

Issue Brief:

Summary of the Evidence of Clinical IT Benefits

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Since the 1960's, researchers from the public and private sectors have attempted to empirically demonstrate the value of electronic medical records and other clinical information technology (IT) tools that hold the promise of improving the quality and safety of patient care and increasing the efficiency of health systems. While clinical IT benefits are not easy to measure for a variety of reasons (see page 4), a growing body of evidence clearly establishes a factual basis for the clinical IT value proposition.

To gain a better understanding about the benefits of clinical IT, the Kaiser Permanente Institute for Health Policy reviewed many of the published studies regarding the use of IT applications in the delivery of health care.¹ Here is what we found:

- *Particularly in an outpatient setting, reminder systems and order entry systems have repeatedly been shown extremely effective for improving compliance with guidelines for preventive health and disease management.*
- *Ample evidence shows that clinical information tools can improve prescription drug administration and patient safety by improving drug dosing, by reducing the number of adverse drug interactions, and by promoting more appropriate pharmaceutical utilization.*
- *We confirmed what at least one other review of literature has found: Studies have shown that specific aspects of clinical information systems are beneficial in small-scale demonstration projects.*
- *A few studies contain substantial documentation of improved productivity, efficiency, service, or major cost savings in non-clinical areas—although large-scale studies on these benefits have yet to be conducted. Studies of adverse drug interactions and improved formulary usage have documented significant cost savings.*

The following are some notable examples of research demonstrating the value and positive impact of clinical IT in peer reviewed literature as well as some unpublished findings.

Increase in Preventive Health Guideline Compliance

The positive effect of computerized reminder systems on preventive health guideline compliance is one of the most studied aspects of clinical IT. For example, one study found that physicians who received computer reminders were twice as likely to provide preventive care as physicians in a control group.² Other studies demonstrate the positive impact of computerized reminders on health risk assessments, immunizations and vaccinations, and cancer screening and diagnosis.

Improved Disease Management

Researchers have documented the positive impact of clinical IT on disease-specific care management. The following are some examples:

Diabetes, the 6th leading cause of death in the United States, is associated with long-term complications and high rates of health care utilization. Clinical information systems have been proven effective in improving care for diabetes patients by stratifying individuals into risk groups, improving physician compliance with guidelines, and improving drug administration.^{3,4}

Hypertension prevalence continues to rise in the United States, increasing the public's risk for heart attacks, strokes and other cardiovascular problems. An electronic medical record system was used by Harvard Community Health Plan to significantly improve follow-up of newly discovered elevation in diastolic blood pressure. Follow-up was attempted or achieved in 84 % of patients in the experimental group but in only 25 % of patients in the control group.⁵

Asthma is a common health problem that affects 14.5 million Americans,⁶ generating at least 9.5 million medical office visits annually.⁷ A computer-generated reminder system was found to improve patient management of the disease and helped reduce asthma related hospitalizations by 60% and emergency department visits by 50%.⁸

Mental Health—Approximately 9.5% of the U.S. population or 44.3 million Americans suffer from a mental disorder in a given year.⁹ Computer administered screening instruments in primary care clinics were found to be useful for diagnosing mental health disorders, increasing the quality of patient care, and eliciting medical information from patients.^{10, 11, 12}

HIV/AIDS—Advances in treatment are enabling persons living with HIV/AIDS to live longer, healthier lives. Getting current HIV treatment guidelines in the hands of practitioners is a major challenge considering the large amount of emerging information. Beth Israel Deaconess Medical Center in Boston saw a positive impact from computerized alerts and reminders on physician adoption of HIV/AIDS clinical practice guidelines. Specifically, the median response time to an alerting condition with the electronic alert system was 11 days, as compared to 52 days without the electronic system.¹³

Increase of Appropriate Prescription Use and Refill Compliance

Patient noncompliance with medical therapy may lead to poor disease management outcomes. At a university health center an automated clinical reminder system was found to be significantly more effective in increasing medication refill compliance in a controlled study.¹⁴

