

Appendix Table 2. Other Institutions Researching Health Information Technology*

Study, Year (Reference), Type of Study (n = 22)	Data Collection	Primary HIT Intervention	Setting	Purpose (To Determine the Effect of . . .)	Dimensions of Care End Points	Effect Evaluated	Type of Institution	Key Findings
Commercially developed systems								
Adherence								
Rollman et al., 2002 (87), RCT	1997–1998	DS/EHR (Logician, MedicalLogic Corp.)	Outpatient	Three interventions on screening for mood disorders and physician agreement with computer-generated diagnosis: 1) computer-generated, paper-based reminders for depression with treatment recommendations; 2) computer-generated, paper-based reminders with diagnosis information; on quality of depression care, and 3) usual care	Effectiveness	Adherence	Academic	No statistically significant difference in depression symptom scores or delivery of recommended processes of depression care for either intervention group when compared with usual care
Utilization of care								
Garrido et al., 2005 (84), retrospective time-series study	2000–2004	EHR (EpiCare, Epic Systems Corp.)	Outpatient	EHR on adherence to recommended care and efficiency measures	Effectiveness	Adherence	Kaiser Permanente	No statistically significant difference in depression symptom scores or delivery of recommended processes of depression care for either intervention group when compared with usual care
Chin and Wallace, 1999 (83), time-series study	1994–1997	EHR/DS (EpiCare, Epic Systems Corp.)	Outpatient	EHR with CPOE and DS on adherence to guideline-based care for radiology services and medication use	Quality/effectiveness	Utilization of care	Kaiser Permanente	48% relative decrease (from 10.6 tests/1000 to 5.6 tests/1000) for upper gastrointestinal tract radiology studies by year 4 after EHR implementation, with a 33–percentage point absolute increase (from 55% to 88%) in adherence to protocols for test ordering; 20% decrease in chest radiographs ordered (years after implementation and information on relative or absolute decrease not provided); 2.3–percentage point absolute decrease (from 4.7% to 2.4%) in prescribing of a nonformulary antidepressant by year 2 after implementation

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Surveillance								
Rollman et al., 2001 (86), RCT	1997–1999	DS/EHR (Logician, MedicalLogic Corp.)	Outpatient	Three interventions on quality of depression care: 1) computer-generated, paper-based reminders for depression with treatment recommendations; 2) computer-generated, paper-based reminders with diagnosis information alone; and 3) usual care	Effectiveness	Surveillance	Academic	Three days after computer notification of possible mood disorder, 65% of physicians agreed with computer-screened diagnosis, 13% disagreed, and 23% were uncertain; no differences in treatment provided across guideline-exposure condition
Time utilization/medication errors								
Koppel et al., 2005 (91), mixed quantitative/qualitative descriptive methods	2002–2004	CPOE (Eclipsys Corp.)	Inpatient	CPOE in facilitating medication prescribing errors	Safety	Medication errors	Academic	CPOE facilitated 22 types of medication error risks; errors were classified as being due to 1) fragmentation of data and failure to integrate CPOE systems with other hospital systems and 2) flaws in human–machine interface
Mekhjjan et al. (88), 2002, pre–post study	2000	CPOE/DS (Invision24, Siemens Corp.)	Inpatient/ICU	CPOE with electronic records for medication administration on care delivery time, workflow process, and costs	Efficiency	Time utilization/medication errors	Academic	64% relative decrease (from 328 to 111 min) in medication turnaround time; 43% relative decrease (from 457 to 261 min) in completion time for radiology procedures; 25% relative decrease (from 31.3 to 23.4 min) in reporting time for laboratory results; 11.3–percentage point absolute decrease (from 11.3% to 0%) in transcription errors; 5% relative decrease (from 3.91 to 3.71 d) in severity-adjusted length of stay; no statistically significant decreases in overall cost

