

**Appendix Table 1. Benchmark Leaders in Health Information Technology Research\***

Study, Year (Reference), Type of Study (n = 52)	Institution	Data Collection	Primary HIT Intervention	Setting	Purpose (To Determine the Effect of . . .)	Dimensions of Care End Points	Effect Evaluated	Key Finding
<b>Quality adherence (n = 20)</b>								
Dexter et al., 2004 (18), RCT	Regenstrief Institute	1998–1999	DS/EHR	Inpatient	Computer-based standing orders vs. computerized physician reminders	Effectiveness	Adherence/ surveillance	12–percentage point absolute increase (from 30% to 42%) in influenza vaccinations and 20–percentage point absolute increase (from 31% to 51%) in pneumococcal vaccinations in the standing-orders group; computer identified 50% and 22% of hospitalized patients as eligible for influenza and pneumococcal vaccinations, respectively; 19% and 7% of patients screened by computer as eligible for influenza and pneumococcal vaccines stated that they had previously been vaccinated and did not require another vaccination (data from outside facilities not present in evaluated system)
Dexter et al., 1998 (19), RCT	Regenstrief Institute	NS	DS/EHR	Outpatient	Computer-generated, paper-based reminders on planning for end-of-life care vs. usual care (no reminder)	Effectiveness	Adherence	20–percentage point absolute increase (from 4% to 24%) in physicians who discussed advance directives; 11–percentage point absolute increase (from 4% to 15%) in physicians caring for patients who completed advanced care plans
Overhage et al., 1997 (20), RCT	Regenstrief Institute	1992–1993	DS/CPOE	Inpatient	Point-of-care computerized reminders on adherence to guideline-based care vs. usual care (CPOE without evaluated reminders)	Effectiveness/ efficiency	Adherence	24–percentage point absolute increase (from 22% to 46%) in adherence to guidelines; adherence increased for immediate, 24-h, and total hospital stays; little increase between immediate and 24-h adherence; 33% relative decrease (from 156 to 105) in number of pharmacist interventions; no statistically significant difference in costs or length of stay

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Overhage et al., 1996 (21), RCT	Regenstrief Institute	1992–1993	DS/EHR	Inpatient	Computer-generated reminders on use of preventive care services vs. usual care	Effectiveness	Adherence	No statistically significant effect demonstrated; high adherence to reminders was anticipated but not demonstrated, and no mechanism to capture reasons for nonadherence was incorporated
Litzelman et al., 1993 (22), RCT	Regenstrief Institute	1989	DS/EHR	Outpatient	Computerized reminders of preventive care; comparison was between requiring physicians to acknowledge the reminder vs. using reminder alone	Effectiveness	Adherence	In group requiring acknowledgment, 12–percentage point absolute increase (from 49% to 61%) in fecal occult blood testing and 7–percentage point absolute increase (from 47% to 54%) in mammography; no statistically significant improvement in Papanicolaou screening
McDonald et al., 1992 (23), RCT	Regenstrief Institute	1978–1981	DS	Outpatient	Computer-generated, paper-based reminders on need for influenza vaccination vs. no computer-based reminders	Effectiveness	Adherence	12%–18% absolute increase (15.6%–29.5% in year 3) in influenza vaccination rates
Tierney et al. (24), 1986, RCT	Regenstrief Institute	1983–1984	DS/data summary/EHR	Outpatient	Three interventions on preventive health: 1) computer-generated, paper-based reminders provided each visit; 2) computer-generated, paper-based care summaries generated monthly; and 3) usual care	Effectiveness	Adherence	Approximate absolute effects of computerized reminders: 33–percentage point absolute increase (from 25% to 58%) in fecal occult blood testing, 33–percentage point absolute increase (from 5% to 38%) in pneumococcal vaccination, 16–percentage point absolute increase (8% to 24%) in screening mammography, and 12–percentage point absolute increase (from 12% to 24%) in metronidazole for trichomonas infections; 9 other preventive care processes evaluated showed no statistically or clinically significant improvement with reminders; effects of reminders were greater than those of the summary reports
McDonald et al., 1984 (25), CCT	Regenstrief Institute	1978–1980	DS/EHR	Outpatient	Computer-generated, paper-based reminders on adherence to protocol-based care vs. usual care (no reminders)	Effectiveness/efficiency	Adherence	15%–20% increase in adherence to protocol-based care; greatest increases seen in preventive care (relative increase in utilization, 200%–400%); information other than laboratory and pharmacy data entered by research assistants; computer system did not capture all patient data