Reduction in Medication Errors

Errors in drug prescribing and dispensing are a major source of morbidity and mortality resulting in high costs in both inpatient and outpatient settings. More than 770,000 people are injured or die due to adverse drug events annually in U.S. hospitals^{15, 16, 17} and up to 70% of these incidents may be avoidable.^{18, 19} A study at Brigham and Women's hospital evaluated a physician order entry system that resulted in a 55% reduction in medical errors and a 17% decrease in the preventable adverse drug event rate with potential cost savings of at least \$480,000 annually.²⁰ Another study at the same institution documented that more than 80% of medication errors unrelated to missed dosage were eliminated by computerized physician order entry.²¹

Reduction in Errors of Omission

Errors of omission, such as failure to act on results or failure to carry out indicated tests, are often contributing factors to serious adverse medicine events. Computer generated reminders have been found to be effective in reducing errors of omission in both inpatient and outpatient settings.^{22, 23}

Improved Medical Data Capture and Display

Recent studies have demonstrated that IT tools enable more comprehensive and accurate clinical documentation by physicians and nurses.^{24, 25} A more complete and precise medical record can be created with automated

systems that prompts for missing or potentially inaccurate information, thereby supporting patient safety, efficiency, and clinical decision making.^{26,27,28} One study found that charting errors occurred in 25% of handwritten flow sheets. A clinical information system eliminated these errors and improved the volume and quality of clinical documentation.²⁹

Inpatient Utilization Reduction

Clinical information technology has been used to improve the quality of inpatient care while decreasing unnecessary hospital utilization. A clinical laboratory alerting system used at LDS Hospital in Salt Lake City, Utah, led to an increased likelihood that patients in life-threatening situations received appropriate care and decreased length of stay by up to 6 days for some conditions.³⁰ In a study conducted at the Regenstrief Institute, a physician order entry system in an inpatient setting was found to lower patient charges and hospital costs mainly by reducing length of stay by 10.5%, reducing test charges by 12.5%, and reducing drug costs by 15.3%. The total charges per admission were 12.7% less for teams that utilized the order entry system than those that did not.³¹

Outpatient Utilization Reduction

The clinical information systems in Kaiser Permanente's Colorado and Northwest regions enabled a reduction in outpatient visits rates in the first three years after system implementation. Total outpatient visit rates decreased approximately 9% (on an age-adjusted basis) in both regions, while key measures of quality remained stable or improved.³²

Reduction of Unnecessary Diagnostic Test

Unnecessary diagnostic tests are a financial burden on the health care industry and an imposition on patients. A Regenstrief Institute study found that computers could assist physicians in estimating the risk of disease, thereby reducing unnecessary diagnostic tests in an outpatient setting.³³ In a separate study at the Regenstrief Institute, physicians ordered 14%-17% fewer diagnostic tests when the charges for tests were displayed on the computer screen—the resulting reduction in charges to the patient or insurer was almost \$7 per patient visit.³⁴

Better Use of Formulary and Generic Drugs

In 2002, pharmaceuticals were estimated at 11% of the national health expenditure, which translates to approximately \$162.4 billion.³⁵ One strategy to control escalating pharmaceutical costs is to influence physician prescribing behavior through the use of clinical IT

systems. A study at Duke University found that providing physicians with monthly-computerized feedback of prescribing charges and patterns encouraged physicians to substitute generic alternatives for brand name prescriptions 30% more often.³⁶

Savings Related to the Storage of Medical Records

Electronic medical records can save a substantial amount of space required for paper storage. Kaiser Permanente's Colorado and Northwest regions estimate annual savings of approximately \$400,000 and \$500,000, respectively, in avoided lease cost after implementation of an electronic medical record.³⁷

Conclusions about the Evidence

While only a limited number of individual empirical studies contain compelling evidence of clinical IT benefit realization, when one looks at the studies collectively there is mounting and persuasive evidence of the positive impact of clinical information technology. Additional research in this area is imperative. Randomized controlled trials are recommended as they provide the most valid information about the efficacy of clinical information systems.³⁸ Further evidence of improvements in productivity, service, and cost savings in non-clinical areas will also help to build the case for clinical IT.

