

Computerized Physician Order Entry with Clinical Decision Support in Long-Term Care Facilities: Costs and Benefits to Stakeholders

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Nursing homes are the setting of care for growing numbers of our nation's older people, and adverse drug events are an increasingly recognized safety and quality concern in this population. Health information technology, including computerized physician/provider order entry (CPOE) with clinical decision support (CDS), has been proposed as an important systems-based approach for reducing medication errors and preventable drug-related injuries. This article describes the costs and benefits of CPOE with CDS for the various stakeholders involved in long-term care (LTC), including nurses, physicians, the pharmacy, the laboratory, the payer (e.g., the insurer), nursing home residents, and the LTC facility. Critical barriers to adoption of these systems are discussed, primarily from an economic perspective. The analysis suggests that multiple stakeholders will incur the costs related to implementation of CPOE with CDS in the LTC setting, but the costs incurred by each may not be aligned with the benefits, which may present a major barrier to broad adoption. Physicians and LTC facilities are likely to bear a large burden of the costs, whereas residents and payers will enjoy a large portion of the benefits. Consideration of these costs and benefits suggests that financial incentives to physicians and facilities may be necessary to encourage and accelerate widespread use of these systems in the LTC setting. *J Am Geriatr Soc* 55:1451–1457, 2007.

Key words: long-term care; economics; computer decision support

Adverse drug events are frequently identified in the nursing home setting; in a recent study of two large long-term care (LTC) facilities, the rate of adverse drug events was nearly 10 per 100 resident-months.¹ The same study indicated that a substantial proportion of the adverse drug events in these LTC facilities may have been preventable and that a majority of errors that were associated with adverse drug events occurred during the ordering and monitoring stages of pharmacotherapeutic management. If these findings are applied to the residents of all U.S. nursing homes, then approximately 1.9 million adverse drug events—more than 40% of which are preventable—may occur each year. Of all adverse drug events, 86,000 may be fatal or life-threatening.

Health information technology, specifically through the implementation of computerized physician/provider order entry (CPOE) with clinical decision support (CDS), is increasingly encouraged as a solution to the challenge of medical error reduction and need for improvement in quality of care. The costs, benefits, and difficulties of implementation of CPOE with CDS in the hospital and ambulatory care settings have been discussed in several publications,^{2,3} but only limited information is available on the use of these systems in LTC facilities.⁴ Potential advantages of CPOE include elimination of handwriting identification problems, reductions in error associated with similar drug names, faster delivery of orders to the pharmacy, and integration with CDS systems that can provide prompts, for instance, regarding serious drug interactions.^{5,6}

This article provides a framework for considering the costs and benefits of CPOE with CDS in the LTC setting, together with a systematic assessment of the stakeholders involved, to identify barriers to adoption. The perspective taken in this overview is primarily economic, rather than clinical. It begins with a detailed description of the key stakeholders and their relationships. Potential costs and benefits are described, with a summary of factors that could affect their magnitude. It concludes with an assessment of potential barriers and the possible misalignment of benefits versus costs, which could result in disincentives to the adoption of these systems.

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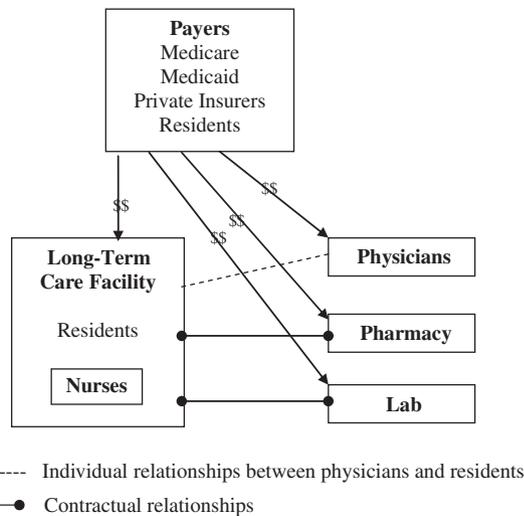


Figure 1. Stakeholder relationships under fee-for-service payment arrangements. Lab = Laboratory.