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**Appendix Table 1—Continued**

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McDonald et al., 1980 (26), CCT	Regenstrief Institute	NS	DS/EHR	Outpatient	Computer-generated, paper-based reminders with and without literature citations on adherence to protocol-based care vs. usual care	Effectiveness	Adherence/medical errors	19–percentage point absolute increase (from 19.8% to 38.4%) in adherence to protocol-based care; minimal learning effects were seen when the computerized reminders were turned off
McDonald, 1976 (27), RCT	Regenstrief Institute	NS	DS/EHR	Outpatient	Computer-generated, paper-based reminders on adherence to protocol-based care for diabetes	Effectiveness/safety/efficiency	Adherence/medication errors	15–percentage point increase (from 11% to 36% and from 13% to 28%) in adherence to protocols; computer systems could not capture all laboratory data kept in paper chart; physicians agreed with a maximum of 57% of computer recommendations; most reminders related to medication care; cost \$2/visit to maintain computer record
McDonald, 1976 (28), RCT	Regenstrief Institute	1975	DS/EHR	Outpatient	Computer-generated, paper-based reminders on adherence to protocol-based care	Effectiveness/safety	Adherence/medication errors	29–percentage point absolute increase (from 22% to 51%) in adherence to protocols; computer system could not capture all laboratory data kept in paper chart; most reminders related to medication-based care
Kucher et al., 2005 (29), CCT	Partners Health Care	2000–2004	DS/CPOE	Inpatient	Computerized alerts for anticoagulation prophylaxis vs. usual care for prevention of venous thromboembolism in high-risk hospitalized patients	Effectiveness	Adherence/surveillance	3.3–percentage point absolute decrease (from 8.2% to 4.9%) in the combined primary end point of deep venous thrombosis or pulmonary embolism within 90 d after hospitalization; 19–percentage point absolute increase (from 33.5% to 14.5%) in use of anticoagulation prophylaxis; as part of intervention, a computer-based risk assessment program was used to screen and identify inpatients at high risk for venous thromboembolism; 80% of patients enrolled had some type of cancer
Abookire et al., 2000 (30), time-series study	Partners Health Care	1995–1999	DS/CPOE	Inpatient	Trends in alerts and physician response to alerts	Safety/effectiveness	Adherence	24–percentage point absolute reduction (from 51% to 27%) in adherence to “definite” medication allergy alerts and 26–percentage point absolute reduction in adherence (from 46% to 20%) to “possible” allergy alerts over 4 y; adherence decreased as number of alerts increased