Why has it been so difficult to document clinical IT benefits?

Although the literature review suggests real promise from these systems, documenting evidence of benefits remains difficult for a number of reasons:

- *Two phenomena—1) process changes associated with implementation and 2) human variability—complicate the process of attributing positive outcomes solely to any clinical IT system.*
- *Because much of the research in the area has been done at individual sites on systems customized by an individual end-user, results are difficult to generalize.*
- *Most studies have focused on individual computerized processes in isolation; few studies focus on entire care delivery systems. Clinical and economic benefits will probably be shown more easily after systems have been fully implemented and additional processes have been computerized.*

Endnotes

- ¹ Raymond B, Dold C, Clinical Information Systems: Achieving the Vision, Kaiser Permanente Institute for Health Policy, February, 2002.
- ² McDonald CJ, Hui SL, Smith DM, Tierney WM, Cohen SJ, Weinberger M, McCabe GP, Reminders to physicians from an introspective computer medical record: a two-year randomized trial, *Annals of Internal Medicine*, 1984, 100:130-138.
- ³ Karson AS, Kuperman GJ, Horsky J, Fairchild DG, Fiskio JM, Bates DW, Patient-specific computerized outpatient reminders to improve physician compliance with clinical guidelines, *JGIM*, 1999, 14(April supplement 2):126.
- ⁴ Kleschen MZ, Holbrook J, Rothbaum AK, Stringer RA, McNerney MJ, Helgerson SD, Improving the pneumococcal immunization rate for patients with diabetes in a managed care population: a simple intervention with a rapid effect. *Journal on Quality Improvement*, 2000, 26(9):538-546.
- ⁵ Barnett GO, Winickoff R, Morgan M, Zielstroff R, A computer-based monitoring system for follow-up of elevated blood pressure, *Medical Care*, 1983, 21(4): 400-409.
- ⁶ CDC, Vital and health statistics series 10, No.200, 1996.
- ⁷ CDC, Advance data 322, 1999.
- ⁸ Curtin K, Hayes BD, Holland CL, Katz LA, Computer-generated intervention for asthma population care management, *Effective Clinical Practice* 1998, 1(1):43-46.
- ⁹ Regier DA, Narrow WE, Rae DS, et al., The de facto mental and addictive disorders service system: epidemiologic catchment area prospective 1-year prevalence rates of disorders and services, *Archives of General Psychiatry*, 1993; 50(2):85-94.
- ¹⁰ Kobak KA, Taylor L, Dotts SL, Greist JH, Jefferson JW, Burroughs D, Mantle JM, Katzelnick DJ, Norton R, Henk HJ, Serlin RC, A computer-administered telephone interview to identify mental disorders, *JAMA*, 1997, 278(11):905-910.
- ¹¹ Spitzer RL, Kroenke K, Williams JB, and the Patient Health Questionnaire Primary Care Study Group, Validation and utility of a self-report version of PRIME-MD: the PHQ primary care study, *JAMA*, 1999, 282(18):1737-1744.
- ¹² Rollman BL, Hanusa BH, Gilbert G, Lowe HJ, Kapoor WN, Schulberg HC, The electronic medical record, *Archives of Internal Medicine*, 2001, 161(2):189-197.
- ¹³ Safran C, Rind DM, Davis RB, Ives D, Sands DZ, Currier J, Slack WV, Cotton DJ, Makadon HJ, Effects of a knowledge-based electronic patient record on adherence to practice guidelines, *M.D. Computing*, 1996, 13(1):55-63.
- ¹⁴ Simkins CV, Wenzloff NJ, Evaluation of a computerized reminder system in the enhancement of patient medication refill compliance, *Drug Intelligence and Clinical Pharmacy*, 1986, 20(Oct):799-802.
- ¹⁵ Lazarou J, Pomeranz B, Corey P, Incidence of adverse drug reactions in hospitalized patients: a meta-analysis of prospective studies, *JAMA*, 1998, 279: 1200-5.