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Cordero et al., 2004 (89), pre-post study with retrospective review	2002	CPOE/DS (Invision24, Siemens Corp.)	Neonatal ICU	CPOE with DS on medication errors and care delivery time in neonatal ICU	Safety/efficiency	Medication errors/time utilization	Academic	13–percentage point absolute decrease (from 13% to 0%) in medication dosing errors; 73% relative decrease (from 10.5 to 2.8 h) in turnaround time for 1 medication (caffeine); 24% relative decrease (from 42 to 32 min) in radiology response time; physician and staff training started 4 wk before CPOE implementation; nurse leaders received 16 h of training, nurses and clerical staff received 8 h, and physicians received 2–4 h; during implementation, information systems staff provided 24-h support
Kilgore et al., 1998 (90), pre-post study	1995–1996	EHR (CareVue 9000, Hewlett-Packard Corp.; PIN System, Eclipsys Corp.)	ICU	Two different nursing ICU information systems with CPOE and results reporting on nurse work patterns and costs	Efficiency	Time utilization	Academic	Effect of computer systems on nurse charting time was inconclusive per authors because ICU patient census varied; staff satisfaction was higher with CareVue 9000 than with PIN System because of interface ease and greater support of workflow; expected net annual savings from preferred system were estimated at \$320 359
Implementation costs								
Krall, 1995 (85), descriptive quantitative study	1994	EHR (EpiCare, Epic Systems Corp.)	Outpatient	EHR use on workflow and attitudes	Efficiency	Implementation cost	Kaiser Permanente	Physicians took 30 d to return to baseline productivity levels (patient visits/d); 2-min increase in physician time per visit; physician satisfaction with system increased over time
Internally developed systems								
Adherence								
Khoury, 1998 (70), time-series study	1993–1997	EHR/DS	Outpatient	EHR with DS on adherence to guideline-based care	Effectiveness/efficiency	Adherence	Kaiser Permanente	Adherence to guidelines improved for 6 conditions; levels of improvement ranged from 4– to 52–percentage point absolute increases in process of care delivery; estimated annual savings, \$2 470 000 (cost of system development not included)

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Ornstein et al., 1995 (72), pre-post study	NS	EHR/DS	Outpatient	EHR with computerized reminders on delivery of preventive care	Effectiveness	Adherence	Academic	7 of 7 counseling measures improved: absolute increase in adherence ranging from 13 to 16 percentage points; 10 of 15 screening processes improved: absolute increase approximately ranging from 3 to 20 percentage points
Garr et al., 1993 (71), pre-post study	1989–1990	DS/EHR	Outpatient	EHR with computerized reminders on delivery of preventive care	Effectiveness	Adherence	Academic	Absolute increases in delivery of preventive care, 1–8 percentage points; all 5 services included
Safran et al., 1995 (75), CCT	1992–1993	EHR/DS	Outpatient	Computerized reminders and alerts on delivery of HIV care	Effectiveness	Adherence	Academic	Approximate 22–percentage point absolute increase (from 46% to 68%) in adherence to recommended process of care at 1 y after occurrence of clinical event warranting reminder; 29–percentage point absolute increase (from 38% to 67%) in physician responses 1 mo after clinical event warranting alert
Schriger et al., 1997 (73), CCT	1992–1995	DS/EHR	Emergency department	Computerized guidelines embedded in computerized charting system designed to track 5 conditions on processes of care for exposure of health care workers to bodily fluids	Effectiveness/efficiency	Adherence	Academic	12–percentage point absolute increase (from 83% to 96%) in adherence to 5 treatment guidelines; 20–percentage point absolute increase (from 63% to 83%) in adherence to 4 guidelines on laboratory test use; 62–percentage point absolute increase (from 31% to 93%) in documented adherence to aftercare guidelines; 42–percentage point absolute increase (from 57% to 98%) in adherence to guidelines for documentation of patient history; all measures decreased toward baseline rates when computer system was turned off; 23% relative decrease (from \$520 to \$401) in total per-patient costs