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Teich et al., 2000 (31), pre–post study	Brigham and Women's Hospital/Partners Health Care	1993	CPOE/DS	Inpatient	Effect of CPOE on physician prescribing practices and adherence to medication formularies	Effectiveness/safety	Adherence	66–percentage point absolute increase (from 15.6% to 81.3%) in formulary adherence for gastric H <sub>2</sub> -blockers; 23–percentage point absolute increase (from 24% to 47%) in appropriate use of subcutaneous heparin prophylaxis; 1.5–percentage point absolute decrease (from 2.1% to 0.6%) in number of medication doses written that exceeded maximum recommended (“possibly because of increased use of order sets”); effects persisted at 1- and 2-y follow-up; cost savings from H <sub>2</sub> -blocker, \$250 000; costs to maintain system, \$700 000/y
Cannon and Allen 2000 (32), RCT	VA	1998	DS/EHR	Outpatient	Guideline-based computerized vs. manual paper-based reminders on screening rates for mood disorders	Effectiveness	Adherence	25.5–percentage point absolute increase (from 61% to 86.5%) in physician screening for mood disorders with computerized system
Demakis et al., 2000 (33), RCT	VA	1995–1996	DS/EHR	Outpatient	Computerized reminders on physician adherence to ambulatory care recommendations vs. usual care (EHR without hypertension reminders)	Effectiveness	Adherence	5.3–percentage point absolute increase (from 53.5% to 58.8%) in adherence to recommended care; 5 of 13 examined care processes improved; effect of reminders decreased over time
Rossi and Every, 1997 (34), RCT	VA	1996	DS	Outpatient	Computer-generated, paper-based reminders on adherence to appropriate care for hypertension treatment vs. usual care (no reminders)	Effectiveness	Adherence	11.3–percentage point absolute increase (from <1% to 11.3%) in appropriate hypertension treatment
Willson et al., 1995 (35), pre–post study	LDS Hospital/Intermountain Health Care	1994–NS	DS	Inpatient	Computerized guidelines for prevention and treatment of pressure ulcers	Effectiveness	Adherence	5–percentage point absolute decrease (from 7% to 2%) in ulcer development

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Evans et al., 1994 (36), RCT	LDS Hospital/ Intermountain Health Care	1990	DS/EHR	Inpatient	Computerized guidelines on appropriateness of antibiotic use	Effectiveness	Adherence	Computer program suggested correct antibiotic in 94% of cases; 17–percentage point absolute increase (from 77% to 94%) in coverage of identified organism; 27% relative decrease (from 22 to 16 h) in time to appropriate treatment after culture results; 21% relative decrease (from \$51.93 to \$41.08) in antibiotic cost; physicians ordered appropriate antibiotics within 12 h of culture collection significantly more often with use of program compared with usual care; 88% of physicians would recommend the program to other physicians, 85% said the program improved antibiotic selection, and 81% said use improved care
Larsen et al., 1989 (37), pre–post study	LDS Hospital/ Intermountain Health Care	1985–1986	DS	Inpatient	Computerized reminders on appropriateness of preoperative antibiotics and on rates of postoperative wound infections	Effectiveness	Adherence	0.4–percentage point absolute decrease (from 1.1% to 0.7%) in total postoperative wound infections; 0.9–percentage point absolute decrease (from 1.8% to 0.9%) in wound infections among patients with general indication for antibiotic prophylaxis; 18–percentage point increase (from 40% to 58%) in appropriateness of antibiotic timing
<b>Surveillance (n = 9)</b>								
Overhage et al., 2001 (38), case–control study	Regenstrief Institute	2000–2001	Electronic results reporting	Outpatient	Electronic laboratory reporting on public health surveillance	Access/ effectiveness	Surveillance	29–percentage point increase (from 71% to 100%) in identified cases during a shigellosis outbreak; 2.5-d decrease in reporting time
Honigman et al., 2001 (39), cohort study	Brigham and Women's Hospital/Partners Health Care	1995–1996	EHR	Outpatient	Computer program to retrospectively detect ADEs vs. chart review	Safety	Surveillance	Sensitivity for ADEs, 58%; specificity, 88%; ADE rate was 5.5/100 patients; 9% of outpatient ADEs required hospitalization
Jha et al., 1998 (40), case series	Brigham and Women's Hospital/Partners Health Care	1995	Data summary/ CPOE	Inpatient	Three interventions for identifying adverse drug events: 1) computer monitoring, 2) chart review, and 3) voluntary reporting	Safety	Surveillance	Computerized monitoring identified 45% of ADEs; chart review identified 65%; voluntary reporting identified 4%; computer was better for ADEs related to quantitative changes (e.g., laboratory values) and chart review was better for ADEs related only to symptoms; voluntary reporting was better for potential ADEs that had not yet occurred