- ¹⁶ Classen DC, Pestonik SL, Evans RS, et al., Adverse drug events in hospitalized patients, *JAMA*, 1997, 277(4):301-6.
- ¹⁷ Cullen DJ, Sweitzer BJ, Bates DW, et al., Preventable adverse drug events in hospitalized patients: a comparative study of intensive care and general care units, *Crit Care Med.*, 1997, 25(8):1289-97.
- ¹⁸ Leape LL, Error in medicine, *JAMA*, 1994, 272: 1851-1857.
- ¹⁹ Raschke RA, et al., A computer alert system to prevent injury from adverse drug events: development and evaluation in a community teaching hospital, *JAMA*, 1998, 280:1317-20.
- ²⁰ Bates DW, Leape LL, Cullen DJ, Laird N, Petersen LA, Teich JM, Burdick E, Hickey M, Kleefield S, Shea B, Vander Vliet M, Seger DL, Effect of computerized physician order entry and a team intervention on prevention of serious medication errors, *JAMA*, 1998, 280(15):1311-1316.
- ²¹ Bates DW, Teich JM, Lee J, Seger D, Kuperman GJ, MaLuf N, Boyle D, Leape L, The impact of computerized physician order entry on medication error prevention, *J Amer Med Informatics Assoc*, 1999, 6(4):313-321.
- ²² McDonald et al. 1984
- ²³ Litzelman DK, Dittus RS, Miller ME, Tierney WM, Requiring physicians to respond to computerized reminders improved their compliance with preventive care protocols, *J Gen Intern Med*, 1993, 8(June):311-317.
- ²⁴ Apkon M, Singhaviranon P, Impact of an electronic information system on physician workflow and data collection in the intensive care unit, *Intensive Care Medicine*, 2001, 27:122-130.
- ²⁵ Nahm R, Poston I, Measurement of the effects of an integrated, point-of-care computer system on quality of nursing documentation and patient satisfaction, *Computers in Nursing*, 2000, 18(5):220-229.
- ²⁶ Sullivan F, Has general practitioner computing made a difference to patient care?, A systematic review of published reports, *BMJ*, 1995, 311:848-52.
- ²⁷ Nahm et al. 2000.
- ²⁸ Whiting-O'Keefe QE, Simborg DW, Epstein WV, Warger A, A computerized summary medical record system can provide more information than the standard medical record, *JAMA*, 1985, 254(9):1185-1192.
- ²⁹ Hammond J, Johnson H, Varas R, Ward C, A qualitative comparison of paper flowsheets vs. a computer-based clinical information system. *Chest*, 1991, 99:155-157.
- ³⁰ Tate KE, Gardner RM, Weaver LK, A computerized laboratory alerting system, *M.D. Computing*, 1990, 7(5):296-301.
- ³¹ Tierney et al., Physician inpatient order writing on microcomputer workstations: effects on resource utilization, *JAMA*, 1993, 269:379-83.
- ³² Unpublished data from the Kaiser Permanente Clinical Information System Benefits Realization Project, 2001.
- ³³ Tierney, et al., Computer predictions of abnormal test results, *JAMA*, 1988, 259:1194.
- ³⁴ Tierney WM, Miller ME, McDonald CJ, The effect on test ordering of informing physicians of the charges for outpatient diagnostic tests, *NEJM*, 1990, 322:1499-504.
- ³⁵ National Health Expenditures, Centers for Medicare & Medicaid Services, Office of the Actuary, 2004.
- ³⁶ Karson et al.
- ³⁷ Medical record cost savings estimates were provided by Kaiser Permanente in response to a survey of CIS benefits conducted in October 2001 by the Kaiser Permanente Institute for Health Policy.
- ³⁸ Balas EA, et al., The columbia registry of controlled clinical computer trials, *Proc Annu Symp Comput Applic Med Care*, 1993: 16: 220-224.

This issue brief is based on "Clinical Information Systems: Achieving the Vision" a publication of the Kaiser Permanente Institute for Health Policy by Brian Raymond and Cynthia Dold (includes partial references). The publication, including all references is available at the Kaiser Permanente Institute for Health Policy web site. See <http://www.kpihp.org/publications/index.html>