STAKEHOLDERS IN THE LTC SETTING

Figure 1 summarizes the relationships between selected stakeholders (nurses, physicians, the pharmacy, and the laboratory) involved in delivering care in the LTC setting. In most cases, only the nurses are employees of the facility. Physicians are generally not employees and bill an insurer for services provided. Pharmacies and laboratories usually provide services through agreements with the LTC facility and bill the insurer for these services. Under capitation, a single monthly or annual rate will be negotiated with the LTC facility, which is then responsible for providing the medical services required by residents under the contract. Therefore, under capitation, payments to pharmacies and

laboratories would flow through the LTC facility, whereas under fee-for-service arrangements, the insurer will make direct payments to all providers. Payers, including Medicaid, Medicare, and private insurers, will have a direct relationship with the LTC facility, but the extent to which these payers have relationships with other stakeholders such as the laboratory and pharmacy will depend on the type of reimbursement provided, whether fee-for-service or capitation. Currently, Medicaid is the primary public payer for LTC services and the largest source of financing, accounting for approximately half of all LTC payments.⁷ Medicaid payment for LTC varies from state to state, and therefore, there is substantial variation in how facilities are reimbursed and what services are capitated.

Identifying the Potential Costs and Benefits

The potential types of costs and benefits of implementing CPOE with CDS in the LTC setting are summarized in Table 1. The LTC facility will experience acquisition costs (an initial increase in costs that do not continue over time related to purchasing and implementing these systems), as well as annual costs (costs that occur over time). The facility will also incur training costs, which include the cost of compensating staff for time spent in training and lost productivity in resident care.

Laboratories and pharmacies will also incur their own acquisition costs if they must create electronic data systems that are compatible with the nursing home's CPOE system, but because nursing homes are often part of larger organizations that contract with a limited number of large pharmacies and laboratory vendors that already have sophisticated information systems, the primary challenge in most cases will be to ensure that the existing laboratory

Table 1. Costs and Benefits of Computerized Physician/Provider Order Entry (CPOE) with Clinical Decision Support (CDS) in the Long-Term Care Setting

Costs or Benefits	Item or Area
Acquisition costs	Initial Purchase or Licensing of Systems Hardware and other infrastructure requirements Hiring additional staff (e.g., information technology related) Implementation of systems Integration of CPOE with CDS systems with vendors' electronic networks Initial training of staff Lost productivity while becoming familiar with the system
Annual costs	Maintenance of systems/annual license fees Upgrade and monitor systems Update of clinical and pharmaceutical information on CDS On-going staff training Increased laboratory costs due to more tests Increase in physician time
Benefits	Efficiency gains in nursing homes Efficiency gains in laboratories and pharmacies Decrease in billing errors and improved cash flow Reduction in costs related to storage of paper records Reduction in prescription drug costs Improved ability to produce patient education materials and medication lists Improved ability to access guidelines and standards for good prescribing Reduction in adverse drug events Reduction in medical costs associated with adverse drug events Improvements in patient health-related quality of life Improved ability to conduct research to further improve patient care

and pharmacy systems are compatible with the CPOE system in the nursing home. New transaction fees may be incurred with CPOE, charged by intermediaries connecting the LTC facility to the pharmacy. Although these fees may represent the costs of ensuring that information is transmitted according to industry standards and to certify the entities that are in the network, the responsibility for paying these fees may have important implications. Should LTC facilities, physicians, or pharmacies be made responsible for these transaction fees, it will serve to exacerbate the economic imbalance between the stakeholders responsible for purchasing the health information technology and those potentially benefiting most from its adoption and use: payers (insurers) and residents of nursing homes. These additional costs may serve to diminish enthusiasm for widespread adoption and use of CPOE with CDS in LTC facilities, especially if the nursing home or physician becomes responsible for these additional costs.