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Kramer et al., 2003 (41), case series	VA	1999–2000	Electronic data collection/EHR	Outpatient	Automated data collection algorithms vs. manual review of EHRs by trained abstracters on diagnosing new cases of depression	Effectiveness	Surveillance	High false-positive rate for diagnosis via automated algorithms; quality indicator scores based solely on automated data show agreement with manual review, but results may show some bias
Kerr et al., 2002 (42), case series	VA	1999–2000	Electronic data collection/EHR	Mixed	Automated queries of computerized disease registries vs. manual chart abstraction (mixed EHR and paper chart sources) on measuring quality of care	Effectiveness	Surveillance	Automated queries from disease registries underestimated rates of completion for quality-of-care process indicators; no differences were noted for intermediate outcome measures; automated queries were less labor-intensive
Classen et al., 1997 (43), case-control study	LDS Hospital/ Intermountain Health Care	1990–1993	Data summary/ DS/EHR	Inpatient	Computer surveillance to identify ADEs and associated costs	Efficiency	Surveillance	Computer system was used to screen 91 574 admissions for ADEs; 2.43 ADEs/100 admissions; 2.45–absolute percentage point increase (from 1.05% to 3.5%) in crude mortality associated with ADEs; 1.9-d increase in attributable length of stay and associated \$2262 increase in costs
Evans et al., 1992 (44), case-control study	LDS Hospital/ Intermountain Health Care	1989–1992	Data summary/EHR	Inpatient	Computerized surveillance vs. manual reporting on identifying and preventing ADEs	Safety	Surveillance	2.36–percentage point absolute increase (from 0.04% to 2.4%) in identified ADEs; alerting system implemented in year 2 in which pharmacists received surveillance reports and contacted physicians; severe ADEs decreased 5.4 percentage points (from 7.6% to 2.2%); ADEs due to allergies decreased 13.6 percentage points (from 15% to 1.4%); analysis of ADE database allowed authors to design reduction initiatives that decreased significant ADEs from 56 events in year 1 to 8 events in year 3
Evans et al., 1993 (45), case-control	LDS Hospital/ Intermountain Health Care	1990–1992	Data summary/ DS/EHR	Inpatient	Computerized surveillance on determining attributable effect of ADEs on hospital length of stay and costs	Safety/ efficiency	Surveillance/ medication errors	Computer system was used to screen the records of 60 836 inpatients; 1348 ADEs were identified in 1209 patients; those with ADEs were matched to a total of 10 542 control patients; ADEs were associated with an attributable increase in length of stay of 1.9 d and increase in attributable costs of \$1939

