA.** Hand-held electronic prescribing. *J Fam Pract.* 2001;50:449-454.

**27. Morrill R, Cromartie J, Hart L.** Metropolitan, urban, and rural commuting areas: toward a better depiction of the U.S. settlement system. *Urban Geography.* 1999;20:727-748.

**28. Best AE.** Secondary data bases and their use in outcomes research: a review of the area resource file and the Healthcare Cost and Utilization Project. *J Med Syst.* 1999;23:175-181.

**29. Baker LC.** Managed care and technology adoption in health care: evidence from magnetic resonance imaging. *J Health Econ.* 2001;20:395-421.

**30. Baker LC, Phibbs CS.** Managed care, technology adoption, and health care: the adoption of neonatal intensive care. *Rand J Econ.* 2002;33:524-548.

**31. Pasko T, Smart D.** *Physician Characteristics and Distribution in the US.* Chicago, Ill: American Medical Association; 2004.

**32. Rabinowitz E.** Will palm-size computers make electronic prescribing happen? *Manag Care.* 1999;8:59-61.

**33. Ash JS, Gorman PN, Seshadri V, Hersh WR.** Computerized physician order entry in U.S. hospitals: results of a 2002 survey. *J Am Med Inform Assoc.* 2004;11:95-99.

**34. Ash JS, Gorman PN, Lavelle M, et al.** Perceptions of physician order entry: results of a cross-site qualitative study. *Methods Inf Med.* 2003;42:313-323.

**35. Ash JS, Stavri PZ, Dykstra R, Fournier L.** Implementing computerized physician order entry: the importance of special people. *Int J Med Inform.* 2003;69:235-250.

**36. Cykert S, Hansen C, Layson R, Joines J.** Primary care physicians and capitated reimbursement. Experience, attitudes, and predictors. *J Gen Intern Med.* 1997;12:192-194.

**37. Linzer M, Konrad TR, Douglas J, et al.** Managed care, time pressure, and physician job satisfaction: results from the physician worklife study. *J Gen Intern Med.* 2000;15:441-450.

**38. Sturm R.** Effect of managed care and financing on practice constraints and career satisfaction in primary care. *J Am Board Fam Pract.* 2002;15:367-377.

**39. Hadley J, Mitchell JM.** HMO penetration and physicians' earnings. *Med Care.* 1999;37:1116-1127.

**40. Burt CW, Sisk JE.** Which physicians and practices are using electronic medical records? Survey data show limited use of these information tools. *Health Aff (Millwood).* 2005;24:1334-1343.

**41. Wholey DR, Padman R, Hamer R, Schwartz S.** The diffusion of information technology among health maintenance organizations. *Health Care Manage Rev.* 2000;25:24-33.

**42. Audet AM, Doty MM, Peugh J, Shamasdin J, Zapert K, Schoenbaum S.** Information technologies: when will they make it into physicians' black bags? *MedGenMed.* December 6, 2004;6:2.

**43. Gans D, Kralewski J, Hammons T, Dowd B.** Medical groups' adoption of electronic health records and information systems. *Health Aff (Millwood).* 2005;24:1323-1333.

**44. Hikmet N, Chen SK.** An investigation into low mail survey response rates of information technology users in health care organizations. *Int J Med Inform.* 2003;72:29-34.

**45. Hansen MH, Hurwitz W.** The problem of nonresponse in sample surveys. *JAMA.* 1946;41:517-529.

**46. Etter JF, Perneger TV.** Analysis of non-response bias in a mailed health survey. *J Clin Epidemiol.* 1997;50:1123-1128.