Physicians will also have acquisition costs related to the purchase of compatible hardware and software for their offices, because a substantial amount of clinical decision-making relating to the care of residents of LTC facilities occurs off site. A survey conducted by the American Medical Association indicated that, of physicians who practice in nursing homes, the majority spend 2 hours or less per week caring for their patients on site.⁸

Annual costs for the facility will entail the cost of maintaining, supporting, and upgrading the CPOE and CDS systems, as well as updating the clinical and pharmaceutical information contained in the CDS system. Annual costs also include on-going training as new staff is introduced to the system and old staff is informed about system changes, including upgrades. Finally, under capitated arrangements, laboratory costs for the facility may increase under CDS as providers are prompted to conduct additional tests to monitor drug therapy. A reduction in costs related to adverse drug events may offset this increase in laboratory costs due to improvements in appropriate monitoring of patients.

With the implementation of CPOE, there should be efficiency gains in the LTC facility in terms of medication ordering and elimination of prescribing errors. Nurses will play an integral role in the use of CPOE and, although initially the time required by nurses will be high, nursing time could decrease as efficiency and familiarity with the new system increases. In their assessment of CPOE systems in the inpatient setting, one study found that CPOE reduces time spent clarifying orders and increases the amount of time that nurses have available to spend on direct patient care.⁹ In the LTC setting, nurses may be required to perform additional monitoring for adverse drug effects, as directed by the computerized alerts, and therefore the overall net efficiency gain for nurses is uncertain.

The CPOE system is likely to lower future costs for laboratories and pharmacies as paper-based orders are eliminated, the process of ordering medications and tests is streamlined, and errors in transmission are reduced. The system may also reduce the time spent by pharmacists clarifying improper or incorrect prescriptions. In addition, the use of CPOE with CDS may lead to a reduction in the number of drugs, drug dosage prescribed, or the number of doses per day, with resulting reductions in costs. Cost sav-

ings from changes in type of medications prescribed (use of generics or lower-tier drugs when applicable) could also result in cost savings in LTC facilities, but the magnitude of these savings is unknown. In the hospital setting, CPOE with CDS has led to substantial reductions in pharmacy costs due to dose recommendations for selected high-cost medications.¹⁰ In addition to steering prescribers toward more cost-effective choices, improved management of drug therapy has the potential to lead to fewer medical errors and associated adverse drug events.

The ability to access electronic data in a comprehensive and efficient manner may enhance the ability to perform quality assurance-type projects. More-ambitious projects may be possible. It may also allow a LTC facility to more readily participate in research projects. In addition, the widespread use of this technology in the LTC setting may lead to a dramatic change in the role and activities of the consultant pharmacists. The ability to access electronic data provides an opportunity for the consultant pharmacist to perform responsibilities that have depended on tedious and time-consuming retrospective review of paper records and an inefficient process for communicating with the prescriber. One can see the role of the consultant pharmacist evolving to leading the development and implementation of CDS systems that address quality concerns preemptively, rather than after the fact.

CPOE and CDS in the LTC setting may increase the time spent by physicians in placing medication orders, even after the initial learning phase. Although no studies examining this in the LTC setting have been published, in the acute care setting, three studies have measured changes in physician time placing orders; these studies have consistently demonstrated substantial increases in physician time per working shift.¹¹⁻¹³ On average there was a 238% increase in physician ordering time. In these studies, there is no clear evidence that, after the initial learning period, physician time is neutral or unchanged from before CPOE implementation. One study reported an increase of 5.5 minutes per patient to write electronic orders in the inpatient setting.¹¹ These experiences in the acute care setting may not be entirely generalizable to the LTC setting, but such reports strongly suggest that physician time relating to placing orders will increase to some extent.

Factors Affecting Cost and Benefits

Whether CPOE with CDS is cost-effective or results in cost savings will depend on a number of factors related to the health information technology software, the overall organization of the healthcare system, and the specific LTC facility. The effect of these factors needs to be considered in any cost-benefit analysis of CPOE or CDS. Ten distinct factors have been identified that could affect the magnitude of costs and benefits in the LTC setting.