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Evans et al., 1986 (46), cohort study	LDS Hospital/ Intermountain Health Care	1984	Data summary/ EHR	Inpatient	Computer vs. manual surveillance for assessing rates of hospital-acquired infections and associated antibiotic use	Safety	Surveillance	14–percentage point absolute increase (from 76% to 90%) in identification of infections; 65% decrease (from 130 to 46 h) in time required for surveillance; 4–percentage point absolute increase (from 19% to 23%) in false-positive rates with the computer; computer screening identified patients receiving antibiotics to which infections were resistant, antibiotics with less expensive alternatives, and patients receiving prophylactic antibiotics for longer than necessary
<b>Medication errors (n = 7)</b>								
Chertow et al., 2001 (47), CCT	Brigham and Women's Hospital/Partners Health Care	1997–1998	DS/CPOE	Inpatient	Computerized drug dosing algorithm to determine effect on medication prescribing in renal insufficiency vs. usual care (CPOE without algorithm)	Efficiency/ effectiveness	Medication errors/ adherence	21–percentage point absolute increase (from 30% to 51%) in appropriate medication orders (dosing levels or dosing frequency); 4.5% reduction (from 4.5 to 4.3 d) in length of stay; no statistically significant decrease in costs
Bates et al., 1999 (48), time-series study	Brigham and Women's Hospital/Partners Health Care	1992–1997	CPOE/DS	Inpatient	CPOE with enhanced DS on rates of nonmissed dose errors and overall noninterrupted serious medication error rates	Safety	Medication errors	86% relative reduction (from 7.6 events/1000 patient-days to 1.1 events/1000 patient-days) in nonintercepted serious medication errors; 82% relative reduction (from 142 events/1000 patient-days to 26.6 events/1000 patient-days) in nonmissed dose errors; reductions seen for all error types; level of DS in system increased over time
Bates et al., 1998 (49), time-series study	Brigham and Women's Hospital/Partners Health Care	1993–1995	CPOE/DS	Inpatient	CPOE on rates of medication errors and preventable ADEs vs. CPOE with addition of team changes	Safety	Medication errors	55% relative risk reduction (from 10.7 events/1000 patient-days to 4.9 events/1000 patient-days) in nonintercepted serious medication errors; non–statistically significant 17% relative reduction (from 4.69/1000 patient-days to 3.86/1000 patient-days) in preventable ADEs; decreases seen for all levels of error severity; team changes conferred no additional benefit over CPOE

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Mullett et al., 2001 (50), pre-post study	LDS Hospital/ Intermountain Health Care	1998–1999	DS/EHR	Pediatric ICU	Computerized guidelines on antibiotic appropriateness and use	Effectiveness/ efficiency	Medication errors/ adherence	32% relative decrease (from 15.8 to 10.8) in number of days that antibiotics were prescribed outside the recommended dosing range; 59% relative decrease in a composite measure of need for pharmacist interventions for incorrect dosing; 6.3–percentage point absolute increase (from 60.2% to 66.5%) in proportion of ICU patients receiving antibiotics; no statistically significant differences in overall antibiotic costs; weighted antibiotic-cost statistic showed decrease in costs
Evans et al., 1999 (51), pre-post study	LDS Hospital/ Intermountain Health Care	1993–1996	DS/EHR	Inpatient	Computerized monitoring of antibiotic doses on appropriateness of dosing and ADE rates	Safety	Medication errors/ utilization of care	0.6–percentage point absolute decrease (from 0.9% to 0.3%) in antibiotic-associated ADEs; 6% relative decrease (from 50% to 40%) in patients receiving excess antibiotic doses for $\geq 1$ d; 12% relative decrease (from 10.1 to 8.9 doses) in number of antibiotic doses prescribed and 13% relative decrease in cost (from \$92.96 to \$80.62); excess dosing was associated with increased ADE rates
Evans et al., 1998 (52), cohort study with historical control	LDS Hospital/ Intermountain Health Care	1992–1995	DS/EHR	Inpatient (ICU)	Computerized alerts on antibiotic use	Effectiveness/ efficiency/ safety	Medication errors/ adherence	Compared with the 2-y preintervention period, reductions were seen for the following: antibiotic-associated ADEs (28 vs. 4), mismatches between infection susceptibility and antibiotic (206 vs. 12 episodes), ordered drugs for which a patient had an allergy (146 vs. 35 episodes), days of excess dosing (from 5.9 to 2.7 d), antibiotic costs (from \$340 to \$102), length of stay (from 13 to 10 d), and total hospital costs (from \$35 283 to \$26 315)
White et al., 1984 (53), RCT	LDS Hospital/ Intermountain Health Care	NS	DS	Inpatient	Computer-generated, paper-based alert system on digoxin toxicity	Safety	Medication errors	2.8-fold increase in withholding digoxin on day alert was signaled; 2.7-fold increase in testing of serum digoxin levels in response to alerts; overall, 22% increase in physician actions in response to digoxin-related events (unweighted event rates in study groups not provided)