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Schriger et al., 2000 (74), CCT	1992–1995	DS/EHR	Emergency department	Computerized guidelines embedded in computerized charting system designed to track 5 conditions on processes of care for evaluation of febrile children < age 3 y presenting to emergency department	Effectiveness/efficiency	Adherence	Academic	Per authors' report, 13–percentage point absolute increase (from 80% to 92%) in documented adherence to guidelines for medical history and physical examination; 33–percentage point absolute increase (from 48% to 81%) in documented adherence to guidelines for aftercare instruction; all rates returned to baseline when computer system was turned off; no statistically significant differences in appropriateness of treatment, appropriateness or utilization rates of diagnostic tests, or test charges per patient
Day et al., 1995 (76), pre–post study	1992–1993	DS/EHR	Emergency department	Computerized guidelines embedded in computerized charting system designed to track 5 conditions on processes of care for lower back pain	Effectiveness/efficiency	Adherence	Academic	No statistically significant differences in appropriateness of diagnostic testing or treatment; no statistically significant decrease in costs; 12– to 51–percentage point absolute increase in documentation of 6 medical history items; 13– to 70–percentage point absolute increase in documentation of 6 aftercare counseling items
Simon et al., 2000 (77), RCT	NS	EHR/data summary/DS	Outpatient	Three interventions: 1) feedback to physicians of computerized data summaries with treatment recommendations for depression care, 2) computerized feedback plus telephone follow-up, and 3) usual care	Effectiveness/efficiency	Adherence	Nonacademic (Group Health Cooperative of Puget Sound)	No statistically significant difference in computerized DS group compared with usual care; 15% relative improvement (from 0.83 vs. 0.98) in depression scores in computerized DS with telephone follow-up group, with associated increase in likelihood of receiving antidepressant therapy; \$80 increase in costs in telephone follow-up group
Utilization of care								
Baird et al., 1984 (78), RCT	NS	DS/electronic prescribing	Outpatient	Computer-generated, paper-based pharmacy reminders from hospital mainframe-based information system on prescription refill rates	Access	Utilization of care	Academic	No statistically significant difference in refill rates; initial development of software program, \$200; cost per day to generate reminders, \$14

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Sanders and Miller, 2001 (79), pre-post study	2000–2001	DS/CPOE	Inpatient	Computerized guidelines integrated into a CPOE system on utilization of CT and MRI	Efficiency	Utilization of care	Academic	5% relative decrease in neuroradiology CT and MRI diagnostic testing; 40% of users receiving computerized guideline ordered a nonrecommended test
Surveillance								
Wells et al., 2003 (81), pre-post study	2001–2002	DS/EHR	Outpatient	EHR on identifying patients taking 2 drugs for which a combination pill is available and then generating computerized reminders to promote combination therapy	Effectiveness	Surveillance/adherence	Academic	27% of patients eligible were switched to combination therapy; cost savings related to combined therapy totaled \$6159 per year; 241 patients were screened as eligible for combination therapy; total number of unique patients seen during study not given
Medication errors								
Potts et al., 2004 (80), pre-post study	2001–2002	CPOE/DS	ICU	CPOE with DS on medication errors in pediatric ICU	Efficiency	Medication errors	Academic	41% relative decrease (from 2.2 errors/100 orders to 1.3 errors/100 orders) in medication errors categorized as potential adverse drug events; 96% relative decrease (from 30 errors/100 orders to 0.2 error/100 orders) in medication prescribing orders; decreases occurred in all categories of medication errors
Implementation cost								
Khoury, 1997 (82), time-series study	1989–NS	EHR	Outpatient	Long-term costs and benefits of implemented EHR	Efficiency	Implementation cost	Kaiser Permanente	Cost of development estimated at \$10 million; project took 8 y from beginning of development to full implementation; total ongoing annual expenses estimated to be \$1.1 million per year; expected savings per year estimated as \$3.7 million, with greatest savings from reduction in medical record room staff; system predicted to pay for itself in year 13

* City and state locations of manufacturers are as follows: MedicaLogic Corp., Beaverton, Oregon; Epic Systems Corp., Verona, Wisconsin; Eclipsys Corp., Boca Raton, Florida; Siemens Corp., New York, New York; Hewlett-Packard Corp., Palo Alto, California. CCT = controlled clinical trial; CPOE = computerized provider order entry; CT = computed tomography; DS = decision support; EHR = electronic health record; HIT = health information technology; ICU = intensive care unit; MRI = magnetic resonance imaging; NS = not specified; RCT = randomized, controlled trial.