Factors Related to Health Information Technology Software

Level of Functionality of the System

The functionality of the system is a critical component that affects the magnitude of the costs and benefits and the potential return on investment. Health information technology systems can range from a simple view-only repository

of clinical data to those that can provide guidance to the healthcare provider relating to medication management and test ordering. CPOE, for instance, represents a lower level of functionality than a CDS system. Cost increases with the level of functionality of the system, and the higher the level of functionality, the greater the potential benefit to be derived. Therefore, the cost–benefit ratio may differ based on the level of functionality of the total system.

Unintended Consequences

Although advantages of CPOE include elimination of handwriting identification problems, reduction in error associated with similar drug names, more-efficient delivery of orders to the pharmacy, and integration with CDS systems that can provide prompts regarding serious drug interactions and for increased patient monitoring, implementation of CPOE with CDS may lead to the occurrence of new types of errors. The unintended consequences of computerization have been widely studied, and the findings indicate that introducing new technology into complex healthcare organizations can pose considerable challenges. In the acute care setting, one study reported 22 types of medication error risks ranging from fragmented CPOE displays that do not allow for a coherent view of a patient's medications to inflexible ordering formats that generate incorrect orders.¹⁴ Use of systems that do not address such issues effectively could reduce quality of care and the level of patient safety.^{15,16}

Differences in Software Systems

A CPOE system has the potential to provide access to comprehensive information for healthcare providers about the medications that a resident is taking, even when off site. Physicians who care for residents of LTC facilities often perform these activities in addition to their office practice and hospital rounding responsibilities or when on call during off-hours and weekends while covering other physicians. They may provide care for only a few individuals residing in a number of different LTC facilities, potentially resulting in the need to work with different CPOE and CDS systems. This could increase the challenges for the physician, resulting in an overall reduction in productivity and quality of patient care. Physicians may also become resistant to using these systems.¹⁷ In one survey, almost 58% of hospitals with fully implemented CPOE found that substantial numbers of orders continued to be handwritten, bypassing the implemented CPOE system.¹⁸ Physicians (and nurse practitioners) may respond similarly when providing care in LTC facilities. Furthermore, they may find the use of telephone orders to be less cumbersome than navigating different CPOE systems when ordering medications off site.

Factors Related to the Healthcare System

Level of Connectivity in the System

A system involving multiple stakeholders provides the potential for greater benefit than one with only a limited number of connected entities when CPOE or CDS is implemented. Connectivity is the extent to which physicians, LTC facilities, pharmacies, and laboratories are linked electronically and communicate with each other. Costs and benefits will differ based on the level of connectivity and the number of relevant users of the system.

Interoperability of Software

Interoperability describes the way in which different software systems work together. The national Alliance for Health Information Technology defines interoperability as the ability of different information technology systems and software applications to communicate; to exchange data accurately, effectively, and consistently; and to use the information that has been exchanged. In the LTC setting, there are a large number of stakeholders whose systems need to connect and function together. The greater the interoperability of the software packages that are available, the higher the probability that the savings anticipated with the implementation of these systems will be realized.

Late Versus Early Adopter

Facilities that purchase and install these systems initially may have higher start-up and operating costs because of low connectivity, low interoperability, and implementation challenges that need to be overcome for the system to perform effectively. Facilities that delay their purchases may incur lower costs. Appropriate incentives should be available to encourage adoption of these systems and compensate early adopters for the higher start-up costs that they will have to incur. An attractive approach promoted by the eHealth Initiative Foundation is to have incentives for the adoption and use of health information technology tied directly to the goal of improving the quality of health care in terms of process and outcomes (e.g., improvements in the quality of medication prescribing and reduction in the frequency of preventable adverse drug events).¹⁹ A potentially troubling strategy for providing incentives for the use of such systems involves the provision of a “free” electronic health records system in return for use of patient data (deidentified) that can be sold to pharmaceutical companies; another entrepreneurial strategy makes “free” systems available to physicians who allow advertisements to display in real time that are relevant to a specific patient's medical conditions. Such efforts have not yet extended into the LTC setting.