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<b>Efficiency: utilization of care (n = 10)</b>								
Tierney et al., 1988 (54), RCT	Regenstrief	1984–1985	DS/CPOE	Outpatient	Computer program that generates and displays pretest probabilities for diagnostic tests on utilization of care	Efficiency	Utilization of care	8.8% decrease (from \$12.27 to \$11.18) in diagnostic test costs per patient visit; greatest decrease was due to reduced utilization of complete blood counts and electrolytes (the 2 most common tests); mean receiver-operating characteristic curve for computer predictions, 0.80
Tierney et al., 1987 (55), pre–post study	Regenstrief	NS	DS/CPOE/EHR	Outpatient	Computer program showing previous test results as physicians are ordering new tests vs. usual care (no display of previous test results)	Efficiency	Utilization of care	8.5% decrease (from 0.56 to 0.51) in number of tests ordered per visit; 13% decrease (from \$13.99 to \$12.17) in test costs per visit; program took 4 s to display past results on screen per test
Tierney et al., 1990 (56), RCT	Regenstrief	1988	DS/CPOE/EHR	Outpatient	Effect of information on point-of-care test costs on utilization vs. usual care (CPOE without information on test costs)	Efficiency	Utilization of care	14.3% decrease (from 1.82 to 1.56) in number of diagnostic tests ordered per visit; 12.9% decrease (from \$51.81 to \$45.13) in diagnostic test costs per visit; effect was greatest for scheduled patient visits
Tierney et al., 1993 (57), RCT	Regenstrief	1990–1991	CPOE/EHR	Inpatient	CPOE on costs and utilization of health care	Efficiency	Utilization of care	12.7% reduction (from \$6964 to \$6077) in total costs per admission; statistically significant decreases in hospital bed, medication, and diagnostic test costs; 0.9-d decrease (from 8.5 to 7.6 d) in length of stay; 33-min increase in physician time spent ordering tests
Wilson et al., 1982 (58), RCT	Regenstrief	NS	EHR	Emergency department	Computer-generated, paper-based patient record summaries on utilization of care vs. usual care (no care summaries)	Efficiency	Utilization of care	Study interrupted by an interval programming error that prevented the previous 4–6 mo of a patient's data from being printed, thus dividing the study into 2 time periods, T1 and T2; 18% decrease (from 3.28 tests/visit to 2.23 tests/visit) in tests ordered for medical visits during T1; 14% decrease (from \$34.91 to \$29.94) in costs; non–statistically significant decrease in tests ordered for surgical visits during T1; no statistically significant difference in utilization or costs during T2
Chen et al., 2003 (59), pre–post study	Brigham and Women's Hospital/Partners Health Care	1995–1999	DS/CPOE	Inpatient	Computerized reminders on rates of inappropriate daily testing of antiepileptic drug levels	Effectiveness/efficiency	Utilization of care	27% decrease (53 of 200 total) in redundant laboratory tests of antiepileptic medication levels; effect of reminders stable over 4 y