LTC Facility Characteristics

Level of Information Technology

There are substantial set-up costs associated with purchasing and implementing the CPOE and CDS systems. Overall, savings will only be realized if cost reduction due to improvements in process efficiency and patient outcomes offset the upfront cost of implementing the system and long-term maintenance. It is estimated that CPOE at a single, 500-bed hospital would cost \$7.90 million to implement and operate and an additional \$1.35 million annually for ongoing costs.²⁰ This cost would increase if the organization did not already have high-capacity network capabilities needed for CPOE and an existing system that contains clinical information that can be integrated into the CPOE system. Therefore, the level of existing information technology in the LTC facility will be a critical determinant of the magnitude of the up-front acquisition costs that will be incurred.

Size of the Organization

Larger facilities will have a different cost-benefit scenario than smaller facilities. Larger LTC facilities or chains may experience greater economies of scale in purchasing and implementing CPOE and CDS systems than smaller facilities. Costs associated with infrastructure, information technology staff, interfaces, and implementation can be shared across a larger base, and in addition, because large facilities have more residents, they may experience larger savings attributable to improvements in care, including prevention of adverse drug events. Larger facilities and chains may also have access to a higher level of expertise in selecting the CPOE and CDS systems. Greater efficiencies may be possible with large LTC facility chains and large pharmacies and laboratories working in concert. Nationwide, more than 50% of LTC facilities are part of chains.²¹ Still, it would be hoped that smaller facilities might learn from the experience of larger facilities, facilitating the use of these systems across the full spectrum of nursing homes.

Purchase Price

The price of the software and hardware purchased by the LTC facility may be lower than the retail price because of volume discounts (specifically for nursing home chains),

and the actual purchase price of these items will affect the cost-benefit ratio.

Type of Resident Pool

The type of population at a particular nursing home will determine the extent of savings that can be achieved from the reduction in adverse drug events. Several studies have identified residents who are at greater risk of having an adverse drug event.¹ In settings where there is a higher proportion of these residents, it may be more likely that savings will be experienced.

Not All Stakeholders Will Share Costs and Benefits Equally

An overall estimation of costs and benefits in the LTC setting provides an assessment at the system level but does not provide information on the specific effects on the individual stakeholders. Analysis from each stakeholder’s perspective (the nursing home, physician, nurse, pharmacy, laboratory, and payer) is essential to identifying potential misalignment of costs versus benefits. Table 2 indicates the likely direction of the increase or decrease in cost due to the implementation of CPOE with CDS for the selected stakeholders. The activities are grouped into five categories: implementing and

Table 2. Costs Associated with Computerized Physician/Provider Order Entry (CPOE) with Clinical Decision Support (CDS) in the Long-Term Care (LTC) Setting

Item	LTC Facility	Physician	Nurse	Pharmacy	Laboratory	Payer*
Implementing and maintaining CPOE/CDS						
Purchasing system	↑					?
Installing, testing, and calibrating system	↑					
Maintaining system	↑					
Upgrading system	↑					
Upgrading clinical information	↑					
Staff training	↑	↑	↑	↑	↑	
Time spent learning new system		↑	↑	↑	↑	
Ordering prescription						
Time spent placing orders directly		↑	↓			
Time spent responding to pop-up messages		↑				
Total number of prescriptions ordered				↓		
Time spent ordering and conducting laboratory tests		↑	↑		↑	
Number of laboratory tests						↑
Filling prescription						
Time spent handling and reading orders				↓		
Time spent preparing and dispensing orders				↓		
Total number of prescriptions filled				↓		
Use of brand name medications (substituted w/generics)						↓
Administering prescription						
Time spent verifying drug with order			↓			
Time spent identifying, locating, and preparing drug			↓			
Time spent administering drug			↓			
Time spent documenting administration of drug			↓			
Monitoring patients						
Time spent monitoring patients			↑			
Number of adverse drug events						↓
Time to perform quality assurance and research		↓	↓	↓		

*Payer effects shown are related to fee-for-service contract mechanism for all services.

maintaining the system, ordering prescriptions, filling prescriptions, administering medication, and monitoring residents. All stakeholders will experience increased costs either due to direct purchases required to implement the system or as opportunity costs due to lost time. For activities related to ordering prescriptions, some stakeholders will benefit, and others will not. Filling prescriptions, administering medication, and monitoring residents are tasks that may benefit from increased efficiencies, but not all stakeholders may share these benefits. The benefits relating to reductions in the occurrence of preventable adverse drug events may accrue to multiple stakeholders. Even those without direct financial benefits may achieve indirect benefits, as in the case of physicians for whom malpractice liability might be reduced by virtue of fewer errors, improved patient safety, and a reduced risk of patient injury. Nevertheless, it should be emphasized that no published study has yet demonstrated a reduction in preventable adverse drug events with the use of CPOE with CDS in the LTC setting.

Nursing homes and physicians are the stakeholders who may experience some negative effects. The nursing home will have substantial start-up costs if these costs are not shared with other stakeholders (e.g., the payer, laboratory, or pharmacy). Physicians (and nurse practitioners) are likely to devote more of their time ordering medications using CPOE with CDS and, if not compensated for these additional tasks, will bear the burden. Some important benefits, including a reduced need for clarification of orders from the pharmacy (fewer telephone calls and faxes to respond to) and fewer requests to address pharmacotherapeutic issues from the consultant pharmacist, may offset this increased effort by prescribers.

There may be substantial misalignments of incentives based on how the providers (e.g., physicians, laboratories, and pharmacy) are reimbursed. For example, under capitated arrangements (in which payers pay a fixed amount for each year of care and the provider assumes the risk), the providers will retain any savings. Under a fee-for-service arrangement (in which payment is based on submitted charges), savings will accrue primarily to the payer. Therefore, the level of capitation will be critical in determining the magnitude of costs and benefits to the stakeholders involved.

CPOE with CDS in LTC Facilities: Relationship to the Medicare Prescription Drug, Improvement, and Modernization Act

A number of challenges relevant to the Medicare Prescription Drug, Improvement, and Modernization Act in the LTC setting may be more efficiently addressed with the availability of CPOE with CDS. As many different drug plans may serve residents of a single LTC facility, with different formularies, step therapy mandates, and prior authorization policies, CPOE with CDS may provide an opportunity to prompt the prescriber to make prescribing decisions consistent with these varying policies. In addition, some medications that residents of LTC facilities commonly use are not covered under Medicare Part D, and the CDS system may have the capacity to make the prescriber aware of this limitation in coverage before filing an order for the drug. These systems may also have the ability to respond to

the changes in coverage or drug plans that occur with transitions to Medicaid eligibility.

SUMMARY

This consideration of the costs and benefits related to implementation of CPOE with CDS in the LTC setting indicates that multiple stakeholders will incur the costs of implementing and maintaining these systems but that the costs that each incurs may not be fully aligned with the benefits. Recognition of the costs and benefits borne by the various participants and the substantial time lag in the realization of benefits suggests that incentives may be necessary to enhance adoption of these systems. For instance, under a fee-for-service mechanism, payers could offset costs to the nursing home for implementing the system through direct subsidies or other forms of incentive payments.

Successful adoption of health information technology depends on physician, nurse practitioner, and nurse receptivity to using these systems. Incentives, nonmonetary or monetary, may need to be in place to encourage and ensure widespread use. Insurers, such as Blue Cross and Blue Shield, are starting to make bonus payments to physicians for implementation of health information technology and electronic communications; such initiatives can play an important role in adoption and use of health information technology in the LTC setting.

If physicians are required to navigate across multiple different systems to care for their patients, their willingness to participate will be lower. Local and regional health initiatives, such as the Massachusetts eHealth Collaborative, the Indiana Health Information Exchange, and the California Regional Health Information Organization, may help foster coordination and collaboration between diverse healthcare stakeholders and lead to the adoption of standardized systems.

This review provides a framework for considering the potential benefits and costs for stakeholders involved in health information technology integration and operations, with a particular focus on CPOE with CDS in the LTC setting. An accurate determination of the magnitude of the costs and savings will be essential to completely understand effects on individual stakeholders. Future studies of these technologies in the LTC setting must incorporate these measures to provide the information necessary to guide and facilitate widespread implementation and use of these systems.