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Bates et al., 1999 (60), RCT	Brigham and Women's Hospital/Partners Health Care	1994	DS/CPOE	Inpatient	Computerized reminders on use of laboratory tests, redundant ordering, and associated costs vs. usual care (CPOE without laboratory-related reminders)	Efficiency	Utilization of care	24–percentage point absolute reduction (from 51% to 27%) in redundant tests; 31% of reminders were overridden by physicians; 41% of overrides were justified; 56% of redundant tests ordered in intervention group were not ordered via computer; only 51% of redundant tests ordered in control group were actually performed; estimated cost savings, \$35 000/y (0.15% of total laboratory expenditures)
Shojania et al., 1998 (61), RCT	Brigham and Women's Hospital/Partners Health Care	1996–1997	DS/CPOE	Inpatient	Point-of-care computerized guidelines on antibiotic use vs. usual care (CPOE without antibiotic DS)	Effectiveness	Utilization of care	32% relative decrease (from 16.7 orders/physician to 11.3 orders/physician) in antibiotic orders; both initial and renewal order rates decreased
Fihn et al., 1994 (62), RCT	VA	NS	Administrative/DS	Outpatient	Computerized scheduling system on follow-up time for anticoagulation monitoring vs. usual care	Safety/access/effectiveness	Utilization of care/medication errors	Approximate 6-d increase (from 25 to 31 d) in follow-up appointment interval; no statistically significant differences in anticoagulation levels or complication rates
Steele et al., 1989 (63), RCT	VA	1987–1988	Data summary/DS	Outpatient	Computer-generated, paper-based feedback of medication costs vs. in-person pharmacist counseling on physician prescribing costs	Efficiency	Utilization of care	No statistically significant differences in costs were found with computer-based system vs. pharmacist counseling
<b>Efficiency: time (n = 6)</b>								
Overhage et al., 2001 (64), RCT, time-motion study	Regenstrief	1996–1998	CPOE/EHR	Outpatient	CPOE on physician time utilization	Efficiency	Time utilization	6.2% increase (from 34.2 to 36.3 min) in physician time per clinic visit; physicians continued to use paper despite CPOE, thereby duplicating tasks; with experience there was a non–statistically significant decrease in physician time of approximately 10% (3.7 min) per clinic visit
Kuperman et al., 1996 (65), cross-sectional analysis	Brigham and Women's Hospital/Partners Health Care	1995–1996	DS	Inpatient	Computerized alerts sent via pager on physician response to serious clinical events	Safety/effectiveness	Time to utilization/response	Physicians responded to 70% of alerts (1214 of 1730 alerts) and immediately placed orders in response to 39% of answered alerts; physicians responded to 82.5% of answered alerts (1002 of 1214) in < 15 min

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Kuperman et al., 1999 (66), RCT	Brigham and Women's Hospital/Partners Health Care	1994–1995	DS	Inpatient	Computerized alerts sent via pager on physician response time to critical laboratory results	Safety/ effectiveness	Time to care/safety	38% decrease (from 1.6 to 1.0 h) in median time until treatment ordered; 11% decrease in mean time (from 4.6 to 4.1 h) until treatment; no statistically significant decrease in ADEs
Pizziferri et al., 2005 (67), pre-post, time-motion study	Brigham and Women's Hospital/Partners Health Care	2001–2003	EHR	Outpatient	EHR use on physician time utilization in clinic	Efficiency	Time utilization	0.5-min decrease (from 27.55 to 27.05 min) in clinic visit time; physicians felt EHRs improved quality, access, and communication but negatively affected workload
Wong et al., 2003 (68), pre-post, time-motion study	VA	NS	EHR	Inpatient (ICU)	Computerized documentation on nursing time utilization	Efficiency	Time utilization	10.9–percentage point absolute decrease (from 35.1% to 24.2%) in documentation time; 8.8–percentage point absolute increase (from 31.3% to 40.1%) in time spent on direct patient care
Pierpont and Thilgen, 1995 (69), pre-post study	VA	NS	EHR	Inpatient (ICU)	Effect of computerized nursing documentation on ICU nurses' time utilization and workflow	Efficiency	Time utilization	7–percentage point absolute decrease (from 17% to 10%) in charting time; 3–percentage point decrease (from 7% to 4%) in data-gathering time; 10% of time was spent at computer reviewing data; no change in time spent in patients' rooms

\* ADE = adverse drug event; CCT = controlled clinical trial; CPOE = computerized provider order entry; DS = decision support; EHR = electronic health record; H<sub>2</sub>-blockers = histamine-2-blockers; HIT = health information technology; ICU = intensive care unit; NS = not specified; RCT = randomized, controlled trial; VA = Department of Veterans Affairs.