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REFERENCES

1. Gurwitz JH, Field TS, Judge J et al. The incidence of adverse drug events in two large academic long-term care facilities. *Am J Med* 2005;118:251–258.
2. 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.
3. Poon EG, Jha AK, Christino M et al. Assessing the level of healthcare information technology adoption in the United States: A snapshot. *BMC Med Inform Decis Mak* 2006;6:1–9.
4. Rochon PA, Field TS, Bates DW et al. Computerized physician order entry with clinical decision support in the long-term care setting: Insights from the Baycrest Centre for Geriatric Care. *J Am Ger Soc* 2005;53:1780–1789.
5. Poissant L, Pereira J, Tamblyn R et al. The impact of electronic health records on time efficiency of physicians and nurses: A systematic review. *J Am Med Assoc* 2005;293:505–516.
6. Kaushal R, Shojania KG, Bates DW. Effects of computerized physician order entry and clinical decision support systems on medication safety: A systematic review. *Arch Intern Med* 2003;163:1409–1416.
7. National Spending for Long-Term Care. LTC Financing Project 2007. Georgetown University [on-line]. Available at http://ltc.georgetown.edu/pdfs/nat_spending2007.pdf Accessed January 24, 2007.
8. Levy C, Epstein A, Landry L et al. Literature review and synthesis of physician practices in nursing homes [on-line]. October 17, 2005. Available at <http://www.aspe.hhs.gov/daltcp/reports/phypraclr.pdf> Accessed July 17, 2006.
9. Andrews T, DiFrancesco M, Gilliam M et al. Putting CPOE to work. *Nurs Manage* 2003;(Suppl):12–14.
10. Teich JM, Schmitz JL, O'Connell EM et al. An information system to improve the safety and efficiency of chemotherapy ordering. *Proc AMIA Symp* 1996, pp 498–502.
11. Tierney WM, Miller ME, Overhage JM et al. Physician inpatient order writing on microcomputer workstations. Effects on resource utilization. *JAMA* 1993;269:379–383.
12. Bates DW, Kuperman G, Teich JM. Computerized physician order entry and quality of care. *Qual Manag Health Care* 1994;2:18–27.
13. Shu K, Boyle D, Spurr C et al. Comparison of time spent writing orders on paper with computerized physician order entry. *Medinfo* 2001;10(Part 2):1207–1211.
14. Koppel R, Metlay JP, Cohen A et al. Role of computerized physician order entry systems in facilitating medication errors. *JAMA* 2005;293:1197–1203.
15. Han YY, Carcillo JA, Venkataraman ST et al. Unexpected increased mortality after implementation of a commercially sold computerized physician order entry system. *Pediatrics* 2005;116:1506–1512.
16. Nebeker JR, Hoffman JM, Weir CR et al. High rates of adverse drug events in a highly computerized hospital. *Arch Intern Med* 2005;165:1111–1116.
17. Shojania KG, Wald H, Gross R. Understanding medical error and improving patient safety in the inpatient setting. *Med Clin North Am* 2002;86:847–867.
18. Ash JS, Gorman PN, Hersh WR. Physician order entry in US hospitals. *Proc AMIA Symp* 1998, pp 235–239.
19. deBrantes F, Glaser J, Marchibroda J. Financial Incentives for Adoption of Health Information Technology by Healthcare Deliverers [on-line]. Available at <http://www.touchbriefings.com/pdf/1251/debrantes.pdf> Accessed May 17, 2007.
20. Computerized Physician Order Entry: Costs, Benefits and Challenges of CPOE—A Case Study Approach. 2003. First Consulting Group [on-line]. Available at http://www.hospitalconnect.com/aha/members_only/content/cpoerep030attach.pdf#search='CPOE%20FCG Accessed January 22, 2007.
21. CMS-OSCAR Form 671 Current Survey as of June 2005. Centers for Medicare and Medicaid Services [on-line]. Available at http://ahcaweb.org/research/oscar_oper.htm Accessed January 25, 2007.